UNIVAC

VORTEX II
Operating System
Programmer Reference

Mini-Computer Operations

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SPERRY UNIVAC®

VORTEX II OPERATING SYSTEM

Programmer Reference Manual

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UPDATE A

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CHANGE RECORD

Change Designation	Issue Date	Change Description
	1/77	Incorporated Addendum 1 issued August 1976
	4/77	F.1 revision changes (plus additional minor revisions).
	2/78	Deleted References to Varian
Rev. 1	7/79	G.1 (7R1.0) revision changes. Added information pertaining to micro-VORTEX and operation of VORTEX II on the V77-800. Incorporated Addendum 1 issued 11/77, Addendum 2 issued 11/77, and Addendum 3 issued 9/78
Rev. 2	10/79	Miscellaneous editing changes. Replaced system generation information with patch program information (Section 15).
Update A	2/80	Included flexible diskette (F3064) information in Section 18 and other appropriate sections.

Change Procedure:

When changes are made to this manual, updated pages are issued. These updated pages are either added to this manual or used to replace obsolete pages. The specific pages affected by each change are identified on the PAGE STATUS SUMMARY page.

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A degree of programming knowledge and experience is prerequisite to an understanding of this manual.

Previous knowledge of operating systems and experience with SPERRY UNIVAC 620 series or 70 series computer systems would be helpful, but are not prerequisite to understanding the manual.

NOTATION IN THIS MANUAL

In the directive formats given in this manual:

- **Boldface type** indicates an obligatory parameter.
- *Italic type* indicates an optional parameter.
- Upper case type indicates that the parameter is to be entered exactly as written.
- Lower case type indicates a variable and shows where the user is to enter a legal value for that variable.

a(1),a(2),...,a(n).

Indicates a series of elements separated by commas repeated and terminated with a period.

If at least one element is required the first element is given in bold. The parentheses are only part of the format description.

For example

a(1),*a(2)*,...,*a(n)*.

where

each a(i) is a single alphabetic character
allows

A,B,C,F,G,H.

or

Z,Y,X.

or

V.

or

blank

as valid in this position.

A number with a leading zero is octal, one without a leading zero is decimal, and a number in binary is specifically indicated as such.

SECTION 1
INTRODUCTION

SPERRY UNIVAC VORTEX II is a modular software operating system for controlling, scheduling, and monitoring taks in a real-time multiprogramming environment. VORTEX II supports memory map operation to a maximum of 1024K of central memory. VORTEX II also provides for background operations such as compilation, assembly, debugging, or execution of tasks not associated with the real-time functions of the system. The basic features of VORTEX II are:

- Memory map management
- Real-time I/O processing
- Provision for directly connected interrupts
- Interrupt processing
- Multiprogramming of real-time and background tasks
- Overlapping output to peripherals with spooling
- Priority task scheduling (clock time or interrupt)
- Load and go (automatic)
- Centralized and device-independent I/O system using logical unit and file names
- Operator communications
- Batch-processing job-control language
- Program overlays
- Background programming aids: FORTRAN and RPG IV compilers, DAS MR assembler, load-module generator, library updating, debugging, and source editor.
- Use of background area when required by foreground tasks
- Disc/drum directories and references
- System generator
- Individual task protection

NOTE: **Throughout this manual, all references to VORTEX imply VORTEX II.**

1.1 SYSTEM REQUIREMENTS

VORTEX requires the following minimum hardware configuration:

a. SPERRY UNIVAC 70 series computers with 32K memory

b. 33/35 ASR Teletype or compatible CRT on a priority interrupt module

c. Priority Interrupt Module (PIM)

d. Rotating memory device (RMD) on a PIM with either a buffer interlace controller (BIC), block transfer controller (BTC), or direct memory interface.

e. One of the following on a PIM:
   (1) Card reader with a BIC
   (2) Paper-tape system or a paper-tape reader
   (3) Magnetic-tape unit with a BIC

f. Memory map hardware

The system supports and is enhanced by the following optional hardware items:

a. Additional main memory (up to a total of 1024K)

b. Additional rotating memory devices

c. Automatic bootstrap loader with VORTEX II (device dependent) system boot

d. Card reader, if one is not included in the minimum system with BIC and PIM

e. Card punch with BIC and PIM

f. Line printer with BIC and PIM

g. Paper-tape punch, if one is not included in the minimum system

h. Process input and output

i. Data communications multiplexor

j. Electrostatic printer/plotter

k. Writable control store

l. Floating-point processor

m. V75 extended instruction set.

All BICs, BTCs, and DCMs must have memory mapping capability.

The rotating-memory device (RMD) serves as storage for the VORTEX operating system components, enabling real-time operations and a multiprogramming environment for solving real-time and nonreal-time problems. Real-time processing is implemented by hardware interrupt controls and software task scheduling. Tasks are scheduled for

execution by operator requests, other tasks, device interrupts, or the completion of time intervals.

Background processing (nonreal-time) operations, such as FORTRAN compilations or DAS MR assemblies, are under control of the job-control processor (section 4), itself a VORTEX background task. These background processing operations are performed simultaneously with the real-time foreground tasks until execution of the former is suspended, either by an interrupt or a scheduled task.

1.2 SYSTEM FLOW AND ORGANIZATION

VORTEX executes foreground and background tasks scheduled by operator requests, interrupts, or other tasks. All tasks are scheduled, activated, and executed by the real-time executive component on a priority basis. Thus, in the VORTEX operating system, each task has a level of priority that determines what will be executed first when two or more tasks come up for execution simultaneously.

The job-control processor component of the VORTEX system manages requests for the scheduling of background tasks.

Upon completion of a task, control returns to the real-time executive. In the case of a background task, the real-time executive schedules the job-control processor to determine if there are any further background tasks for execution.

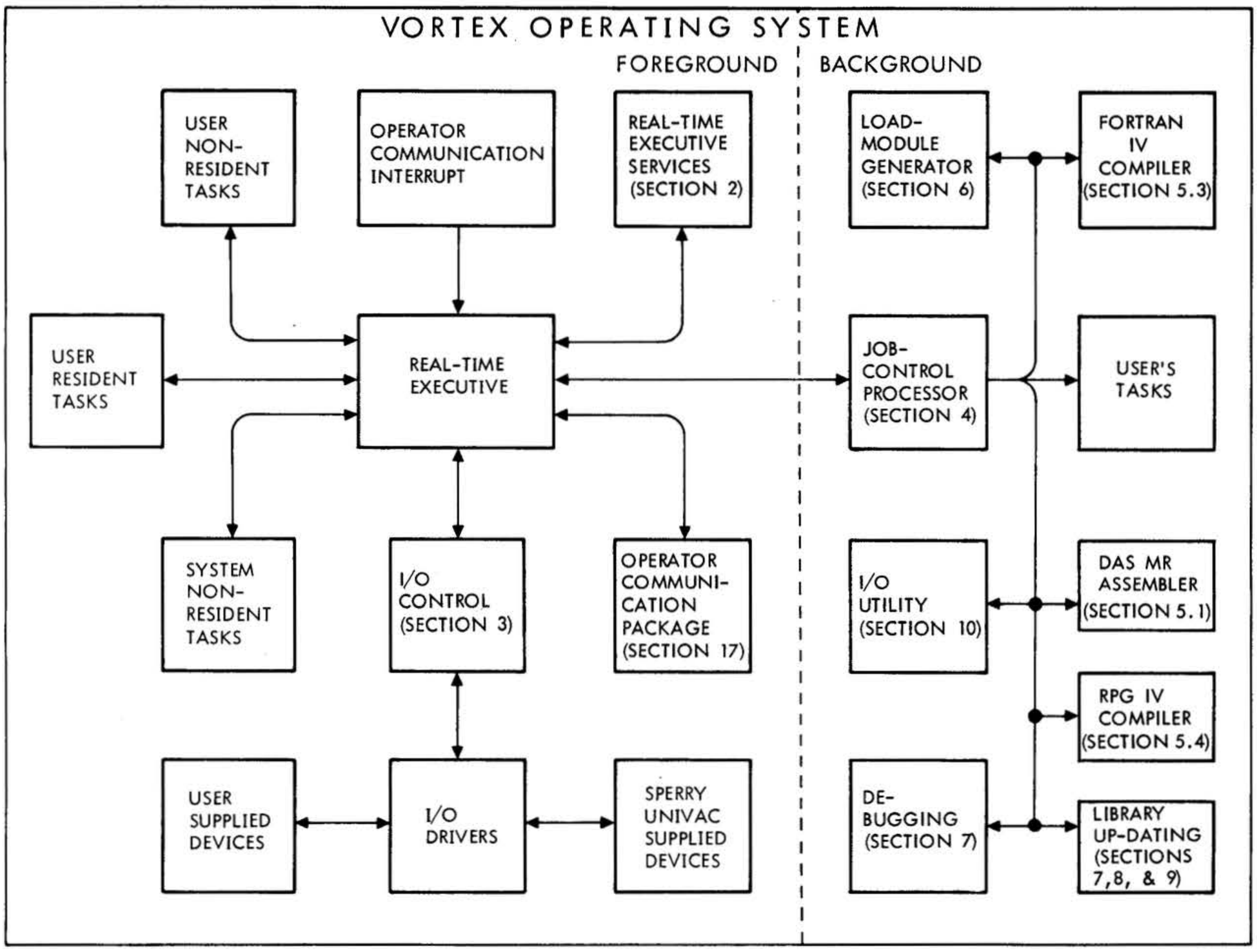
During execution, any foreground task can use any real-time executive service (section 2.1).

Figure 1-1 is an overview of the flow in the VORTEX operating system. Section numbers refer to further discussion of this manual.

1.2.1 Computer Memory

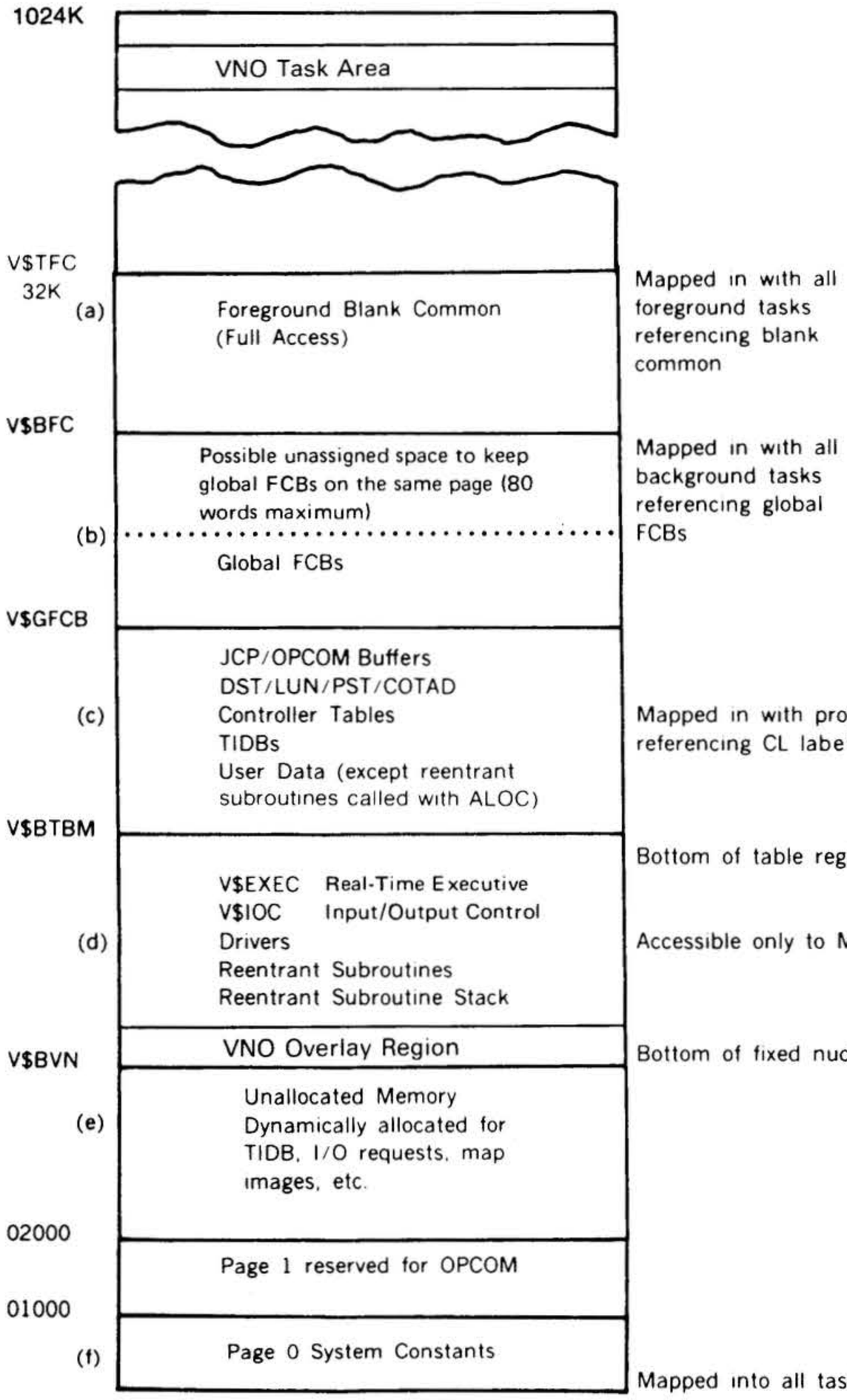
VORTEX requires a minimum of 32K words of main memory and supports up to a maximum of 1024K words.

The system generation (SGEN, section 15) programs execute in a non-memory map environment and consequently utilize only the first physical 32K words of main



VTII-1314

Figure 1-1. VORTEX System Flow



NOTE: VTFC, VBFC, etc. are system pointers in page 0 described in section 14, table 14-1.

NOTE: V$TFC, top of nucleus, is specified on SGEN MRY directive (described in section 15.5.1).

Figure 1-2. VORTEX Nucleus, Map 0

memory. All resident tasks and data reside in the first 32K of logical memory and are considered as part of the VORTEX nucleus. The nucleus is assigned to be in the executive mode, map 0, virtual memory (see section 1.3).

Figure 1-2 illustrates the map 0 nucleus memory layout. The 32K words memory space is grouped into several modules:

a. Foreground Blank Common Module: This module is mapped with all foreground tasks referencing blank common.

b. Global FCB Module: This module is mapped with all background tasks referencing the global FCBs. It is read only access mode for priority 0 tasks and read/write for priority 1 tasks. This module is of approximately 90 words.

c. Nucleus Table Module: This module is mapped with all tasks with an external name defined in the CL library. Read-only access mode for priority 0 tasks and read/write access for all other tasks. The bottom of this module is defined in V$BTBM and is determined by SGEN during the nucleus module building. Control record CTL,21 specifies the end of the nucleus table module. All user data and programs which are to be included in this module must precede the CTL,21 control record. The approximate size of this module is 1000 words (RMD, line printer, card reader, Teletype, CRT).

d. Nucleus Programs Module: This module consists of V$EXEC, V$IOC, I/O drivers, reentrant subroutines, stacks, and any user programs inserted between the CTL,21 and CTL,PART0003 SGEN tasks. The bottom of this module is defined by V$CRDR.

e. Map 0 Allocable Memory Space: The virtual memory space between page two and V$CRDR is available for dynamic allocation. I/O request block, TIDB block, and map image memory space are allocated in this region. Page one is reserved for the OPCOM task. The actual physical memory assigned to the virtual memory space is memory management performed by the RTE component.

f. Page 0: Always reserved for system constants, interrupt traps, and background literal pool (a description is found in section 14, table 14-3).

The unused physical memory in the first 32K and all physical memory above 32K are designated as allocable memory. This is the physical memory which is dynamically allocated for map 0 memory space as described in e, and which is allocated to a user mode task's logical memory.

1.2.2 Rotating Memory Device

At least one RMD (disc or drum) is required for storage of VORTEX operating system components. The RMD is divided into a fixed number of variable-length areas called **partitions**. These are defined at system-generation time (section 15).

The following reside on the RMD (figure 1-3):

a. System initializer, loader, and VORTEX nucleus in absolute format

b. Checkpoint file

c. GO file

d. User library

e. Transient files

f. Relocatable object-module library

g. Relocatable load-module library

1.2.3 Secondary Storage

The VORTEX operating system supports any secondary storage devices that have been specified at system-generation time.

System Initializer and Loader
VORTEX Nucleus in Absolute Format
CL Directory
Relocatable Object-Module Library
Relocatable Load-Module Libraries
Checkpoint File
GO File
User Library
Transient Files

Figure 1-3. VORTEX RMD Storage Map

1.3 MEMORY MAP CONCEPT

VORTEX logical (virtual) memory is defined to be 32K words. This is the maximum memory space that any single task can address, even though the physical memory space may be as great as 1024K words. Where in actual or

physical memory that task resides is transparent to the task and is a memory management function performed by the RTE component of VORTEX.

Each logical memory space (32K) is organized into fixed-size blocks of 512 words (01000 in octal), called logical (virtual) pages. Hence, there are 64 logical pages within a 32K logical memory space. The size of the logical memory available to a task is reduced by:

a. Page 0: The first page of 512 words is reserved for system constants, interrupt trap locations, background literal pool and communication link for IOC and V$EXEC calls. This page is mapped in all logical memories.

b. Nucleus Modules: A task referencing an external name which is defined in the CL library will have the corresponding VORTEX nucleus module mapped in logical memory for a task. (Section 1.2.1 describes in greater detail the nucleus modules.) These are:
   (1) Foreground blank common module.
   (2) Global FCB module, and/or
   (3) Nucleus table module

c. Any FORTRAN program performing input/output operation will have the nucleus table module mapped into its virtual memory. FORTRAN runtime package requires access to the device specification table (DST), logical unit tables (LUT), and controllers tables for linking information. The maximum available logical memory space available is V$BTBM (bottom of nucleus table module, location 0331) minus 01000 (program start logical address). V$BTBM is defined on the SGEN listing.

d. **This paragraph does not apply to micro VORTEX systems.** For background priority 1 tasks, page 0 is set to read/write access mode to permit tasks, e.g., JCP, to modify low memory pointers V$JCFG, V$CRDM, etc. Hence, the method of transferring control from user mode to executive mode for I/O and RTE calls is to map in the pages containing the entry to V$IOC (I/O calls), V$EXEC (RTE calls), and V$IOST (STAT calls). Therefore a priority 1 task making an I/O call (or RTE call, or STAT call), executes a JSR,X to location 0404. Because page 0 is set to read/write access mode, the instruction at 0404 (JMP V$IOC) is executed. The first instruction in V$IOC (likewise, V$EXEC and V$IOST) is a disable PIM (EXC 0444) instruction. Execution of an I/O type instruction in the user map generates a memory-protection interrupt, which forces the system to the executive mode and hence the means of transferring control to the map 0 tasks. Therefore, the available memory space for a background task is from location 01000 to the page where V$IOC (which is lower in memory than V$EXEC) resides. V$IOC address is defined on the SGEN output listing.

All user mode tasks are loaded from logical address 01000. A task not referencing external names defined in the CL library has all of the logical memory available to it except page 0.

Physical memory is also organized into fixed-size blocks of 512 words, referred to as physical pages. A system with physical memory size of 256K words contains 512 physical pages (64 physical pages for each 32K words of memory).

Allocation of logical memory to physical memory is accomplished by pages. A task of 010000 (4096 in decimal) words will reside in eight physical pages of physical memory. These physical pages need not be contiguous. However, that fact is transparent to the task. During execution, the task assumes that its eight pages are contiguous. The linking of physical pages is performed by the memory map hardware. All user program object modules are assembled relative to location 0. Load modules are generated by SGEN and LMGEN to be relative to logical address 01000.

A map defines the 64 logical pages within a logical memory. Each logical page can be set to one of four possible access modes:

Unassigned	The logical addresses within that virtual page are unassigned.
Read/Write	All accesses including write operation permitted to/from the logical page.
Read Operand Only	Only operand fetches permitted from the logical page.
Read Only	Only instruction or operand fetches permitted within the logical page.

Each logical page, except for the pages with unassigned status, must be assigned to a physical page. The RTE task sets the status for each page, allocates a physical page to each logical page, and loads the corresponding mapping registers.

The memory map hardware provides a 4-bit map register for the 16 possible maps. This 4-bit map register is set by the RTE component to select the proper map (0-15). Map 0 is defined as the executive mode. All other map selections (1-15) are designated as being in the user mode. However, when the system is forced to the executive mode, state 0, by an I/O, real-time, or memory map interrupt, the map register will continue to contain the currently executing user map selection number.

Executive Mode

All instructions except HALT are permitted in this mode. Any interrupt will force the hardware to enter this mode in executive mode state 0. The interrupt will not disable the map. VORTEX Real-Time Executive (RTE), Input/Output Control (IOC), I/O drivers, and other resident tasks and constants are mapped into the executive mode. The instructions and data which comprise the VORTEX nucleus are mapped in the executive mode. Any task executing I/O instructions (EXC, OAR, SEN, etc.) must execute in map 0.

A HALT instruction executed in the executive mode with the map enabled will generate an interrupt. The HALT is permitted only in the disabled map state.

There are four executive modes states as shown in table 1-1. A map 0 task will normally execute in state 0. In state 0, all instruction fetches and operand fetches and stores are performed in map 0 logical memory. If a map 0 task must fetch and store data to or from a user map (1-15), the map 0 task must switch to the proper executive mode state (1, 2 or 3), then upon completion of the fetch or store, restore the executive mode to state 0. A convenient way of switching executive or mode states is to output one of the control words established by the RTE component in the page 0 system data region, locations 0334-0337: V$ST0, V$ST1, V$ST2, and V$ST3 for executive mode states 0 through 3 respectively. An example of switching to executive mode 3 is OME 046, V$ST3, where 046 is the memory-map device address.

Table 1-1. Executive Mode States

State	Instruction Fetch	Operand Fetch	Store
0	MAP 0	MAP 0	MAP 0
1	MAP 0	MAP 0	*MAP N
2	MAP 0	MAP N	MAP 0
3	MAP 0	MAP N	MAP N

+MAP 0 refers to the executive task map.
*MAP N refers to the task map specified by the map register. (n = 1-15)

User Mode

All operands and instructions are mapped in accordance with the map register contents. Error conditions will cause interrupts, which force the system to the executive mode. User mode is entered from the executive mode under control of RTE.

Privileged instructions (e.g., EXC, HALT) are not permitted in this mode. An interrupt is generated if a task attempts to execute a privileged instruction. Foreground tasks may execute disable and/or enable PIMS and RT clock instructions (EXC 0444, EXC 0244, EXC 0147, EXC 0747). Section 14.4.4 describes this subject further.

Section 2.2, RTE System Flow, describes the user mode and executive mode tasks.

1.4 BIBLIOGRAPHY

The following Sperry Univac manuals are pertinent to the use of VORTEX and the 70/620 series computers:

Title	Document Number
FORTRAN IV (VORTEX) Reference Manual	UP-8671
HASP/RJE Operator's Manual	UP-8675
VTAM Reference Manual	UP-8676
TOTAL Reference Manual	UP-8679
RPG II Reference Manual	UP-8680
COBOL Reference Manual	UP-8681
TSS Reference Manual	UP-8753
Assembly Language Reference Manual	UP-8682
VIDEO Reference Manual	UP-8683
V70 Architecture Reference Manual	UP-8634
VORTEX II System Generation User Guide/Programmer Reference	UP-9083

Note: The VORTEX II System Generation User Guide/Programmer Reference UP-9083 contains information previously found in VORTEX II Installation Manual (98A 9952 25x).

SECTION 2
REAL-TIME EXECUTIVE SERVICES

The VORTEX **real-time executive (RTE) component** processes, upon request by a task, operations that the task itself cannot perform, including those involving linkages with other tasks. RTE **service requests** are made by macro calls to V$EXEC, followed by a parameter list that contains the information required to process the request.

The contents of the volatile A and B registers and the setting of the overflow indicator are saved during execution of any RTE macro. After completion of the macro, these values are returned. The contents of the X register are lost. If the task uses the V75 registers 3 through 7, the contents of R3 through R7 are also saved.

There are 32 priority levels in the VORTEX system, numbered 0 through 31. Levels 0 and 1 are for background tasks and levels 2 through 31 are for foreground tasks. If a background task is assigned a foreground priority level, or vice versa, the task automatically receives the lowest valid priority level for the correct environment. Lower numbers assign lower priority. If more than one task has the same priority level, they are selected for execution on a first-in, first-out basis. Background and foreground RTE service requests are similar.

Certain RTE service request macros are illegal in unprotected background (level 0) tasks. Table 2-1 lists the RTE macros, indicates whether they are legal in level 0 tasks, and indicates whether there is a FORTRAN library subroutine (Section 13) provided.

Table 2-1. RTE Service Request Macros

Mnemonic	Description	Level 0	FORTRAN
SCHED	Schedule a task	Yes	Yes
SUSPND	Suspend a task	Yes	Yes
RESUME	Resume a task	No	Yes
DELAY	Delay a task	No	Yes
LDELAY	Delay and reload from specified logical unit	No	Yes
PMSK	Store PIM mask register	No	Yes
TIME	Obtain time of day	Yes	Yes
OVLAY	Load and/or execute an overlay segment	Yes	Yes
ALOC	Allocate a reentrant stack	No	Yes
DEALOC	Deallocate the current reentrant stack	No	No
EXIT	Exit from a task (upon completion)	Yes	Yes
ABORT	Abort a task	No	Yes
IOLINK	Link background I/O	Yes	No
PASS	Pass map 0 data	Yes	Yes
TBEVNT	Set/fetch task's TBEVNT	Yes	No
ALOCPG	Allocate memory page(s) (Priority 0 in map 0)	Yes	No
DEALPG	Deallocate memory page(s) (Priority 0 in map 0)	Yes	No
MAPIN	Map in specified memory page(s)	No	No
PAGNUM	Identify physical page number	Yes	No
RECOV	Pass address of recovery routine	Yes	No
AFAUT	Arithmetic fault setup	Yes	No
SRFAULT	Save/restore arithmetic fault status	Yes	No
SETPAR	Set parity enable	Yes	No

Whenever a task is aborted, all currently active I/O requests are completed. Pending I/O requests are de-queued. Only then is the aborted task released.

Note: A **task name** comprises one to six alphanumeric characters (including $), left-justified and filled out with blanks. Embedded blanks are not permitted.

2.1 REAL-TIME EXECUTIVE MACROS

This section describes the RTE macros given in table 2-1.

The general form of an RTE macro is

label **mnemonic**,*p(1)*,*p(2)*,...,*p(n)*

where

label permits access to the macro from elsewhere in the program

mnemonic is one of those given in table 2-1

each *p(n)* is a parameter defined under the descriptions of the individual macros

The omission of an optional parameter is indicated by retention of the normal number of commas unless the omission occurs at the end of the parameter string. Thus, in the macro (section 2.1.1)

```
SCHED      8,,106,,'TA','SK','A'
```

the first double comma indicates a default value for the wait option and the second double comma indicates omission of a protection code.

Error messages applicable to RTE macros are given in Appendix A.2.

2.1.1 SCHED (Schedule) Macro

This macro schedules the specified task to execute on its designated priority level. The scheduling task can pass two values in the A and B registers to the scheduled task (a task using the V75 registers 3 through 7 can also pass parameters in R3 through R7). A TIDB is created for each scheduled task, (see section 14 for a description of TIDB). The macro has the general form.

label **SCHED level,** wait, **lun,** *key,* **'xx','yy','zz',***f,t*

where

level is the value from 0 (lowest) to 31 (highest) of the priority level of the scheduled task

wait is 0 (default value) if the scheduling and scheduled task obtain CPU time based on priority levels and I/O activity, or 1 if the scheduling task is suspended until completion of the scheduled task

lun is the name or number of the logical unit whose library contains the scheduled task.

key is the protection code, if any, required to address **lun** (0306 or 'F' to schedule a nonresident task from the foreground library). The foreground library logical unit and its protection key are specified by the user at system-generation time

xxyyzz is the name of the scheduled task in six ASCII characters, coded in pairs between single quotation marks and separated by commas; e.g., the task named BIGJOB is coded 'BI','GJ','OB' and the task named ZAP is coded 'ZA','P',' '

f is 1 if the TIDB address of the scheduled task is to be returned in the A register, or 0 (default value) if the original value is to be returned.

t V77-800 only. If $t = 1$, the scheduled task will be executed in trace mode. If $t = 0$ (default), the scheduled task will not be executed in trace mode.

The FORTRAN calling sequence for this macro is

CALL SCHED(level,*wait***,lib,***key***,name)**

where **lib** is the number of the library logical unit containing the task, and **name** is the three-word Hollerith array containing the name of the scheduled task. The other parameters have the definitions given above.

All tasks are activated at their entry-point locations, with the A and B registers (and the V75 registers if available) containing the value to be passed. The scheduled task executes when it becomes the active task with the highest priority.

The specified logical unit (which can be a background library, a foreground library, or any user-defined library on an RMD) must be defined in the schedule-calling sequence.

Expansion: The task name is loaded two characters per word. The wait option flag is bit 12 of word 2 (w). The scheduled task TIDB address flag is bit 13 of word 2 (f). Bit 15 of word 2 is a flag used to indicate TRACE mode execution on V77-800 systems.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2	t	X	f	w	0	0	0	0	0	1	level					
Word 3	key									lun						
Word 4	Task name															
Word 5	Task name															
Word 6	Task name															

Examples: Schedule the foreground library task named TSKONE on priority level 5. Use the no-wait option so that scheduled and scheduling tasks obtain Central-Processor-Unit (CPU) time based on priority levels and I/O activity.

```
FL      EQU     106     (LUN assigned to
                        foreground library FL)
KEY     EQU     0306    (Protection code
                        for FL)
        .
        .
        .
SCHED   5,0,FL,KEY,'TS','KO','NE'
        .               (Control return to
        .               highest priority)
        .
```

Note: the KEY line can be coded with the equivalent ASCII character enclosed in single quotation marks.

```
KEY     EQU     'F'
```

The same request in FORTRAN is

```
DIMENSION N1,N2(3)
DATA N1/2H F/
DATA N2(1),N2(2),N2(3)/2HTS,2HKO,2HNE/
CALL SCHED(5,0,106,N1,N2)
```

or

```
CALL SCHED(5,0,106,2H F,6HTSKONE)
```

The following restrictions must be noted when using the ;SCHED macro:

- A foreground task may only schedule another foreground task (priority 2 through 31).
- A priority 0 background task can only schedule another priority 0 task.
- A priority 1 background task can schedule a task at any priority 0 through 31.

2.1.2 SUSPND (Suspend) Macro

This macro suspends the execution of the task initiating the macro. The task can be resumed only by an external interrupt, a simulated interrupt caused by IOC or I/O completion events for the task, or a RESUME (section 2.1.3) macro. The macro has the general form

lable **SUSPND** **susp**

where **susp** is 0 if the task is to be resumed by RESUME or 1 if the task is to be resumed by external interrupt, or 2 if the task is to be resumed by external interrupt or by IOC or I/O completion events via a simulated interrupt (i.e., TBEVNT word in task's TIDB is set to 1).

The FORTRAN calling sequence for this macro is

CALL SUSPND(susp)

Expansion: The **susp** flag is bit 0 of word 2 (s).

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	0 0 0 0 1 1 s

Example: Suspend a task from execution. Provide for resumption of the task by interrupt, which reactivates the task at the location following SUSPND.

```
SUSPND    1
```

The same request in FORTRAN is

```
CALL SUSPND (1)
```

2.1.3 RESUME Macro

This macro resumes a task suspended by the SUSPND macro. The RESUME macro also activates a task suspended by a type 2 or type 3 DELAY request. The RESUME macro has the general form

label **RESUME** **'xx','yy','zz'**

where **xxyyzz** is the name of the task being resumed, coded as in the SCHED macro (section 2.1.1).

The RTE searches for the named task and activates it when found. The task will execute when it becomes the task with the highest active priority. If the priority of the specified task is higher than that of the task making the request, the specified task executes before the requesting task and immediately if it has the highest priority.

The FORTRAN calling sequence for this macro is

CALL RESUME(name)

where **name** is the three-word Hollerith array containing the name of the specified task.
Expansion: The task name is loaded two characters per word.

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	0 0 0 1 0 0
Word 3	Task name
Word 4	Task name
Word 5	Task name

Example: Resume (reactivate) the task TSKTWO, which will execute when it becomes the task with the highest active priority.

```
RESUME    'TS','KT','WO'
```
(Control return)

Control returns to the requesting task when it becomes the task with the highest active priority. Control returns to the location following RESUME.

The same request in FORTRAN is

```
DIMENSION N1(3)
DATA N1(1),N1(2),N1(3)/2HTS,2HKT,2HWO/
CALL RESUME(N1)
```

or

```
CALL RESUME(6HTSKTWO)
```

2.1.4 DELAY Macro

This macro suspends the requesting task for the specified time, which is given in two increments. The first increment is the number of 5-millisecond periods, and the second, the number of minutes. The macro has the general form

label **DELAY** **milli**,*min*,*type*

where

milli is the number of 5-millisecond increments delay

min is the number of minutes delay

type is 0 (default value when the task is to be suspended for the specified delay, remain in memory, and automatically resume following the DELAY macro

1 when the task is to exit from the system, relinquishing memory, and

after the specified delay, be automatically rescheduled and reloaded in a elapsed time mode, or

2 when the task is to resume automatically after the specified delay or upon receipt of an external interrupt whichever comes first, and automatically resume following the DELAY macro; or

3 when the task is to resume automatically after the specified delay, or upon receipt of an external interrupt, or completion of an I/O request initiated previously, whichever comes first, and automatically resume following the DELAY macro.

IOC resumes execution of the task by setting the TBEVNT word in the task's TIDB to 1.

The FORTRAN calling sequence for this macro is

CALL DELAY(milli,min,type)

where the integer-mode parameters have the definitions given above.

The maximum value for either **milli** or *min* is 32767. Any such combination given the correct sum is a valid delay definition; e.g., for a 90-second delay, the values could be 6000 and 1, respectively, or 18000 and 0. After the specified delay, the task becomes active. When it becomes the highest-priority active task, it executes.

Note that the resolution of the clock is a user-specified variable having increments of 5 milliseconds. The time interval given in a DELAY macro must be equal to or greater than the resolution of the clock. The delay interval is stored in minute increments and real-time clock resolution increments.

Expansion: The **type** flag is bits 0 and 1 of word 2.

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2					0	0	1	0	0	1						type
Word 3	milli															
Word 4	min															

Examples: Assuming a 5-millisecond clock increment, delay the execution of a task for 90 seconds. At the end of this time, the task becomes active. When it becomes the highest-priority task, it executes.

```
DELAY       6000,1
```

Delay the execution of a task for 90 seconds or until receipt of an external interrupt, whichever comes first, at which time the task becomes active. Such a technique can test devices that expect interrupts within the delay period.

```
DELAY       18000,0,2
```

Delay the execution of a task for 90 seconds, or until receipt of an external interrupt, or the completion of a previously initiated I/O request, whichever comes first.

```
DELAY       18000,0,3
```

2.1.5 LDELAY Macro

This macro is a type 1 DELAY macro with additional parameters to specify the logical unit from which the task is to be reloaded after the delay. The macro has the general form:

label **LDELAY** **milli,***min***,lun,key**

where

milli is the number of 5-millisecond increments delay

min is the number of minutes delay

lun is the number of the logical unit from which the task is to be loaded after the delay (DELAY tape 1 reloads from FL library)

key is the protection code for the logical unit

The FORTRAN calling sequence for this macro is

CALL LDELAY (milli,min,lun,key)

where the integer-mode parameters have the definitions given above.

Time is the same as specified for DELAY.

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2					0	0	1	0	0	1				1	1	1
Word 3	milli															
Word 4	min															
Word 5	key										lun					

Example: Assuming a 5-millisecond clock increment, delay the execution of a task for 90 seconds. At the end of this time, the task becomes active. When it becomes the highest priority task, it is loaded from logical unit 128 which has protection key A, and executed.

```
LDELAY      6000,1,128,0301
```

2.1.6 PMSK (PIM Mask) Macro

This macro redefines the PIM (priority interrupt module) interrupt structure, i.e., enables and/or disables PIM interrupts. The macro has the general form

label **PMSK** **pim,mask**,*opt*

where

pim is the number (1 through 8) of the PIM being modified

mask indicates the changes to the mask, with the bits indicating the interrupt lines that are either to be enabled or disabled, depending on the value of *opt*, and with the other lines unchanged

opt is 0 (default value) if the set bits in **mask** indicate newly enabled interrupt lines, or 1 if the set bits in **mask** indicate newly disabled interrupt lines

The FORTRAN calling sequence for this macro is

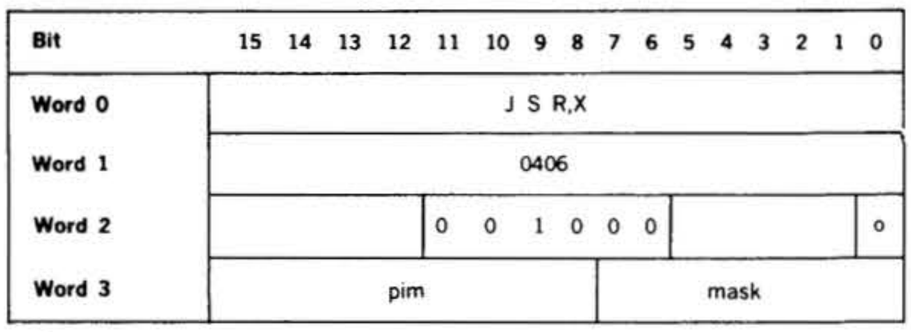
CALL PMSK(pim,mask,opt)

where the integer-mode parameters have the definitions given above.

The eight bits of the mask correspond to the eight priority interrupt lines, with bit 0 corresponding to the highest-priority line.

VORTEX operates with all PIM lines enabled unless altered by a PMSK macro. Normal interrupt-processing allows all interrupts and does one of the following: a) posts (in the TIDB) the interrupt occurrence for later action if it is associated with a lower-priority task, or b) immediately suspends the interrupted task and schedules a new task if the interrupt is associated with a higher-priority task. PMSK provides control over this procedure.

Note: VORTEX (through system generation) initializes all undefined PIM locations to nullify spurious interrupts that may have been inadvertently enabled through the PMSK macro.



Examples: Enable interrupt lines 3, 4, and 5 on PIM 2. Leave all other interrupt lines in the present states.

```
PMSK        2,070
```

The same request in FORTRAN is

```
CALL PMSK(2,56,0)
```

Disable the same lines.

```
PMSK        2,070,1
```

2.1.7 TIME Macro

This macro loads the current time of day in the A and B registers with the B register containing the minute, and the A register the 5-millisecond, increments. The macro has the form

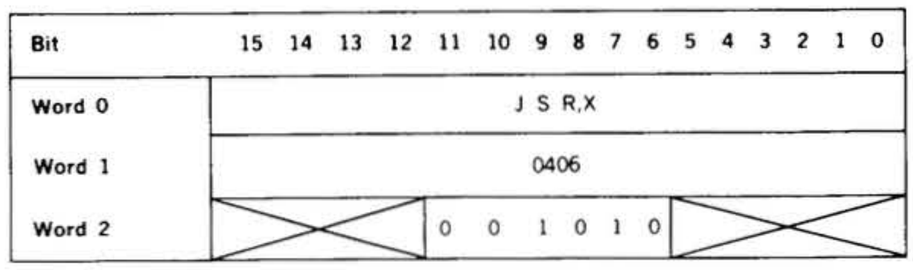
label **TIME**

The FORTRAN calling sequence for this macro is

CALL TIME(min,milli)

where **min** is the integer minutes to the 24 hour total, and **milli** is the seconds in 5-millisecond integer increments.

Expansion:



Example: Load the current time of day in the A (5-millisecond increments) and B (1-minute increments) registers.

```
TIME
(Return with time in A
and B registers)
```

2.1.8 OVLAY (Overlay) Macro

This macro loads and/or executes overlays within an overlay-structured task. It has the general form

label **OVLAY** *type,'xx','yy','zz'*

where

type is 0 (default value) for load and execute, or 1 for load and return following the request. If only load is specified, the load address is returned in the X register.

xxyyzz is the name of the overlay segment, coded as in the SCHED macro (section 2.1.1)

The FORTRAN calling sequence for this macro is

```
CALL        OVLAY(type,reload,name)
```

where **type** is a constant or name whose value has the definition given above, **reload** is a constant or name with the value **zero** to load or non-zero to load only if not currently loaded, and **name** is a three-word Hollerith array containing the overlay segment name.

FORTRAN overlays must be subroutines if called by a FORTRAN call.

Expansion: The overlay segment name is loaded two characters per word. The **type** flag is bit 0 of word 2 (t).

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2	X				0	0	1	0	1	1	X					t
Word 3	Overlay segment name															
Word 4	Overlay segment name															
Word 5	Overlay segment name															

When the load and execute mode is selected in the OVLAY macro RTE executes an equivalent of a root segment JSR instruction to enter the overlay segment. Therefore, the return address of the root segment is available to the overlay segment in the X register.

Example: Find, load, and execute overlay segment OVSG01 without return.

```
OVLAY       0,'OV,'SG','01'
            (No return)
```

The same request in FORTRAN is

```
DIMENSION N1(3)
DATA N1(1),N1(2),N1(3)/2HOV,2HSG,2H01/
CALL OVLAY(0,0,N1)
```

or

```
CALL OVLAY(0,0,6HOVSG01)
```

External subprograms may be referenced by overlays. If a subprogram S is called in several overlays, and S is not in the main segment, each overlay will be built with a separate copy of S.

When using FORTRAN overlays containing I/O statements for RMD files defined by CALL V$OPEN or CALL V$OPNB statements (described in section 5.3.2), the main segment must contain an I/O statement so that the runtime I/O program (V$FORTIO) will be loaded with the main segment. FCB arrays must be in the main segment or in common, so they are linked in memory and cannot be in any overlay.

2.1.9 ALOC (Allocate) Macro

This macro allocates space of variable length from dynamic memory for reentrant subroutines. The macro has the general form

```
label       ALOC        address
```

where **address** is the address of the reentrant subroutine to be executed.

The FORTRAN calling sequence for this macro is

```
EXTERNAL    subr
CALL        ALOC(subr)
```

where **subr** is the name of the DAS MR assembly language subroutine.

The address of the assigned block for the current task is contained in V$CRS. The first word of the reentrant subroutine, whose address is specified in the general form of ALOC, contains the number of words to be allocated. If fewer than five words are specified, five words are allocated.

Control returns to the location following ALOC when a DEALOC macro (section 2.1.10) is executed in the called subroutine. Between ALOC and DEALOC, (1) subroutine cannot be suspended, (2) no IOC calls (section 3) can be made, and (3) no RTE service calls can be made.

Reentrant subroutines are normally included in the resident library at system-generation time so they can be concurrently accessed by more than one task. The maximum size of the push-down stack is also defined at system-generation time.

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2	X				0	0	0	1	1	0	X					
Word 3	Reentrant subroutine address															

Reentrant subroutine: The reentrant subroutine called by ALOC contains, in entry location x, the number of words to be allocated. Execution begins at x + 1. The reentrant subroutine returns control to the calling task by use of a DEALOC macro.

The reentrant stack is used to store register contents and allocate temporary storage needed by the subroutine being called. The location V$CRS contains a pointer to word 0 of the current allocation in the stack. By loading the value of the pointer into the X (or B) register, temporary storage cells can be referenced by an assembly language M field of 5,1 for the first cell; 6,1 for the second; etc.

A stack allocation generated by the ALOC macro has the format:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	Contents of the A register															
Word 1	Contents of the B register															
Word 2	Contents of the X register															
Word 3	ovfl	Contents of the P register														
Word 4	Stack control pointer (for RTE use only)															
Word 5 . . . Word n	For reentrant subroutine use (temporary storage)															
Words n+1 to n+5	V75 registers 3-7															

where ovfl is the overflow indicator bit.

The current contents of the A and B registers are stored in words 0 and 1 of the stack and are restored upon execution of the DEALOC macro. The same procedure is used with the setting of the overflow indicator bit in word 3 of the stack. The contents of word 2 (X register) point to the location of the reentrant subroutine to be executed following the setting up of the stack. The contents of word 3 (bits 14-0) point to the return location following ALOC.

Example: Allocate a stack of six words. Provide for deallocation and returning of control to the location following ALOC.

```
        EXT     SUB1
        ALOC    SUB1
                (Return Control)
        .
        .
NAME    SUB1
SUB1    DATA    6
        .
        .
        .
        DEALOC
        END
```

Each time SUB1 is called, six words are reserved in the reentrant stack. Each time the reentrant subroutine makes a DEALOC request (section 2.1.10), six words are deallocated from the reentrant stack. If the calling task uses the V75 registers, 11 words are allocated/deallocated.

2.1.10 DEALOC (Deallocate) Macro

This macro deallocates the current reentrant stack, restores the contents of the A and B (and V75) registers and the setting of the overflow indicator to the requesting task, and returns control to the location specified in word 3 (P register value) of the reentrant stack (section 2.1.9). This macro is used to return from a reentrant subroutine called via an ALOC macro. The DEALOC macro has the form

label **DEALOC**

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2					0	0	0	1	1	1						

Example: Release the current reentrant stack, restore the contents of the volatile registers and the setting of the overflow indicator and return control to the location specified in word 3 of the stack.

```
        .
        .
        .               (Reentrant subroutine)
        DEALOC
        END
```

2.1.11 EXIT Macro

This macro is used by a task to signal completion of that task. The requesting task is terminated upon completion of its I/O. The macro has the form

label **EXIT**

The FORTRAN calling sequence (no parameters specified) is

CALL EXIT

If the task making the EXIT is in unprotected background memory, the macro schedules the job-control processor (JCP) task (section 4).

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0406															
Word 2					0	0	0	0	1	0						

Example: Exit from a task. The task making the EXIT call is terminated upon completion of its I/O requests.

```
        .
        .
        .
        EXIT            (No return)
```

2.1.12 ABORT Macro

This macro aborts a task. Active I/O requests are completed, but pending I/O requests are dequeued. The macro has the general form

label **ABORT** **'xx','yy','zz'**

where **xxyyzz** is the name of the task being aborted, coded as in the SCHED macro (section 2.1.1).

The FORTRAN calling sequence for this macro is

CALL ABORT(name)

where **name** is the three-word Hollerith array containing the name of the task being aborted.

Expansion: The task name is loaded two characters per word.

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	0 0 0 1 0 1
Word 3	Task name
Word 4	Task name
Word 5	Task name

Example: Abort the task TSK and return control to the location following ABORT.

```
          .
          .
          .
ABORT     'TS','K','  '
          .       (Control return)
          .
          .
```

The same request in FORTRAN is

```
DIMENSION N1(3)
DATA N1(1),N1(2),N1(3)/2HTS,2HK ,2H  /
CALL ABORT(N1)
```

or

```
CALL ABORT(6HTSK    )
```

2.1.13 IOLINK (I/O Linkage) Macro

This macro enables background tasks to pass buffer address and buffer size parameters to the system background global FCBs. It has the general form

label **IOLINK** **lungsd,bufloc,***bufsiz*

where

lungsd is the logical unit number of the global system device

bufloc is the address of the input/output buffer

bufsiz is the size of the buffer (maximum and default value: 120

Global file control blocks: There are eight global FCBS (section 3.5.11) in the VORTEX system reserved for background use. System background and user programs can reference these global FCBs. JCP directive /PFILE (section 4.2.11) stores the protection code and file name in the corresponding FCB before opening/rewinding the logical unit. The IOLINK service request passes the buffer address and the size of the record to the corresponding logical-unit FCB. The names of the global FCBs are *SIFCB*, *PIFCB*, *POFCB*, *SSFCB*, *BIFCB*, *BOFCB*, *GOFCB*, and *LOFCB*, where the first two letters of the name indicate the logical unit.

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	0 0 1 1 0 0 lungsd
Word 3	bufloc
Word 4	bufsiz

Example: Pass the address and size specifications of a 40-word buffer at address BUF to the PI global FCB.

```
PI        EQU       4
          EXT       PIFCB
          .       (PI logical-unit number 4)
          .
          .
          IOLINK    PI,BUF,40
          READ      PIFCB,P1,0,1
          .       (Read 40 ASCII words
                    from PI)
          .
          .
BUF       BSS       40
          END
```

If the PI file is on an RMD, reassign the PI to the proper RMD partition, and then position the PI file using JCP directive /PFILE.

2.1.14 PASS Macro

This macro fetches map 0 data into the user map. It has the general form

label **PASS** **count,from,to**

where

count is the number of words to be passed

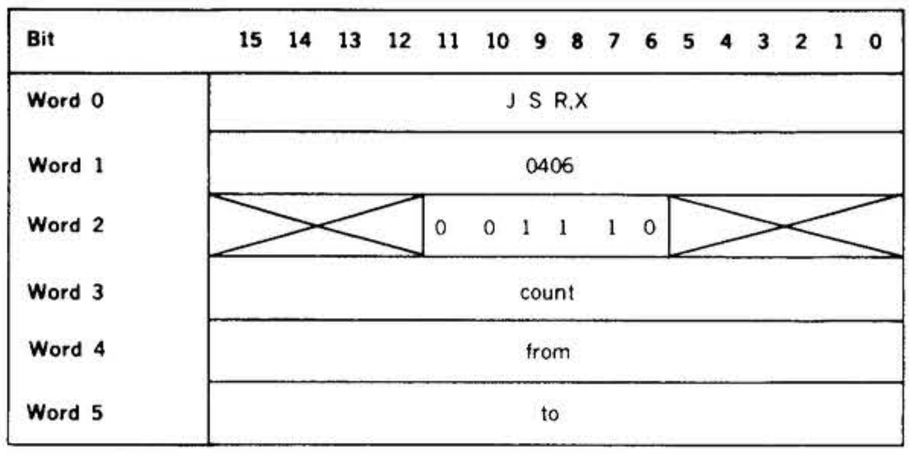
from is the map 0 fetch address

to is the user map store address

The FORTRAN calling sequence for this macro is:

CALL PASS(count,from,to)

Expansion:



If a negative or zero word count is specified, an EX16 error message is posted and the task aborted. Any memory protection violation will result in an EX20-EX25 error message.

Example: Pass the TIDB information into PBUF

```
V$CTL  EQU   0300

       LDA   V$CTL     (Get TIDB address)
       STA   P1+4
P1     PASS  29,*,PBUF
       .
       .
       .
PBUF   BSS   29
       END
```

2.1.15 TBEVNT (Set or Fetch TBEVNT) Macro

This macro fetches or sets the requesting task's event word, TBEVNT, word 3 of the TIDB. It can also be used to change other words in the TIDB. However, most changes to entries in the TIDB could cause irrecoverable errors, so the TBEVNT macro should be used only with caution. Section 14 gies information about the format and contents of the TIDB.

This macro has the general form

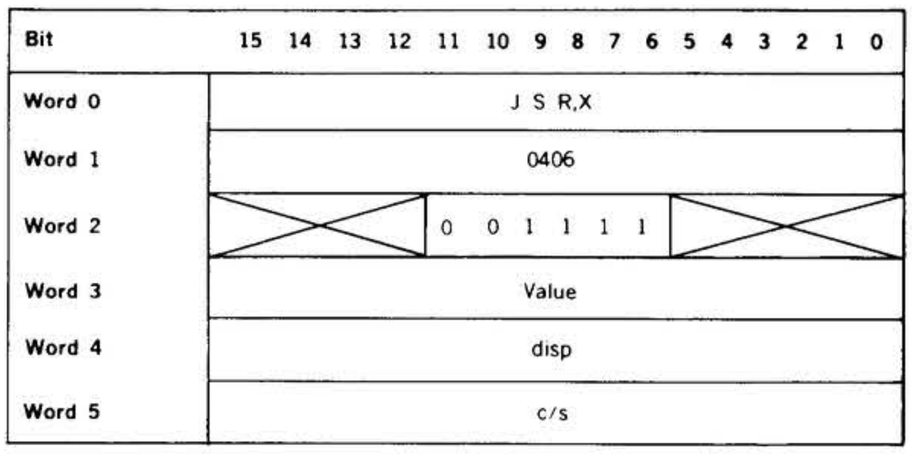
label **TBEVNT** **value,***disp,c/s*

where

value is a value or bit mask for the specified TIDB word. If *disp* is 0, and **value** is in the range 0 - 0177776, the TBEVNT word will be changed. A value of 0177777 fetches the TBEVNT contents into the A register. If *disp* is not zero, it sets or resets (depending on *c/s*) the word specified by *disp*.

disp is the displacement of the word in the TIDB to be set or reset, or 0 for TBEVNT (word 3). The default is 0.

c/s is the clear or set indicator. If *disp* is not 0, *c/s* = 0 for clear (the zero bits of the **value** indicate the bits of the specified word to be set to 0) and 1 for set (the one bits in **value** indicate the bits to be set to 1). Default is 0.



Default values: *disp* = 0 *c/s* = 0

Example: Save the value of TBEVNT in TEMP then set TBEVNT to 02.

Example: Reset TBPL (word 2 of TIDB) bit 8; and then, set it again.

2.1.16 ALOCPG (Allocate Memory Pages) Macro

This macro allocates in physical pages from the pool of available pages to logical pages starting at the specified logical address, modulo 01000. The logical pages to be mapped must not have been previously assigned. The logical pages are assigned as read/write access mode. If an

error condition occurs, an EX27 error message is output and the task resumes operation at the specified reject address. The general form is

label **ALOCPG n,logical addr,reject addr**

where

n is the number of pages to be allocated

logical addr is the logical address, modulo 01000, where the n pages are allocated. If the logical address is negative (1's complement) the address is assumed to be in map 0. If the logical address is positive, the address is assumed to be the requestor's map. Priority zero tasks cannot allocate memory in map 0.

reject addr is the error return address when a task exits or is aborted all ALOEPG pages are automatically deallocated.

Expansion:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	0 1 0 0 0 0
Word 3	n
Word 4	logical addr
Word 5	reject addr

Example: Allocate 4 pages of memory to the requesting task's virtual memory starting at logical address 06000. If error, go to ERR01.

```
          ALOCPG    4,06000,ERR01
          .
          .
          .
ERR01     STA       (Error routine)
```

2.1.17 DEALPG (Deallocate Memory Pages) Macro

This macro deallocates n pages of memory starting at the specified logical address, modulo 01000. The deallocated logical pages are set to unassigned access mode. Deallocated physical pages, which were not assigned by MAPIN requests, are returned to the pool of available pages. Specifying logical page 0 or non-read/write page results in EX30 error message to be posted and the task's operation resumed at the reject address. The general form is

Note: This request should not be used in background tasks as it may leave "holes" in memory which can create problems when checkpointing a background task.

label **DEALPG n,logical addr,reject addr**

where

n is the number of pages to be deallocated

logical addr is the logical address, modulo 01000, where the n pages are deallocated if negative, 1's complement of map 0 logical address (illegal for priority 0 tasks)

reject addr is the error return address

Expansion:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	0 1 0 0 0 1
Word 3	n
Word 4	logical addr
Word 5	reject addr

Example: Deallocate 4 pages of memory in the requesting task's virtual memory starting at logical address 06000. If error, go to ERR02.

```
          .
          DEALPG    4,06000,ERR02
          .
          .
ERR02     LDA       (Error routine)
          .
          .
```

2.1.18 MAPIN (Map-In Specified Physical Pages of Memory) Macro

This macro allows the requestor to specify physical pages of memory to be assigned to the requestor's logical memory starting at the specified logical address, modulo 01000. Priority 0 tasks are not permitted to execute the MAPIN request. The specified logical pages to be mapped must not have been previously assigned except by a previous MAPIN request. All logical pages are set to the read/write access mode. Pages mapped in by this request do not effect the pool of available pages. The requested physical pages cannot include page 0 nor any of the pages assigned to the nucleus program module. Any error condition causes EX31

to be output and the task resumed at the reject address. The general form is

label **MAPIN** **n,log add,{buff / pg},reject**

where

n if positive is the number of pages of memory to be allocated. If negative, it is assumed to be the one's complement of the number of pages to be allocated

log add is the requestor's logical address, modulo 01000, where the specified physical pages are to be mapped

{buff / pg} is the actual physical page number to be mapped, or the address of the buffer containing the physical page numbers. If **n** is positive and this parameter is positive and less than 2048, this parameter is interpreted as a physical page number. If **n** is greater than 1, all physical pages assigned will be consecutive. If **n** is negative and this parameter is greater than 1023, this parameter is assumed to be a map 0 buffer address, e.g., TIDB map image address. If **n** is positive and this parameter is negative, this parameter is assumed to be the one's complement of the buffer address within the requestor's logical space, which contains the physical page numbers

reject is the error return address

Expansion:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	0 1 0 0 1 0
Word 3	n
Word 4	logical addr
Word 5	buffer addr of physical page
Word 6	reject addr

Example: Copy the same 2 physical pages as used by task A, logical address ABUF, into task B's logical memory at logical address BBUF. Task A scheduled task B, passing task A's TIDB address to task B.

```
TASK A
            NAME    TASKA
            TITLE   TASKA
FL          EQU     106
KEY         EQU     0306
V$CTL       EQU     0300
            .
            LDBI    ABUF            (B = Buffer Address)
            LDA     V$CTL           (A = Task A's TIDB)
            SCHED   2,0,FL,KEY,'TA','SK','B'
            .                       (Schedule task B, pass
            .                       parameters in A, B)
            .
ABUF        BSS     02000
            END

TASK B
            NAME    TASKB
            TITLE   TASKB
TBMING      EQU     27
TASKB       STA     P1+4            (Set task A's TIDB addr)
P1          PASS    29,*,PBUF       (Pass task A's TIDB
                                    into PBUF)
*           .
            TBA                     (B = ABUF addr)
            TZB
            LLSR    9               (A = Page number, B =
                                    offset in page)
            ADDE    TBMING+PBUF
            STA     M1+5            (Add task A's map image
                                    addr
M1          MAPIN   2,BBUF,*,RA     (MAPIN same 2 physical
                                    pages at BBUF shared by
                                    task A at ABUF)
            TBA
            LSRA    7               (B = Offset into page)
            ADDI    BBUF            (Add BBUF addr)
            TAB                     (B = Start of ABUF)
            .
            .
PBUF        BSS     29              (TIDB buffer)
            BSS     TASKB-*+512     (Set to page boundary)
BBUF        EQU     *               (Assume task B < 512
                                     words)
            END
```

2.1.19 PAGNUM (Identify Physical Page Number) Macro

This macro allows the requestor to identify the physical page number assigned to a specified logical address. If an unassigned logical address is specified, return is to the requestor with the A register = 0. Otherwise, return is made with the A register set to the physical page number and the B register set to the task's map image address for the specified logical address. The general form is

label **PAGNUM** **logical addr**

where **logical addr** is the address where the identity of the assigned physical page is requested.

Expansion:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0406
Word 2	0 1 0 0 1 1
Word 3	logical addr

Example: Identify the physical page assigned to PBUF.

```
          .
          LDAI    PBUF      (Get RBUF addr)
          STA     P1+3
P1        PAGNUM  *         (Identify physical page)
          .
          .
          .
PBUF      BSS     100
```

2.1.20 RECOV (Error Recovery) Macro

This macro allows the requestor to pass the address of a recovery routine to VORTEX. Control will be passed to the routine if VORTEX attempts to terminate the task abnormally. Return from the user's recovery routine should be made via the EXIT macro. The macro has the general form:

LABEL RECOV ADDR

where

ADDR is the address of the error recovery routine

The recovery address is kept in TBENTY of the user's TIDB. Repeated calls to RECOV are allowed but the last specified recovery address is always the address used. Note that if an abend occurs and control is passed back to the user, registers are not preserved. When using RECOV with a driver, the user must be aware of, and handle the fact that IOC uses TBENTY when activating the driver. Thus the recovery routine becomes the driver initialization routine.

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	JRS, X
Word 1	0406
Word 2	1 1 0 0 1
Word 3	Address of error handling routine

Example:

```
BEGIN   RECOV   ERROR
        .
        .
        .
ERROR   EQU     (error recovery routine)
```

2.1.21 AFAUT (Arithmetic Fault Setup) Macro

This paragraph applies to V77-800 users only.

The AFAUT macro allow V77-800 users to specify the action to be taken when an arithemetic fault occurs.

Expansion:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 1	JSR,X
Word 2	0406
Word 3	010011
Word 4	FLAGS
Word 5	MASK
Word 6	EXITS

Word 4: FLAGS:

Bit 0(OV) = 0: Reset overflow interrupt enable.
1: Set overflow interrupt enable.

Bit 1(UN) = 0: Reset underflow interrupt enable.
1: Set underflow interrupt enable.

Bit 2(AOV) = 0: Don't abort on overflow interrupt.
1: Abort on overflow interrupt.

Bit 3(AUN) = 0: Don't abort on underflow interrupt.
1: Abort on underflow interrupt.

Bit 4(DOM) = 0: Don't disable overflow error message.
1: Disable overflow error message.

Bit 5(DUM) = 0: Don't disable underflow error message.
1: Disable underflow error message.

Word 5: MASK: This is a bit mask. 1-bits indicate which of the above bits are to be modified

Word 6: EXITS: This is a pointer to a two word block

EXITS(0) Address of overflow processor. Null if AOV is set. Continue in line if zero.

EXITS(1) Address of underflow processor. Null of AUN is set. Continue in line if zero.

2.1.22 SRFAULT (Save/Restore Arithmetic Fault Status) Macro

This paragraph applies to V77-800 users only.

The SRFAULT macro saves and restores arithmetic fault interrupt enable status. Its function is to allow DASMR subroutines which are part of an executable FORTRAN program (i.e., with a FORTRAN main program) to use the V70 Overflow Indicator (e.g., the Run-Time I/O module) without getting trapped out by an arithmetic fault interrupt. Such a subroutine would issue a SAVE request on entry which would disable overflow fault interrupts, and RESTORE request on exit.

The two requests are distinguished by the contents of the A-register:

A = 0: Save arithmetic fault interrupt enable status.

A ≠ 0: Restore arithmetic fault interrupt enable status.

Expansion:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	JSR, X
Word 1	0406
Word 2	0 1 0 0 1

2.1.23 SETPAR (Set Parity Enable) Macro

This paragraph applies to V77-800 systems only.

The SETPAR macro allows V77-800 users to selectively enable or disable memory parity during execution of the requesting task.

Expansion:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	JRS, X
Word 1	0406
Word 2	1 1 0 0 1
Word 3	mask

where

mask is the parity enable mask. The values and corresponding functions of mask are

00 disable all parity
01 enable double bit parity error only
03 enable all parity

Example:

Disable single bit parity.

```
SETPAR,1        disable single bit parity
EXC DISPIM      disable PIMS
EXC DISCLK      disable clock

                .
                .
                .
        non-interruptible code
                .
                .
                .
EXC ENAPIM      Restore parity upon returning from
                the first clock or PIM interrupt.
EXC ENACLK
```

2.2 RTE SYSTEM FLOW

The RTE component loads and executes a task depending on the category of that task:

Executive Mode Tasks

These are the VORTEX system and user tasks designated during system generation (SGEN) to be resident (excludes tasks specified on SGEN TSK directives). The RTE, IOC, I/O drivers, and common interrupt processors are examples of system executive mode tasks (map 0). OPCOM is loaded into and executed from page 1 of map 0. All other non-resident tasks are defined to be user mode tasks.

User Mode Tasks

a. Background tasks with a priority of zero: Tasks that are executed via a DASMR or FORTRAN load-and-go operation and those that are loaded and executed from the BL library with a JCP/LOAD directive are in this group.
These tasks are loaded with the first page of physical memory (0-0777) designated as read operand only. The literal and indirect pointer pool is loaded in the first page at locations 0500-0777. The remainder of the background task is loaded in whatever physical pages are available at the time the task is loaded. These pages are designated as read/write access. If a

nucleus module is referenced, that module is mapped as read operand only. All other pages in the logical memory are designated as unassigned. The RTE component designates an available map key (1-15) to the background task and sets the appropriate mapping registers to reflect the task's logical memory.

b. Background priority 1 tasks: System tasks such as the Job-Control Processor (JCP), Input/Output Utility (IOUTIL), System Maintenance (SMAIN), Source Editor (SEDIT), DAS MR, FORTRAN, RPG IV, MIDAS, MICSIM, and File Maintenance (FMAIN) require full access to the nucleus (to modify tables or utilize the global FCBs). These tasks are loaded with the required nucleus modules designated as read/write access mode permitting fetches and stores into these areas. The literal and indirect pointer pool is loaded in the first page at locations 0500-0777. The task is loaded starting at logical address 01000.

c. Foreground tasks: Page 0 is mapped read operand only for a foreground task. Nucleus modules (including blank common) referenced by foreground tasks, are mapped in the read/write access mode (see figure 2-1). The maximum logical memory space available to a foreground task is thus dependent on the number and type of nucleus module referenced by the task. The pages within the logical memory not utilized are mapped as unassigned. All foreground tasks are loaded at logical memory address 01000.

d. Read-only pages: During the creation of a load module by LMGEN, the user has the capability to specify pages within the load module as read-only pages. The designated read-only pages are indicated in the pseudo TIDB block. When the task is loaded, the RTE component will designate those pages in the task's logical memory as read-only pages.

2.3 TASK LIMITATIONS AND DIFFERENCES

In the VORTEX environment, background and foreground tasks either share or are differentiated by the following characteristics:

a. A background task has a priority level of 0 or 1. A foreground task can have a priority of 2 through 31.

b. Only one background task can be executed at a time. Excluding the RTE, IOC, and I/O driver tasks, a maximum of 15 (user mode of 1 through 15) user foreground tasks can be in operation concurrently, provided physical memory size is adequate. See section 2.5 for a description of checkpointing of tasks.

c. A background task can be checkpointed and its operation pre-empted by a foreground task. A foreground program memory space is not checkpointed (see section 2.5).

d. A background task can have literals and indirect pointers, a foreground task cannot.

e. All tasks whether background or foreground have individual task protection.

f. If allocable memory is not available to load a background task, the RTE component will output an error message (EX05) and abort the operation. If a foreground task is to be loaded and allocatable memory is not available, the RTE component will reattempt the load when memory becomes available.

g. Background level 0 or 1 task can schedule a task from the background library only.

h. Foreground tasks can utilize foreground blank common. Background tasks cannot.

i. Background level 0 tasks have restricted RTE requests (see table 2-1). Foreground tasks have no restriction on RTE service requests.

	Background Priority	Priority of Task Background Priority	Foreground Priorities
Nucleus Modules	0	1	2-31
Foreground Blank COMMON Nucleus Module	UN	UN	RW
Global FCT Nucleus Module	ROP	RW	UN
System Table Nucleus Module	ROP	RW	RW
System Resident Tasks Nucleus Module	UN	UN	UN
Page 0 System Constants	ROP	RW ROP*	ROP

Key:
- RW Read-Write Access Mode
- ROP Read Operand Only Access Mode
- RO Read-Only Access Mode
- UN Unassigned Access Mode
- * for micro-VORTEX only

Note: Since the upper three modules are defined contiguously, without regard to page boundaries, and since maps are full pages, a map for any of these modules may include a partial page of an adjoining module, with the same access mode.

Figure 2-1. Matrix of Nucleus Module Access Mode

2.4 ABORT PROCEDURE

Whenever a task is aborted, all currently active I/O operations are allowed to complete. All I/O requests that are threaded (queued, or waiting to be activated) are not activated. Upon completion of all active I/O operations and after all pending requests are dethreaded, the aborted task is released.

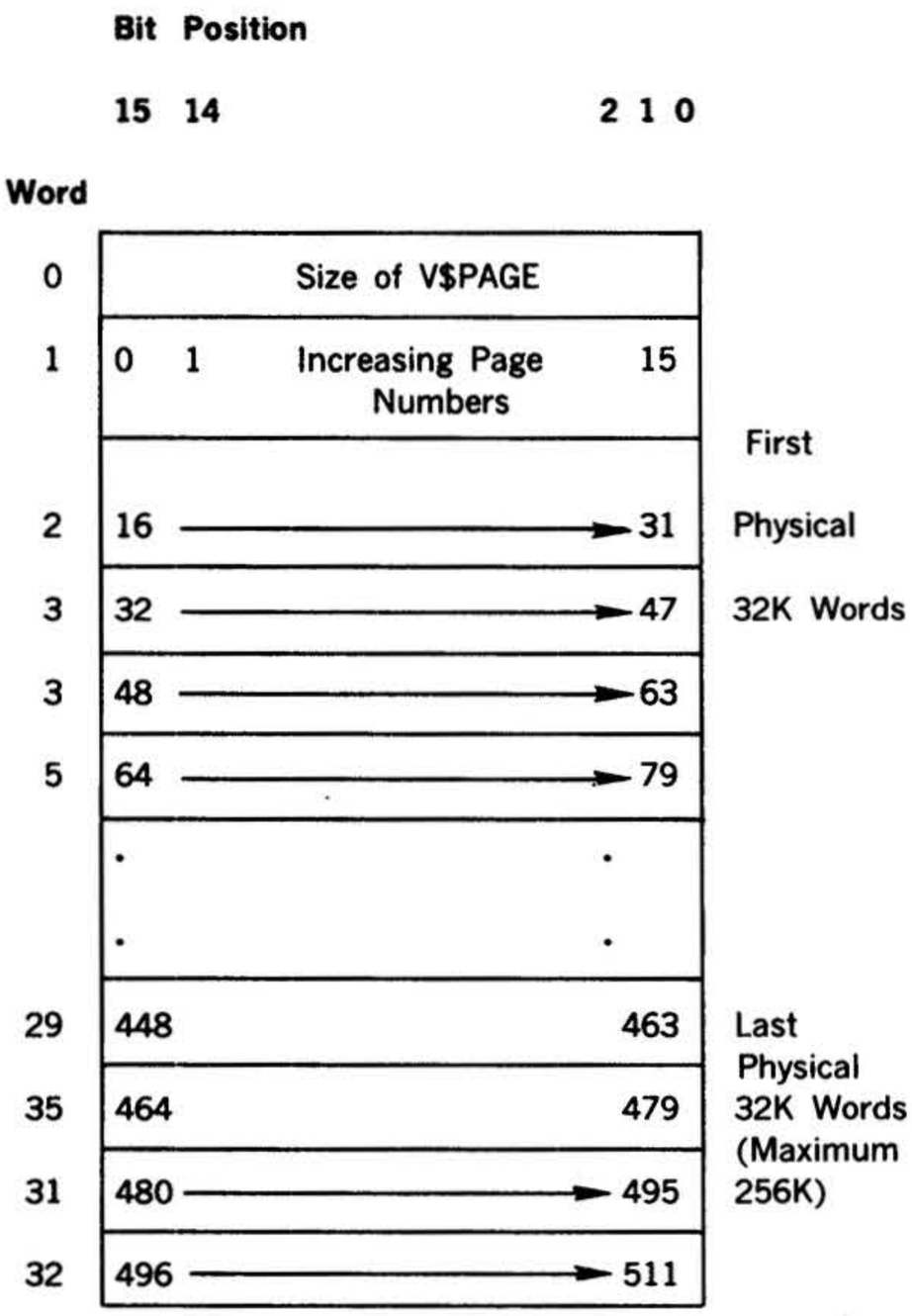
2.5 CHECKPOINTING OF TASKS

A background task's memory space and/or assigned map may be checkpointed for use by a foreground task. The background task is restarted when memory space and/or a map key becomes available.

A foreground task may be checkpointed by a higher priority foreground task. It may also be checkpointed by a lower priority task depending on the value of TBST bit 8. The default value of this bit is on (=1) i.e., "may be checkpointed by a lower priority task". In order to turn this bit off, a usage of TBEVNT (2.1.15) is recommended. The foreground task's memory space is never checkpointed. More than one foreground task's map may be checkpointed.

2.6 PAGE ALLOCATION SCHEME

The page allocation routine scans the page bit mask table, V$PAGE (figure 2-2) to determine the allocable physical pages. To expedite the process, the allocation routine first checks the page 0 system word V$NPAG to find the total number of allocable pages in V$PAGE. If the required number of pages exceeds V$NPAG, scanning of V$PAGE is not attempted. The allocation routine scans V$PAGE starting with the word number specified in V$LPP (page 0 system pointer). The system generation program initially sets V$LPP to the deallocated pages. In micro-VORTEX, V$PAGE is scanned from the top instead of the bottom.



Corresponding Page Bit Positions:

1 = Page is allocatable

0 = Page is unallocatable

V$PGT	Address of V$PAGE
V$LPP	0, Pointer to last word tested
V$NPAG	Number of available pages

Figure 2-2. V$PAGE, Page Allocation Table

The size of V$PAGE is determined by SGEN based on the physical memory size specified on the MRY directive.

SECTION 3
INPUT/OUTPUT CONTROL

The VORTEX **input/output-control component** (**IOC**) processes all requests for I/O to be performed on peripheral devices. The IOC comprises an I/O-request processor, a find-next-request processor, an I/O-error processor, and I/O drivers. The IOC thus provides a common I/O system for the overall VORTEX operating system and eliminates the programmer's need to understand the computer hardware.

All I/O with remote devices connected through the Data Communications Multiplexor (DCM) uses the VORTEX Telecommunications Access Method (VTAM). VTAM interfaces with IOC. Use of VTAM is described in the VTAM Reference Manual.

The contents of the volatile A and B registers and the setting of the overflow indicator are saved during execution of any IOC macro. After completion of the macro, these data are returned. The contents of the X register are lost.

If a physical-device failure occurs, the I/O drivers perform error recovery as applicable. Where automatic error recovery is possible, the recovery operation is attempted repeatedly until the permissible number of recovery tries has been reached, at which time the I/O driver stores the error status in the user I/O-request block, and the I/O-error processor posts the error on the OC logical unit. The user can then try another physical device or abort the task.

3.1 LOGICAL UNITS

A **logical unit** is an I/O device or a partition of a rotating-memory device (RMD). It is referenced by an assigned number or name. The logical unit permits performance of I/O operations that are independent of the physical-device configurations by making possible references to the logical-unit number. The standard interfaces between the program and the IOC, and between the IOC and the I/O driver, permit substitution of peripheral devices in I/O operations without reassembling the program.

VORTEX permits up to 256 logical units. The numbers assigned to the units are determined by their reassignability:

a. *Logical-unit numbers 1-100* are used for units that can be reassigned through the operator communications component (OPCOM, section 17) or the job-control processor (JCP, section 4).

b. *Logical-unit numbers 101-179* are used for units that are not reassignable.

c. *Logical-unit numbers 180-255* are used for units that can be reassigned through OPCOM only.

d. *Logical-unit number 0* indicates a dummy device. The IOC immediately returns control from a dummy device to the user as if a real I/O operation had been completed.

VORTEX logical-unit assignments for all systems are specified in table 3-1. All logical-unit numbers that are not listed are available to the reassignability scheme above.

Table 17-1 shows the scheme of system names for physical devices. Table 3-2 shows the possible logical-unit assignments.

Table 3-1. VORTEX Logical-Unit Assignments

Number	Name	Description	Function
0	DUM	Dummy	For I/O simulation
1	OC	Operator communication	For system operator communication with immediate return to user control; Teletype or CRT only
2	SI	System input	For inputs of all JCP control directives to any device
3	SO	System output	For display of all input control directives and output system messages; teletypewriter or CRT only. VORTEX allows "SO" to be assigned to DUM. If a background program detects an error, it usually goes to "SO" for corrected input. If SO = DUM, the input buffer is reprocessed, causing an infinite loop

Table 3-1. VORTEX Logical-Unit Assignments

(continued)

Number	Name	Description	Function
4	PI	Processor input	For input of source statements from all operating system language processors
5	LO	List output	For output of operating system input control directives, system operations messages, and operating system language processors' output listings
6	BI	Binary input	For input of object-module records from operating system processors
7	BO	Binary output	For output of object-module records from operating system language processors
8	SS	System scratch	For system scratch use; all operating system language processors that use an intermediate scratch unit input from this unit
9	GO	Go unit	For output of the same information as the BO unit by the system assembler and compiler; RMD partition or MT.
10	PO	Processor output	For processor output; all operating system language processors that use an intermediate scratch unit output to this unit; PO and SS are assigned to the same device at system-generation time
11	DI	Debugging input	For all debugging inputs
12	DO	Debugging output	For all debugging outputs
101	CU	Checkpoint unit	For use by VORTEX to checkpoint a background task; partition protection key S; RMD partition only
102	SW	System work	For generation of a load module by the system load-module generator component; or for cataloging, loading, or execution by other system components; partition protection key B; RMD partition only
103	CL	"Core" -resident library	For all "core" -resident system entry points; partition protection key C; RMD partition only (12 names per 2 sectors)

Table 3-1. VORTEX Logical-Unit Assignments
(continued)

Number	Name	Description	Function
104	OM	Object-module library	For the VORTEX system object-module library; partition protection key D; RMD partition only
105	BL	Background library*	For the VORTEX system background library; partition protection key E; RMD partition only
106	FL	Foreground library*	For the VORTEX system foreground library; partition protection key F; RMD partition only

* Other units can be assigned as user foreground libraries provided they are specified at system-generation time. However, there is only one background library in any case.

Table 3-2. Valid Logical-Unit Assignments

Logical Unit	OC	SI	SO	PI	LO	BI	BO	SS	GO
Unit No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Device									
Dummy				DUM	DUM	DUM	DUM	DUM	
Card punch					CP		CP		
Card reader		CR		CR		CR			
CRT device	CT	CT	CT	CT	CT				
RMD (disc/drum) partition		D		D	D	D	D	D	D
Line printer					LP				
Magnetic-tape unit		MT		MT	MT	MT	MT	MT	MT
Paper-tape reader/ punch		PT		PT	PT	PT	PT		
Teletype	TY	TY	TY	TY	TY				
Remote Teletype		TC	TC	TC	TC				

Logical Unit	PO	DI	DO	CU	SW	CL	OM	BL	FL
Unit No.	**10**	**11**	**12**	**101**	**102**	**103**	**104**	**105**	**106**
Device									
Dummy	DUM		DUM						
Card punch	CP								
Card reader		CR							
CRT device	CT	CT	CT						
RMD (disc/drum) partition	D			D	D	D	D	D	D
Line printer	LP		LP						
Magnetic-tape unit	MT								
Paper-tape reader/ punch	PT								
Teletype	TY	TY	TY						
Remote Teletype		TC	TC						

3.2 RMD FILE STRUCTURE

Each RMD (rotating-memory device) is divided into up to 20 memory areas called **partitions**. Each partition is referenced by a specific logical-unit number. The boundaries of each partition are recorded in the core-resident **partition specification table** (**PST**). The first word of the PST contains the number of VORTEX physical records per track. The second word of the PST contains the address of the bad-track table, if any, or zero. Subsequent words in the PST comprise the partition entries. Each PST entry is in the format:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	Beginning partition address (track number)
Word 1	ppb / Protection key
Word 2	Number of bad tracks in the partition
Word 3	Ending partition address + 1

Section 9.1 describes the full PST format.

The **partition protection bit**, designated ppb in the above PST entry map, when set, requires the correct protection key to read/write from this partition.

Note that PST entries overlap. Thus, word 3 of each PST entry is also word 0 of the following entry. The length of the PST is 3n + 2, where n is the number of partitions in the system. The relative position of each PST entry is recorded in the **device specification table** (**DST**) for that partition.

The **bad-track table**, whose address is in the second word of the PST, is a bit string constructed at system-generation time and thereafter constant. The bits are read from right to left within each word, and forward through contiguous words, with set bits flagging bad tracks on the RMD.

The 70-755x and 70-756x, RMD drivers use a bad sector table (BST) instead of a bad track table. This RMD may also contain up to 63 partitions instead of 20, and so the PST occupies the first 2 logical 120 word records of the RMD. The third logical record contains the second half of the boot program, so that the BST begins on the fourth logical 120 word record instead of the second as for other RMDs. Because the second half of the boot program must be on the third logical record, 70-755x system disks must be formatted using the FORMAT-H routine before the first and between any subsequent system generations. The BST format is logically the same as the BTT (bad track table).

Each RMD partition can contain a **file-name directory** of the files contained in that partition. The beginning of the directory is in the first sector of that partition. The directory for each partition has a variable number of entries arranged in n sectors, 19 entries per sector. Sectors containing directory information are chained by pointers in the last word of each sector. Thus, directory sectors need not be contiguous. (**Note:** Directories are not automatically created when the partitions are defined at system-generation time. It is possible to use a partition with no directory, e.g., by a foreground program that is collecting data in real time.) Each directory entry is in the format:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	File name
Word 1	File name
Word 2	File name
Word 3	Current position of file
Word 4	Beginning file address
Word 5	Ending file address

The file name comprises six ASCII characters packed two characters per word. Word 3 contains the current address at which the file is positioned, is initially set to the ending file address, and is manipulated by the OPEN and CLOSE macros (sections 3.5.1 and 3.5.2). The extent of the file is defined by the addresses set in words 4 and 5 when the file is created, and which remain constant.

At system-generation time, the first sector of each partition is assigned to the file-name directory and a zero written into the first word. Once entries are made in the file-name directory, the first word of each sector contains a count of the entries in that sector.

The last entry in each sector is a one-word entry containing either the value 01 (end of directory), or the address of the next sector of the file-name directory.

The file-name directories are created and maintained by the VORTEX file-maintenance component (section 9) for IOC use. User access to the directories is via the IOC, which references the directories in response to the I/O macros OPEN and CLOSE. The file-maintenance component sets words 0, 1, 2, 4, and 5 of each directory entry, which then remain constant and unaffected by IOC operations. The IOC can modify only the current position-of-file parameter.

In the case of a file containing a directory, an OPEN is required before the file is accessible. The macro searches the file directory for the entry corresponding to the name in the file-control block (FCB) in use. When the entry is found, the file boundary addresses and the current position-of-file value from the directory entry are stored in the FCB. If the OPEN macro

a. Specifies the option to rewind, the FCB current position is set equal to the address of the beginning of file.

b. Specifies the option not to rewind, the FCB current position is set equal to the address of the position of file.

Once a file is thus opened, READ and WRITE operations are enabled. The IOC references the file by the file boundary values set by the OPEN, rather than by the file name. READ and WRITE operations are under control of the FCB current position value, the extent of the file, and the current record number.

A CLOSE macro disables the IOC and user access to the file by zeroing the four file-position parameters in the FCB. If the CLOSE macro

a. Specifies the option to update, the current position-of-file value in the directory entry is set to the value of the FCB current position, allowing reference by a later OPEN.

b. Specifies the option not to update, the file-directory entry remains unmodified.

Special directory entries: A **blank entry** is created when a file name is deleted, in which case the file name is ****** and words 3 through 5 give the extent of the blank file. A **zero entry** is created when one name of a multiname file is deleted, in which case the deleted name is converted to a *blank entry* and all other names of the multiname file are set to zero.

When using sequential access with file extension (access method 9) VORTEX will automatically create a file extension for the user if an EOD (end of device) status occurs on an RMD device during a write operation. The file extension is created by the manager routine VZFMA. The file size is equal to the size of the original file and is completely separate (non contiguous and non linked) from the base file segment and its file extensions are loosely linked by sharing the same file name and containing a unique file extension number. The current file extension number is maintained in word 2, bits 12-15, of the current FCB. A file may contain up to 3 extensions, if these are exceeded a standared EOD status is returned to the user. All file extensions must reside in the same logical unit as the base segment thus the number of extensions may be limited due to available space on the logical unit. On read requests, when an EOD status is returned, the next sequential file extension is searched for and, if found, I/O continues using the file extension. For both reads and writes, the handling of file extensions is transparent to the user.

Note: Files that contain extensions should not be used with direct access I/O as the user FCB file extents are subject to modification by the file extension logic. If a file created with sequential I/O, has had extensions created, and is to then be used with direct access I/O, that file must be copied into a contiguous single file.

3.3 I/O INTERRUPTS

VORTEX uses a complete, interrupt-driven I/O system, thus optimizing the allocation of CPU cycles in the multiprogramming environment.

3.4 SIMULTANEOUS PERIPHERAL OUTPUT OVERLAP (SPOOL)

The VORTEX spooler is a generalized set of routines which permit queuing of a task's output to intermediate RMD files. This avoids the user task waiting for the device transfer completion. Total system throughput will be increased because waiting for transfers to be completed, both in the use of I/O calls with suspended returns and that of tasks which are terminating, will be minimized.

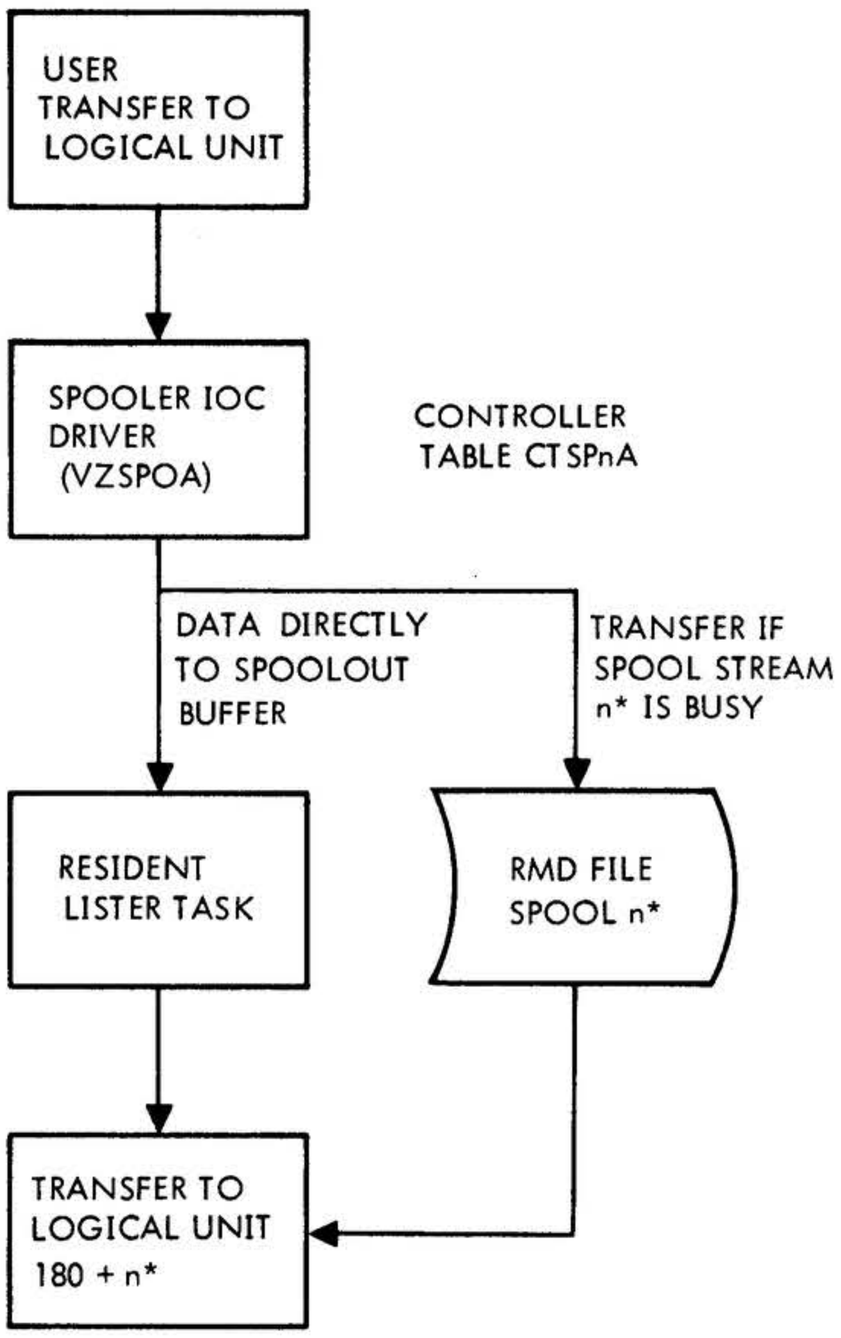
Also, non-resident tasks may transfer to a spooled device and immediately exit, instead of remaining resident until completion of the transfer.

At system generation, the user may have the output of some logical units, such as LO, automatically spooled. During operation, the operator may assign device outputs to the spooler through JCP or OPCOM assign directives.

Components

The SPOOL subsystem consists of two components: (1) an IOC driver to which data output may be assigned and which transfers output for its associated logical unit to a circular RMD file or directly to the output listing task, and (2) and output listing task which accepts messages from this circular RMD file or directly from the IOC driver and transfers them to the appropriate output device.

Communication between these two tasks is accomplished through parameters within the listing task which are



* WHERE n IS AN INTEGER FROM ZERO TO SEVEN

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Figure 3-1. Spooling Subsystem Flow

3.4.1 SPOOL Operation

During the system generation, up to eight spool pseudo devices may be defined. These pseudo-devices, SP0A through SP7A are dummies which can be assigned to any logical unit used only for output. Such assignments can be made permanently at SGEN time, or dynamically through JCP or OPCOM.

Each pseudo-device, SPiA, has a corresponding RMD file name, SPOOLi. These files must be defined on an RMD partition which is permanently assigned to logical unit 107 (named SX). Each spool pseudo-device and file is then associated with a logical unit (180-187) to which the LISTER writes unit record output. For example, a user issuing a WRITE request to an LUN assigned to device SPiA, will have data transferred to file SPOOLi on RMD.

The data will be read from the RMD and written to LUN 180 + i, whose name is Si, as time and the device allow.

If the output device is not busy when a user request is made, and if the RMD stream is inactive, the user data is moved directly to the output device via a SPOOL buffer. In this case, the user request is set complete as soon as the buffer is queued for the device.

If a user's I/O requests are made and a spool pseudo-device number for the appropriate SPOOLi file could not be found, of if the RMD is inoperative for any reason, the RMD is bypassed. That is, each user request causes a SPOOL buffer containing the user's data to be queued directly to the output device, up to a maximum of two buffers per stream. If the user should issue a request that would require a third buffer for that stream, then the SPOOL driver enters a delay loop until the two buffer limit can be satisfied. During this wait time, the user's I/O is active.

If the output device to which a user is spooling output should go down or become not ready, data continues to be accepted and spooled to RMD, but not more than two SPOOL buffers will be tied up waiting for the device to become usable. If an RMD is down when this case occurs, user's requests will be delayed after two buffers are allocated to the stream.

Should the user fill the RMD file for a stream with data before the device can catch up, the next user request remains active until space is available in the RMD.

3.4.2 SPOOL Files

Certain RMD files are required for maximum spooler operation. Without these, the SPOOL subsystem will function at a reduced rate. Files SPOOL0 through SPOOL7, where the last digit is the SPOOL stream number, are used as circular files and may be established at varying lengths to improve system performance. SPOOL operation will be slower if RMD files are totally filled with data to be output.

Files must be created after SGEN but before the first user of the SPOOL program. To establish files in a manner consistent with SPOOL, an exact procedure must be followed. If LO is assigned to SPOOL, it must be reassigned temporarily to a non-spooled device through OPCOM using a command such as:

```
;ASSIGN,LO=LP
```

where LP is not a spooled device. After this step, the actual file or files must be created using FMAIN in the following manner:

```
/FMAIN
INIT,107,S
CREATE,107,S,SPOOL0,120,n
CREATE,107,S,SPOOL1,120,n
.
.
.
CREATE,107,S,SPOOL7,120,n
/FINI
```

established by the IOC driver. When these and other system parameters indicate that the listing task has caught up with the spoolout task, output messages will be transferred directly to the listing task, instead of going through the RMD SPOOL file. (This avoids the overhead of two RMD transfers).

All data records transferred to the circular RMD file will contain record length and a key signifying whether the transfer is to be write or a function as well as other synchronization data. Data will be transferred to RMD in an unpacked mode (one record per sector) in order to avoid delays caused by unwritten still-to-be packed records. SPOOL file overflow messages will be output when appropriate after allowing the RMD circular file certain amounts of time to remove its oldest entry.

Figure 3-1 shows a simplified flow of output data through the SPOOL subsystem.

The last parameter n of the CREATE directives is the number of records. A CREATE directive is required for each data stream. As many CREATE directives as data streams are required.

The number of 120-word records to be established within the file is given as the last parameter of the CREATE directive. SPOOL files are circular files; entries are being placed on one end while being removed from the other end. When the SPOOL subsystem determines that the file is full, i.e., that another entry cannot be placed on the file without destroying one which has not been removed, transfers to the spooler driver will not be completed until a new file entry becomes available (the oldest entry has been removed from the file). As file size is increased, the likelihood of a full file is decreased. File size should be a function of expected stream utilization and device output speed, which determines how quickly entries are moved from circular spooler files. The 1060 error message indicates that a file is full. If this message is received frequently the number of records in that file should be increased for maximum spooling efficiency.

This procedure for creation of SPOOL files needs to be done only once. It is performed immediately after completion of SGEN when the "VORTEX SYSTEM READY" message is output. If these file sizes are found to be unsatisfactory, the system may be rebooted and file sizes modified by executing the procedure again.

As part of the SGEN for systems using the SPOOL program, controller table 0 (stream 0) must be included since the initialization routine is included in its buffers. Additional controller tables may be included as desired. However, storage requirements may be varied by using different controller tables: all even addresses contain four 74-word buffers, and odd streams contain only two 74-word buffers. For systems with a large amount of SPOOL throughput, it is recommended that four buffers be specified for controller tables, otherwise two-buffer tables should be sufficient.

3.5 I/O-CONTROL MACROS

I/O requests are written in assembly language programs as I/O macro calls. The DAS MR assembler provides the following I/O macros to perform I/O operations, thus simplifying coding:

- OPEN — Open file
- CLOSE — Close file
- READ — Read one record
- WRITE — Write one record
- REW — Rewind
- WEOF — Write end of file
- SREC — Skip one record
- FUNC — Function
- STAT — Status
- DCB — Generate data control block
- FCB — Generate file control block

The following I/O macros apply to the 70-755x RMD only:

- DEMAND — Demand the controller for this unit
- RELEAS — Release the controller after a DEMAND
- BCB — Generate Buffer Controller Block
- RESERV — Reserve the controller for this unit
- RELRSV — Release the controller after a RESERV

The IOC performs a validity check on all I/O requests. It then queues (according to the priority of the requesting task) each valid request to the controller assigned to the specified logical unit. Finally, the IOC schedules the appropriate I/O driver to service the queued request.

The assembler processes the I/O macro to yield a macro expansion comprising data and executable instructions in the form of assembler language statements.

Certain I/O operations require parameters in addition to those in the I/O macro. These parameters are contained in a table, which, according to the operation requested, is called either a file control block (FCB, section 3.5.11) or a data control block (DCB, section 3.5.10). Embedded but omitted parameters (e.g., default values) must be indicated by the normal number of commas.

Error messages applicable to these macros are given in Appendix A.3.

I/O Macros: *The general form of I/O macros* is:

label **name** **cb,lun,***wait,mode*

where the symbols have the definitions given in section 3.5.1.

If the **cb** is for an FCB, it is mandatory. If it is for a DCB, it is optional.

The expansion of an I/O macro is:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R,X															
Word 1	0404															
Word 2	c	Status						e	cc			Priority*				
Word 3	w	Mode			Op--code			Logical--unit number								
Word 4	FCB or DCB address															
Word 5	User task identification block address*															
Word 6	IOC thread address*															

where

c	set indicates completion of I/O tasks
Status	is the status of the I/O request
e	set indicates an irrecoverable I/O error
cc	is the completion code
Priority	is the priority level of the task making the request
w	is the wait/immediate-return option
Mode	is the mode of operation
Op-code	specifies the I/O operation to be performed
*	indicates an item whose initial value is zero

The wait option causes the task to be suspended until its I/O is complete. The immediate option causes control to be returned immediately to the task after the I/O request is queued. Therefore, to multiprogram effectively within VORTEX, the wait option is preferred.

Word 2 contains the following information:

a. Bit 15 indicates whether the I/O request is complete.

b. Bits 14 through 9 contain one of the error-message status codes described in Appendix B.2.

c. Bit 8 indicates an irrecoverable I/O error.

d. Bits 7 through 5 contain a completion code: 000 indicates a normal return; 101, an error; 110, an end of file, beginning of device, or beginning of tape; and 111, end of device, or end of tape.

e. Bits 4 through 0 indicate the priority level of the task making the request.

Word 3 contains the following information:

Bits 0-7 Logical Unit (LUN)

When an I/O request is made to VIOC, VIOC uses the LUN as an index into the logical unit table (LUT). V$IOC then uses the current assignment pointer of that entry in the LUT to determine the address of the DST on which the

I/O is to be performed. To determine the DST address, the current assignment value less one is multiplied by the length of a DST (3 words) and added to the base address of the DST block. V$IOC verifies the validity of the specified LUN.

If the LUN is invalid, a parameter error has occurred (refer to sections 3.1 and 3.3).

Bits 8-11 Op-Code

Op-codes can range in value from 0 to 15; however, not all op-codes are applicable for every device. V$IOC, using the op-code as an index gets an entry from a bit table. This word contains a 1 in the bit position associated with the op-code and is compared with the controller table item CTOPM. If the corresponding bit in CTOPM is set to 1, it means that the device connected to the controller can perform the requested operation. If the corresponding bit in CTOPM is zero, the I/O request is not performed, and the I/O complete indicator (bit 15) set.

Bit 8-11	Meaning
0000	Read
0001	Write
0010	Write EOF
0011	Rewind
0100	Skip record
0101	Function
0110	Open
0111	Close
1000-1111	used only by 70-755x RMD
1001	Demand
1010	Releas
1011	Reserv
1100	Relrsv

Bits 12-14 Mode

The mode bits are not used by V$IOC nor V$FNR. The I/O driver use this information whenever applicable to the op-code.

Bit 15 Wait Option

V$IOC uses this bit to determine whether the requesting task is to be suspended until I/O is completed or whether an immediate return is required.

Bit 15 = 0 Suspend until I/O completed. V$IOC sets bit 14 in TBST in the requesting task's TIDB.

Bit 15 = 1 Immediate return required (via V$DISP). V$IOC clears bit 14 in TBST in the requesting task's TIDB.

Word 5 initially points to the user's task identification block. Upon completion of a READ or WRITE macro (sections 3.5.3 and 3.5.4), the IOC sets word 5 to the actual number of words transmitted.

Word 6 initially contains the request block thread. Upon completion of a READ or WRITE operation the IOC sets word 6 to the number of retries attempted prior to completion of the request.

Status macro: *The general form of the status (STAT) macro* is:

label **STAT** **req,err,aaa,bbb,busy**

where the symbols have the definitions given in section 3.5.9.

The normal return is to the first word following the macro expansion.

The expansion of the STAT macro is:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	J S R,X
Word 1	0373
Word 2	Address of the I/O macro
Word 3	Address of the I/O error routine
Word 4	aaa
Word 5	bbb
Word 6	Address of the busy or I/O not complete routine

where **aaa** is the address of the end of file, beginning of device or beginning of the tape routine and **bbb** is the address of the end of the tape or end of the device routine.

Control block macro: *The general form of the DCB macro* is:

label **DCB** *rl,buff,fun*

where the symbols have the definitions given in section 3.5.10.

The expansion of the DCB macro is:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	Record length
Word 1	Direct Address of user data area
Word 2	Function code

The function code applies only to I/O drivers that allow:

a. The line printer to slew to top of form or to space through the channel selection for paper-tape form control.

b. The paper-tape punch to punch leader.

c. The card punch to eject a blank card as a separator.

The general form of the FCB macro is:

label **FCB** *rl,buff,acc,key,'xx','yy','zz'*

where the symbols have the definitions given in section 3.5.11.

The expansion of the FCB macro is:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	Record length															
Word 1	Address of user data area															
Word 2			Ext #		Access method				Protection key							
Word 3	Current record number															
Word 4	Current end-of-file address															
Word 5	Beginning file address															
Word 6	Ending file address															
Word 7	File name															
Word 8	File name															
Word 9	File name															

The access method (word 2, bits 11 through 8) specifies one of the four methods of reading or writing a file:

a. *Direct access by logical record:* The I/O driver uses the contents of FCB word 3 as the number of the logical record within a file to be processed, but does not alter word 3 after reading or writing. Word 3 is set by the user to the desired record number prior to each read/write.
Specifying FCB word three to zero will cause access to the partition directory. Care should be taken when supplying this value so that directories are not accidentally destroyed.

b. *Sequential access by logical record:* The I/O driver uses the contents of word 3 as the number of the logical record within a file to be processed, then increments the contents of word 3 by one. Word 3 is set initially to zero when the FCB macro expands. Successive reading and writing thus accesses records sequentially.

c. *Direct access by physical record:* The I/O driver uses the contents of FCB word 3 as the number of the VORTEX physical record to be processed within a file (120-word length), but does not alter word 3 after a read or write. Word 3 is set by the user to the desired record number prior to each read/write.
Specifying FCB word three to zero will cause access to the partition directory. Care should be taken when supplying this value so that directories are not accidentally destroyed.

d. *Sequential access by physical record:* The I/O driver uses the contents of FCB word 3 as the number of the VORTEX physical record to be processed within a file (120-word length), then increments the contents of word 3 by one. Word 3 is set initially to zero when the FCB macro expands. Successive reading and writing thus accesses records sequentially.

The file extension number currently active is contained in word 2, bits 13-12. This field is updated each time a new extention is created or opened.

Bits 15 and 14 of word 2 are used by V70-755x RMD as follows:

15 = BCB flag
14 = verify after write flag

3.5.1 OPEN Macro

This macro, which applies only to RMDs or magnetic-tape units, enables I/O operations on the devices by initializing the file information in the specified FCB. The macro has the general form

label **OPEN** **fcb,lun,***wait,mode*

where

fcb is the address of the file control block

lun is the number of the logical unit being opened

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

mode is 0 (default value) for rewinding or 1 for not rewinding. In the former case, word 3 (current record number) of the FCB is set to 1, word 4 (current position-of-file address) is set to the current position-of-file address given by the RMD file directory, and rewinds the magnetic-tape unit. In the latter case, the current position-of-file address given by the RMD file directory is copied into word 4, converted to a record number and stored in word 3 of the FCB, thus initializating the user FCB, enabling reading or writing from a previously specified location, and the magnetic-tape position is left unchanged (not rewound).

OPEN must precede any other I/O request (except REW) because the FCB file information must be complete before any file-oriented I/O is possible. If a file has already been opened, an OPEN will be accepted.

The OPEN macro is file-oriented, while the REW macro is oriented to the logical unit. An REW destroys information completed by a previous OPEN on the same logical unit.

The OPEN macro changes words 3, 4, 5, and 6 of the FCB (section 3.5.11).

If an attempt is made to apply the OPEN macro to any device other than an RMD or a magnetic-tape unit, the I/O request is processed internally by the IOC but not by an I/O driver. The IOC indicates the status as I/O complete.

Example: Read a 120-word record from the FI10 on logical unit 18, an RMD partition with sequential, record-oriented access. BUFF is the address of the user's buffer area. Use the wait and rewind options, and set the logical-unit protection key to 1.

```
X1      EQU     18      (LUN assigned to unit X1)
RL      EQU     120     (Record length 120)
WAIT    EQU     0       (Wait option)
REW     EQU     0       (Rewind option)
KEY     EQU     1       (Logical-unit protection key)
SEQR    EQU     1       (Sequential, record-oriented
                         access)
OPEN    OPEN    FCB,X1,WAIT,REW
READ    READ    FCB,X1,WAIT
          .
          .
          .
FCB     FCB     RL,BUFF,SEQR,KEY,
                'FI','10',' '
```

3.5.2 CLOSE Macro

This macro, which applies only to RMDs or magnetic-tape units, updates information in the specified FCB file. This records and retains the current position within the file. The *mode* option ignores the updating, thus retaining the previously defined position in the file. The macro has the general form

label **CLOSE** **fcb,lun**,*wait*,*mode*

where

fcb is the address of the FCB

lun is the number of the logical unit being closed

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

mode is 0 (default value) for not updating, or 1 for updating In the former case, there is no change to the current position-of-file address in the RMD file directory, words 3, 4, 5, and 6 of the FCB are set to zero, and the magnetic-tape position is left unchanged (not rewound). In the latter case, the contents of FCB word 3 (current record number) are converted to an address and stored in the current position-of-file address in the RMD file directory, words 3, 4, 5, and 6 of the FCB are set to zero, and an end-of-file mark written on the magnetic tape.

The CLOSE macro cannot be used if there is no such file defined in the FCB (section 3.5.11).

If an attempt is made to apply the CLOSE macro to any device other than an RMD or magnetic-tape unit, the I/O request is processed internally by the IOC, but not by an I/O driver. The IOC indicates the status as I/O complete.

Example: Close the file MATRIX on logical unit 180, an RMD partition with sequential, record-oriented access. Use the wait and update options.

```
SEQR     EQU      1       (Sequential, record-
                          oriented access)
UPDATE   EQU      1       (Update option)
WAIT     EQU      0       (Wait option)
         .
         .
         .
CLOSE    CLOSE    FCB,180,WAIT,UPDATE
         .
         .
         .
FCB      FCB      0,0,SEQR,,'MA','TR','IX'
```

3.5.3 READ Macro

This macro retrieves a record of specified length from the specified logical unit, and places it in the specified area of main memory. The macro has the general form

label **READ** **cb,lun**,wait,mode

where

cb is the address of the data control block, or of the file control block

lun is the number of the logical unit from which the record is read

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

mode specifies the I/O mode: 0 (default value) for system binary, 1 for ASCII, 2 for BCD, or 3 for unformatted I/O (see appendix C for format)

The number of words read is stored in word 5 of the I/O macro.

Example: Read a record from logical unit 4, a magnetic-tape unit. Use system binary mode and the immediate return option. The record length is 60 words, and the address of the user's data area is BUFF.

```
IM       EQU      1       (Immediate return)
BIN      EQU      0       (System binary mode)
MT       EQU      4       (LUN assigned to
                          magnetic-tape unit)
RECL     EQU      60      (Record length 60 words)
         .
         .
MTRD     READ     TAPE,MT,IM,BIN
         .
         .
         .
TAPE     DCB      RECL,BUFF  (Data control block)
BUFF     BSS      60         (User data area)
```

Note that the READ macro had a mode value of zero. Since this is the default value, the macro could have been coded:

```
MTRD     READ     TAPE,MT,IM
```

3.5.4 WRITE Macro

This macro takes a record of specified length from the specified area of main memory, and transmits it to the specified logical unit. The macro has the general form

label **WRITE** **cb,lun**,*wait*,*mode*

where the parameters have the same definitions and take the same values as in the READ macro (section 3.5.3).

The number of words written is stored in word 5 of the I/O macro. The first byte of each print line is treated as a print control character and not echoed when outputting to a listing device.

Example: Obtain a system binary record 60 words in length from the user's data area BUFF, and transmit it to logical unit 16, a magnetic-tape unit. Use the immediate-return option.

```
IM       EQU      1       (Immediate return)
BIN      EQU      0       (System binary mode)
MT       EQU      16      (LUN assigned to magnetic-
                          tape unit)
RECL     EQU      60      (Record length 60 words)
         .
         .
         .
MTWT     WRITE    TAPE,MT,IM,BIN
         .
         .
         .
TAPE     DCB      RECL,BUFF  (Data control block)
BUFF     BSS      60         (User data area)
```

3.5.5 REW (Rewind) Macro

This macro, which applies only to magnetic-tape or rotating-memory devices, repositions the specified logical unit to the beginning-of-unit position. It has the general form

label **REW** **cb,lun,***wait*

where

cb is the address of the FCB or DCB, which is optional

lun is the number of the logical unit being rewound

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

Note that the DCB address is an optional parameter, but that the FCB address is mandatory.

To reposition a named file on an RMD, use the OPEN macro (section 3.5.1).

Magnetic-tape devices: REW rewinds the specified unit and, upon successful completion of the task, returns a beginning-of-device (BOD) status.

WARNING

V$IOC returns to the issuing program prior to rewind completion. When rewinding is complete, the issuing RQBLK is updated. Therefore, the issuing RQBLK must not be modified prior to rewind completion.

Rotating-memory devices: REW places the start-RMD-partition and end-RMD-partition addresses in words 5 and 6, respectively, of the FCB (section 3.5.11).

Examples: Rewind logical unit 23, a magnetic-tape unit. Use the wait option, here specified by default.

```
MT      EQU     23      (LUN assigned to magnetic-
                        tape unit)
        .
        .
        .
REWT    REW     MT
        .
        .
        .
```

Rewind logical unit 10, an RMD partition. Use the wait option, here specified by default. Note that the REW for an RMD must have an associated FCB (section 3.5.11).

```
DISC    EQU     10      (LUN assigned to RMD
                        partition)
RECL    EQU     120
        .
        .
        .
REWD    REW     FCB,DISC
        .
        .
        .
FCB     FCB     RECL,BUFF,,,'SY','ST','EM'
                        (section 3.5.11)
BUFF    BSS     120
```

3.5.6 WEOF (Write End of File) Macro

This macro writes an end of file on the specified logical unit. It has the general form

label **WEOF** **cb,lun,***wait*

where

cb is the address of the control block

lun is the number of the affected logical unit

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

Example: Write an end of file on logical unit 10. Use the wait option, here specified by default.

```
TAPE    EQU     10
        .
        .
        .
EOF     WEOF    CB,TAPE
        .
        .
        .
```

3.5.7 SREC (Skip Record) Macro

This macro, which applies only to magnetic-tape, card reader, or rotating-memory devices, skips one record in either direction on the specified logical unit. It has the general form

label **SREC** **cb,lun,***wait,mode*

where

cb is the address of the control block

lun is the number of the logical unit being manipulated

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

mode specifies the direction of the skip: 0 (default value) for a forward skip, or 1 for a reverse skip. Reverse skip does not apply to the card reader.

If applied to an RMD, SREC adds or subtracts from the value of word 3 of the FCB (section 3.5.11).

If an attempt is made to apply this macro to a device other than a magnetic-tape or rotating-memory unit, the I/O request is processed internally by the IOC but not by an I/O driver. The IOC indicates the status as I/O complete.

Example: Skip back one record on logical unit 57, a magnetic-tape unit. Use the immediate-return option.

```
MT      EQU     57    (LUN assigned to magnetic-
                      tape unit)
REV     EQU     1     (Reverse)
IM      EQU     1     (Immediate return)
        .
        .
SKIP    SREC    CB,MT,IM,REV
        .
        .
```

3.5.8 FUNC (Function) Macro

This macro performs a miscellaneous function on a specified logical unit. The function (when present) cannot be defined by any of the preceding I/O control functions. The macro has the general form

label **FUNC** **dcb,lun,***wait*

where

dcb is the address of the data control block

lun is the number of the logical unit being manipulated

wait is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

FUNC causes certain I/O drivers to perform special functions specified by the function code *fun* in a DCB macro (section 3.5.10):

I/O Driver	Function Code	Function
Card punch	0	Eject blank card
Paper-tape punch	0	Punch 256 blank frames for leader
Line printer and Teletype printer	0	Advance paper to top of next form, or on Teletype 3 lines *
	1	Advance paper one line
	2	Advance paper two lines
Statos	7	Advance paper to bottom of form
	8	Normal print size*
	9	Large print size*

* Only if supported by Statos hardware character generator.

I/O Driver	Function Code	Function
Statos	00	Advance paper to top of form
	01	Advance paper one line
	02	Advance paper two lines
	07	Advance paper to bottom of form
	08	Step plotter one raster line
	10	Select small/upright
	11	Small/ +90 degrees
	12	Small/ 180 degrees
	13	Small/ −90 degrees
	14	Large/upright
	15	Large/ +90 degrees
	16	Large/ 180 degrees
	17	Large/ −90 degrees
	20	Cut paper
	21	End cut
70-755x	0	Identify unit (see 3.6.4)
	1	Status of unit

Plot data may be transmitted to the Statos by specifying unformatted mode, 3, in the WRITE macro. Each 1 bit will cause a dot to be printed in its corresponding position in the output line. The most significant bit in the first word output represents the leftmost dot position. Functions 10-21 are processed only if hardware capability is available.

Statos — The WRITE macro enables the transfer of one data buffer to the printer/plotter and allows for five different modes of operation:

- Mode 1 -- Compatible line printer (70-6701) mode
- Mode 3 -- Plot (raster) mode (binary raster data transfer)
- Mode 4 -- Print mode selectable size and orientation
- Mode 5 -- Simultaneous print/plot mode (ASCII data transfer)
- Mode 6 -- Simultaneous print/plot mode (binary raster data)

All other modes default to mode 1. Modes 4, 5, and 6 are processed only if hardware capability is available.

If an attempt is made to apply the FUNC macro to any other device, the I/O request is processed internally by the IOC but not by an I/O driver. The IOC indicates the status as I/O complete.

Example: Skip two lines on the printer, which is logical unit 5. Use the wait option, here specified by default.

```
LP      EQU     5       (LUN assigned to line
CNT     EQU     2       printer) (Paper-tape
                        channel 2)
        .
        .
        .
UPSP    FUNC    DCB,LP
        .
        .
        .
DCB     DCB     0, 0, CNT
```

3.5.9 STAT (Status) Macro

This macro examines bits 5-6 of the status word in an I/O macro to determine the result of an I/O function request. The STAT macro has the general form

label **STAT** **req,err,aaa,bbb,busy**

where

req is the address of the I/O macro (e.g., READ)

err is the address of the I/O-error routine

aaa is the address of the end of file, beginning of device, or beginning of tape routine

bbb is the address of the end of device or end of tape routine

busy is the address of the I/O-not-complete routine

All parameters (except the label) are mandatory. The contents of the overflow indicator and the A and B registers are saved. Upon normal completion, control returns to the user at the first word after the end of the macro expansion.

CAUTION

Foreground tasks should not loop to check for completion of I/O tasks because this inhibits all lower-level tasks.

Example: Rewind logical unit 12, a magnetic-tape unit, and check for beginning of device (load point). Use the immediate-return option.

```
MT      EQU     12      (LUN assigned to magnetic-
                        tape unit)
IM      EQU     1       (Immediate return)
        .
        .
REW     REW     0,MT,IM (DCB can be omitted
                        for REW)
        .
        .
        .
BUSY    STAT    REW,ERR,BOT,EQT,BUSY
        .
        .
BOT
        .
        .
        .
ERR
```

3.5.10 DCB (Data Control Block) Macro

This macro generates a DCB as required by I/O macro requests to devices other than RMDs. Note that not all such requests (e.g., rewinding a magnetic-tape unit) require a DCB. The macro has the general form

label **DCB** *rl,buff,fun*

where

rl is the length, in words, of the record to be transmitted

buff is the address of the user's data area

fun is the function code for a FUNC request and is unused for other requests (section 3.5.8)

Example: Read a record from logical unit 4, a magnetic-tape unit. Use system binary mode and the immediate-return option. The record length is 60 words, and the address of the user's data area is BUFF.

```
IM      EQU     1       (Immediate return)
BIN     EQU     0       (System binary mode)
MT      EQU     4       (LUN assigned to magnetic-
                        tape unit)
RECL    EQU     60      (Record length 60 words)
        .
        .
        .
MTRD    READ    TAPE,MT,IM,BIN
        .
        .
        .
TAPE    DCB     RECL,BUFF (Data control block)
```

3.5.11 FCB (File Control Block) Macro

This macro generates an FCB required by any I/O macro request to an RMD. The macro has the general form

label **FCB** *rl,buff,acc,key,'xx','yy','zz'*

where

rl is the length, in words, of the record to be transmitted

buff is the address of the user's data block

acc specifies the access method and is 0 (default value) for the direct access by logical record, 1 for sequential access by logical record, 2 for direct access using the relative sector number (beginning with 1) within the file, 3 for sequential access using the relative sector number within the file, 4 for direct access by physical sector, 5 for sequential access by physical sector, and 9 for sequential access with file extension.

key is the protection code, if any, required to address that logical unit. This is a single alphanumeric ASCII character coded between single quotation marks (e.g., the protection code H would be coded 'H') or as the eight-bit octal equivalent, in which case no quotation marks are used (e.g., 0310 for the protection code H). The default value is binary zero (not the character 0).

xxyyzz is the name of the file being referenced. The file name is one to six ASCII characters, coded in pairs between single quotation marks and separated by commas, e.g., the file named ARRIBA is coded 'AR' ,'RI' , 'BA' . Embedded blanks are illegal.

Table 3-3 shows the use of FCB words 3, 4, 5, and 6 for the I/O macros.

Example: Create an FCB for the file FILEXX. Use the logical-record-oriented, sequential-access method with a record length of 120 words. The user's data area is BUFF and the protection code is Z.

```
SEQR    EQU     1       (Sequential, record-
                        oriented access)
RECL    EQU     120     (Record length 120
                         words)
        .
        .
        .
DISC    FCB     RECL,BUFF,SEQR,'Z',
        .       'FI','LE','XX'
        .
        .
BUFF    BSS     120
```

Note that the protection code character Z is coded between single quotation marks, i.e., 'Z', but it can also be coded as the octal value of the ASCII character, in which case no quotation marks are used, i.e., 0332. Thus, the statement given in the example above is equivalent to

```
DISC        FCB     RECL,BUFF,SEQR,
                    0322,'FI','LE','XX'
```

Table 3-3. FCB Words Under I/O Macro Control

Word	OPEN	READ	WRITE	SREC	CLOSE	REW
			Sequential-Access Method			
3	Set to position of current record by mode chosen	Increments record number by one	Increments record number by one	Adds or subtracts one	Put into position of file on directory by mode chosen	Current record set (director, partition) to one or beginning address of logical unit (non-directory partition)
4	Set to current position of file as noted on directory	Checks end of file	No action	Checks end of file	Cleared	Set to ending address of logical unit

Table 3-3. FCB Words Under I/O Macro Control *(continued)*

Word	OPEN	READ	WRITE	SREC	CLOSE		REW
5	Set to beginning of file address put in this word	No action	No action	No action	Cleared	Set to beginning address of logical unit (non-directory partition)	Skip first directory sector (directory partition)
6	Set to end of file address	No action	No action	No action	Cleared	Set to ending address of logical unit	
			Direct-Access Method				
3	Set to position of current record by mode chosen	No action	No action	No action	Put into position of file on directory by mode chosen	Current record set (directory partition) to one or beginning address of logical unit (non-directory partition)	
4	Set to current position of file as noted on directory	No action	No action	No action	Cleared	Set to ending address of logical unit	
5	Set to beginning of file address	No action	No action	No action	Cleared	Set to beginning address of logical unit (non-directory partition)	Skip first directory sector (directory partition)
6	Set to end of file address	No action	No action	No action	Cleared	Set to ending address of logical unit	

3.6 DISK DEVICE I/O OVERVIEW

This section applies only to the 70-755x, 70-7560, 70-7561 and 70-7562 disk devices.

3.6.1 Alternate Sector Partition

Each disk spindle contains an alternate sector partition for that spindle. The first 2n sectors (where n = number of

partitions per spindle) contain the alternate sector directory for that spindle. The remainder of the alternate sector partition is used for subsequent sector assignments and additional directories if needed. The alternate sector partition is the first partition on the spindle and can either be specified at, or defaulted at system generation. The default size is 1 percent of the spindle capacity. The partition is an unkeyed partition with a partition designator of * (asterisk).

Bad sectors are located and identified during the disk pack formatting operation. The formatter creates a table of bad sectors for the entire disk pack. During system generation, partitions and their associated PST entries are created, alternates to bad sectors are assigned, and the alternate sector table is built. Alternates to bad sectors are always allocated from the alternate sector partition.

3.6.2 Alternate Sector Processing

When a bad sector is detected during a data transfer operation, the alternate sector table for spindle being accessed is read into memory and the table is searched for an entry containing the address of the sector flagged bad. If the entry is not found, the I/O request is terminated with the appropriate error status. Refer to Appendix A for a list of error conditions. When a match is obtained, the following actions are taken by the driver:

1. A channel control block (CCB) specifying command buffer out is created.

2. A command buffer containing the position to transfer data command and an alternate sector address is created.

3. A channel control block specifying data buffer in/out is created for the data buffer corresponding to the alternate sector.

4. The command buffer out CCB is command chained to the data buffer in/out CCB, then an initiate channel function is performed.

5. Upon receipt of the operation complete interrupt, the read/write heads are repositioned to the sector following the bad sector and the data transfer operation is continued to normal completion.

3.6.3 Data Record Blocking And Deblocking

The operating system utilizes records of 120 words and multiples of 120 words for I/O operations on disks. The use of 120-word physical sectors for the disks yields a utilization efficiency of approximately 73%. Increasing the physical sector size improves the disk utilization efficiency by increasing the data storage area with respect to fixed areas of sectors. The disk controller provides the capability to select one of several different hardware sector sizes through the use of plug-in PROMs. When sector sizes larger than 120 words are selected, the disk driver will perform automatic blocking and deblocking of user data records on all I/O requests, unless this feature is overridden.

On write requests which specify one of the access modes 0 through 3, the disk driver will pack as many whole and partial data records as a hardware sector can contain using the following procedures.

1. User data records which reside on the same hardware sector as the record to be written, are read into memory.

2. The new data record is data-chained to the other records which were read in during step a.

3. All of the data records are written onto the sector.

A write request requiring a blocking operation will take a minimum of 1, a maximum of 2 and an average of 1.5 revolutions to complete.

On read requests which specify one of the access modes 0 through 3, the disk driver will perform automatic deblocking of user data records. On deblocking operations, the driver utilizes the "transfer-in" channel capability of the disk controller to eliminate data on the same sector preceding the desired record. Consequently, an additional revolution of the disk is not required to perform a deblocking operation.

On read and write requests which specify access modes 4 and 5, user data records are read or written starting on hardware sector boundaries. Blocking and deblocking have no significance when these access modes are selected.

3.6.4 Identification Buffer Description

A three-word record containing unit informatin is placed in a user-supplied buffer in response to an identify function (mode = 0). The format of the three word buffer is:

Bit	15 14 13 12 11 10 9 8	7 6 5 4 3 2 1 0
Word 0	CN	ua
Word 1	type	class
Word 2	size	

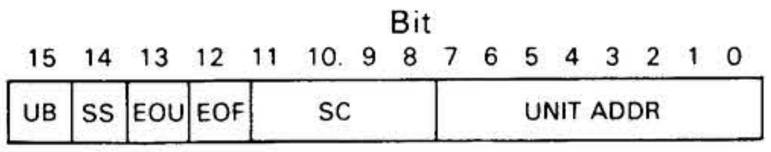
Word	Bit	Field	Explanation
0	10-8	CN	Controller number
	7-0	ua	unit address
1	7-4	type	type of unit
		0	40 megabyte capacity
		1	80 megabyte capacity
		2	150 megabyte capacity
		3	300 megabyte capacity
	3-0	class	class of device 70-755x
		5	(2825-xx, 2826-xx, 2842-xx or 2843-xx) moving head disk
2	15-0	size	is the unit sector size (in words)

3.6.5 Status Buffer Description

Status information up to a maximum 4 words is returned to a user-supplied buffer in response to a status function (mode = 1). The status information consists of a primary status word followed by three other words including the secondary status.

3.6.5.1 Primary Status

The format of the primary status word is as follows:



Bit	Field	Explanation
15	UB	Unit Busy
14	SS	Secondary status
13	EOU	End of Unit
12	EOF	End of File
11-8	Status code	0 no error 1 memory error 2 map error 3 unit data error 4 attention 5 off line 6 chaining interrupt 7 memory timeout 10 command reject 11 rate error 12-17 not used
7-0	Unit Addr	Address of unit supplying status

For a detailed description of the status conditions, refer to the descriptions on input transfers in the V70-755x Disk Controller Manual (document number UP-8662), and the 70-7560, 70-7561, 70-7562 Disk Controller Manual (document number UP-9039).

3.6.5.2 Secondary Status Buffer

The contents of the secondary status buffer are as follows:

BIT	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	C
Word 1	T S
Word 2	0 ◄——► 0 SF

Word	Bit	Field	Definition
0	15-0	C	Cylinder address of the last operation
1	15-8	T	Track address of the last operation
1	7-0	S	Sector address of the last operation
2	15-10	ZERO	All zeros
2	9-0	SF	Secondary status field

Bit 9 = Not used
Bit 8 = Write protect error
Bit 7 = Sector flagged bad
Bit 6 = Data synchronization fail
Bit 5 = Header synchronization fail
Bit 4 = Sector search error
Bit 3 = Track select error
Bit 2 = Cylinder seek error
Bit 1 = Data check error
Bit 0 = Header CRC error

For a detailed description of the secondary status buffer, refer to the description of the status input buffer in the V70-755x Disk Controller Manual (document number UP-8662) and the 70-7560, 70-7561, 70-7562 Disk Controller Manual (document number UP-9039).

3.6.5.3 Disk Access Methods

The 70-755x, 70-7560, 70-7562 and 70-7562 disk units make use of four file access methods. The type of access method to be used is specified in the FCB macro. Each of the access methods is described in the following paragraphs.

Direct Access by Logical Record In this method the disk driver calculates the logical record address specified in word 3 of the FCB by using the record size specified in word 1 of the BCB. Words 3, 4, 5, and 6 are not updated by the disk driver and must be updated by the user accordingly.

Sequential Access by Logical Record The disk driver calculates the address of the logical record specified in Word 3 of the FCB by using the record size specified in word 1. Words 3 and 4 are updated as specified in the chart under comments in Table 3-4.

Direct Access by Relative Record Number The relative sector number is specified in Word 3 of the FCB. The disk driver calculates the absolute address by using the system sector size (120 words), rather than the FCB record size as in the direct access by logical record method. Words 3, 4, 5 and 6 of the FCB are not updated by this disk driver and must be updated by the user accordingly.

Sequential Access by Relative Record Number The disk driver determines the absolute sector address for the relative sector specified in word 3 of the FCB by using the system sector size (120 words) and not the FCB record size. Words 3 and 4 are updated as specified in Table 3-44.

Direct Access by Physical Record The disk driver uses the contents of Word 3 of the user-supplied FCB as a recorded number within the specified file, and converts it to a physical sector address. All READ and WRITE operations begin on physical sector boundaries and may extend across several hardware records. Word 3 of the FCB is not altered following the completion of I/O operations.

The size of physical sectors is variable and depends on the current selection in effect for the controller. Regardless of the relation of user record length to physical sector size, blocking and deblocking of user records will not be performed by the driver when this access method is designated.

Note: Both direct and sequential access by phsyical record may result in data files that are not compatible with logical and relative record access methods due to sector boundary considerations. Therefore, care should be taken to use only direct or sequential access by physical record on files which have been created using these access methods.

Sequential Access by Physical Record The disk driver determines the physical sector address corresponding to the record number specified in Word 3 of the user-supplied FCB. Read and Write operations always begin on physical sector boundaries, and may extend across several hardware sectors. Words 3 and 4 of the FCB are updated by the driver after the requested operation has been completed. Refer to Table 3-4.

The size of the physical sector is variable. It is dependent upon the current selection in effect for the controller. Even if the user record length is different from the physical sector size, automatic blocking and deblocking of user records will not be performed by the driver.

3.7 70-755x, 70-7560, 70-7561, 70-7562 I/O CONTROL MACRO DESCRIPTIONS

3.7.1 DEMAND

The DEMAND macro causes the controller of the disk unit associated with the designated logical unit to acquire immediate control of the interconnected channel of a dual channeled disk drive. The DEMAND macro has the general format

```
label   DEMAND   lun , wait
```

where

lun	is the number of the logical unit being opened
wait	is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete

The DEMAND macro overrides alternate channel operations and retains control of the interconnected channel until a subsequnt RELEAS request. It is the responsibility of tasks in systems with dual channel disk configurations to maintain the necessary coordination to avoid disruptions causes by the arbitrary and unwarranted use of the DEMAND request.

Example: Acquire immediate control of the disk unit associated with logical unit 180.

```
LUN         EQU         180     (logical unit number)
            .
            .
            .
            DEMAND      ,LUN
```

3.7.2 RELEAS

The RELEAS macro relinquishes control of the interconnected channel for the disk unit associated with the designated logical unit. The RELEAS macro has the general format

```
label   RELEAS   ,lun    , wait
```

where

lun	is the number of the logical unit being opened
wait	is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete.

The RELEAS request should be issued after a DEMAND request on the same logical unit. A RELEAS request without a preceding DEMAND request has no effect.

Example: Release logical unit 180 from a previous DEMAND condition.

```
LUN     EQU     180     (logical unit number)
.
.
.
        RELEAS  ,LUN
```

3.7.3 FCB MACRO

The FCB (File Control Block) macro generates an additional list of parameters required by I/O requests involving disk file operations. The FCB macro hs the general form

label **FCB rl,**{**buffer ,** / **BCB adr**} acc, key, 'N1','N2','N3, c

where

rl is the length in words of the record to be transmitted. If a READ request is specified with the transfer in channel option selected, **rl** indicates the size of the file record. Physical or logical record structure is designated by the access method parameter.

buffer is the address of the user data area (C=0, no buffer chaining).

BCB adr is the address of the first Buffer Control Block (C=1, buffer chaining specified).

acc is the access method to be used when referencing the file.

Values are:

0 direct access by logical record
1 sequential access by logical record
2 direct access by relative record number
3 sequential access by relative record number
4 direct access by physical record
5 sequential access by physical record.

The six access methods are described in Section 3.6.5.3.

key is the protect code necessary to address those logical units which are protected.

N1,N2,N3 is the 6 ASCII character file name being referenced.

c is the buffer chaining indicator

0 no buffer chaining (default value)

1 buffer chaining specified. When this option is selected, the buffer address parameter is the pointer to the first buffer control block.

These parameters must appear in the order shown, separated by commas. If a parameter is omitted and it is not the last one in the sequence, it must be represented by its trailing comma.

Words 3, 4, 5, and 6 are used by IOC as shown in Table 3-4. Relative record number begins with 1.

Example: Create an FCB for a file named "FILEXB", using the sequential access method, logical record oriented. The record length is 128, the user data area address is BUFF, the protect key code is Z.

```
SEQR    EQU     1   (access method)
RECL    EQU     128
.
.
.
DISC    FCB     RECL,BUFF,SEQR,
                'Z','F1','LE','XB'
.
.
.
BUFF    BSS     128
```

3.7.4 BCB MACRO

The BCB macro generates a four word buffer control block which describes a user data buffer in main memory. Non-contiguous data buffers to be used for a data transfer operation are chained together through their associated buffer control blocks. The BCB macro has the general form

label BCB **buf adr, buf len,** offset, nxt bcb

Table 3-4. IOC Word Usage for 70-755x 70-7560, 70-7561, and 70-7562 Disk

Sequential Access Method

Word	Instruction OPEN	READ	WRITE	SREC	CLOSE	REW
3	Position of current record set per mode chosen (see open)	Increments Record # by one	Increments Record # by one	Adds or subtracts one	Position of file on directory is set per mode chosen (see open)	Current record is set to one or begin address of logical unit
4	Current position of file as noted on directory put in this word	Uses position to check end-of-file	no action	Uses position to check end-of file	no action	Set to end of logical unit address
5	Beginning file address put in this word	no action	no action	no action	no action	Beginning logical unit address put in this word
6	End file address put in this word	no action	no action	no action	no action	End logical unit acddress put in this word

Direct Access Method

Word	Instruction OPEN	READ	WRITE	SREC	CLOSE	REW
3	Position of current record set per mode chosen (see OPEN)	no action	no action	Adds or subtracts one	Position of file on directory is set per mode chosen (see CLOSE)	Current record set to one or begin address of logical unit
4	Current position of file as noted on directory put in this word	no action	no action	no action	no action	Set to end address of logical unit
5	Beginning file address put in this word	no action	no action	no action	no action	Beginning logical unit address put in this word
6	End file address put in this word	no action	no action	no action	no action	End logical unit address put in this word

where

buf adr is the address of the user data buffer

buf len is the length of the user data buffer (in words)

offset is the displacement value of the first word within a file record which is to be read. The offset parameter has relevance only for READ operations utilizing the "Transfer-In Channel" capability. The default value for offset is zero. The range of offset is 0 offset file record length.

nxt bcb is address of the next buffer control block in the chain. If this parameter is zero, it indicates the end of the chain. The default value of nxt bcb is zero.

The BCB macro does not contain any executable instructions. Therefore, buffer control blocks must be generated out of line.

The BCB macros must be used to link and describe non-contiguous buffers when the chain option of the FCB macro has been selected. If the "Transfer-In Channel" capability for a READ request is desired, the BCB macro must be used to generate the buffer control block regardless of the number of buffers utilized.

The "c" parameter in the FCB macro must be set to indicate buffer chaining. In addition, the buffer address parameter in the BCB macro must point to the first buffer control block.

All buffer control blocks which are to be used for data transfer requests must be created and linked before the I/O request is issued.

Examples:

Example 1. Write a 128 word record on file "FILEXC" from three non-contiguous buffers labeled BUFF1 (30 words), BUFF2 (40 words), and BUFF3 (58 words). The logical sequential access method and buffer chaining options are selected. The protection code for the file is Z. The logical unit number is 28 and the wait option is specified.

```
LUN     EQU     28      (logical unit number)
CHAIN   EQU     1
RL      EQU     128
SEQR    EQU     1       (logical sequential
                         access method)
BUFL1   EQU     30      (length of buffer 1)
BUFL2   EQU     40      (length of buffer 2)
BUFL3   EQU     58      (length of buffer 3)
        .
        .
        .
        WRITE   FCBXC,LUN
        .
        .
        .
FCBXC   FCB     RL,BCB1,SEQR,'Z','FI','LE','XC',CHAIN
        .
        .
        .
BCB1    BCB     BUF1,BUFL1,,BCB2
BCB2    BCB     BUF2,BUFL2,,BCB3
BCB3    BCB     BUF3,BUFL3
        .
        .
        .
BUF1    BSS     30
BUF2    BSS     40
BUF3    BSS     58
```

Example 2. Read 3 non-contiguous entries from a record in file "FILEXD" on logical unit 180. The entries start on words 20, 40, and 60 of the record and 10, 15, and 20 word entries respectively are read using the transfer in channel option. The logical sequential access method, wait, and buffer chaining options are selected. The three buffers are labeled BUFA, BUFB, and BUFC.

```
LUN     EQU     180     (logical unit number)
RL      EQU     256     (file record length)
SEQR    EQU     1       (logical sequential
                         access method)
CHAIN   EQU     1       (buffer chaining option)
BUFASZ  EQU     10      (buffer 1)
BUFBSZ  EQU     15      (buffer 2)
BUFCSZ  EQU     20      (buffer 3)
```

```
DISP1    EQU    20  (displacement of first entry)
DISP2    EQU    40  (displacement of second entry)
DISP3    EQU    60  (displacement of third entry)
          .
          .
          .
         READ    FCBXD,LUN
          .
          .
          .
FCBXD    FCB     RL,BCBA,SEQR,'J','FI','LE',
                 'XD',CHAIN
          .
          .
          .
BCBA     BCB     BUFA,BUFASZ,DISP1,BCBB
BCBB     BCB     BUFB,BUFBSZ,DISP2,BCBC
BCBC     BCB     BUFC,BUFCSZ,DISP3
          .
          .
          .
BUFA     BSS     10
BUFB     BSS     15
BUFC     BSS     20
```

3.7.5 RESERV

The RESERV request causes the controller of the disk unit associated with the designated logical unit to acquire immediate control of the interconnected channel of a dual channeled disk drive. The RESERV macro has the general form

label RESERV ,**lun** , wait

where

lun	is the number of the logical unit being opened
wait	is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete.

The reserve condition will remain in effect on the controller and disk unit designated by the RESERV request until a subsequent RELRSV request is issued. The reserve condition on the designated disk unit and controller may be overridden by a DEMAND request issued to the alternate controller.

Example: Place the disk unit associated with logical unit 180 in the reserve condition.

```
LUN      EQU      180      (logical unit number)
          .
          .
          .
         RELEAS    ,LUN
```

3.7.6 RELRSV

The RELRSV request relinquishes control of the interconnected channel for the disk unit associated with the designated logical unit. This request resets the reserve condition set by the RESERV request. The RELRSV macro has the general form:

label RELRSV ,**lun** , wait

where

lun	is the number of the logical unit being opened
wait	is 1 for an immediate return, or 0 (default value) for a return suspended until the I/O is complete.

The RELRSV request should be issued after a RESERV request on the same disk unit. A RELRSV request without a preceeding RESERV request has no effect.

Example: Reset the reserve condition on the disk unit associated with logical unit 180.

```
LUN      EQU      180      (logical unit number)
          .
          .
          .
         RELRSV    ,LUN
```

SECTION 4
JOB-CONTROL PROCESSOR

The **job-control processor** (**JCP**) is a background task that permits the scheduling of VORTEX system or user tasks for background execution. The JCP also positions devices to required files, and makes logical-unit and I/O-device assignments.

4.1 ORGANIZATION

The JCP is scheduled for execution whenever an unsolicited operator key-in request to the OC logical unit has a slash (/) as the first character.

Once initiated, the JCP processes all further JCP directives from the SI logical unit.

If the SI logical unit is a Teletype or a CRT device, the message **JC**** is output to indicate the SI unit is waiting for JCP input. The operator is prompted every 15 seconds (by a bell for the Teletype or tone for the CRT) until an input is keyed in.

If the SI logical unit is a rotating-memory-device (RMD) partition, the job stream is assumed to comprise unblocked data. In this case, processing the job stream requires an /ASSIGN directive (section 4.2.6).

A JCP directive has a maximum of 80 characters, beginning with a slash. Directives input on the Teletype are terminated by the carriage return.

All JCP directives are echoed to the SO logical unit if SI ≠ SO. All directives, except /C and /P have the time of day append onto the front of the directive when echoed to SO. The format is

HH:MM:SS **/JCP** *directive*

4.2 JOB-CONTROL PROCESSOR DIRECTIVES

This section describes the JCP directives:

a. Job-initiation/termination directives:

/JOB	Start new job
/ENDJOB	Terminate job in progress
/FINI	Terminate JCP operation
/C	Comment
/P	Pause
/MEM	Allocate extra memory for background task

b. I/O-device assignment and control directives:

/AFILE	Assign RMD file and open file.
/ASSIGN	Make logical-unit assignment(s)
/SFILE	Skip file(s) on magnetic-tape unit
/SREC	Skip record(s) on magnetic-tape unit or RMD partition
/WEOF	Write end-of-file mark
/REW	Rewind magnetic-tape unit or RMD partition
/PFILE	Position rotating memory-unit file
/FORM	Set line count on LO logical unit
/KPMODE	Set keypunch mode
/OPEN	Open VTAM line or terminal
/CLOSE	Close VTAM line or terminal
/CFILE	Close file on global logical unit

c. Language-Processor directives:

/DASMR	Schedule DAS MR assembler
/FORT	Schedule FORTRAN compiler
/RPG	Schedule RPG II compiler
/DBGEN	Schedule TOTAL system
/COBOL	Schedule COBOL compiler

d. Utility directives:

/CONC	Schedule system-concordance program
/SEDIT	Schedule symbolic source-editor task
/FMAIN	Schedule file-maintenance task
/LMGEN	Schedule load-module generator
/IOUTIL	Schedule I/O-utility processor
/SMAIN	Schedule system-maintenance task
/COMSY	Schedule compression/edit system
/FMUTIL	Schedule file utility task

e. Program-loading directives:

/EXEC	Schedule loading and execution of a load-module from the SW unit file
/LOAD	Schedule loading and execution of a user background task
/ALTLIB	Schedule the next background task from the specified logical unit rather than from the background library
/PLOAD	Schedule loading and execution of a user background task at priority level 1
/DUMP	Dump background at completion of task execution
/TRACE	Invoke trace mode (V77-800 only)

JCP directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between the individual character strings of the directive, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after a period.

Each JCP directive begins with a slash (/).

The general form of a job-control statement is

/name,*p(1)*,*p(2)*,...,*p(n)*

where

name is one of the directive names given (any other character string produces an error)

each *p(n)* is a parameter required by the JCP or by the scheduled task and defined below under the descriptions of the individual directives

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of some directives, optional periods, optional blank separators between character strings, and the optional replacement of commas by equal signs are omitted from descriptions.

Error messages applicable to JCP directives are given Appendix A.4.

4.2.1 /JOB Directive*

This directive initializes all background system pointers and flags, and stores the job name if one is specified. It has the general form

/JOB,*name*

where *name* is the name of the job and comprises up to eight ASCII characters (additional characters are permitted but ignored by the JCP).

The job name, if any, is then printed at the top of each page for all VORTEX background programs.

The occurrence of the /JOB directive causes the scheduling of the background task V$ACT1. V$ACT1 is a dummy task on BL which only performs an EXIT. However, V$ACT1 may be replaced by a user task to perform any desired accounting function.

Example: Initialize the job TASKONE.

```
/JOB,TASKONE
```

4.2.2 /ENDJOB Directive*

This directive initializes all background system pointers and flags, and clears the job name. It has the form

/ENDJOB

The occurrence of the /ENDJOB directive causes the scheduling of the background task V$ACT2. V$ACT2 is a dummy task on BL which only performs an EXIT. However, V$ACT2 may be replaced by a user task to perform any desired accounting function.

Example: Terminate the job in process.

```
/ENDJOB
```

4.2.3 /FINI (Finish) Directive*

This directive terminates all JCP background operations and makes an EXIT request to the real-time executive RTE component (section 2.1.11). It has the form

/FINI

To reschedule JCP after a FINI, input any JCP directive from the OC unit

The occurrence of the /FINI directive causes the scheduling of the background task V$ACT3. V$ACT3 is a dummy task on BL which only performs an EXIT. However, V$ACT3 may be replaced by a user task to perform any desired accounting function.

Example: Terminate JCP operations.

```
/FINI
```

* The JCP directives JOB, ENDJOB, and FINI reset all logical unit table 1 units to their default (system) values. JOB and ENDJOB do not set the SI logical unit. Logical unit 1 (OC) is not reset by the occurrence of /JOB, /ENDJOB, or /FINI.

4.2.4 /C (Comment) Directive

This directive outputs the specified comment to the SO and LO logical units, thus permitting annotation of the listing. It is not otherwise processed. It has the general form

/C,*comment*

where **comment** is any desired free-form comment.

Example: Annotate a listing with the comment *Rewind all mag tapes.*

```
/C,REWIND ALL MAG TAPES
```

4.2.5 /MEM (Memory) Directive

This directive assigns additional 512-word blocks of main memory to the next scheduled background task. It has the general form

/MEM,n

where **n** is the number of 512-word blocks of main memory to be assigned.

/MEM permits larger symbol tables for FORTRAN compilations and DAS MR assemblies.

The total area of the 512-word blocks of memory plus the background program itself cannot be greater than the total area available for background and nonresident foreground tasks. An attempt to exceed this limit causes the scheduled task to be aborted.

Example: Allocate an additional 1,024 words of main memory to the next scheduled task.

```
/MEM,2
```

4.2.6 /ASSIGN Directive

This directive equates and assigns particular logical units to specific I/O devices. It has the general form

/ASSIGN,l(1) = **r**(1),*l*(2) = *r*(2),...,*l*(*n*) = *r*(*n*)

where

each **l(n)** is a logical-unit number (e.g., 102) or name (e.g., SI)

each **r(n)** is a logical-unit number or name, or a physical-device system name (e.g., TY00, table 17-1)

The logical unit to the left of the equal sign in each pair is assigned to the unit/device to the right.

If the controller and unit numbers are omitted from the name of a physical device, controller 0 and unit 0 are assumed.

An inoperable device, i.e., one declared down by the ;DEVDN operator key-in request (section 17.2.10), cannot be assigned. A logical unit designated as unassignable cannot be reassigned.

Example: Assign the PI logical unit to card reader CR00 and the LO logical unit to Teletype TY00.

```
/ASSIGN,PI=CR,LO=TY
```

4.2.7 /SFILE (Skip File) Directive

This directive, which applies only to magnetic-tape units and card readers, causes the specified logical unit to move the tape forward the designated number of end-of-file marks. It has the general form

/SFILE,lun,neof

where

lun is the number or name of the affected logical unit

neof is the number of end-of-file marks to be skipped

If the end-of-tape mark is encountered before the required number of files has been skipped, the JCP outputs to the SO and LO logical units the error message **JC05,nn**, where **nn** is the number of files remaining to be skipped.

Example: Skip three files on the BI logical unit.

```
/SFILE,BI,3
```

4.2.8 /SREC (Skip Record) Directive

This directive, which applies only to magnetic-tape units, card readers, and RMDs, causes the specified logical unit to move the tape the designated number of records in the required direction. In the case of RMDs, word 4 of the FCB is adjusted the appropriate number of records. It has the general form

/SREC,lun,nrec,*direc*

where

lun is the number or name of the affected logical unit

nrec is the number of records to be skipped

direc indicates the direction to be skipped; F (default value) for forward, or R for reverse. Reverse skip does not apply to the card reader.

If a file mark (forward skip only), end of tape, or beginning of tape is enountered before the required number of records has been skipped, the JCP outputs to the SO and LO logical units the error message **JC05,nn**, where **nn** is the number of records remaining to be skipped.

Note: File marks are not detected on a reverse skip.

Example: Skip nine records forward on the BO logical unit.

```
/SREC,BO,9
```

4.2.9 /WEOF (Write End of File) Directive

This directive writes an end-of-file mark on the specified logical unit. It has the general form

/WEOF,lun

where **lun** is the number or name of the affected logical unit. (Not accepted for RMD.)

Example: Write an end-of-file mark on the BO logical unit.

```
/WEOF,BO
```

4.2.10 /REW (Rewind) Directive

This directive, which applies only to magnetic-tape units and RMDs, causes the specified logical unit(s) to rewind to the beginning of tape. It has the general form

/REW,lun,*lun,...,lun*

where **lun** is the number or name of a logical unit to be rewound.

Example: Rewind the BO and PI logical units.

```
/REW,BO,PI
```

4.2.11 /PFILE (Position File) Directive

This directive, which applies only to RMDs and MT assigned to global logical units causes the specified logical unit to move to the beginning of the designated file. It has the general form

/PFILE,lun,*key,name*

where

lun	is the number or name of the affected logical unit. The logical unit must be one of the system defined logical units which has a global FCB
key	is the protection code required to address **lun**
name	is the name of the file to which the logical unit is to be positioned

Global file control blocks: There are eight global file control blocks (FCB, section 3.5.11) in the VORTEX system that are reserved for background use. System background and user programs can reference these global FCBs. The /PFILE directive stores *key* and *name* in the corresponding FCB before opening/rewinding the logical unit. To pass the buffer address and size of the record to the corresponding logical-unit FCB, make an RTE IOLINK service request (section 2.1.13). The names of the global FCBs are *SIFCB, PIFCB, POFCB, SSFCB, BIFCB, BOFCB, GOFCB,* and *LOFCB,* where the first two letters of the name indicate the logical unit.

Example: Position the PI logical unit to beginning of file FILEXY, whose protection key is $.

```
/PFILE,PI,$,FILEXY
```

4.2.12 /FORM Directive

This directive sets the specified line count on the LO logical unit. This is the number of lines printed by DAS MR assembler or FORTRAN compiler before a top of form is issued. The directive has the general form

/FORM,lines

where **lines** is the number (from 5 to 9999, inclusive) of lines to be printed before a top of form is issued.

The default value of **lines** is defined at system-generation time. If the directive contains a value outside the legal range, the default value is used.

Example: Set a line-count value of 100.

```
/FORM,100
```

4.2.13 /KPMODE (Keypunch mode) Directive

This directive specifies the mode, 026 or 029, (BCD or EBCDIC respectively) in which VORTEX is to read and punch cards. It has the general form

KPMODE,m

where **m** is 0 for 026 mode, or 1 for 029 mode.

Example: Specify that cards be read and punched in 029 keypunch mode.

```
/KPMODE,1
```

4.2.14 /DASMR (DAS MR Assembler) Directive

This directive schedules the DAS MR assembler (section 5.1) with the specified options for background operation on priority level 1. It has the general form

/DASMR,*p(1)*,*p(2)*,...,*p(n)*

where each *p(n)*, if any, is a single character specifying one of the following options:

Parameter	Presence	Absence
B	Suppresses binary object	Output binary object
L	Outputs binary object on GO file	Suppresses output of binary object on GO file
M	Suppresses symbol-table listing	Output symbol-table listing
N	Suppresses source listing	Outputs source listing
I	Flags implicit indirect instructions with '*II error'.	Assembles implicit indirect instructions.
X	Listings in hexadecimal	Listings in octal

The /DASMR directive can specify these parameters in any order.

The DAS MR assembler reads source records from the PI logical unit on the first pass. The PI unit must have been set to the beginning of device before the /DASMR directive. This can be done with an /ASSIGN (section 4.2.6), /SFILE (section 4.2.7), /REW (section 4.2.10), or /PFILE (section 4.2.11) directive.

A load-and-go operation requires, in addition, an /EXEC directive (section 4.2.22).

Example: Schedule the DAS MR assembler with no source listing, but with binary-object output on the GO file.

```
/JOB,EXAMPLE
/PFILE,BO,,BO
/DASMR,N,L
```

/JOB initializes the GO file to start of file. If BO is assigned to a rotating memory partition, a /PFILE,BO,,BO must precede the /DASMR directive to initialize the file (unless the assembly is part of a stacked job - see section 4.3 for sample deck setup).

4.2.15 /FORT (FORTRAN Compiler) Directive

This directive schedules the FORTRAN compiler (section 5.3) with the specified options for background operation on priority level 1. It has the general form

/FORT,*p(1)*,*p(2)*,...,*p(n)*

where each *p(n)*, if any, is a single character specifying one of the following options:

Parameter	Presence	Absence
A	Produce DASMR listing	Suppress DASMR listing
B	Suppresses binary object	Output binary object
D	Assigns two words to integer array items and to integer and logical variables (ANSI standard)	Assigns one word to integer array items and to integer and logical variables
H	Generate code using Floating-Point Processor (FPP)	Generate no FPP instructions
L	Outputs binary object on GO file	Suppresses output of binary object on GO file
M	Suppresses symbol-table listing	Outputs symbol-table listing

N	Suppresses source listing	Outputs source listing
O	Outputs object-module listing	Suppresses object-module listing
X	Compiles conditionally	Compiles normally
F	Generates code with calls to faster firmware routines (see section 20.2)	Generates subroutine calls

The /FORT directive can contain any or all such parameters in any order.

Sample deck formats are illustrated in section 4.3.

The FORTRAN compiler reads source records from the PI logical unit. The PI unit must have been set to the beginning of device before the /FORT directive. This can be done with an /ASSIGN (section 4.2.6), /SFILE (section 4.2.7), /REW (section 4.2.10), or /PFILE (section 4.2.11) directive.

A load-and-go operation requires, in addition, an /EXEC directive (section 4.2.22).

Example: Schedule the FORTRAN compiler with binary-object, source, symbol-table, and object-module listings; normal compilation; and no binary-object output on the GO file.

```
/FORT,O
```

4.2.16 /CONC (System Concordance) Directive

This directive schedules the system concordance program (section 5.2) for background operation. It has the form

/CONC,*L*

where L is an optional parameter to request that all symbols in a source program be listed. Normally, CONC only lists those symbols which were referenced.

The concordance program inputs from the SS logical unit and uses the same source statements that are input to the DAS MR assembler. It outputs to the LO logical unit a listing of all symbols and their referenced locations in the same input program.

The SS unit is set to the beginning of device before the /CONC directive.

Example: Schedule the system concordance program.

```
/ASSIGN,PI=MT00
/REW,PI
/DASMR
/PFILE,SS,,SS
/CONC,L
```

4.2.17 /SEDIT (Source Editor) Directive

This directive schedules the symbolic source editor (section 8) for background operation on priority level 1. It has the form

/SEDIT

Example: Schedule the symbolic source editor.

```
/SEDIT
```

4.2.18 /FMAIN (File Maintenance) Directive

This directive schedules the file maintenance task (section 9) for background operation on priority level 1. It has the form

/FMAIN

Example: Schedule the file maintenance task.

```
/FMAIN
```

4.2.19 /LMGEN (Load-Module Generator) Directive

This directive schedules the load-module generator (section 6) for background operation on priority level 1. A memory map is output unless suppressed. The directive has the general form

/LMGEN,*M,N*

where

M	if present, suppresses the output of a memory map.
N	if present, print both alphabetical and address map. If absent, an alphabetical sort is printed.

Example: Schedule the load-module generator task without a memory map.

```
/LMGEN,M
```

4.2.20 /IOUTIL (I/O Utility) Directive

This directive schedules the I/O utility processor (section 10) for background operation on priority level 0. The directive has the form

/IOUTIL

Example: Schedule the I/O utility processor.

```
/IOUTIL
```

4.2.21 /SMAIN (System Maintenance) Directive

This directive schedules the system maintenance task (section 16) for background operation on priority level 1. The directive has the form

/SMAIN

Example: Schedule the system maintenance task.

```
/SMAIN
```

4.2.22 /EXEC (Execute) Directive

This directive schedules the load-module loader to load and execute a load module from the SW logical unit file. Since this is not a VORTEX system task, execution is on priority level 0. The directive has the general form

/EXEC,*D*

Where D, if present, dumps all of the background upon completion of execution. The dump format consists of eight memory locations per line. Both octal and ASCII representation appear in the dump. During ASCII dump non-ASCII characters appear as blanks. ASCII dump is suppressed if dump is to a TY or CT device.

The dump format consists of eight memory locations per line as follows:

XXXXXX AAAAAA BBBBBB... HHHHHH

where XXXXXX is the starting memory address location of the eight following data words and AAAAAA through HHHHHH are the octal values of those locations. The occurrence of an asterisk between two lines indicates that all dump lines between those lines have the same value as the previous line.

/EXEC can be used to create a load module (named SW) on the SW logical unit and then schedule it, or to execute an existing load module on the SW logical unit. The action taken depends on the setting of bit 2 of the low core flag V$JCPF. If the bit is set, LMGEN is scheduled to read binary from the GO logical unit and catalog the task on SW. If the bit is not set, the current load module on SW is executed. This bit is set by performing a "load-and-go" assembly or compulation using the "L" option flag. This bit is cleared by the loading of any background program. (**Note:** JCP directives which do not load tasks, for example, /ASSIGN, /PFILE, do not clear this bit.). The load module on SW may be executed at anytime until SW is modified (i.e., another load-and-go, LMGEN, COMSY, or any other task that writes to SW).

Example: Schedule the loading of a user load module from the SW unit file without a background dump.

```
/EXEC
```

Schedule a FORTRAN load-and-go operation.

```
/FORT,L
/EXEC
```

When a dump has been specified the dump will be output to the List Output unit after the task exits or is aborted. Once the dump has started, it may be terminated by use of the Operator Communication ;ABORT. When the dump is aborted in this manner, it is required that the executing task be aborted by a previous action.

Example:

`/EXEC,D`	Executes a load module from SW unit file requesting background dump on exit
`;ABORT,SW`	Causes the task to abort and dump the background
`;ABORT,JPDUMP`	Causes the background dump to be aborted
`;ABORT,SW`	Causes the task to be released and JCP to be reloaded

Note: When executing load and go, /EXEC has additional optional parameters. These parameters are used to replace (R1,...,R4) or insert (I1,I2,I3) "canned" LMGEN directives. Standard LMGEN canned load and go directives are (see section 6 for further explanation):

```
TIDB,SW,1,0
LD,GO,  ,GO
LIB
END
```

As LMGEN processes the canned directives (if insert or replace have been specified), LMGEN will process further directives from device SI until an end-of-file is input. The end-of-file will resume LMGEN processing of the remainder of the canned directives.

Insert and replace parameters must be entered in the following order:

```
R1,I1,R2,I2,R3,I3,R4
```

Note: Any number of parameters may be used.

Example: Request load and go execution, replacing the canned LMGEN LIB directive.

```
/EXEC,R3
```

The device PI specifies a library search from user library logical unit 115 with protection code M. Directives will be processed as follows:

	Canned	PI
1.	`TIDB,SW,1,0`	
2.	`LD,GO, ,GO`	
3.		`LIB,115,m`
4.		`End of File`
5.	`END`	

4.2.23 /LOAD Directive

This directive schedules a user task, which must be present in the background library or alternate library, for background execution on priority level 0. The directive has the general form

/LOAD,name,*p(1),p(2),...,p(3)*

where

name	is the name of the user task being scheduled
each *p(n)* (if any)	is a parameter required by the user task

Each parameter specified, if any, will be in the job-control buffer when the user task is scheduled. The parameter string, which can extend to the end of the 80-character buffer, will appear in the buffer exactly as it does in the input directive. The address of the first word of the parameter string is in location V$JCB.

Example: Schedule the user task TSKONE with parameters ALPHA1 and ALPHA2.

```
/LOAD,TSKONE,ALPHA1,ALPHA2
```

4.2.24 /ALTLIB (Alternate Library) Directive

This directive replaces the background library with the specified alternate library unit as the unit from which a background task is to be loaded. The directive has the general form:

/ALTLIB,lun,key

where

lun	is the number or name of the alternate library logical unit
key	is the protection code required to address lun

This directive affects the loading of the next task which would normally be loaded from the background library. It affects the loading of VORTEX language processors and utility tasks in addition to user tasks loaded with the /LOAD directive.

It has no effect on a /EXEC directive. After execution of the background task, the background library is restored as the logical unit from which background tasks are to be loaded.

Example: Schedule the user task TSKONE from logical unit 25, protection key N.

```
/ALTLIB,25,N
/LOAD,TSKONE
```

4.2.25 /DUMP Directive

This directive causes all of background to be dumped upon completion of execution of a task executed from the background library or an alternate library. The dump format is the same as the format for /EXEC,D (see section 4.2.22).

Example: Schedule the execution of user task TSKONE with a dump at completion of execution.

```
/DUMP
/LOAD,TSKONE
```

4.2.26 /CFILE Directive

This directive, which applies only to RMDs and MTs assigned to global logical units, causes the file currently attached to the global FCB file on a logical unit to be closed with an update. It has the general form.

/CFILE,lun

where

lun	is the name or number of the affected logical unit. The logical unit must be one of the global logical units.

Example: Close the file currently attached to the PO global FCB.

/CFILE,PO

4.2.27 /DBGEN (Data Base Generator) Directive

This directive schedules the Data Set Generator Program (see TOTAL Manual for more detailed information) for background operation on priority level 1. It has the form

/DBGEN

Example: Schedule the Data Base Generator for TOTAL.

```
/DBGEN
```

4.2.28 /PLOAD Directive

This directive schedules a user task, which must be present in the background library or alternate library, for background execution on priority level 1. The directive has the general form

/PLOAD,xxxxxx,*p(1),p(2),...p(n)*

where

xxxxxx	is the name of the user task being scheduled. The name must not contain numeric characters.
p(n)	is a parameter required by the user task.

Each parameter specified, if any, will be in the job-control buffer when the user task is scheduled. The parameter string, which can be extended to the end of the 80-character buffer, will appear in the buffer exactly as it does in the input directive. The address of the first word of the parameter string is in location V$JCB.

4.2.29 /FMUTIL Directive

This directive causes files, directories, and/or partitions to be dumped or loaded from RMD's or magnetic tapes, and schedules the file maintenance utility (section 21) for background operation on priority level 1. The directive has the form

/FMUTIL

Examples: Schedule File Maintenance Utility.

```
/FMUTIL
```

4.2.30 /RPG (RPG II Compiler) Directive

This directive schedules the RPG II compiler (section 5.5) with the specified options for background operations on priority level 1. It has the general form

/RPG,*p(1),p(2),...,p(n)*

where

p(n)	is a single character specifying one of the following options:

Parameter	Presence	Absence
B	Suppresses binary object.	Output binary object.
D	Include RPG debug features in object module.	Suppress debug features.
L	Outputs binary object on GO file.	Suppresses output of binary object on GO file.

The /RPG directive can contain up to five such parameters in any order.

Sample deck formats are illustrated in section 4.3.

The RPG II compiler reads source records from the PI logical unit. The PI unit must have been set to the beginning of device before the /RPG directive. This can be done with an /ASSIGN (section 4.2.6), /SFILE (section 4.2.7), /REW (section 4.2.10), or /PFILE (section 4.2.11) directive.

Example: Schedule the RPG II compiler with binary object, source, and symbol-table listings; normal compilation; and no binary object output on the GO file.

```
/RPG
```

Example: Schedule RPG II for normal compilation but with binary object output on the GO file instead of the BO file.

```
/RPG,L,B
```

4.2.31 /P (Pause) Directive

This directive outputs the specified comment to the SO and LO logical units and then causes JCP to be suspended. In addition to the specified comment, instructions are output to SO on how to resume JCP. It has the general form

/P,*comment*

where

comment is any desired free-form comment.

Example: Request that the current job requires MT # 800 on MT00 before it continues.

```
/P, Mount MT #800 on MT00
```

in addition, JCP will output:

```
Pause---WHEN READY, TYPE --;RESUME, JCP
```

4.2.32 /AFILE Directive

This directive equates and assigns the specified global logical unit to the specified RMD device and then opens (with rewind) the specified file. It has the general form

/AFILE,I(1),I(2), *key,filename*

where

I(1) is the global logical unit name or number.

I(2) is the logical unit name or number of the RMD device to be assigned.

key is the protect code.

filename is the name of the file to which the logical unit is to be positioned.

See note on global files in section 4.2.11.

Example: Position the SI logical unit to file PROG1 on logical unit 30 (no protect key).

/AFILE,SI,30,,PROG1

4.2.33 /TRACE Directive

This paragraph applies to V77-800 systems only.

The /TRACE directive causes the next scheduled background task to be executed in the TRACE mode on V77-800 systems. This directive has the format

/TRACE

Example: Schedule the execution of the user task TSKONE in TRACE mode.

```
/TRACE
/LOAD,TSKONE
```

4.2.33.1 TRACE Mode

The TRACE mode enables a user to obtain an instruction by instruction trace of the execution of a task. To execute a task in the TRACE mode, the user: either executes the JCP command

/TRACE

or adds the parameter T at the end of the OPCOM command

;SCHED

Example:

;SCHED,TEST,5,FL,F,T

If a task is executing in TRACE mode, register contents will be displayed to LO after each instruction (except IOC or RTE requests) is executed. The register contents are displayed in the form:

```
TR26,pppppp aaaaaa, yyyyyy, yyyyyy
******ERROR,INSTR=xxxxxx,  A=xxxxxx,  B=xxxxxx,
X=xxxxxx
R3=xxxxxx, R4=xxxxxx, R5=xxxxxx, R6=xxxxxx, R7=xxxxxx
```

where

pppppp	is the task name
xxxxx	is the octal value of the specified register
yyyyyy	represents an irrelevant value

4.3 SAMPLE DECK SETUPS

The batch-processing facilities of VORTEX are invoked by JCP control directives in combination with programs and data. These elements form the input job stream to VORTEX. The input job stream can come from various peripherals and be carried on various media. These examples illustrate common job streams and deck-preparation techniques.

Example 1 - Card Input: Compile a FORTRAN IV main program (with source listing and octal object listing), and assemble a DAS MR subprogram. Then load and execute the linked program.

```
/JOB,EXAMPLE1
/FORT,L,O
      .
      .
      .
  (Source Deck)
      .
/DASMR,L
      .
  (Source Deck)
      .
      .
      .
/EXEC
/ENDJOB
```

Example 2 - Card Input: Assemble a DAS MR program (with source listing and load-and-execute) and generate a concordance listing. The DAS MR program is cataloged on RMD partition D00K under file name USER1 with protection key U. Assign the PI logical unit to RMD partition D00K, open file name USER1 for the assembler, assemble the program, and execute the program with a dump.

```
/JOB,EXAMPLE2
/ASSIGN,PI=D00K
/PFILE,PI,U,USER1
/DASMR,L
/PFILE,SS,,SS
/CONC
/EXEC,D
/ENDJOB
```

Example 3 - Card Input: Assemble a DAS MR program (with source listing and object-module output on the BO logical unit). Assign the PI logical unit to magnetic-tape unit MT00, the PO logical unit to dummy device, the SS logical unit to the PI logical unit, the BO logical unit to RMD partition D00J, and output the object module to file name USER2 with no protection key. Before assembly, position the PI logical unit to the third file. Allocate four additional 512-word blocks for the DAS MR symbol-table area.

```
/JOB,EXAMPLE3
/ASSIGN,PI=MT00,PO=DUM,SS=PI,BO=D00J
/REW,PI
/SFILE,PI,2
/PFILE,BO,,USER2
/MEM,4
/DASMR
/ENDJOB
```

Example 4 - Card Input: After generation of a VORTEX system, use FMAIN to initialize and add object modules to the object-module library (OM) with protection key D. Assign the BI logical unit to CR00.

```
/JOB,EXAMPLE4
/ASSIGN,BI=CR00
/FMAIN
INIT,OM,D
INPUT,BI
ADD,OM,D
      .
      .
      .
  (Object Modules)
      .
 (2-7-8-9 EOF Card)
      .
      .
      .
/ENDJOB
```

Example 5 - Card Input: Load and go operation. Compile a FORTRAN IV main program, a subprogram and assemble a DASMR subprogram. Save output on BO. Execute the linked programs.

```
/JOB,EXAMPLE5
/PFILE,BO,,BO
/FORT,L
      .
      .
      .
      (Source deck FORTRAN main program)
      .
      (Source deck FORTRAN subprogram)
      .
/DASMR,L
      .
      (Source deck DASMR subprogram)
      .
      .
      .
/EXEC
/FINI
```

SECTION 5
LANGUAGE PROCESSORS

The VORTEX operating system supports three language processors: the *DAS MR assembler* (section 5.1), the *FORTRAN IV compiler* (section 5.3), and the *RPG IV compiler* (section 5.4), plus the ancillary *concordance program* (section 5.2.).

5.1 DAS MR Assembler

DAS MR is a two-pass assembler scheduled by job-control directive /DASMR (section 4.2.14). DAS MR uses the secondary storage device unit for pass 1 output. It reads a source module from the PI logical unit and outputs it on the PO unit. The source input for pass 2 is entered from the SS logical unit.

When an END statement is encountered, the SS unit is repositioned and reread. During pass 2, the output can be directed to the BO and/or GO units for the object module and the LO unit for the assembly listing. The SS or PO file, which contains a copy of the source module, can be used as input to a subsequent assembly.

A DAS MR symbol consists of one to six characters, the first of which must be alphabetic, with the rest alphabetic or numeric. Additional alphanumeric characters can be appended to the first six characters of the symbol to form an extended symbol up to the limit imposed by a single line of code. However, only the first six characters are recognized by the assembler.

DAS MR symbols may also be formed from the pound sign, exclamation mark or dollar sign, in initial and other positions.

Since the DAS MR assembler is used within the VORTEX system under VORTEX I/O control, the VORTEX user can specify the desired I/O devices. However, the PO and SS logical units must be the same magnetic-tape unit or RMD partition. Except when PI is equal to SS as shown in section 4.3 (example 3).

DAS MR has a symbol-table area for 175 symbols at five words per symbol. To increase this area, input before the /DASMR directive a /MEM directive (section 4.2.5), where each 512-word block enlarges the capacity of the table by 100 symbols.

A VORTEX physical record on an RMD is 120 words. Source records are blocked three 40-word records per VORTEX physical record, and object modules are blocked two 60-word modules per record. However, in the case where SI = PI = RMD, records are not blocked but assumed to be one per VORTEX physical record. When an input file contains more than one source module each new source module must start at a physical record boundary. Unused portions of the last physical record of the previous source modules should be padded with blank records. Proper blocking may be ensured by following the END statement of the previous source module with two blank records.

Detailed references to the DASMR assembly language are given in the appropriate Sperry Univac reference manuals (see section 1.3). These references include descriptions of the directives recognized by the assembler (table 5-1), except for the title directive which is discussed below. DASMR will assemble the entire V70 extended instruction set.

Table 5-1. Directives Recognized by the DAS MR Assembler

BES	IFF
BSS	IFT
CALL	LIST
COMN	LOC
CONT	MAC
DATA	MZE
DETL	NAME
DUP	NLIS
EJEC	NULL
END	OPSY
EMAC	ORG
ENTR	PZE
EQU	RETU
EXT	SET
FORM	SPAC
GOTO	SMRY
	TITLE

Error messages applicable to the DAS MR assembler are given in Appendix A.5.1.

5.1.1 TITLE Directive

This directive changes the title of the assembly listing and the identification of the object program. It has the general form

TITLE *symbol*

where *symbol* is the new title of the assembly listing; the label field being ignored by the assembler. There are a maximum of eight characters in *symbol*.

At the beginning of assembler pass 1, the title of the assembly listing and the identification of the object program are initialized as blanks. When a TITLE directive is encountered, title and identification assume the *symbol* given in the directive.

Examples: Entitle the assembly listing and object program NEWTITLE.

```
TITLE     NEWTITLE
```

Reinitialize the title and identification, obliterating the old title.

```
TITLE
```

5.1.2 VORTEX Macros

The DAS MR assembler contains macro definitions for the real-time executive (RTE, section 2.1) and I/O control (IOC, section 3.5) macros. Figure 5-1 illustrates these definitions.

```
*
M1          MAC
            EXT         V$IOC
            JSR         0404,1
            DATA        0100000
F           FORM        1,3,4,8
            F           P(1),P(2),P(3),P(4)
            DATA        P(5),0,0
            EMAC
*
*           VORTEX READ MACRO DEFINITION
*           READ        DCB,LUN,W,M
*                             WHERE DCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
*                                     M = I/O MODE
READ        MAC
            M1          P(3),P(4),0,P(2),P(1)
            EMAC
*
*           VORTEX WRITE MACRO DEFINITION
*           WRITE       DCB,LUN,W,M
*                             WHERE DCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
*                                     M = I/O MODE
WRITE       MAC
            M1          P(3),P(4),1,P(2),P(1)
            EMAC
*
*           VORTEX WRITE END OF FILE MACRO DEFINITION
*           WEOF        DCB,LUN,W
*                             WHERE DCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
WEOF        MAC
            M1          P(3),0,2,P(2),P(1)
            EMAC
*
*           VORTEX REWIND MACRO DEFINITION
*           REW         DCB,LUN,W
*                             WHERE DCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
REW         MAC
            M1          P(3),0,3,P(2),P(1)
            EMAC
*
*           VORTEX SKIP RECORD MACRO DEFINITION
*           SREC        DCB,LUN,W,M
*                             WHERE DCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
*                                     M = I/O MODE
```

Figure 5-1. VORTEX Macro Definitions for DAS MR

```
SREC        MAC
            M1          P(3),P(4),4,P(2),P(1)
            EMAC
*
*           VORTEX FUNCTION MACRO DEFINITION
*           FUNC        DCB,LUN,W
*                             WHERE DCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
FUNC        MAC
            M1          P(3),0,5,P(2),P(1)
            EMAC
*
*           VORTEX OPEN MACRO DEFINITION
*           OPEN        FCB,LUN,W,M
*                             WHERE FCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
*                                     M = I/O MODE
OPEN        MAC
            M1          P(3),P(4),6,P(2),P(1)
            EMAC
*
*           VORTEX CLOSE MACRO DEFINITION
*           CLOSE       FCB,LUN,W,M
*                             WHERE FCB = FCB OR DCB ADDRESS
*                                   LUN = LOGICAL UNIT NO.
*                                     W = WAIT OPTION
*                                     M = I/O MODE
CLOSE       MAC
            M1          P(3),P(4),7,P(2),P(1)
            EMAC
*
*           VORTEX STATUS MACRO DEFINITION
*           STAT        FCB,ERR,EOF,EOD,BUSY
*                             WHERE FCB = FCB OR DCB ADDRESS
*                                   ERR = ERROR RETURN ADDRESS
*                                   EOF = END OF FILE, BEGINNING
*                                         OF DEVICE, OR BEGINNING OF
*                                         TAPE RETURN ADDRESS
*                                   EOD = END OF DEVICE OR END OF TAPE
*                                         RETURN ADDRESS
*                                  BUSY = BUSY RETURN ADDRESS
*
STAT        MAC
            EXT         V$IOST
            JSR         0373,1
            DATA        P(1),P(2),P(3),P(4),P(5)
            EMAC
*
*           VORTEX DEVICE CONTROL BLOCK MACRO DEFINITION
*           DCB         RL,BUF,CNT
*                             WHERE RL = RECORD LENGTH
*                                   BUF = DATA ADDRESS
*                                   CNT = COUNT
DCB         MAC
            DATA        P(1),P(2),P(3)
            EMAC
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*          VORTEX FILE CONTROL BLOCK MACRO DEFINITION
*          FCB       RL,BUF,AC,KEY,'N1','N2','N3'
*                         WHERE RL = RECORD LENGTH
*                               BUF = DATA ADDRESS
*                               AC = ACCESS METHOD
*                               KEY = PROTECTION KEY
*                               N1 = FIRST 2 ASCII FILE NAME
*                               N2 = SECOND 2 ASCII FILE NAME
*                               N3 = THIRD 2 ASCII FILE NAME
FCB        MAC
           DATA      P(1),P(2)
F          FORM      6,2,8
           F         0,P(3),P(4)
           DATA      0,0,0,0,P(5),P(6),P(7)
           EMAC
*
M2         MAC
           EXT       V$EXEC
           JSR       0406,1
           EMAC
*
*          VORTEX SCHEDULE MACRO DEFINITION
*          SCHED     PL,W,LUN,KEY,'N1','N2','N3',F
*                         WHERE PL = PRIORITY LEVEL
*                               W = WAIT OPTION
*                               LUN = LOGICAL UNIT NO.
*                               KEY = PROTECTION KEY
*                               N1 = FIRST 2 ASCII TASK NAME
*                               N2 = SECOND 2 ASCII TASK NAME
*                               N3 = THIRD 2 ASCII TASK NAME
*                               F = TIDB ADDRESS FLAG
SCHED      MAC
           M2
F          FORM      2,1,1,6,1,5
           F         0,P(8),P(2),1,0,P(1)
F          FORM      8,8
           F         P(4),P(3)
           DATA      P(5),P(6),P(7)
           EMAC
*
*          VORTEX EXIT MACRO DEFINITION
*          EXIT
*
EXIT       MAC
           M2
           DATA      0200
           EMAC
*
*          VORTEX SUSPEND MACRO DEFINITION
*          SUSPND    T
*                         WHERE T = TYPE OF SUSPENSION
SUSPND     MAC
           M2
F          FORM      4,6,5,1
           F         0,3,0,P(1)
           EMAC
*
*          VORTEX RESUME MACRO DEFINITION
*          RESUME    'N1','N2','N3'
*                         WHERE N1 = FIRST 2 ASCII TASK NAME
*                               N2 = SECOND 2 ASCII TASK NAME
*                               N3 = THIRD 2 ASCII TASK NAME
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
RESUME    MAC
          M2
          DATA      0400,P(1),P(2),P(3)
          EMAC
*
*         VORTEX ABORT MACRO DEFINITION
*         ABORT     'N1','N2','N3'
*                        WHERE N1 = FIRST 2 ASCII TASK NAME
*                              N2 = SECOND 2 ASCII TASK NAME
*                              N3 = THIRD 2 ASCII TASK NAME
ABORT     MAC
          M2
          DATA      0500,P(1),P(2),P(3)
          EMAC
*
*         VORTEX ALLOCATE MACRO DEFINITION
*         ALOC      ADDR
*                        WHERE ADDR = ADDRESS OF REENTRANT
*                                     SUBROUTINE
ALOC      MAC
          M2
          DATA      0600,P(1)
          EMAC
*
*         VORTEX DEALLOCATE MACRO DEFINITION
*         DEALOC
*
DEALOC    MAC
          M2
          DATA      0700
          EMAC
*
*         VORTEX PRIORITY INTERRUPT MASK MACRO DEFINITION
*         PMSK      NUM,MSK,TYP
*                        WHERE NUM = PIM NUMBER
*                              MSK = PIM LINE MASK
*                              TYP = ENABLE OR DISABLE TYPE
PMSK      MAC
          M2
F1        FORM      4,6,5,1
          F1        0,010,0,P(3)
F         FORM      8,8
          F         P(1),P(2)
          EMAC


*
*         VORTEX DELAY MACRO DEFINITION
*         DELAY     T5,TM,DT
*                        WHERE T5 = DELAY TIME IN 5 MILLI-
*                                   SECOND INCREMENTS
*                              TM = DELAY TIME IN 1 MINUTE
*                                   INCREMENTS
*                              DT = DELAY TYPE
DELAY     MAC
          M2
F         FORM      4,6,4,2
          F         0,011,0,P(3)
          DATA      P(1),P(2)
          EMAC
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*
*          VORTEX LDELAY MACRO DEFINITION
*          LDELAY    T5, TM, LUN,KEY
*                         WHERE T5 = DELAY TIME IN 5-MILLISECOND
*                                    INCREMENTS
*                               TM = DELAY TIME IN 1-MINUTE
*                                    INCREMENTS
*                              LUN = LOGICAL UNIT NUMBER FOR TASK LOAD
*                              KEY = PROTECTION KEY
LDELAY     MAC
           M2
           DATA       01107,P(1),P(2)
           FORM       8,8
           F          P(4),P(3)
           EMAC
*
*          VORTEX TIME REQUEST MACRO DEFINITION
*          TIME
*
TIME       MAC
           M2
           DATA       01200
           EMAC
*
*          VORTEX OVERLAY MACRO DEFINITION
*          OVLAY     TF,'N1','N2','N3'
*                         WHERE TF = TYPE FLAG
*                               N1 = FIRST 2 ASCII TASK NAME
*                               N2 = SECOND 2 ASCII TASK NAME
*                               N3 = THIRD 2 ASCII TASK NAME
*
OVLAY      MAC
           M2
F          FORM       4,6,5,1
           F          0,013,0,P(1)
           DATA       P(2),P(3),P(4)
           EMAC
*
*          VORTEX IOLINK MACRO DEFINITION
*          IOLINK     LUN,BUF,NUM
*                         WHERE LUN = LOGICAL UNIT NO.
*                               BUF = USER'S BUFFER LOCATION
*                               NUM = BUFFER SIZE
IOLINK     MAC
           M2
F          FORM       4,6,6
           F          0,014,P(1)
           DATA       P(2),P(3)
           EMAC
*
*
*          VORTEX PASS MACRO DEFINITION
*          PASS             COUNT,FROM,TO
*                              WHERE COUNT = WORD COUNT
*                                    FROM  = FROM ADDRESS
*                                    TO    = TO ADDRESS
*
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*
PASS        MAC
            M2
F           FROM            4,6,6
            F               0,016,0
            DATA            P(1),P(2),P(3)
            EMAC
*
*           VORTEX TBEVNT MACRO DEFINITION
*           TBEVNT    VALUE, , DISP, ,C/S

*
*           WHERE
                        VALUE = IS A BIT MASK

                        DISP  = IS THE TIDB WORD TO BE ALTERED.
                                IT IS EXPRESSED BY WAY OF A NUMBER,
                                THE DISPLACEMENT (OR POSITION) OF THIS
                                WORD IN THE TIDB.

                    C/S     = IS THE CLEAR/SET INDICATION (0 = CLEAR,
                                1 = SET)

                OPTIONS:        BOTH DISP AND C/S ARE OPTIONAL AND
                                THE DEFAULT FOR BOTH IS 0.

                IMPLEMENTATION:
                                WHEN DISP = 0 THE ACTION DEPENDS ON
                                THE VALUE OF VALUE:

*                               VALUE, IF 0-177776, IS SET INTO
*                               THE REQUESTING TASK'S TIDB TBEVNT
*                               WORD.  IF VALUE IS 0177777, RETURN
*                               IS WITH THE REQUESTOR'S TBEVNT IN
*                               THE A REGISTER

                                WHEN DISP = 0, DISP WILL BE ALTERED
                                ACCORDING TO VALUE AND C/S.

                                C/S = 0,  ALL THE BITS IN DISP CORRESPONDING
                                          TO THE ZERO (0) BITS IN VALUE
                                          WILL BE RESET TO 0.

                                C/S = 1,  ALL THE BITS IN DISP CORRESPONDING
                                          TO THE ONE (1) BITS IN VALUE
                                          WILL BE SET TO 1.

TBEVNT      MAC
            M2
            DATA            01700
            DATA            P(1),P(2),P(3)
            EMAC
*
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*          VORTEX ALLOCATE PAGE MACRO DEFINITION
*          ALOCPG          N,LOGICA  ADDR,REJECT ADDR
*                                    WHERE N = NUMBER OF PAGES TO ALLOCATE
*                               LOGICAL ADDR = LOGICAL ADDRESS
*                                              MODULO 01000, WHERE
*                                              PAGES ARE ALLOCATED
*                               REJECT ADDR  = ERROR RETURN ADDRESS
*
ALOCPG     MAC
           M2
           DATA            02000
           DATA            P(1)
           DATA            P(2)
           DATA            P(3)
           EMAC
*
*          VORTEX DEALLOCATE PAGE MACRO DEFINITION
*          DEALPG          N,LOGICAL ADDR,REJECT ADDR
*                                    WHERE N = NUMBER OF PAGES TO DEALLOCATE
*                               LOGICAL ADDR = LOGICAL ADDRESS,
*                                              MODULO 01000, WHERE
*                                              PAGES ARE TO BE
*                                              DEALLOCATED
*                               REJECT ADDR  = ERROR RETURN ADDRESS
*
*
DEALPG     MAC
           M2
           DATA            02100
           DATA            P(1)
           DATA            P(2)
           DATA            P(3)
           EMAC
*
*          VORTEX MAPIN MACRO DEFINITION
*          MAPIN           N,LOBICAL ADDR,BUFFER ADDR,REJECT ADDR
*                                    WHERE N = NUMBER OF PAGES TO BE MAPPD
*                               LOGICAL ADDR = LOGICAL ADDRESS, MODULO
*                                              01000, WHERE PAGES ARE TO
*                                              BE ALLOCATED
*                               BUFFER ADDR  = PHYSICAL PAGE NUMBER
*                                              OR BUFFER ADDRESS CON-
*                                              TAINING PHYSICAL PAGES
*                                              TO BE MAPPED
*                               REJECT ADDR  = ERROR RETURN ADDRESS
*
*
MAPIN      MAC
           M2
           DATA            02200
           DATA            P(1)
           DATA            P(2)
           DATA            P(3)
           DATA            P(4)
           EMAC
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*          VORTEX  PAGE NUMBER MACRO DEFINITION
*          PAGNUM     LOGICAL ADDR
*                                WHERE LOGICAL ADDR = ADDRESS WITHIN THE
*                                                     REQUESTING TASK'S VIRTUAL
*                                                     MEMORY WHERE IDENTIFICATION
*                                                     OF THE ASSIGNED PHYSICAL
*                                                     PAGE IS REQUIRED
*
*
PAGNUM     MAC
           M2
           DATA            02300
           DATA            P(1)
           EMAC
```

Figure 5-1. VORTEX Macro Definitions for DAS MR (continued)

5.1.3 Assembly Listing Format

Figure 5-2 is a sample listing following the format described in this section.

Page format: The assembly listing is limited to the number of lines per page specified by the VORTEX resident constant V$PLCT, with each line containing no more than 120 characters. Each page has a page number and title line followed by one blank line, and then the program listing containing two lines less than the number specified by V$PLCT. (This specification can be changed through the job-control processor (JCP).)

```
PAGE    23    01/22/72  PROG1      VORTEX     DASMR          V$JCP

                   588               EJEC
                   589  *
                   590  *           SUBROUTINE PRINTS JCP DIRECTIVE ON SO AND LO DEVICE
                   591  *
000660 074056 A    592  JCPRT       STX        JSPRX
000661 064056 A    593               STB        JCPRB
000662 010412 A    594               LDA        V$JCB          GET BUFFER ADDRESS
000663 005311 A    595               DAR
000664 054003 A    596               STA        *+4            SETUP LOFCB
                   597               IOLINK     LO,*,41
000665 006505 A
000666 000604 E
000667 001405 A
000670 000665 R
000671 000051 A
000672 030400 A    598               LDX        V$LUT1         ADRS OF LOG UNIT TBL
000673 015003 A    599               LDA        SO,X
000674 150463 A    600               ANA        BM377          SO CUR ASSIGNMT
000675 054274 A    601               STA        JCTA
000676 015002 A    602               LDA        SI,X
000677 150463 A    603               ANA        BM377          SO CUR ASSIGNMT
000700 144271 A    604               SUB        JCTA           SO, SI SAME LUN
000701 001010 A    605               JAZ        JCPR1
000702 000714 R
000703 017000 I    606               LDA        JCFBCS+3       STORE 'LOFCB' ADRS IN CALL
000704 054004 A    607               STA        *+5
                   608               WRITE      LOFCB,SO,0,1   NO - WRITE TO SO
000705 006505 A
000706 000630 E
000707 100000 A
000710 010403 A
000711 000633 E
000712 000000 A
000713 000000 A
000714 030400 A    609  JCPR1       LDX        V$LUT1
000715 015005 A    610               LDA        LO,X
000716 150463 A    611               ANA        BM377          LO CUR ASSIGNMT
000717 144252 A    612               SUB        JCTA           LO, SO SAME LUN
000720 001010 A    613               JAZ        JCPRE          YES
000721 000733 R
000722 017000 A    614               LDA        JCFCBS+3       STORE 'LOFCB' ADRS IN CALL
000723 054004 A    615               STA        *+5
                   616               WRITE      LOFCB,LO,0,1   NO - WRITE TO LO
```

Figure 5-2. Sample Assembly Listing

At the end of the assembly, the following information is printed after the END statement:

a. A line containing the subheading ENTRY NAMES

b. All entry names (in four columns), each preceded by its value and a flag to denote whether the symbol is absolute (A), relocatable (R), or common (C).

c. A line containing the subheading EXTERNAL NAMES

d. All external names (in four columns), each preceded by its value and a flag to denote that the symbol is external (E)

e. A line containing the subheading SYMBOL TABLE

f. The symbol table (in four columns), each symbol preceded by its value and a flag to denote whether the symbol is absolute (A), relocatable (R), common (C), or external (E)

g. A line containing the subheading mmmm ERRORS ASSEMBLY COMPLETE, where mmmm is the accumulated error count expressed as a decimal integer, right-justified and left-blank-filled

Line format: Beginning with the first character position, the format for a title line is:

a. One blank

b. The word PAGE

c. One blank

d. Four character positions that contain the decimal page number

e. Two blanks

f. Eight character positions that contain the current date obtained from the VORTEX resident constant V$DATE

g. Two blanks

h. Eight character positions that contain the program identification obtained from the VORTEX resident constant V$JNAM

i. Two blanks

j. The word VORTEX

k. Two blanks

l. The word DASMR

m. Two blanks

n. Eight character positions that contain the program title from the TITLE directive

o. Blanks through the 120th character position

Beginning with the first character position, the format for an assembly line is:

a. One blank

b. Six character positions to display the location counter (octal) of the generated data word

c. One blank

d. Six character positions to display the generated data word (octal)

e. One blank

f. One character position to denote the type of generated data word: absolute (A), relocatable (R), common (C), external (E), literal (L), or indirect-address pointer generated by the assembler (I)

g. One blank

h. Four character positions containing the decimal symbolic source statement line number, right-justified and left-blank-filled

i. One blank

j. Eighty character positions that contain the image of the symbolic source statement. (If the symbolic source statement is not a comment statement, the label, operation, and variable fields are reformatted into symblolic source statement character positions 1, 8, and 16, respectively. If commas separate the label, operation, and variable fields, they are replaced by blank characters.)

k. Blanks, if necessary, through the 120th character position

Error Chaining: If syntax errors occur during an assembly error, chaining is provided to assist in finding the errors. If errors occur, the error message at the end of the assembly contains a decimal value within parentheses corresponding to the source line number at which the last error occurred. The line number referenced in turn references the next line number containing an error. The last line number containing an error does not have a chaining reference. If no errors occurred, the error message does not contain a chaining reference.

5.2 CONCORDANCE PROGRAM

The background **concordance program (CONC)** provides an indexed listing of all source statement symbols in DASMR programs, giving the number of the statement associated with each symbol and the numbers of all statements containing a reference to the symbol. CONC is scheduled by job-control directive /CONC (section 4.2.16). Upon completion of the concordance listing, control returns to the JCP via EXIT.

Input to CONC is through the SS logical unit. The concordance is output on the LO unit. CONC uses system

global file control block SSFCB. If the SS logical unit is an RMD, a /REW or /PFILE directive (section 10) establishes the FCB before the /CONC directive is input to the JCP.

CONC has a symbol-table area to process 400 no-reference symbols at five words per symbol, plus 400 referenced symbols (averaging five references per symbol) at ten words per symbol. To increase this area, input before the /CONC directive a /MEM directive (section 4.2.5), where each 512-word block enlarges the capacity of the table by approximately 75 symbols.

CONC processes both packed records (three source statements per 120-word VORTEX physical record) and unpacked records (one source statement per record).

5.2.1 Input

CONC receives source-statment input from the SS logical unit. There is, however, no positioning of the SS unit prior to reading the first record. The source statements are identical with those input to the VORTEX assembler and thus conform to the assembler syntax rules.

As the inputs are read, each source statement is assigned a line number, 1, 2, etc., which is identical with that printed on the assembly listing. When a symbol appears in the label field of a symbolic source statement, the line number of that source statement is assigned to the symbol. When the symbol appears in the variable field of a source statement, the line number of that statement is used as a reference for the symbol.

5.2.2 Output

CONC outputs the concordance listing on the LO logical unit. Output begins when one of the following events occurs:

a. CONC processes the source statement END

b. Another job-control directive is input

c. An SS end of file or end of device is found

d. A reading error is found

e. *The symbol-table area is filled*

If the output occurred because the symbol-table area of memory was full, CONC clears the concordance tables, outputs error message CN01, and continues until one of the other terminating conditions is encountered. In all other cases, CONC terminates by calling EXIT.

The concordance listing is made in the order of the ASCII values of the characters comprising the symbols.

Beginning with the first character position, the format for a title line is:

a. One blank

b. The word PAGE

c. One blank

d. Four character positions that contain the decimal page number

e. Two blanks

f. Eight character positions that contain the date obtained from the VORTEX resident constant V$DATE

g. Two blanks

h. Eight character positions that contain the program identification obtained from the VORTEX resident constant V$JNAM

i. Two blanks

j. The word VORTEX

k. Two blanks

l. The word CONC

m. Blanks through the 72nd character position

Beginning with the first character position, the format for a concordance cross-reference listing is:

a. Two blanks

b. Four character positions that contain the decimal line number of the source statement assigned to the symbol in item (e) below

c. One blank

d. One character position containing an asterisk (*) if there are no references to that symbol (otherwise blank)

e. Six character positions containing the symbol being listed

f. Two blanks

g. Four character positions that contain the decimal line number of a source statement referencing the symbol in item (e) above

h. Items (f) and (g) are repeated as necessary for each source statement referencing the symbol in item (e) above, where up to nine references are placed on the first line, and subsequent references on the next line(s). Continuation lines that may be required for ten or more references to the same symbol do not repeat items (a) through (e)

i. Blanks through the 72nd character position of the last line of the entry

Figure 5-3 illustrates the concordance listing.

```
PAGE     1  09/22/71     V$OPCM  VORTEX  CONC

  509   B          841   859   879   990  1001  1002  1012  1068  1072
                  1074  1112  1230  1231
  261   B10      *
  262   B11      *
  263   B12      *
 1206   ODATE     1180  1182  1190
 1937   ONUM       895   928   936  1017  1182  1190  1196  1254  1284
                  1406  1418
```

Figure 5-3. Sample Concordance Listing

5.3 FORTRAN IV COMPILER

The **FORTRAN IV compiler** is a one-pass compiler scheduled by job-control directive /FORT (section 4.2.15). The compiler inputs a source module from the PI logical unit and produces an object module on the BO and/or GO units and a source listing on the LO unit. No secondary storage is required for a compilation.

If a fatal error is detected, the compiler automatically terminates output to the BO and GO units. LO unit output continues. The compiler reads from the PI unit until an END statement is encountered or a control directive is read. Compilation also terminates on detection of an I/O error or an end-of-device, beginning-of-device, or end-of-file indication from I/O control.

The output comprises relocatable object modules under all circumstances: main programs and subroutines, function, and block-data subprograms.

Error messages applicable to the FORTRAN IV compiler are given in Appendix A.5.2.

FORTRAN IV has conditional compilation facilities implemented by an X in column 1 of a source statement. When the X appears in the /FORT directive, all source statements with an X in column 1 are compiled (the X appears on the LO listing as a blank). When the X is not present, all conditional statements are ignored by the compiler. X lines are assigned listing numbers in either case, but the source statement is printed only when the X is present.

FORTRAN IV has a symbol-table area for approximately 70 symbols (i.e., names), if none of the logical units used is assigned to an RMD device. Each RMD assignment requires buffer space of 120 words (except when BO = GO = RMD, in which case BO and GO use the same buffer) and the symbol capacity is reduced by 24 symbols per buffer. To increase the symbol-table area, input before the /FORT directive a /MEM directive (section 4.2.5), where each 512-word block enlarges the capacity of the table by 100 symbols. If a larger symbol-table is used, greater subexpression optimization is possible.

A VORTEX physical record on an RMD is 120 words. Source records are blocked three 40-word records per VORTEX physical record, object modules are blocked two 60-word modules per record, and list modules are output one record per physical record. However, in the case where SI = PI = RMD, records are not blocked but assumed to be one per VORTEX physical record. When the file contains more than one source module, each new source module must start at a physical record boundary. The unused portion of the last physical record of the previous module should be padded with blanks.

Table 5-2 lists the VORTEX real-time executive (RTE) service request macros available through FORTRAN IV. These macros are detailed in section 2.1.

Table 5-2. RTE Macros Available Through FORTRAN IV

ABORT	EXIT	SCHED
ALOC	OVLAY	SUSPND
DELAY	PMSK	TIME
LDELAY	RESUME	PASS

5.3.1 FORTRAN IV Enhancements

The VORTEX FORTRAN IV language additions and enhancements make the VORTEX FORTRAN compiler more consistent with IBM FORTRAN (level G). Except for these additions and enhancements, FORTRAN compilation and execution with the VORTEX operating system is the same as with the Master Operating System (MOS) described in the FORTRAN IV Reference Manual (98 A 9902 03x).

FORTRAN-complied programs can execute in either foreground or background.

Detailed information on the VORTEX FORTRAN IV language additions and enhancements are given in the VORTEX FORTRAN IV Reference Manual (98 A 9902 04x).

5.3.1.1 Variables

VORTEX FORTRAN IV variables are identifiers which consist of a string of one to six alphanumeric characters and correspond to the type of data the variable represents. Variables are classified into the following five fundamental types: INTEGER, REAL, DOUBLE PRECISION, COMPLEX, and LOGICAL.

The following list shows each variable type with its associated standard and optional length (in bytes):

Variable Type	Standard	Optional
INTEGER	2	4
REAL	4	8
COMPLEX	8	-
LOGICAL	2	-
DOUBLE PRECISION	8	-

5.3.1.2 Constants

There are four categories of VORTEX FORTRAN IV constants: NUMERICAL, LOGICAL LITERAL, and HEXADECIMAL. These four constant data constructions are discussed below.

NUMERICAL constants are integer, real, or complex numbers. Integer constants may be positive, zero, or negative. If the constant has so sign, it is interpreted as representing a positive value. If a zero is specified, with or without a preceding sign, the sign will have no effect on the value zero. The constant has the general form

sn

where

s is the optional signed character (+ or -).

n is a decimal character string (maximum magnitude is 1073741823).

LOGICAL constants allow for the use of logical operations through the medium of the logical expression. Thus, two logical constants are provided to represent the "true" and "false" logical values. The constant has the general form

.TRUE. or **.FALSE.**

LITERAL constants are a string of alphanumeric and/or special characters. If apsostrophes delimit the literal, a single apostrophe within the literal is represented by two apostrophes. The number of characters in a string, including blanks, may not be less than 1 or greater than 255. Blanks within the character string will be considered part of the string. The constant has the general form

wHs or 's'

where

w is a positive non-zero constant denoting the width of the character string.

s denotes the character string.

HEXADECIMAL constant consists of the letter Z followed by 1 to 16 hexadecimal digits. The constant has the general form

Zn

where

n is a 1 to 16 hexadecimal digit string.

The maximum number of digits allowed in a hexadecimal constant depends on the length specification of the variable being initialized. If the number of digits is greater than the maximum, the left-most digits are truncated. If the number is less than the maximum, the left-most positions are filled with zeros.

5.3.1.3 IMPLICIT Statement

The IMPLICIT statement must be the first statement in a main program or the second statement in a subprogram. The statement enables the user to specify the type, including length of all variables, arrays, and function names. The statement has the general form

IMPLICIT type *s(a1,...,)

where

type is a type name.

*s is optional; and, represents one of the permissible length specifications (see variable).

a is an initial character string (A, B,...,Z,$,) in that order.

5.3.1.4 Explicit Type Statements

The Explicit Type Specification statement declares the type of variable, function name, statement function name, or array by its name rather than by its initial character. Optionally, it may also initialize the variable. The statement overrides the IMPLICIT statement, which in turn overrides the predefined convention. The statement has the general form

type*s a1*s1*(k1)/x1/*,...

where

type is a type name.

*s is optional; and, represents one of the permissible length specifications.

a is a variable, array, or function name.

(k) is optional; and, gives dimension information for arrays. When the TYPE statement in which it appears is in a subprogram, *k* may contain

integer variables of length 2 (section 5.3.1.1), provided that the array is a dummy argument.

/x/ — is optional; and, represents initial data values (see DATA statement).

5.3.1.5 DOUBLE PRECISION Statement

The DOUBLE PRECISION statement overrides any specification of a variable made by either the predefined convention or the IMPLICIT statement. The statement has the general form

DOUBLE PRECISION a(*k*),...,

where

a — represents a variable, array, or function name.

(*k*) — is optional; and, is composed of one to seven unsigned integer constants that represent the maximum value of each subscript in the array. *k* may contain integer variables of length 2, provided that the array is a dummy argument.

5.3.1.6 PAUSE Statement

The execution of the PAUSE statement causes the unconditional suspension (SUSPND) of the object program being executed pending operator action. To resume the suspended task, input the operator-communication key-in request RESUME. The statement has the general form

PAUSE
or
PAUSE *n* or **PAUSE** *m*

where

n — is a string of one to five decimal digits.

m — is a literal constant enclosed in apostrophes.

5.3.1.7 STOP Statement

The execution of the STOP statement causes the unconditional termination of the execution of the object program beging executed. The statement has the general form

STOP
or
STOP *n* or **STOP** *m*

where

n — is a string of one to five decimal digits.

m — is a literal constant enclosed in apostrophes.

5.3.1.8 CALL Statement

The execution of the CALL statement causes the specified subroutine to be executed. The CALL statement arguments must agree in number and order of appearance with the dummy arguments in the SUBROUTINE statement. The statement has the general form

CALL name (a1,a2),...,

where

name — is the name of a SUBROUTINE subprogram.

a — is an actual argument that is being supplied to the SUBROUTINE subprogram. The argument may be a variable array element, array name, literal, or arithmetic or logical expression. Each a may also be of the form **&***n*, where *n* is a statement number.

5.3.1.9 RETURN Statement

The RETURN statement provides the method by which the calling program is reentered following the execution of a subprogram. The normal sequence of execution following the RETURN statement of a SUBROUTINE subprogram is to the next statement following the CALL statement in the calling program. The statement has the general form

RETURN or **RETURN** *i*

where

i — is an integer constant or variable whose value, for example n, denotes the n-th asterisk in the argument list of a SUBROUTINE statement. RETURN *i* may be specified only in a SUBROUTINE subprogram.

5.3.1.10 READ/WRITE Statements

VORTEX FORTRAN IV allows two optional parameters to the READ/WRITE statements. These optional parameters allow for conditional exits on an end-of-data or transmission error.

Example: READ(4,10,ERR = 105,END = 200)A,B

In the above example, control will be transferred to statement 105 if an I/O error occurs, or to statement 200 if an end-of-data occurs on unit 4.

5.3.1.11 ENCODE/DECODE Statement

ENCODE/DECODE statements perform data conversion according to a FORMAT statement without performing external I/O operations. ENCODE statement takes an I/O list, converts each element and places it in a specified buffer. DECODE statements work from the buffer into the I/O list. For example:

```
      DIMENSION I(40)
      READ(CDR,10)I
   10 FORMAT(40A2)
      DECODE(10,20,I)K,L
   20 FORMAT(2I5)
```

These statements read an ASCII card image into array I. The first two fields of five ASCII characters are then decoded into their integer equivalent and placed into the variables K and L.

5.3.1.12 Direct-Access INPUT/OUTPUT Statements

The direct-access INPUT/OUTPUT statements allows a programmer to go directly to any point in a file which resides on an RMD, and process a record without having to process all the records within the file. To use direct-access INPUT/OUTPUT statements (READ, WRITE, and FIND), the file(s) to be operated on must be described with a DEFINE FILE statement. The statement has the general form

DEFINE FILE a1(m1,r1,f1,v1),...

where

a — specifies the unit number.

m — represents the relative position of a record within the file.

r — specifies the maximum size of each record in the file.

f — specifies whether the file is to be read or written with or without format control.

v — specifies an integer variable (not an array element) called an associated variable, which points to the record immediately following the last record transmitted.

5.3.1.13 Direct-Access READ Statement

The READ statement causes data to be transferred from a direct-access device into internal storage. The statement has the general form

READ(a'r,*b*,*ERR* = Ec)*list*

where

a — specifies the unit number and must be followed by an apostrophe.

r — represents the relative position of a record within the file.

b — is optional; and, if given, is either the statement number of the FORMAT statement, or the name of an array that contains an object-time format.

ERR = Ec — is optional; and, specifies the number of a statement to which control is given when an error condition is encountered

list — is optional; and, is an I/O list. The I/O list must not contain the associated variable.

5.3.1.14 Direct-Access WRITE Statement

The WRITE statement causes data to be transferred from internal storage to a direct-access device. The statement has the general form

WRITE (a'r,*b*)*list*

where

a — specifies the unit number and must be followed by an apostrophe.

r — represents the relative position of a record within the file.

b — is optional; and, if given, is either the statement number of the FORMAT statement, or the

name of an array that contains an object-time format.

list — is optional; and, is an I/O list. The list must not contain the associated variable.

5.3.1.15 FIND Statement

The FIND statement causes the next input record to be found while the present record is being processed. The statement has the general form

FIND (a'r)

where

a — specifies the unit number and must be followed by an apostrophe.

r — represents the relative position of a record within the file.

At the conclustion of a FIND operation, the associated variable points to the record found.

5.3.1.16 DATA Statement

The DATA statement is used to define initial values of variables, array elements, and arrays. This statement cannot precede any specification statement that refers to the same variables, array elements, or arrays. The DATA statement may not precede an IMPLICIT statement. It has the general form

DATA k/d/,...

where

k — is a list containing variables, array elements, or array names.

d — is a list of constants (integer, real, complex, hexadecimal, logical, or literal), any of which may be preceded by *i**, where *i** indicates that the constant is to be specified i times.

5.3.1.17 TITLE Statement

The TITLE statement declares a module name which is output to the top of each page of the source listing and to the object module. It has the general form

TITLE name

where

name — is the title to be output. The title contains up to eight characters, and is output in the object text as the name by which the program is to be referenced by SMAIN.

If a TITLE statement is used, it must be the first source statement. A TITLE statement forces a page eject on the LO listing.

5.3.1.18 Subprogram Multiple Entry

VORTEX FORTRAN IV facilitiates multiple entry into SUBROUTINE and FUNCTION subprograms by specifying a CALL statement or a FUNCTION reference that refers to an ENTRY statement in the subprogram. Entry is made at the first executable statement following the ENTRY statement. The statement has the general form

ENTRY name(a1,a2,a3),...

where

name — is the name of an entry point.

a — is a dummy argument corresponding to an actual argument in a CALL statement or FUNCTION reference.

5.3.1.19 SUBROUTINE Subprogram

The SUBROUTINE subprogram may contain any FORTRAN IV statement except a FUNCTION statement, another SUBROUTINE statement, or an BLOCK DATA statement. If an IMPLICIT statement is specified, it must immediately follow the SUBROUTINE statement. SUBROUTINE has the general form

SUBROUTINE name(a1,a2,a3),...

where

name — is the SUBROUTINE name.

a — is a distinct dummy argument. Each argument used must be a variable or array name, the dummy name of another SUBROUTINE, FUNCTION subprogram, or an asterisk "*" which denotes a return point specified by a statement number in the calling program.

The actual arguments can be:

- A literal, arithmetic, or logical constant
- Any type of variable or array element
- Any type of array name
- Any type of arithmetic or logical expression
- The name of a FUNCTION or SUBROUTINE subprogram
- A statement number

5.3.1.20 FUNCTION Subprogram

The FUNCTION subprogram is an independent subprogram consisting of a FUNCTION statement and at least one RETURN statement. It has the general form

type **FUNCTION** name*s(a1,a2,a3),...,

where

type	is INTEGER, REAL, DOUBLE PRECISION, COMPLEX, or LOGICAL. Its inclusion is optional.
name	is the name of the FUNCTION.
*s	represents one of the permissible length specifications.
a	is a dummy argument or dummay SUBROUTINE name or other FUNCTION subprogram.

5.3.1.21 Subscripts

A subscript is a set of integer subscript quantities that are associated with an array name to identify a particular element of the array. A maximum of seven subscript quantities, separated by commas, can appear in a subscript. The following rules apply to the construction of subscript quantities:

- Subscript quantities may contain arithmetic expressions that use any of the arithmetic operators: +, -, *, /, **
- Subscript quantities may contain FUNCTION references
- Subscript quantities may contain array elements
- Integer and real mixed-mode expressions within subscript quantities are evaluated according to normal FORTRAN rules. If the evaluated expression is real, it is converted to integer
- The evaluated result of a subscript quantity should always be greater than zero

5.3.1.22 Z Format Code

The hexadecimal Z format code causes a string of hexadecimal digits to be interpreted as a hexadecimal value and to be associated with the corresponding I/O list element for purposes of data transmitting. It has the general form

Zw

where

w	denotes a string of hexadecimal digits. The maximum value that can be read is FFFFFFFFFFFFFFF

On input, if an input field contains an odd number of digits, the number will be padded on the left with a hexadecimal zero when it is stored.

On output, if the number of characters in the storage location is less than w, the left-most print positions are filled with blanks. If the number of characters in the storage location is greater than w, the left-most digits are truncated and the rest of the number is printed.

5.3.2 Execution-Time I/O Units

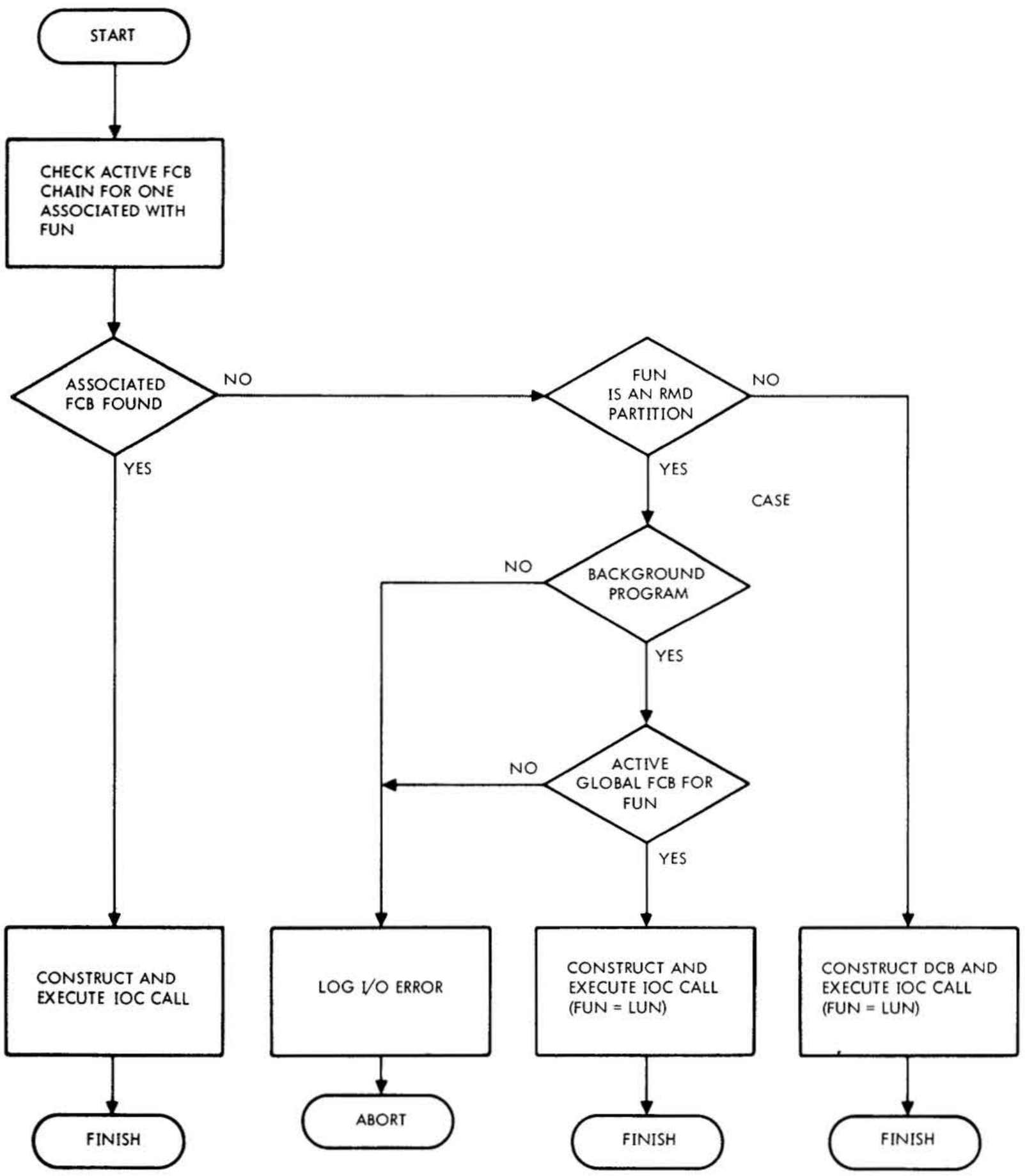
All FORTRAN I/O statements (FORTRAN IV manual) include a FORTRAN unit number (FUN) or name, which may or may not be identical with the logical unit containing the required file(s). Four different cases of FORTRAN units must be distinguished as indicated in figure 5-4.

Case 1, non-RMD unit: The logical-unit number is assigned to the device by SGEN (section 15) or by the JCP /ASSIGN directive (section 4.2.6), where the FORTRAN unit number is identical with that of the file unit. Thus, to rewind the PO logical unit (unit 10, magnetic-tape unit 0), the job stack can be:

```
.
.
.
/ASSIGN,PO=MT00
/FORT
.
.
.
REWIND 10
.
.
```

Case 2, RMD file executing in background only: The JCP /PFILE directive (section 4.2.11) positions the PI unit to a background reassignable logical unit, and loads a global FCB. As in case 1, the FORTRAN unit number is identical with that of the file unit. Thus, to read the file FILE1 on logical unit 50 (protection code X) where PI is logical unit 4, the job stack can be:

```
/FORT,L,B
.
.
.
READ (4,...
.
.
END
```



NOTE: THE FORTRAN LOGICAL UNIT FUN IS NOT NECESSARILY IDENTICAL WITH THE FILE LOGICAL UNIT (LUN) UNLESS SO INDICATED.
V$OPEN OVERRIDES A /PFILE ASSIGNMENT.

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Figure 5-4. FORTRAN I/O Execution Sequences

```
/ASSIGN,PI=50
/PFILE,4,X,FILE1
/EXECC
```

Case 3, normal RMD file executing in foreground or background: the CALL V$OPEN statement associates any specified RMD file with the FORTRAN unit number. The CALL V$OPEN statement overrides any /PFILE assignment (case 2). The format of the statement is:

CALL V$OPEN(fun,lun,name,mode)

where

fun is the name or number of the FORTRAN unit which must be a numeric value, defined by a DATA statement, or an assignment statement

lun is the name or number of the logical unit which must be a numberic value, defined by a DATA statement, or an assignment statement

name is the name of the 13-word array containing the file name and the protection code

mode is the mode of the I/O-control open macro (section 3.5.1)

V$OPEN constructs an FCB in the first ten words of the specified 13-word array, performs an IOC OPEN on this FCB, and links it with the active FCB chain. The remaining three words of the array contain an FCB-chain link, the FORTRAN unit number, and the file logical unit number. Thus, to reference file FIL on logical unit 20 (protection code Q) by the number 2, rewinding upon opening, the job stack can be:

```
.
.
.
/FORT
.
.
.
DIMENSION IFCB(13)
DATA IFCB(3)/2H Q/
DATA IFCB(8),IFCB(9),IFCB(10)/2HFI,2HL ,2H /
.
.
.
CALL       V$OPEN(2,20,IFCB,0)
.
.
.
```

File FIL can now be referenced by FORTRAN statements by using 2 as the designation of the FORTRAN logical unit. For instance,

```
READ (2,...
```

executes an IOC READ call, reading from FIL using IFCB as the FCB.

Note: V$OPEN sets the record length to 120 words and the access method to 3, sequential access using relative VORTEX physical record number within the file. The user should not change the record length or access method parameters in the FCB because the FORTRAN Run-Time I/O package has reserved only a 120 word buffer.

Any record in a file opened by V$OPEN can be directly accessed by operating on the FCB array. Thus, using the job stack in the previous example, record 61 in file FIL is read by inputting

```
.
.
.
IFCB(4)=61
READ(2,...
.
.
.
```

To dissolve an existing association between an RMD file and a FORTRAN logical unit, use the CALL V$CLOS statement of the format.

CALL V$CLOS(fun,mode)

where

fun is the name or number of the FORTRAN logical unit

mode is the mode of the I/O-control CLOSE macro (section 3.5.2)

Thus, when the processing of file FIL in the previous example is complete, to close/update FIL and take IFCB off the active FCB chain so that FORTRAN statements with **fun** = 2 no longer reference FIL, the job stack can be:

```
.
.
.
CALL       V$CLOS(2,1)
.
.
.
```

Note: the auxiliary FORTRAN I/O statements REWIND, BACKSPACE, and ENDFILE cannot be used with RMD files. Use instead (where IFCB is the ECB array):

```
IFCB(4) = 1  For rewind
IFCB(4) = IFCB(4) -1 For backspace
CALL V$CLOS(fun, 1)  For endfile
```

Case 4, blocked RMD file executing in foreground or background: the CALL V$OPNB statement associates any specified RMD file with a FORTRAN unit number. This statement overrides any /PFILE statement. The format is:

CALL V$OPNB (fun, lun, name, mode, recsz, buff, rbwfl)

where

fun is the name or number of the FORTRAN unit which must be a numeric value, defined in a DATA statement or an assignment statement

lun is the name or number of the file logical unit which must be a numeric value, defined in a DATA statement or an assignment statement

name is the name of a 14-word FCB array

mode is the mode of the I/O control OPEN macro

recsz is the logical record size in words

buff is the address of a blocking buffer array

rbwfl is the read-before-write flag

The first parameters are identical in function to those of the CALL V$OPEN statement. The other three specify blocking information.

An RMD file opened by a CALL V$OPNB statement is processed as though it were a consecutive series of logical records, each one **recsz** words in length. These logical records continue across physical record boundaries with no space wasted (except possibly at the end of file). Input and output is buffered through the user-supplied buffer array **buff** as specified above.

Since actual physical I/O is performed on **buff**, the file must be large enough to do I/O on the end of the last logical record. It is sufficient to allocate RMD space for one more logical record than will ever be used.

It is the user's responsibility to declare the size of the buffer array **buff** sufficiently large, remembering that it is a function of the logical record size **recsz**, that it must be a multiple of the basic record size of 120, and that it must be large enough to include enough basic 120-word physical records to cover a logical record, even though the physical record may overlap the physical record boundaries. The following tables specify all conditions, where:

Q(x/y) means the quotient of x/y
R(x/y) means the remainder of x/y

recsz < 120

R(120/**recsz**)	Size of Array **Buff**
= 0	120 words
≠ 0	240 words

recsz ≥ 120

R(**recsz**/120)	Size of Array **Buff**
= 0	recsz
= 1	120 * (1 + Q(**recsz**/120))
> 1	120 * (2 + Q(**recsz**/120))

If **recsz** is not a multiple or factor of 120 words, the blocking buffer **buff** must allow room for an extra 120-word physical record at the start or end of a logical record.

On a WRITE operation where **recsz** is not a multiple of 120 words, data on the RMD can be overwritten unless a read-before-write is performed. In some situations, such as initial file creation in a strictly sequential fashion, this is unnecessary and slow.

The parameter **rbwfl** allows the user to select this feature. If **rbwfl** is zero, read-before-write is disabled. Any non-zero value enables read-before-write.

Example: An RMD file opened by CALL V$OPNB can be accessed randomly, as with CALL V$OPEN, by a replacement statement using the logical record number.

```
/FORT
 DIMENSION IFCB(14),IBUFF(120)
DATA IFCB(3),IFCB(8),IFCB(9),IFCB(10)
    /0,2HBL,2HFI,2HLE/
CALL V$OPNB(2, 10, IFCB, 0, 10, IBUFF, 1)
IFCB(4) = 5
READ (2) I
READ (2) J
```

This sequence causes the unkeyed file name BLFILE on logical unit 10 to be opened and assigned FORTRAN unit number 2. The first READ statement causes the entire first 120-word physical record (first 12 logical records) to be input into blocking buffer IBUFF, and the first word of the fifth logical record to be transferred to I . The second READ would not require another physical input for record 6 in IBUFF. This READ statement would simply transfer the first word of logical record 6 to J.

To flush the blocking buffer, close the file and disassociate the FORTRAN and logical unit numbers the CALL V$CLSB statement is provided. Its format is:

CALL V$CLSB (fun,mode)

where

fun is the FORTRAN unit number

mode is the mode of the I/O control CLOSE macro

The end-of-file information in a FILE NAME DIRECTORY refers to a physical 120-word record number. Therefore, if logical record size is not a multiple of 120 words, the user may need to define his own end-of-file mark. Close and Update, Open and Leave, and IOCHK (section 5.3.4) EOF features all operate on this File Name Directory parameter referring strictly to 120-word physical record numbers.

5.3.3 Runtime I/O Exceptions

The FORTRAN runtime I/O program allows a program to detect I/O errors and end-of-file or end-of-device conditions. Status of a READ or WRITE operation is available immediately after the operation is complete and before another I/O operation is executed. This status can be checked by executing a subroutine or function call in the form.

CALL IOCHK(status)

where status is the name of an integer variable which is to receive the result of the status check.

If the last I/O operation had been completed normally, the value of zero will be returned. If an error had occurred, the value minus one is returned. If either an end-of-file or an end-of-device had occurred, the value positive one will be returned.

The status may be checked and the result tested in a single statement by use of the form:

IF (IOCHK(status)) label(1), label(2), label(3)

where

status is the name of an integer variable which receives the result of the status check. A value of zero indicates normal completion. A negative non-zero value indicates an error. A positive non-zero value indicates EOF or EOD.

label(1) is a statement label to which control is transferred, if an I/O error occurred.

label(2) is a statement label to which control is to be transferred if the operation was completed normally.

label(3) is a statement label to which control is transferred, if an end-of-file or end-of-device was encountered.

If the program does not check the status of a READ or WRITE operation in which an error occurs, FORTRAN will abort execution of the task upon the next entry to the runtime I/O routine. At that time the diagnostic message will be output to the System Output device. Any data which is input to a read in which an error occurred will be invalid. After a call to IOCHK is executed, any error status is reset and the program may proceed with additional input and/or output.

5.3.4 Reentrant Runtime I/O

The VORTEX runtime I/O program processes all FORTRAN READ, WRITE, auxiliary I/O, and open and close statements at execution time. It is composed of two modules, V$FORTIO and the reentrant task V$RERR. Both are in the OM library. V$RERR is also in the nucleus portion of the SGL. SGEN then automatically loads V$RERR in the VORTEX nucleus, and all FORTRAN programs automatically link to it. If V$RERR is not desired in the VORTEX nucleus, the SGEN directive DEL, V$RERR must be entered during system generation. Each FORTRAN program will then get its own copy of V$RERR from the OM library. V$RERR is approximately 3K words long.

5.4 RPG IV COMPILER

5.4.1 Introduction

The VORTEX RPG IV System is a software package for general data processing applications. It combines verstile file and record defining capabilities with powerful processing statements to solve a wide range of applications. It is particularly effective in processing data for reports. The VORTEX RPG IV system consists of the RPG IV compiler and RPG IV runtime/loader program.

The VORTEX RPG IV compiler and the runtime/loader execute as level zero background programs in unprotected memory. Both the compiler and the runtime/loader will operate in 6K of memory with limited work stack space. The stack space may be expanded and consequently larger RPG programs compiled and executed by use of the /MEM directive.

The RPG IV language and its compilation and execution under VORTEX are described in the Sperry Univac 70/620 RPG IV User's Manual (98A 9947 03x).

Error messages applicable to the RPG IV compiler are given in Appendix A.

5.4.2 RPG IV I/O Units

The RPG IV compiler reads source records from the Processor Input (PI) file, write object records on the Binary Output (BO) file, and lists the source program on the List Output (LO) file.

The RPG IV runtime/loader will normally load the RPG object program from the Binary Input (BI) file. When the program executes, the READ CARD, PUNCH and PRINT statements are performed on logical units 13, 14, and 15 respectively, statements for performing input and output to logical units 16 through 22.

5.4.3 Compiler and Runtime Execution

The RPG compiler and the runtime package should be cataloged into the background library (BL) using LMGEN.

The compiler and runtime package should be defined as background unprotected tasks with the names PRGC and RPGRT, respectively.

The compiler is scheduled from the background library by the directive

```
/LOAD,RPGC
```

The compiler terminates when the required END statement in the RPG program is encountered. The compiler exits to the executive. There is no provision for stacking multiple compilations or for operating in compile-and-go mode.

The compiler rewinds the PI, BO, and LO files at the beginning of the compilation.

The runtime/loader is scheduled from the background library by the directive

```
/LOAD,RPGRT
```

The loader expects the RPG object program is on the Binary Input (BI), and loads and executes it. If the load directive contains the name of an RPG program to be loaded in the form,

```
/LOAD,RPGRT,name
```

the runtime/loader will assume the program mentioned is in the background library and will load it from there. An RPG object program may be 'cataloged' into the background library by creating a directory entry and allocating file space with FMAIN and copying the RPG object program into the file with IOUTIL.

5.5 RPG II COMPILER

5.5.1 Introduction

The VORTEX RPG II System is an industry compatible software package for general data processing applications. It combines versatile file and record defining capabilities with powerful processing statements to solve a wide range of applications. It is particulary effective in processing data for reports. The VORTEX RPG II system consists of the RPG II compiler and RPG II runtime interpreter.

The VORTEX RPG II compiler executes as a level one background program in unprotected memory. The compiler will operate in 4K of memory with limited work space. The work space may be expanded and consequently larger RPG programs may be compiled by use of the /MEM directive.

The RPG II language, and its compilation and execution under VORTEX is described in the RPG II User's Manual.

5.5.2 RPG II I/O Units

The RPG II compiler reads source records from the Processor Input (PI) file, writes object records on the Binary Output (BO) file, and lists the source program on the List Output (LO) file. Optionally, object records may be written on the GO file.

5.5.3 Compiler and Runtime Execution

The RPG II compiler and the runtime package should be cataloged into the background library (BL) using LMGEN.

The compiler and runtime package should be defined as a background unprotected task, with the name RPG.

The compiler is scheduled from the background library by the directive:

```
/RPG
```

The compiler terminates when the required /* statement in the RPG program is encountered. The compiler exits to the executive. There is no provision for stacking multiple compilations or for operating in compile-and-go mode.

The compiler rewinds PI, BO, and LO files at the beginning of the compilation.

An RPG object program may be 'cataloged' into the background library by creating a directory entry and allocating file space with FMAIN and copying the RPG object program into the file with IOUTIL.

SECTION 6
LOAD-MODULE GENERATOR

The **load-module generator** (**LMGEN**) is a background task that generates background and foreground tasks from relocatable object modules. The tasks can be generated with or without overlays, and are in a form called **load modules**.

To be scheduled for execution within the VORTEX operating system, all tasks must be generated as load modules.

6.1 ORGANIZATION

LMGEN is scheduled for execution by inputting the job-control processor (JCP) directive /LMGEN (section 4.2.19).

LMGEN has a symbol-table area for 200 symbols at five words per symbol. To increase this area, input a /MEM directive (section 4.2.5), where each 512-word block will enlarge the capacity of the table by 100 symbols.

INPUTS to the LMGEN comprise:

- *Load-module generator directives* (section 6.2) input through the SI logical unit.
- *Relocatable object modules* from which the load module is generated.
- *Error-recovery inputs* entered via the SO logical unit.

Load-module generator directives define the load module to be generated. They specify the task types (unprotected background or protected foreground) and the locations of the object modules to be used for generation of the load modules. The directives supply information for the cataloging of files, i.e., for storage of the files and the generation of file-directory entries for them. LMGEN directives also provide overlay and loading information. The directives are input through the SI logical unit and listed on the LO logical unit. If the SI logical unit is a Teletype or a CRT device, the message **LM**** is output on it to indicate that the SI unit is waiting for LMGEN input.

Relocatable object modules are used by LMGEN to generate the load modules. The outputs from both the DAS MR assembler and the FORTRAN compiler are in the form of relocatable object modules. Relocatable object modules can reside on any VORTEX system logical unit and are loaded until an end-of-file mark is found. The last execution address encountered while generating a segment (root or overlay, section 6.1.1) becomes the execution address for that segment. (**Note:** If the load module being generated is a foreground task, no object module loaded can contain instructions that use addressing modes utilizing the first 2K of memory, other than the base page (page 0). No assembler generated indirects or literals are allowed.

A VORTEX physical record on an RMD is 120 words. Object-module records are blocked two 60-word records per VORTEX physical record. However, in the case of an RMD assigned as the SI logical unit, object modules are not blocked but assumed to be one object module record per physical record.

Error-recovery inputs are entered by the operator on the SO logical unit to recover from errors in load-module generation. Error messages applicable to this component are given in Appendix A.6.

Recovery from the type of error represented by invalid directives or parameters is by either of the following:

a. Input the character C on the SO unit, thus directing LMGEN to go to the SI unit for the next directive.

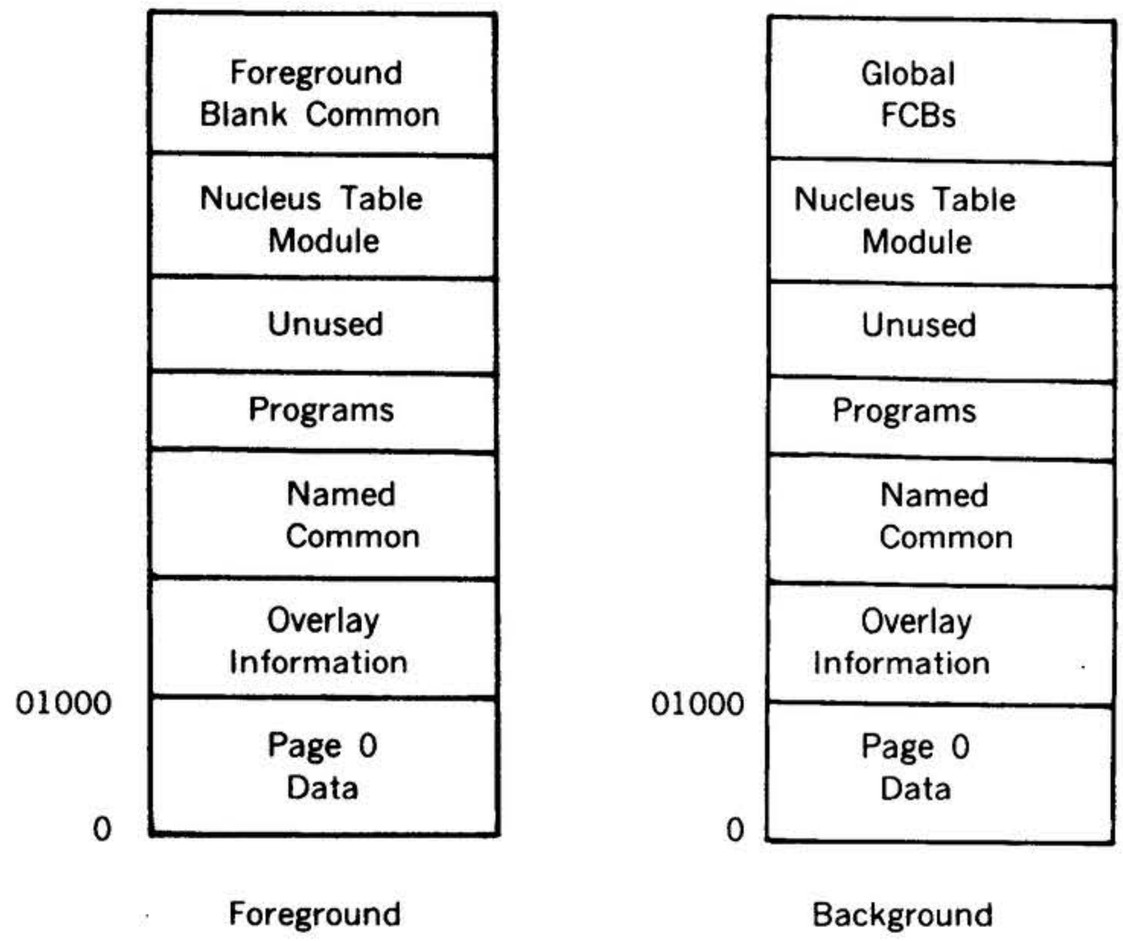
b. Input the corrected directive on the SO unit for processing. The next LMGEN directive is then input from the SI unit.

If recovery is not desired, input a JCP directive (section 4.2) on the SO unit to abort the LMGEN task and schedule the JCP for execution. (**Note:** An irrecoverable error, e.g., I/O device failure, causes LMGEN to abort. Examine the I/O error messages and directive inputs to determine the source of such an error.)

OUTPUTS from the LMGEN comprise:

- *Load modules* generated by the LMGEN
- *Error messages*
- *Load-module maps* output upon completion of a load-module generation

Load modules are LMGEN-generated absolute or relocatable tasks with or without overlays. They contain all information required for execution under the VORTEX operating system. During their generation, LMGEN uses the SW logical unit as a work unit. Upon completion of the load-module generation, the module is thus resident on the SW unit. LMGEN can then specify that the module be cataloged on another unit, if required, and output the load module to that unit. Figure 6-1 shows the structure of a load module.



All foreground tasks share the foreground blank common area but may have their own named common area.

Figure 6-1. Load-Module Overlay Structure (virtual memory)

Note: LMGEN locks out the partition while it is modifying the directory.

Error messages applicable to the load-module generator are output on the SO and LO logical units. The individual messages, errors, and possible recovery actions are given in appendix A.6.

Error messages which apply to problems with a particular object module will include the title of the object module to which the error relates.

Load-module maps are output on the LO logical unit upon completion of the load-module generation, unless suppressed. The maps show all entry and external names and labeled data blocks. They also describe the items given as defined or undefined, and as absolute or relocatable, and indicate the relative location of the items. The load-module map lists the items in the format, four entries per line:

Print position	2 3 4 5 6 7 8	9	10	11	12 13 14 15 16
	item	*b*	*x*	*b*	*location*

where

item is a left-justified entry or external name or labeled data block

b is a blank

x is A for an absolute or R for a relocatable item

location is the left-justified relative location of the item

The load-module map is sorted in alphabetical order (right justified) by default. An additional numerically sorted map may be output by specifying the 'N' option (see section 4.2.19).

The following appear at the end of the LMGEN map.

[$IAP]	Top of indirect address pool, which begins at 0500
[$LIT]	Bottom of literal pool, which begins at 0777
[$PED]	Last loaded location. Foreground, word size of load module. Background, last location loaded (loading begins at 01000).

LMGEN performs special handling for an external of the form 'V$PED'. LMGEN satisfies this external with the last loaded location plus one of the load modules for both overlayed and non-overlayed tasks. This external can be used for specifying table areas behind tasks that link with external routines. V$PED cannot be used in an overlay segment of an overlayed module.

6.1.1 Overlays

Load modules can be generated with or without overlays. Load modules with overlays are generated when task requirements exceed core allocation. In this case, the task is divided into overlay segments that can be called as required. Load modules with overlays are generated by use of the OV directive (section 6.2.3) and comprise a root segment and two or more overlay segments (figure 6-1), but only the root segment and one overlay segment can be in memory at any given time. Overlays can contain executable codes, data, or both.

When a load module with overlays is loaded, control transfers to the root segment, which is in main memory. The root segment can then call overlay segments as required.

Called overlay segments may or may not be executed, depending on the nature of the segment. It can be an executable routine, or it can be a table called for searching or manipulation, for example. Whether or not the segment consists of executable data, it must have an entry point.

The generation of the load module begins with the root segment, but overlay segments can be generated in any order.

The root segment can reference only addresses contained within itself. An overlay segment can reference addresses contained within itself or within the root segment. Thus, all entry points referenced within the root segment or an overlay segment are defined for that segment and segments subordinate to it, if any.

For an explanation of DAS MR and FORTRAN calls to overlays see section 2.1.8.

6.1.2 Common

Common is the area of memory used by linked programs for data storage, i.e., an area common to more than one program. There are two types of common: named common and blank common. (Refer to the FORTRAN IV Reference Manual, document number 98 A 9902 03x, or the DAS MR COMN directive description in the computer handbook, for the system being used.

Named common is contained within a task and is used for communication among the subprograms within that task.

Blank common can be used like named common or for communication among foreground tasks.

The extent of blank common for foreground tasks is determined at system generation time. The size of the foreground blank common can vary within each task without disturbing the positional relationship of entries but cannot exceed the limits set at system generation time.

The extent of blank common for background tasks is allocated within the load module. The size of the background blank common can vary within each task, but the combined area of the load module and common cannot exceed available memory.

Each blank common is accessible only by the corresponding tasks, i.e., foreground tasks use only foreground blank common, and background tasks use only background blank common.

All definitions of named and blank common areas for a given load module must be in the first object module loaded to generate that load module.

6.1.3 Shared Procedures

Load modules can be generated with or without shared procedures. Shared procedures are uniquely defined (shared procedure checksum) by name (1 to 6 ASCII characters), size, logical starting address, and external and entry point resolution. Shared procedures should be reentrant programs with no internal modification.

When a task with shared procedures is initiated, VORTEX will search for a previously loaded shared procedure with the same checksum. If one is found currently loaded, the shared procedure will not be loaded, but the remainder of the task will be loaded and the shared procedure currently in memory will be mapped into the task logical memory space. The shared procedure will be "shared" by two different tasks. Only one copy of the shared procedure will occupy physical memory.

Load module generation with shared procedures has the following restrictions:

a. A load module may have up to ten shared procedures

b. All shared procedures must be loaded before any non-shared object modules

c. Each shared procedure must have no unresolved externals at the completion of shared procedure generation (externals may be satisfied by previously loaded shared procedures or the LIB directive)

d. Generation of a shared procedure is terminated by a LIB directive

e. A load module cannot contain overlays.

6.2 LOAD-MODULE GENERATOR DIRECTIVES

- TIDB Create task-identification block
- LD Load relocatable object modules
- OV Overlay
- LIB Library search
- CLD Load relocatable object modules without re-opening or repositioning
- MEM Default extra memory pages
- SP Create shared procedure
- END

Load-module generator directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between the individual character strings of the directives, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period.

The general form of a load-module generator directive is

name,*p(1)*,*p(2)*,...,*p(n)*

where

name is one of the directive names given above

each *p(n)* (if any) is a parameter required by the directive and defined below under the descriptions of the individual directives

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of the directives, optional periods, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted.

Error messages applicable to load-module generator directives are given in Appendix A.6.

6.2.1 TIDB (Task-Identification Block) Directive

This directive must be input before any other LMGEN directives can be accepted. It permits task scheduling and execution, and specifies the overlay and debugging characteristics of the task. The directive has the general form

TIDB,name,type,segments,*DEBUG*, **ropages**

where

name is the name (1 to 6 ASCII characters) of the task

type is 1 for an unprotected background task on BL, or 2 for a protected foreground task or 3 for a background task on an alternate library

segments is the number (2 to 9999) of overlay segments in a task with overlays, or 0 for a task without overlays (note that the number 1 is invalid)

DEBUG is present when debugging is desired

ropages is an optional ready-only page specifier (1-77). It can be a single number or a range of consecutive numbers (e.g., 3,5).

The *DEBUG* parameter includes the DEBUG object module as part of the task. If the task is a load module without overlays, DEBUG is the last object module loaded. If the task is a load module with overlays, DEBUG is the last object module loaded in the root segment (section 6.1.1).

The **ropage** parameter allows specification of a range of virtual pages as read-only.

Examples: Specify an unprotected background task named DUMP as having no overlays but with debugging capability.

```
TIDB,DUMP,1,0,DEBUG
```

Specify a protected foreground task named PROC as having a root segment and four overlay segments.

```
TIDB,PROC,2,4
```

6.2.2 LD (Load) Directive

This directive specifies the logical unit from which relocatable object modules are to be loaded. It has the general form

LD,lun,*key,file*

for loading from RMD logical units, and

LD,lun

for loading from any other logical unit, where

lun	is the name or number of the logical unit where the object module resides
key	is the protection code required to address **lun**
file	is the name of the RMD file

From the object modules, LMGEN generates load modules (with or without overlays) on the SW logical unit. Loading of object modules from the specified logical unit continues until an end-of-file mark or an end-of-load module record (appendix G.6) is encountered.

Successive LD directives permit the loading of object modules that reside on different logical units. The execution address for the load module is the last encounter execution address.

Examples: Load the relocatable object modules from logical unit 6 (BI) until an end-of-file mark is encountered.

```
LD,6
```

Open a file named DUMP on logical unit 9 (GO) with no protection code. (LMGEN loads the relocatable object modules and closes the file.)

```
LD,9,,DUMP
```

6.2.3 OV (Overlay) Directive

This directive specifies that the named segment is an overlay segment. It has the general form

OV,segname

where **segname** is the name (1 to 6 ASCII characters) of the overlay segment.

Example: Specify SINE as an overlay segment.

```
OV,SINE
```

6.2.4 LIB (Library) Directive

This directive indicates that all load (LD, section 6.2.2) directives have been input, i.e., all object modules have been loaded except those required to satisfy undefined externals. LIB also specifies the libraries to be searched (and the order in which the search is made) to satisfy all undefined externals. The directive has the general form

LIB,*lun(1)*,*key(1)*,*lun(2)*,*key(2)*,...,*lun(n)*,*key(n)*

where

each *lun(n)*	is the name or number of a resident-library RMD logical unit to be searched
each *key(n)*	is the protection code required to address the preceding logical unit

The search is conducted in the order in which the logical units are given in the LIB directive. When not specified by LIB, the core-resident (CL) and object-module (OM) libraries are searched after all specified libraries have been searched. However, if LIB specifies the CL and/or OM libraries, they are searched in the order given in LIB.

If the generation of the load module involves overlays, a LIB directive follows each overlay generation.

Examples: Specify to the LMGEN a sequence of libraries to be searched to satisfy undefined externals. Use logical unit 116, a user library, having protection code M; followed by logical unit 103, the CL library, having protection code C; and the OM library, having protection code D. (Because the last two libraries are searched in any case, note that the two inputs following are equivalent.)

```
LIB,116,M,103,C,104,D
```

or, more briefly,

```
LIB,116,M
```

To change the order of search to logical units 104, 115, and 103, input

```
LIB,104,D,116,M,103,C
```

or, more briefly,

```
LIB,104,D,116,M
```

To search only the CL and OM libraries to satisfy undefined externals, input

```
LIB
```

(OM is searched before CL)

6.2.5 END Directive

This directive terminates the generation of the load module and, if specified, causes the creation of a file and a directory entry (section 9) for the load-module contents on the indicated logical unit. The indicated logical unit, if any, is an RMD, and thus may require a protection code. The directive has the general form

END,*lun*,*key*

where

lun	is the name or number of the logical unit on which the file containing the load module will reside
key	is the protection code, if any, required to address *lun*

If TIDB (section 6.2.1) specified an unprotected background task (TIDB directive **type** = 1), the logical unit, if any, specified by the END directive must be that of the BL unit, i.e., unit 105. If TIDB specified a protected foreground task (TIDB directive **type** = 2), the logical unit, if any, specified by the END directive must be that of the FL unit, i.e., unit 106, or that of any available assigned RMD partition. If TIDB specified an alternate library background task (TIDB directive type = 3), the logical unit, if any, specified by the END directive, may be that of any available assigned RMD partition.

If the END directive does not specify a logical unit, the load module resides on the SW logical unit only.

If there are still undefined externals, the load module is not cataloged even if END specifies a legal logical unit. In this case, the load module resides on the SW unit only.

Examples: Specify that the load module is complete (no more inputs to be made), create a file and a directory entry on the BL logical unit (105), and catalog the module. The protection code is E. (**Note:** The load module will also reside on the SW unit.)

```
END,105,E
```

Specify that the load module is complete (no more inputs to be made) and is to reside on the SW unit only.

```
END
```

6.2.6 CLD Directive

This directive specifies the logical unit from which relocatable object modules are to be loaded. It has the general forms

CLD,lun,*key,file*

or

CLD,lun

Where use of the two forms and the meaning of lun, key, and file is as for the LD directive (section 6.2.2). This directive specifies the same action as for the LD directive except that successive CLD directives do not cause reopening or repositioning of the specified logical unit.

6.2.7 MEM (Memory) Directive

This optional directive is used to specify the default number of extra memory blocks to be attached to a background task in a similar manner to the /MEM directive of JCP. This value is in addition to a /MEM request and is stored in word 12 of the task's pseudo TIDB. The directive has the general form

MEM,n

where

n	is the number of 512 word blocks (pages)

This directive, if used, must appear after the last LIB directive and before the END directive.

6.2.8 SP (Shared Procedure) Directive

This directive specifies that a shared procedure is to be generated as part of the load module. It has the general form

SP,name

where

name	is the name (1 to 6 ASCII characters) of the shared procedure

Example: Specify AIDX as the name of the shared procedure.

```
SP,AIDX
```

6.3 SAMPLE DECKS FOR LMGEN OPERATIONS

Example 1: Card and Teletype Input

Generate a background task without overlays using LMGEN with control records input from the Teletype and object module(s) on cards. Assign the BI logical unit to card reader unit CR00. Assign the task name EXC4 and catalog to the BL logical unit, and load DEBUG as part of the task from the OM library.

```
/JOB,EXAMPLE4          (Teletype input)
/ASSIGN,BI=CR00
/LMGEN
TIDB,EXC4,1,0,DEBUG
LD,BI
LIB
END,BL,E
/ENDJOB
```

Note: The object module deck must be followed by an end of file (2-7-8-9 in card column 1).

Example 2: Card Input

Generate a foreground task with overlays using LMGEN with control records and object modules input from the card reader. Assign the BI and SI logical units to card reader unit CR00. Assign the task name EXC5, overlay names SGM1, SGM2, and SGM3, and catalog to the FL logical unit.

```
/JOB,EXAMPLE5
/ASSIGN,BI=CR00,SI=CR00
      •
    (Deck)
      •
/LMGEN
TIDB,EXC5,2,3
LD,BI
(Object Module(s) -- root segment)
  (End of File)
LIB
OV,SGM1
LD,BI
(Object Module(s))
  (End of File)
LIB
OV,SGM2
LD,BI
(Object Module(s))
  (End of File)
LIB
OV,SGM3
LD,BI
(Object Module(s))
  (End of File)
LIB
END,FL,F
/ENDJOB
```

Example 3: Teletype and RMD Input

Generate a foreground task without overlays using LMGEN with control records input from the Teletype and object module(s) from an RMD. The object module resides on RMD 107 under the name PGEX. Assign the task name EXC6, search the OM library first to satisfy any undefined externals, and catalog on RMD 120.

```
/JOB,EXAMPLE6
/LMGEN
TIDB,EXC6,2,0
LD,107,Z,PGEX
LIB,OM,D
END,120,X
/ENDJOB
```

Example 4: Shared Procedure Generation

Generate a background task with two shared procedures. Control records are input from the Teletype, and object modules from an RMD. The first shared procedure is name PART1 and is comprised of object module PRT10B on RMD 107. The second shared procedure is named PART2 and is comprised of object module PRT20B on RMD 107. The remainder of the object modules are in the card reader. The taskname is SHARED and cataloged to the BL logical unit.

```
/JOB,EXAMPLES
/ASSIGN,BI=CR00
/LMGEN
TIDB,SHARED,1,0
SP,PART1
LD,107,Z,PRT10B
LIB
SP,PART2
LD,107,Z,PRT20B
LIB
LD,BI
LIB
END,BL,E
/ENDJOB
```

6.4 RELINK

RELINK is a background program which is used to "relink" (reestablish VORTEX nucleus pointers) an existing load module with a modified nucleus (one recreated with a SYSGEN and for which changes have been introduced that moved certain nucleus pointers or adresses). The load module may be restored on a library partition by any copy process such as FMUTIL, IOUTIL, or equivalent program. RELINK makes the load module executable on the new system without the need to perform an entire LMGEN process. RELINK needs to be executed only once for each load module after the nucleus has been modified and the load module restored. RELINK may also be used for relinking a load module that has been transferred from another system, e.g. through CPU to CPU data links, on disk pack, or on magnetic tape. This is particularly useful in a master-slave configuration where the slave system is not capable of supporting development activities: programs are compiled and LMGENed on the host system and transferred to the slave system.

RELINK uses a Core Resident Symbol Table (CRST) located at the end of the load module file (this is not part of the user program space) which has been established by LMGEN. RELINK extracts entries from this table and searches for the nucleus pointer name in the system CL directory. When this name is found, RELINK "patches" the appropriate locations in the load module RMD file and continues this process until the CRST table is complete. The VORTEX system loader (V$SAL) does not use the CRST, since the load module has been patched. There is no limit to the number of times an existing load module may be relinked. However, relinking is possible only if all load module referenced nucleus pointers exist on the new system on which the load module is to be relinked.

Note: The RELINK program cannot be used to relink load modules cataloged by SYSGEN (OPCOM, JCP, FMAIN, etc.). It may only be used to relink load modules cataloged by LMGEN. This means that SYSGEN cataloged load modules cannot be transported from one system to another.

RELINK may be executed by JCP command of the form

```
/LOAD,RELINK
```

RELINK will respond with the prompt:

```
LUN,KEY,LD MODULES
```

The user then inputs the name of the load modules that are to be relinked in the format:

```
LUN,KEY,mod name, mod name,...
```

where

LUN	is the logical unit number on which the load module resides (may be lun name)
KEY	is the protection key, if any, required for that LUN
mod name	is the name of the load module on that LUN, or the keyword word "ALL" if all load modules on the specified LUN are to be relinked.

Up to ten mod names may be specified on a single input line; however, the directive may not contain any embedded blanks, since a blank character terminates the directive line processing. All the "mod names" must reside on the specified LUN.

A continuation directive may be used for "mod names" on the previously specified LUN by starting the directive with a comma and omiting the LUN and KEY parameters. A continuation line may not be used as the first directive line. Each directive line is processed before the next directive (either new or continuation) is accepted. If a load module resides on a different LUN, it must be specified by a new directive giving the dirrerent LUN and KEY.

As each load module is relinked, the following message appears on the SO device:

```
**xxxxxx  RELINKED**
```

where

xxxxxx	is the name of the module which has been relinked.

The prompt LUN,KEY,LD MODULES occurs only once.

To exit from RELINK and return to JCP the user may enter the command

```
END
```

If a directive beginning with a slash (/) is encountered, an 1013 diagnostic message is output and RELINK exits.

Example: Relink the load modules PROG1, PROG2, and PROG3 from the background library, and load modules PROG4 and PROG5 from the foreground library.

```
/LOAD,RELINK
LUN,KEY,LD MODULES
BL,E,PROG1,PROG2,PROG3
**PROG1     RELINKED**
**PROG2     RELINKED**
**PROG3     RELINKED**
FL,F,PROG4,PROG5
**PROG4     RELINKED**
**PROG5     RELINKED**
END
```

SECTION 7
DEBUGGING AIDS

The VORTEX II system contains two debugging aids: the *debugging program (DEBUG)* and the *snapshot dump program (SNAP)*.

7.1 DEBUGGING PROGRAM

The 1414-word VORTEX debugging program (DEBUG) is added to a task load module whenever the DEBUG option is specified by a load-module generator TIDB directive (section 6.2.1). The DEBUG object module is the last object module loaded of the root segment if the task is an overlay load module. The load-module generator sets the load-module execution address equal to that of DEBUG.

If DEBUG has been attached to the load module, DEBUG will execute when the load module is loaded or scheduled.

During the execution of DEBUG, the A, B, and X pseudoregisters save the contents of the real A, B, and X registers, and restore the contents of these registers before terminating DEBUG. If the task uses V75, registers, the contents of R3 through R7 are also saved and restored.

When debugging is complete, the input of any job-control directive (section 4.2) returns control to the VORTEX system.

INPUTS to DEBUG comprise the directives summarized in table 7-1 input through the DI logical unit. When DEBUG is first entered, it outputs on the Teletype or CRT device the message **DG**** followed by the TIDB task name and the address of the first allocatable memory cell. This message indicates that the system is ready to accept DEBUG directives on the DI unit.

Table 7-1. DEBUG Directives

Directive	Description
A	Display and change the contents of the A pseudoregister
Ax	Change, but do not display, the contents of the A pseudoregister
B	Display and change the contents of the B pseudoregister
Bx	Change, but do not display, the contents of the B pseudoregister
***Rn**	Display and change the contents of the V75 register n (n = 0-7).
***Rnx**	Change, but do not display, the contents of the V75 register n.
Cx	Display and change the contents of memory address x
Fx	Set base address to value of x
Gx	Load the contents of the pseudoregisters into the respective A, B, and X registers, and transfer to memory address x
Ix,y,z	Initialize memory addresses x through y with the value of z
O	Display and change the overflow indicator
P	Read DEBUG directives from BI unit until EOF
QC	Clear all traps and restore original contents to trap cells
QL	Display current trap locations
QSv,w,x,y,z	Place traps at memory addresses v,w,x,y,z
Sx,y,z,m	Search memory addresses x through y for the z value, using mask m
Ty,x	Place a trap at memory address y, starting execution at address x

Table 7-1. DEBUG Directives *(continued)*

Directive	Description
Ty	Place a trap at memory address y, starting execution at the last trap location
X	Display and change the contents of the X pseudoregister
Xy	Change, but do not display, the contents of the X pseudoregister
xxxxxx	Display the contents of memory address xxxxxx
xxxxxx,yyyyyy	Display the contents of memory addresses xxxxxx through yyyyyy

* = V75 systems only

Each DEBUG directive has from 0 to 72 characters and is terminated by a carriage return. Directive parameters are separated by commas, but DEBUG treats commas, periods, and equal signs as delimiters.

Numerical data are always interpreted as octal by DEBUG. Negative numbers are accepted, but they are converted to their two's complements by DEBUG.

The user may specify a "base address" using the F command. The purpose of this command is to allow the use of relocatable addresses in DEBUG. If the base address is set to the load address of the program being debugged, all subsequent DEBUG directive address parameters will have this base address added before accessing memory. Thus,an absolute location may be accessed by specifying its relocatable address. Also, all addresses output on the DO logical unit will be relocatable addresses, not absolute addresses.

The default value for the base address is zero, allowing the use of absolute addressing. Although the base address can be changed at any time, to avoid confusion, the user should set the base address as desired at the start of the debugging operation and not modify it thereafter.

The base address can be used in a change command which sets (but does not display) memory locations. The parameters to which the base address is to be added should specify a "*+" before the numerical data. These parameters (normally representing relocatable addresses) will have the base address added before storing in memory.

Traps may be placed at as many as five memory addresses. If a QS or T command attempts to place a trap where one already exists, the trap is left in place and processing continues. An attempt to set more than five different traps will result in the rejection of th command and the issuance of an error message.

An error message, EX20-EX25, is output and the task is aborted, if a memory-map protection violation occurs.

OUTPUTS from DEBUG consist of corrections to registers and memory, displays, listings on the DO logical unit, and error messages. Numerical data are always to be interpreted as octal.

Error messages applicable to the debugging program are given in Appendix A.7.

Examples of DEBUG directive usage: Note that, in the following examples, operator inputs are in **bold** type. Entries in *italics*, are program responses to the directives.

Display the contents of a pseudoregister A:

A
(001200)

Display and change the contents of a pseudoregister B:

B
(001200) **010406**

Change, but do not display, the contents of a pseudoregister X:

X02050

Display, but do not change, the status of the overflow indicator:

O
(000001)

Display and change the status of the overflow indicator:

O
(000000) **000001**

Display, but do not change, the contents of memory address 002050:

C002050
(102401)

Display and change the contents of memory address 002050:

C002050
(102401)
001234

Display and change the contents of memory address 002050, then display the contents of the next sequential location:

C002050
001234, *(102401)*
(000067)

Display, but do not change, the contents of memory address 002050, then display the contents of the next location:

C002050
(102401),
(000067)

Change, but do not display the contents of memory addresses 002050 through 002053:

C002050,001234,005526,000123,007777

Change, but do not display, the contents of memory addresses 002050 through 002052. Specify the base address to be added to the changed contents of the second location:

C002050,001000,*+001123,177776

Set base address to 0010000:

F001000

Load the contents of the pseudoregisters into the respective A, B, and X registers, and start execution at memory address 001001:

G001001

Initialize memory addresses 000200 through 000210 to the value 077777:

I000200,000210,077777

Set traps at memory adresses 001248,001265, 001154, 001331, and 001475, then return control to DEBUG:

QS001248,001265,001154,001331,001475

List current trap locations:

QL
001248 001265 001154 001331 001475

Clear all traps and restore original contents to trap locations:

QC

Search memory addresses 000200 through 000240 for the value 000110 using the mask 000770, and display addresses that compare:

S000200,000240,000110,000770
000220 (017110)
000234 (000110)
000237 (001110)

Load the contents of the pseudoregisters and the overflow indicator status into the respective registers, and start execution at memory address 001234, specifying a trap address of 001236. Display the contents of the A, B, and X registers and the setting of the overflow indicator when the trap address is encountered:

T001236,001234
001236 (142340) 002000 010405 012345 000001

Execute the same trap if the task uses V75 instructions (assuming Rn = n):

T001236,001234
001236 (142340) 002000 010405 012345 000001
000003 000004 000005 000006 000007

Display the contents of memory address 001234:

001234
(001200)

Display the contents of memory addresses 001234 through 001237:

001234,001237
001230 005000 - - - - - - 005000
Total of 8 values

7.2 SNAPSHOT DUMP PROGRAM

The 294-word **snapshot dump program (SNAP)** provides on the DO logical unit both register displays and the contents of specified areas of memory. It is added to a task load module if the task contains a SNAP request and calls the SNAP external routine. SNAP is entered directly upon execution of the SNAP display request CALL SNAP. The SNAP display request is an integral part of the task and is assembled with the task directives. Thus, no external intervention is required to output a SNAP display.

SNAP outputs the message **SN**** followed by the task TIDB name before listing the requested items. The calling sequence for a SNAP display is

```
        EXT     SNAP
        CALL    SNAP
        DATA    start
        DATA    end
        DATA    tidb
```

where

start is the first address whose contents are to be displayed

end is the last address whose contents are to be displayed

tidb is less than zero if dump of task TIDB is desired, is positive if TIDB dump is to be suppressed

If **start** is a negative number, there is no memory dump. If more than one location is specified to be displayed, the output dump will be in complete lines of eight addresses, e.g., if **start** is 01231 and **end** is 01236, the dump will display the contents of addresses 01230 through 01237, inclusive. SNAP displays octal data.

If there is an error in the SNAP display request, only the contents of the A, B, and X (and V75 if present) registers and the setting of the overflow indicator are displayed.

Output examples: with the snap request at 01234, display the contents of the A (017770), B (001244), and X (037576) registers, and the overflow indicator (on).

```
 SN** TASK01
 001234 017770 001244 037576 000001
*000003 000004 000005 000006 000007
```

Using the same data, display, in addition, the contents of memory addresses 001002 through 001025, inclusive and request a dump of the active TIDB.

```
 SN**  SW       000500
 001023   000000    000000    001023    000000
*000003   000004    000005    000006    000007

 TIDB LOC 055013 =CONTENTS=
 055010   000000    000000    000000    000000    000001    000000    000000    001527
 055020   001527    067001    001326    141146    001000    065604    000007    001302
 055030   000001    001541    000002    000000    002000    151727    120240    120240
 055040   000500    000000    074627    064604    055075    000003    000004    000005
*055050   000006    000007    000000    000000    000000    000000    000000    000000

 SNAP DUMP
 001000   006505    070275    001402    001031    000050    006505    066270    100000
 001010   010002    075334    000000    000000    006505    070137    001005    001101
 001020   001101    001101    001014    002000    001107    001000    001027    001000
```

* These lines appear only if the task uses V75 register

7.3 SYSTEM MEMORY DUMP

The system memory dump facility consists of the following three major components:

- DSYSTM and VZRMm (nucleus resident)
- DSPMEM (background task)
- FILINT (foreground task)

These components combine to provide the user with a system memory dump under three conditions:

a. pre-determined occurrence of an error

b. at any time by use of the CPU console interrupt

c. upon a system halt

The general run of events leading up to a system memory dump are:

a. The foreground task FILINT is activated upon system boot, opening the appropriate RMD dump file and transferring control to a portion of the nucleus task DMEMRY, which saves the RMD set-up information for later use. Control then returns to FILINT, which exits.

b. Upon a selected condition (as mentioned above), the VORTEX system passes control to DSYSTM, which shuts down VORTEX and dumps all assigned maps to the previously opened RMD file via a standalone RMD driver VZRMm. Upon completion of the dump, DSYSTM updates the file number, activates FILINT, and reactivates VORTEX.

c. FILINT then outputs the dump file used to the OC devices and opens the next sequential file. If all files have been used, FILINT returns to the first file.

d. The user may, at some later point in time, examine the selected dump file via the background program DSPMEM.

7.3.1 DSPMEM Program

DSPMEM is a background utility program used to display the contents of the dump image file created by the VORTEX II nucleus program DSYSTM. The contents of the file are formatted and output to the system LO device. DSPMEM is controlled by directives input from the system SI device.

DSPMEM is scheduled using the JCP command

/LOAD,DSPMEM

7.3.2 DSPMEM Directives

The following are DSPMEM directives:

- FIL
- TID
- TSK
- END

DSPMEM directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas. Embedded blanks are not allowed. The occurrence of the first blank terminates the directive. The general form of the directive is

name,p(1),p(2),p(3)

where

name	is one of the directive names given above
each **p(n)**	is a parameter required by the individual directive (if any exists) described below.

Error messages applicable to DSPMEM are given in appendix A.7.

7.3.2.1 FIL (Image File) Directive

This directive must be input before using either the TID or TSK directives. It is used to specify the image file to which the TID and TSK directives apply, and has the general form

FIL,name

where

name is the image file name to be examined.

No further FIL directives are needed until it is desired to examine a different image file. The status at dump time is output to LO in the format

```
EX22 ERROR IN TASK   DEBUG
ADDR= 002476, INST= 056000
A=000003   B=000200   X=002323
3=000000   4=000000   5=000000   6=000000   7=000000
```

Example: Specify image file IMAGE0 to be examined.

```
FIL,IMAGE0
```

7.3.2.2 TID (TIDB) Directive

This directive is used to request a list of one or all TIDBs on the TIDB chain at DMEMRY dump time. The directive has the general form

TID,name

where

name is the TIDB name or address (in octal); or the characters 'ALL', signifying that all TIDBs are to be displayed

Format of the TID directive output is

```
*******DEBUG *******
 011000--TBTHRD= 071640   TBST  = 001421   TBPL  = 040402   TBEVNT= 000000
 011004--TBRSA = 002476   TBRSB = 000000   TBRSX = 011150   TBRSP = 002613
 011010--TBRSTS= 143152   TBENTY= 001000   TBTMS = 071527   TBTMIN= 000000
 011014--TBISA = 001306   TBISB = 000001   TBISX = 001251   TBISP = 001237
 011020--TBISRS= 000000   TBIO  = 000000   TBKN1 = 142305   TBKN2 = 141325
 011024--TBKN3 = 143640   TBTLC = 001000   TBCPTH= 000000   TBATSK= 071767
 011030--TBRSE = 010122   TBSIZ = 006000   TBNUCL= 000001   TBMIMG= 011050
 011034--TBIST = 100041   TBRSR3= 000000   TBRSR4= 000000   TBRSR5= 000000
 011040--TBRSR6= 000000   TBRSR7= 000000   TBISR3= 000000   TBISR4= 000000
 011044--TBISR5= 000000   TBISR6= 000000   TBISR7= 000000
-------------------------------------------------------------------------
```

If the subject TIDB is a driver TIDB, then the first fifteen words of the controller table (if attached) is output in the format

```
CONTROLLER TABLE, FIRST 12 WORDS
 071527--CTTIDB= 173001   CTADNC= 000020   CTOPM = 000047   CTDST = 063460
 071533--CTRQBK= 011000   CTRTY=  000772   CTDVAT= 000001   CTIOA = 000000
 071537--CTSTAT= 000000   CTBICB= 000000   CTFCB = 004364   CTWDS = 000000
```

If request blocks are queued to the controller, then they are output in the format

```
REQUEST BLOCK QUEUED TO CONTROLLER
 011000--RSTPR = 000000  ROPWD = 010002  RFCB  = 004364  RTIDB = 011100
 011004--RADNR = 000000
-------------------------------------------------------------------------
```

Multiple TID directives can be issued to display more than one TIDB. The TIDB of the task specified by the TSK directive is output together with the TSK directive output. The TID directive is thus not needed if a single TIDB is to be displayed and the task is to be displayed using the TSK directive.

Examples: Specify the displaying of all TIDBs at dump time.

```
TID,ALL
```

Specify the displaying of the TIDB for task IOUTIL at dump time.

```
TID,IOUTIL
```

7.3.2.3 TSK (Task) Directive

This directive is used to request a display of a specified task's memory space at dump time. The directive has the general form

TSK,name,p(1),...,p(n)

where

name	is the task TIDB name or address (in octal)
each p(i)	is a dump limit parameter of the following:

P	is dump through program region only
T	to dump through table region only
F	to dump through foreground common only
M	to not dump mapped-in page (MAPIN RTE call)
Sxxx	where xxx is the starting page number (octal or decimal) to dump
Exxx	where xxx is the ending page number (octal or decimal) to dump
V	to exclude the dumping of VNO tasks. Note: this parameter is required to suppress VNO tasks even if P, T, F, or E are specified
blank	to dump entire task space

Parameters P, T, and F are mutually exclusive. The last encountered parameter takes precedence.

The output of the TSK parameter has the format

```
*******DEBUG ********
 011000--TBTHRD= 071640   TBST   = 001421   TBPL   = 040402   TBEVNT= 000000
 011004--TBRSA  = 002476   TBRSB  = 000000   TBRSX  = 011150   TBRSP  = 002613
 011010--TBRSTS= 143152   TBENTY= 001000   TBTMS  = 071527   TBTMIN= 000000
 011014--TBISA  = 001306   TBISB  = 000001   TBISX  = 001251   TBISP  = 001237
 011020--TBISRS= 000000   TBIO   = 000000   TBKN1  = 142305   TBKN2  = 141325
 011024--TBKN3  = 143640   TBTLC  = 001000   TBCPTH= 000000   TBATSK= 071767
 011030--TBRSE  = 010122   TBSIZ  = 006000   TBNUCL= 000001   TBMIMG= 011050
 011034--TBIST  = 100041   TBRSR3= 000000   TBRSR4= 000000   TBRSR5= 000000
 011040--TBRSR6= 000000   TBRSR7= 000000   TBISR3= 000000   TBISR4= 000000
 011044--TBISR5= 000000   TBISR6= 000000   TBISR7= 000000

 MAP 01 TIDB MAP IMAGE
 011050--002000  001002  001003  001004  000000  000000  000000  000000
 **
 011140--000000  000000  000000  000000  000000  000000  000000  000000
```

```
MAP 01 ACTUAL IMAGE AS READ
000000--002000  001002  001003  001004  000000  000000  000000  000000
**
000070--000000  000000  000000  000000  000000  000000  000000  000000


PAGE 00, RP  ACCESS CONTROL, PHYSICAL PAGE 0000
000000--002000  021556  000000  000000  000000  000000  000000  000000
000010--000000  000000  000000  000000  000000  000000  005000  072153
000020--002000  043344  002000  043133  002000  043113  002000  042773
000030--002000  042763  002000  043103  002000  042757  002000  042757
000040--002     1151  001000  043762  002     042724  001403  000000
000050--        2     120240  120240                  000000  000000
```

where (going from top to bottom) the first section is the tasks TIDB contents at dump time, the second section is the TIDB map image as kept in memory, the third section is the map RAM image as read in, the fourth section is the task's memory space at dump time displayed on a page basis, and the fifth section (if a map 0 task and VNO (Virtual Nucleus Overlay) tasks are present) is a dump of all VNO task on a page basis.

Multiple TSK directives can be issued to display more than one task. A task's TIDB address ought to be used, where the specified task has the same TIDB name as another.

Examples: Specify the displaying of the nucleus memory at dump time. Use V$EROR as the task name.

```
TSK,V$EROR
```

Specify the displaying of the program USEROO memory at dump time. Display only the program region and do not display mapped-in pages.

```
TSK,USEROO,M,P
```

7.3.2.4 END Directive

This directive is employed to exit DSPMEM and return to JCP. The directive has the form

```
END
```

There are no parameters to this directive.

7.3.2.5 Usage Considerations

An image file is not protected from being used again before it is examined by DSPMEM. To save a file for later examination, use FMAIN to rename the file to a name other than IMAGEx and then create a new image file to take its place. Note that procedure should not be used if the system only has one dump image file (IMAGE0).

FILINT uses logical unit 190 to open the next dump image file. Attempting to reassign logical unit 190 to another disc partition or another disc unit or type may result in dump errors or possible damage to disc files. Hence do not reassign 190 after VORTEX is active.

7.3.3 System Generation Requirements

The following SYSGEN directives must be used to support the System Memory Dump:

a. Assign logical unit 190 to the RMD partition which is to contain the dump image files. This file must have a protection key of 'Z' or be unprotected. The partition should contain at least 1-1/2 * 5 * n sectors, where **n** is the number of 512-word pages in the system.

b. EQP,RM0x,0,1,0,0 where **x** is the RMD model code for the RMD which is to contain the dump files.

Note: Flexible diskette (F3064) will not support the System Memory Dump. ←

7.3.4 Post SYSGEN Requirements

The following post system generation requirements must be met to support the System Memory Dump:

a. The foreground program FILINT and the background program DSPMEM must be cataloged. This is done by standard VORTEX II job streams.

b. The dump image files must be created by using the following FMAIN directive

```
CREATE,190,Z,IMAGEx,512,n
```

where

- **x** is the file number (0-9), which must be contiguous (i.e., 0,1,2,3) and begin with zero
- **n** is the number of 512-word records required, at least 1-1/2 times the number of pages in the system.

Example: Direct DSYSTM to dump to the DOON partition of a 70-7500 disc, using three dump files on a 96K system.

```
SYSGEN
      EQP,RM0C,0,1,0,0
      PRT,D00N,X,Z
      ASN,190=D00N
```

```
FMAIN
        CREATE,190,Z,IMAGE0,512,288
        CREATE,190,Z,IMAGE1,512,288
        CREATE,190,Z,IMAGE2,512,288
```

7.3.5 Invoking a Dump

A system memory dump may be invoked by using any one of the following three methods.

a. A patch may be made to a nucleus program, causing a call to DSYSTM when a predetermined condition occurs. This is done by inserting a call to DSYSTM. Thus the following patch should to be employed to cause a dump on any EX20-EX24 memory map violation:

```
V$PSTR,CALL,DSYSTM,JMP,V$DISP
V$DSYS,JMP,V$PSTR
```

To use DMEMRY/DCORE instead of DSYSTM use

```
V$PSTR,100747,100444,JMP,DMEMRY
```

b. The console interrupt may be used to cause a dump at any time when VORTEX II is running. By this method, VORTEX II will halt with I = 0444 and

A = dump file number (the 'x' of 'IMAGEx')

B = error code (the 'xx' of 'DMxx', equal to zero if there are no errors; see appendix A.7)

Engaging console run continues VORTEX execution from the point where it was shut down by the pressing of console interrupt.

c. When the system has halted or has "locked up", a DSYSTM dump can be invoked by commencing execution at location zero. The results are the same as for the employment of console interrupt save that the system must be rebooted to bring up VORTEX instead of merely pressing console run.

After each dump (except from a halt or "locked up" system) the dump file name used is output to the OC device and the next sequential file opened. If the dump file just used is the last sequential file, an IO10 diagnostic will occur for FILINT and the first sequential file will be opended. After any dump file is used, it may be examined using DSPMEM at any time until it is used again.

Rebooting the system always re-selects dump image file IMAGE0. To protect dump image file IMAGE0, use the method described in section 7.3.1.6 and then immediately reboot the system. In general, whenever dump image file IMAGE0 is recreated, the system should be rebooted immediately after its recreation.

7.4 INTERMAP DEBUG PROGRAM (V$DBUG)

The Intermap Debug Program (V$DBUG) is a catalogued foreground library program. It requires a VORTEX II system that was generated with the 228 word nucleus module V$FSD. Interaction between V$DBUG and the program being debugged is accomplished by an encoded halt violation. Data may be examined or changed in the task being debugged, in the nucleus (Map 0) area or in a VNO task. When a trap is set, two words of memory in the task being debugged are replaced by an encoded halt (0525), V$DBUG is suspended and the task being debugged is activated. When the trap is reached, the encoded halt is executed. This suspends the task, restores the two words of memory to their originial content, sets the P counter in the tasks TIDB to the execution address contained in the trap command and reactivates V$DBUG. All registers of the task being debugged are available for display. Input to V$DBUG is described below and is entered through the DI logical unit.

Each V$DBUG command has from 0 to 72 characters and is terminated by a carriage return. All numeric inputs are treated as octal if they begin with a zero, otherwise, they are treated as decimal.

The program to be debugged may be scheduled prior to scheduling V$DBUG or it may be a foreground program scheduled by V$DBUG. V$DBUG should be scheduled with a higher priority than the task being debugged. The ;TSTAT command may be used to obtain the TIDB address of an already scheduled task. V$DBUG may be scheduled as follows:

```
;SCHED,V$DBUG,20,FL,F
```

The teletype dialog after V$DBUG is scheduled:

```
DA* ENTER TASK TIDB ADDRESS
```

There are three valid responses. An invalid response causes a DA01 error message and repeats the message.

```
END
```

This will cause V$DBUG to exit.

```
(S,Area [F-User Map, N-Map 0, V-VNO], Task Name)
```

```
(TIDB Address, Area)
```

Links V$DBUG to an already scheduled task.

V$DBUG will then respond with:

```
DA* task name, map image addr
```

Task name and map image address are from the TIDB of the task to be debugged.

At this point, one of the following three entries will be output. Task to be debugged must be re-scheduled if DA** is not output at this point.

DA02 Task Aborted
DA03 Task Exited
DA** Ready for V$DBUG

There are three valid responses to DA** at this point; any other response causes a DA04 error message and repeats the DA** query. The responses are:

END

This causes V$DBUG to exit. You should abort any task scheduled by V$DBUG.

TC

This allows you to display to TIDB of the task being debugged. At this point if the task was scheduled by V$DBUG it is unallocated and unloaded. The TIDB display commands are used following this entry.

OK

Allows use of regualr, not TIDB display, commands.

A 'TC' entry is followed by a DA** and TIDB display commands are allowed. An 'OK' is followed by:

MAP KEY task map key

Map key of task being debugged.

DA**

Regular debug commands may now be entered and a current copy of the task to be debugged's TIDB is available for display.

7.4.1 Regular Commands (following an 'OK' or 'TEND')

The first letter describes the action and the second letter is either part of the action code or an area code. The area codes (F-user map, N-nucleus or Map 0, V-VNO) are indicated by a lower case a in the examples. Parameters for regular commands consist of data and delimiters with no delimiter between the command and the first parameter. Entries are interpreted as follows:

7.4.1.1 Data

First position indicates type and all data must be consistent with type

0 ---- Octal Value

1 - 9 -Decimal Value

@ ---- Base Symbol

Other - CL Directory Symbol

7.4.1.2 Delimiters

Space - End of parameters or command code

+ ---- Add to preceding value

- ---- Subtract from preceding value

' ---- Parameter Separator

---- Cancel the command

7.4.1.3 Alter

A a Start Loc, Data

Data may be up to 7 items separated by commas

7.4.1.4 Set Base Symbol

B a @ One character, Value

There may be up to 10 symbols for each area. @T is automatically set to TIDB address of task being debugged in the appropriate table and does not count against the 10 symbols.

BC@ a

Clears the symbol table for indicated area. An @ instead of an area code will clear all three tables.

BD@ a

Displays the symbol table for indicated area. An @ instead of an area code will display all three tables.

7.4.1.5 Change/Display

C a

Start Loc, Data (up to 7 items separated by commas).

7.4.1.6 Display

D a

Start Loc, Number (1-8 locations may be displayed.)

7.4.1.7 Exit V$DBUG

END

7.4.1.8 Initialize

I a Start Loc, Number (1-6), Data

7.4.1.9 LO Logical Unit Display

LP

(alternate entries start/stop printing on LO logical unit)

7.4.1.10 Memory Dump

MD

(Hook only - VORTEX ALOC to accomplish this will be incorporated when available.)

7.4.1.11 Trap

T a Location, Address

(Command is not allowed following a TX command)

The address is required and changes TBRSP in the TIDB of the task being debugged so that when it is activated again it will go to that address. This action occurs after returning from a trap, not before trap execution.)

Upon completion of the specified trap, register contents are examined by using the TIDB display command (see below) and examining TBRSA-TBRSR7.

7.4.1.12 TIDB Display

TC

allows execution of the TIDB Display commands after obtaining a copy of the task being debugged's TIDB.

7.4.1.13 Transfer Area

Required only for VNO debugging or display (Allows examination of areas outside the task being debugged. This command applies to all following commands which have an area code as the second letter until a 'TEND' command is encountered.)

7.4.1.14 TXO

Zero indicated you wish to examine map 0 (N) data.

7.4.1.15 TXTIDB Addr

A TIDB indicates you wish to examine data in a VNO (V) task area.

7.4.2 TIDB DISPLAY COMMANDS

7.4.2.1 A,B,X,R3-R7,P,O --

These commands display the corresponding word of the TIDB of task being debugged.

7.4.2.2 ALL --

Displays all words of the TIDB of the task being debugged of the above.

7.4.2.3 1 - 39 --

Displays corresponding word of the TIDB

7.4.2.4 TEND --

gets a new copy of the TIDB and allows regular commands.

7.5 THE DMEMRY PROGRAM

The DMEMRY program is a stand-alone VORTEX II map dump program which may be used for "panic dumps" of memory. The DMEMRY program is part of the VORTEX II system generation library and is included in the system as a nucleus resident task at system generation time unless a "DEL,DMEMRY" directive is specified.

7.5.1 Considerations

The following considerations should be noted when using DMEMRY:

- DMEMRY is a nucleus resident task of 02192 words consisting of the DMEMRY module and the DCORE module.
- DMEMRY is a stand-alone program which outputs information to the 70-6701 line printer.
- DMEMRY interfaces with the AID utility. DMEMRY assumes that the starting address of AID is 076000. If the AID utility is not loaded into the system, place a halt instruction at 076000 and set the contents of the A, B, X, and P registers as needed using the console switches.
- DMEMRY operates in a memory mapped environment. If a non-mapped AID function is required (e.g., R0, read magnetic tape 0 into memory), the system must be reset and AID must be re-executed.

7.5.2 DMEMRY Operating Instructions

The DMEMRY program is executed whenever the VORTEX II system is halted. The halt may be unplanned (for example installing a halt instruction in the memory protect processor at V$MP4+5 to cause a halt whenever a memory protect violation is detected) is detected) or planned.

Operating instructions for the DMEMRY program are as follows:

1. When the system halts, start execution at AID (076000).
2. Using the AID utility, start execution at the address of DMEMRY. This starting address is shown on the system generation listing.
3. After DMEMRY execution is started, the following information is printed.
   a. The task where the memory protect violation occurred.
   b. The type of memory protect violation that occurred. Refer to Table 14-1 for additional information.
   c. The location of the error.
   d. The contents of the A, B, and X registers at the time of the memory protect violation.
   e. A dump of all TIDB's. A dump of all queued I/O requests. A dump of 16 words of linked controller tables for drivers. If no I/O has been requested of a driver, the .MEMRY prints the message "CONTROLLER TABLE ADDR. NOT SET BY IOC IN TBRSTS".
   f. Instructions which explain how to obtain a memory dump for a task and the starting address of DCORE.
4. Using the AID utility, place in the X register the TIDB address of the task to be dumped. The TIDB addresses are listed when DMEMRY is invoked.
5. Using the AID utility, start execution of DCORE. The starting address of DCORE is shown on the system generation listing and on the dump printed by DMEMRY.
6. DCORE will list the following information:
   a. The task's map image as saved in memory.
   b. The task's map image as read from the mapping registers.
   c. A memory dump of the assigned logical pages.
   d. The page access mode assignment.

   DCORE will exit to AID when this operation is complete.
7. Repeat steps 4 and 5 for each additional task. Specify V$EROR if a dump of map 0 is required.

SECTION 8
SOURCE EDITOR

The VORTEX operating system **source editor** (**SEDIT**) is a background task that constructs sequenced or listed output files by selectively copying sequences of records from one or more input files. SEDIT operates on the principle of forward-merging of subfiles and has file-positioning capability. The output file can be sequenced and/or listed.

8.1 ORGANIZATION

SEDIT is scheduled by the job-control processor (JCP, section 4.2.17) upon input of the JCP directive /SEDIT. Once activated, SEDIT inputs and executes directives from the SI logical unit until another JCP directive (first character = /) is input, at which time SEDIT terminates and the JCP is again scheduled.

SEDIT has a buffer area for 100 source records in MOVE operations (section 8.2.8). To increase this, input a /MEM directive (section 4.2.5), immediately preceding the /SEDIT directive, where each 512-word block will increase the capacity of the buffer area by 12 source records.

INPUTS to SEDIT comprise:

a. *Source-editor directives* (section 8.2) input through the SI logical unit.

b. *Old source records* input through the IN logical unit.

c. *New or replacement source records* input through the ALT logical unit.

d. *Error-recovery inputs* entered via the SO logical unit.

Source-editor directives specify both the changes to be made in the source records, and the logical units to be used in making these changes. The directives are input through the SI logical unit and listed as read on the LO logical unit, with the VORTEX standard heading at the top of each page. If the SI logical unit is a Teletype or a CRT device, the message **SE**** is output to it before directive input to indicate that the SI unit is waiting for SEDIT input.

There are two groups of source-editor directives: the copying group and the auxiliary group. **The copying group directives** copy or delete source records input on the IN logical unit, merge them with new or replacement source records input on the ALT unit, and output the results on the OUT unit. Copying-group directives must appear in sequence according to their positioning-record number since there is no reverse positioning. If the remainder of the source records on the IN unit are to be copied after all editing is completed, this must be explicitly stated by an FC directive, (section 8.2.9). Ends of file are output only when specified by FC or WE directives (sections 8.2.9 and 8.2.13). The processing of string-editing directives is different from that of record-editing directives. A string-editing directive affects a specified record, where source records on the IN unit are copied onto the OUT unit until the specified record is found and read into memory from the IN unit. After editing, this record remains in memory and is not yet copied onto the OUT unit. This makes possible multiple field-editing operations on a single source record. **The auxiliary group directives** are those used for special I/O or control functions.

All source records, whether old, new, or replacement records, are arranged in blocks of three 40-word records per VORTEX RMD physical record. Any unused portion of the last physical record of an RMD file on the IN unit should be padded with blanks. When necessary, SEDIT will pad the last RMD record on the OUT unit. When the OUT file will contain more than one source module for input to a language processor, the user should insert two blank records after each END statement to insure that each source module starts on a physical record boundary. Record numbers start with 1 and have a maximum of 9999. Sequence numbers start at any value less than the maximum 9999, and can be increased by any integral increment. These specifications for sequence numbers are given by the SE directive (section 8.2.10).

Error-recovery inputs are entered by the operator on the SO logical unit to recover from errors in SEDIT operations. Error messages applicable to this component are given in Appendix A.8. Recovery is by either of the following:

a. Input the character C on the SO unit, thus directing SEDIT to go to the SI unit for the next directive.

b. Input the corrected directive on the SO unit for processing. The next SEDIT directive is then input from the SI unit.

If recovery is not desired, input a JCP directive (section 4.2) on the SO unit to abort the SEDIT task and schedule the JCP for execution. (Note: If there is an I/O control error on the SO unit, SEDIT is terminated automatically.)

OUTPUTS from the SEDIT comprise:

a. *Edited source-record sequences* output on the OUT logical unit.

b. *Error messages*.

c. *The listing of the SEDIT directives* on the LO logical unit.

d. *Comparison outputs* (compare-inputs directive, section 8.2.15).

e. Listing of source records on the LO logical unit when specified by the LI directive (section 8.2.11).

Error messages applicable to SEDIT are output on the SO and LO logical units. The individual messages and errors are given in Appendix A.8.

The listing of the SEDIT directives is made as the directives are read. Source records, when listed, are listed as they are input or output. The VORTEX standard heading appears at the top of each page of the listing.

LOGICAL UNITS referenced by SEDIT are either fixed or reassignable units. The three fixed logical units are:

a. **The SI logical unit**, which is the normal input unit for SEDIT directives.

b. **The SO logical unit**, which is used for error-processing.

c. **The LO logical unit**, which is the output unit for SEDIT listings.

The three reassignable logical units are:

a. **The SEDIT input (IN) logical unit**, which is the normal input unit for source records. This is assigned to the PI logical unit when SEDIT is loaded, but the assignment can be changed by an AS directive with an IN parameter (section 8.2.1).

b. **The SEDIT output (OUT) logical unit**, which is the normal output unit for source records. This is assigned to the PO logical unit when SEDIT is loaded, but the assignment can be changed by an AS directive with an OU parameter.

c. **The SEDIT alternate input (ALT) logical unit**, which is the alternate input unit used for new or replacement source records. This is assigned to the BI logical unit when SEDIT is loaded, but the assignment can be changed by an AS directive with an AL parameter.

Note: If PI, or PO, or BI are assigned to RMD units when SEDIT is loaded, SEDIT will attempt to open files named "PI", or "PO" or "BI" on the respective units. If the file does not exist, an "SE02" error is generated.

8.2 SOURCE-EDITOR DIRECTIVES

This section describes the SEDIT directives:

a. Copying group:
- **AS** Assign logical units
- **AD** Add record(s)
- **SA** Add string
- **REPL** Replace record(s)
- **SR** Replace string
- **DE** Delete record(s)
- **SD** Delete string
- **MO** Move record(s)

b. Auxiliary group:
- **FC** Copy file
- **SE** Sequence records
- **LI** List records
- **GA** Gang-load all records
- **WE** Write end-of-file
- **REWI** Rewind
- **CO** Compare records

SEDIT directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between individual character strings of the directive, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period.

The general form of an SEDIT directive is

name,*p(1)*,*p(2)*,...,*p(n)*

where

name is one of the directive names given above or a longer string beginning with one of the directives names (e.g., AS or ASSIGN)

each *p(n)* is a parameter defined below under the descriptions of the individual directives

Where applicable in the following descriptions, a field specification of the format (**first,last**) or (**n1,n2,n3**) is still separated from other parameters by parentheses even though it is enclosed in commas. Note also that the character string **string** is coded within single quotation marks, which are, of course, neither a part of the string itself nor of the character count for the string.

8.2.1 AS (Assign Logical Units) Directive

This directive specifies a unit assignment for an SEDIT reassignable logical unit (section 8.1). It has the general form

AS,**nn** = **lun**,*key*,*file*

where

nn is **IN** if the directive is making an assignment of the IN logical unit, **OU** if the OUT logical unit, or **AL** if the ALT logical unit

lun is the name or number of the logical unit being assigned as the IN, OUT, or ALT unit

key is the protection code, if any, required to address **lun**

file is the name of an RMD file, if required

If the SEDIT reassignable units are to retain the assignments made when SEDIT was loaded (default assignments: IN = PI, OUT = PO, ALT = BI), no AS direc-

tive is required. Each AS directive can make only one reassignment (e.g., if both IN and OUT are to be reassigned, two AS directives are required).

Any RMD affected by an AS directive is automatically repositioned to beginning of file.

The AS directive merely fixes parameters in I/O control calls within SEDIT. It does not alter I/O control assignments in the logical-unit table (table 3-1).

Note: AS resets the corresponding record counter; however, no physical rewinding of devices occurs.

Examples: Assign the PI logical unit as the SEDIT reassignable IN unit.

```
AS,IN=PI
```

or, the unabbreviated form

```
ASSIGN,INPUT=PI
```

Assign logical unit 8 as the SEDIT reassignable OUT unit.

```
AS,OU=8
```

Assign as the SEDIT reassignable IN unit the file FILEX on logical unit 111, an RMD partition without a protection key.

```
AS,IN=111,,FILEX
```

8.2.2 AD (Add Records) Directive

This directive adds source records. It has the general form

AD,recno

where **recno** is the number of the record last copied from the IN logical unit before switching to the ALT unit for further copying.

The AD directive copies source records from the IN logical unit onto the OUT logical unit beginning with the current position of the IN unit and continuing up to and including the record specified by **recno**. Then, source records are copied from ALT onto OUT from the current position of the unit up to but *not* including the next end-of-file mark.

Example: Copy records from IN onto OUT from the current position of IN up to and including IN record 7. Then, switch to ALT and copy records from the current position of that unit up to but *not* including the next end-of-file mark.

```
AD,7
```

8.2.3 SA (Add String) Directive

This directive inserts a character string into a source-record field. It has the general form

SA,recno,(first,last),'string'

where

recno is the number of the source record in which the character string is to be inserted

first is the number of the first character position to be affected

last is the number of the last character position to be affected

string is the string of characters to be inserted in the field delimited by character positions **first** and **last** in record number **recno**

The SA directive copies source records from the IN logical unit onto the OUT logical unit beginning with the current position of the IN unit and continuing up to but *not* including the record specified by **recno**. The record **recno** is read into the memory buffer. The character string **string** shifts into the left end of the specified field **first,last**, with characters shifted out of the right end of the field being lost. There is no check on the length of **string** and shifting continues until it is left-justified in the field with excess characters, if any, being truncated on the right.

The record remains in the memory buffer, thus permitting multiple string operations on the same record. (If IN is already positioned at **recno** because of a previous string operation, there is, of course, no change in position.)

The record **recno** is read out of the memory buffer and onto the OUT unit when an SEDIT directive affecting another record is input.

The field specification **first,last** is lost after one manipulation. Subsequent string operations must specify the character positions based on the *new* configuration. For example, for the character string ACDEGbb in positions 1 through 7, addition of the character B in position 2 requires the field specification (2,7). Then, to add the character F between E and G, one must specify the field (6,7) rather than (5,7) because of the shift previously caused by insertion of the character B.

Example: Change the erroneous DAS MR source-statement operand in character positions 16-21 of the 32nd record from LOCXbb to LOC,Xb.

```
SA,32,(19,20),','
```

8.2.4 REPL (Replace Records) Directive

This directive replaces one sequence of source records with another sequence of records. It has the general form

REPL,recno1,*recno2*

where

recno1 is the number of the first record to be replaced

recno2 is the number of the last record to be replaced

If *recno2* is omitted, it is assumed equal to **recno1**, i.e., one record will be replaced.

The REPL directive copies source records from the IN logical unit onto the OUT logical unit beginning with the current position of the IN unit and continuing up to but *not* including the record specified by **recno1**. Then, records are read from IN, but not copied onto OUT, up to and including the record specified by *recno2*. Thus, the records **recno1** through *recno2*, inclusive, are deleted. Then, source records are copied from the ALT logical unit from the current position of the unit up to but *not* including the next end-of-file mark.

Example: Copy records from IN onto OUT from the current position of IN up to and including record 9. Replace IN records 10 through 20, inclusive, with records on ALT, copying those between the current position of ALT and the next end-of-file mark onto OUT. Do not copy the end-of-file mark.

```
REPL,10,20
```

8.2.5 SR (Replace String) Directive

This directive replaces one character string within a source record with another character string. It has the general form

SR,recno,(n1,n2,n3),'string'

where

recno is the number of the source record in which the character string is to be replaced

n1 is the number of the first character position of the string to be replaced

n2 is the number of the last character position of the string to be replaced

n3 is the number of the last character position of the field in which the string to be replaced occurs

string is the string of characters to be inserted in the field delimited by character positions **n1** and **n3** in record number **recno** after shifting out the characters in positions **n1** through **n2**, inclusive

The SR directive copies source records from the IN logical unit onto the OUT logical unit beginning with the current position of the IN unit and continuing up to but *not* including the record specified by **recno**. The record **recno** is read into the memory buffer. Field **n1,n3** is then shifted to the left and filled with blanks until the field **n1,n2** is shifted out. Then, the character string **string** shifts into the left end of the field **n1,n3**. There is no check on the length of **string** and shifting continues until it is left-justified in the field **n1,n3** with excess characters, if any, being truncated on the right.

The record remains in the memory buffer, thus permitting multiple string operations on the same record. (If IN is already positioned at **recno** because of a previous string operation, there is, of course, no change in position.)

The record **recno** is read out of the memory buffer and onto the OUT unit when a SEDIT directive affecting another record is input.

The field specification **n1,n2,n3** is lost after one manipulation. Subsequent string operations must specify the character positions based on the *new* configuration.

Example: Copy records from IN onto OUT up to and including record 49, and replace the present contents of character positions 10 through 12, inclusive, in IN unit source record 50 with the character string XYb.

```
SR,50,(10,12,12),'XY '
```

8.2.6 DE (Delete Records) Directive

This directive deletes a sequence of source records. It has the general form

DE,recno1,*recno2*

where

recno1 is the number of the first record to be deleted

recno2 is the number of the last record to be deleted

If *recno2* is omitted, it is assumed equal to **recno1**, i.e., one record will be deleted.

The DE directive processing is exactly like that of the REPL directive (section 8.2.4) except that there is no copying from the ALT unit after the deletion of the records **recno1** through *recno2*, inclusive.

Examples: Copy records from IN onto the OUT logical unit up to and including record 49, but delete records 50 through 54, inclusive.

```
DE,50,54
```

Position IN at record 2, deleting record 1.

```
DE,1
```

8.2.7 SD (Delete String) Directive

This directive deletes a character string from a source record. It has the general form

SD,recno,(n1,n2,n3)

where

recno	is the number of the source record from which the character string is to be deleted
n1	is the number of the first character position of the string to be deleted
n2	is the number of the last character position of the string to be deleted
n3	is the number of the last character position of the field in which the string to be deleted occurs

The SD directive processing is exactly like that of the SR directive (section 8.2.5) except that no new character string is shifted into field **n2,n3** after the field **n1,n2** is shifted out.

Example: Copy records from IN onto OUT up to and including record 99, and delete characters 2 through 4, inclusive, from record 100, shifting characters 5 through 10, inclusive, three places to the left, with blank fill on the right.

```
SD,100,(2,4,10)
```

8.2.8 MO (Move Records) Directive

This directive moves a block of records forward on a unit. It has the general form

MO,recno1,*recno2*,**recno3**

where

recno1	is the number of the first record to be moved
recno2	is the number of the last record to be moved
recno3	is the number of the record after which the block of records delimited by **recno1** and *recno2* is to be inserted

If *recno2* is omitted, it is assumed equal to **recno1**, i.e., one record will be moved.

The MO directive copies source records from the IN logical unit onto the OUT logical unit beginning with the current position of the IN unit and continuing up to but *not* including the record specified by **recno1**. The records **recno1** through *recno2* are then read into a special MOVE area in memory. The position of IN is now *recno2* + 1. When OUT reaches (by some succeeding directive) **recno3** + 1, the contents of the MOVE area are copied onto OUT. Multiple MO operations are legal.

Example: Copy records from IN onto OUT up to and including record 4, save records 5 through 10, inclusive, in the MOVE area of memory, copy records 11 through 99, inclusive, from IN onto OUT, and then copy records 5 through 10 from the MOVE area to OUT. This gives a record sequence on OUT of 1-4, 11-99, 5-10 (FC directive, section 8.2.9.).

```
MO,5,10,99
FC
```

8.2.9 FC (Copy File) Directive

This directive copies blocks of files, including end-of-file marks. It has the general form

FC,*nfiles*

where *nfiles* (default value = 1) is the number of files to be copied.

If the IN logical unit and/or the OUT logical unit is an RMD partition, *nfiles* must be 1 or absent. If OUT is a named file on an RMD, there will be an automatic close/update. Whenever an end-of-file mark is encountered, all record counters are reset to zero.

Examples: Copy files from IN onto OUT up to and including the next end-of-file mark on the IN unit.

```
FC
```

Copy the next six IN files (including end-of-file marks) onto OUT. This includes the sixth end-of-file mark. (Note: If IN and/or OUT is an RMD partition, there will be an error.)

```
FC,6
```

8.2.10 SE (Sequence Records) Directive

This directive assigns a decimal sequence number to each source record output to the OUT logical unit. It has the general form

SE,*(first,last),initial,increment*

where

first	is the first character position of the sequence name field
last	is the last character position of the sequence number field, where the default value of *first,last* is 76,80
initial	is the initial number to be used as a sequence number (default value = 10)
increment	is the increment to be used between successive sequence numbers (default value = 10)

There is also a special form of the SE directive to stop sequencing:

SE,N

where there are no parameters other than the letter **N**.

Examples: In the next record output to OUT, place 00010 in character positions 76 through 80, and increment the field by 10 in each succeeding record.

```
SE
```

In the next record output to OUT, place 030 in character positions 15 through 17, and increment the field by 7 on each succeeding record.

```
SE,(15,17),30,7
```

Stop sequencing.

```
SE,N
```

8.2.11 LI (List Records) Directive

This directive lists, on the LO logical unit, the records copied onto the OUT unit. The LI directive has the general form

LI,*list*

where *list* is A (default value) if all OUT records are to be listed, C if only changed records are to be listed, or N if listing is to be suppressed. Source records output to the OUT file are listed with their OUT record number at the left of the print list.

Examples: List all records output to OUT.

```
LI
```

Suppress all listing except that of SEDIT directives.

```
LI,N
```

8.2.12 GA (Gang-Load All Records) Directive

This directive loads the same character string into the specified field of every record copied onto the OUT logical unit. It has the general form

GA,*(first,last)*,**'string'**

where

first	is the first character position of the field to be gang-loaded
last	is the last character position of the field to be gang-loaded, where the default value of *first,last* is 73,75
string	is the string of characters to be gang-loaded into character positions first through *last*, inclusive in all records copied onto OUT

There is also a special form of the GA directive to stop gang-loading:

GA

where there are *no* parameters in the directive.

In every OUT record, GA clears the specified field, and loads the string into it. There is no check on the length of **string** and shifting continues until it is left-justified in the specified field with excess characters, if any, being truncated on the right.

Examples: Load character string VDMbb in character positions 11 through 15, inclusive, of every record copied onto OUT.

```
GA,(11,15),'VDM  '
```

Stop gang-loading.

```
GA
```

8.2.13 WE (Write End of File) Directive

This directive writes an end-of-file mark on the OUT logical unit. It has the form

WE

without parameters. If OUT is a named file on an RMD, there will be an automatic close/update.

Example: Write an end-of-file mark on OUT, a magnetic-tape unit.

```
WE
```

8.2.14 REWI (Rewind) Directive

This directive rewinds the specified SEDIT logical unit(s). It has the general form

REWI,p(1),*p(2)*,*p(3)*

where each **p(n)** is a name of one of the SEDIT logical units: IN, OU, or AL. These can be coded in any order.

Example: Rewind all SEDIT logical units.

```
REWI, IN, AL, OU   UT
```

8.2.15 CO (Compare Inputs) Directive

This directive compares the specified field in the inputs from the IN logical unit with those from the ALT logical unit and lists discrepancies on the LO logical unit. The directive has the general form

CO,*(first,last)*,*limit*

where

first	is the first character position of the field to be compared
last	is the last character position of the field to be compared, where the default value of *first,last* is 1,80.
limit	is the maximum number of discrepancies to be listed before aborting the comparison and passing to the next directive.

Any discrepancy between the IN and ALT inputs is listed in the format

```
I recordnumber or EOF inrecord
A recordnumber or EOF altrecord
```

If the comparison terminates by reaching the *limit* number of discrepancies, SEDIT outputs on the LO the message

```
SEDIT COMPARE ABORTED
```

to prevent long listings of errors, for example, where a card is misplaced or missing on one input. A normal termination of a comparison (at the next end-of-file mark) concludes with the message

```
SEDIT COMPARE FINISHED
```

Example: Compare character positions 1 through 80, inclusive, from the IN and ALT units until either an end of file is found or there have been 5 discrepancies listed on the LO.

```
CO,,5
```

8.3 EXAMPLE OF EDITING A FILE

Following is a sample job stream for editing an existing file on a magnetic tape onto a new file on magnetic tape. The input file consists of 80-character records followed by an end-of-file mark. The job stream and the edit cards are read through the system input device.

```
/JOB,EDIT
/ASSIGN,PI=MT00,PO=MT10
/REW,PI,PO
/SEDIT
AS,IN=PI
AS,OUT=PO
AS,ALT=SI
DE,5
REPL,8,10
            LDA    TEMP
(EOF card, 2-7-8-9 punch)
ADD,17
TBL         BSS    5
(EOF card, 2-7-8-9 punch)
FC
REWI,IN,OUT
/ENDJOB
```

The result of running the preceding source editor example would be the following:

Input File

```
 1 *
 2 *        CATALOG ROUTINE
 3 *
 4 A$3      EQU     6
 5 B$3      EQU     9
 6 *
 7 CATLOG   DATA    0
 8          LDA     TMX
 9          LDB     TMY
10          JBZM    ODER
11          ADD     PARM6
12          ANAI    0770
13          STA     TBL+2
14          LRLA    6
15          STA     TBL+4
16          TZB
17          JMP*    CATLOG
```

Output File

```
 1 *
 2 *        CATALOG ROUTINE
 3 *
 4 A$3      EQU     6
 5 *
 6 CATLOG   DATA    0
 7          LDA     TEMP
 8          ADD     PARM6
 9          ANAI    0770
10          STA     TBL+2
11          LRLA    6
12          STA     TBL+4
13          TZB
14          JMP*    CATLOG
15 TBL      BSS     5
```

SECTION 9
FILE MAINTENANCE

The VORTEX **file-maintenance component** (**FMAIN**) is a background task that manages file-name directories and the space allocations of the files. It is scheduled by the job-control processor (JCP) upon input of the JCP directive /FMAIN (section 4.2.18).

Only files assigned to rotating-memory devices (disc or drum) can be referenced by name.

File space is allocated within a partition forward in contiguous sectors of the same cylinder, skipping bad tracks. The only exception to this continuity is the file-name directory itself, which is a sequence of linked sectors that may or may not be contiguous.

9.1 ORGANIZATION

FMAIN inputs file-maintenance directives (section 9.2) received on the SI logical unit and outputs them on the LO logical unit and on the SO logical unit if it is a different physical device from the LO unit. Each directive is completely processed before the next is input to the JCP buffer.

If the SI logical unit is a Teletype or a CRT device, the message **FM**** is output on it before input to indicate that the SI unit is waiting for FMAIN input.
If there is an error, one of the error messages given in Appendix A.9 is output on the SO logical unit, and a record is input from the SO unit to the JCP buffer. If the first character of this record is /, FMAIN exits via the EXIT macro. If the first character is C, FMAIN continues. If the first character is neither / nor C, the record is processed as a normal FMAIN directive. FMAIN continues to input and process records until one whose first character is / is detected, when FMAIN exits via exit. (An entry beginning with a carriage return is an exception to this, being processed as an FMAIN directive).

FMAIN has a symbol-table area for 200 symbols at five words per symbol. To increase this area, input a /MEM directive (section 4.2.5), where each 512-word block will enlarge the capacity of the table by 100 symbols.

9.1.1 Partition Specification Table

Each rotating-memory device (RMD) is divided into up to 20 memory areas called **partitions**. Each partition is referenced by a specific logical-unit number. The boundaries of each partition are recorded in the core-resident **partition specification table** (**PST**). The first word of the PST contains the number of VORTEX physical records per track. The second word of the PST contains the address of the bad-track table, if any. Subsequent words in the PST comprise the four-word partition entries. Each PST is in the format:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	Size of bad track table (120-words)															
Word 1	Address of bad track table (0 if none) relative to word 0															
Word 0	Beginning partition track address															
Word 1	PPB	Not used												Protection code		
Word 2	Number of bad tracks in partition															
Word 3	Ending partition address + 1															
	•															
	•															
	•															

The partition protection bit, designated ppb in the above PST entry map, is unused in file maintenance procedures.

Note that PST entries overlap. Thus, word 3 of each PST entry is also word 0 of the following entry. The relative position of each PST entry is recorded in the **device specification table** (**DST**) for that partition.

The **bad-track table**, whose address is in the second word of the PST, is a bit string read from right to left within each word, and forward through contiguous words, with set bits flagging bad tracks on the RMD. (If there is no bad-track table, the second word of the PST contains zero.)

The file name comprises six ASCII characters packed two characters per word, left justified, with blank fill. Word 3, which contains the current address at which the file is positioned, is initially set to the ending file address, and is manipulated by I/O control macros (section 3). The extent of the file is defined by the addresses set in words 4 and 5 when the file is created, and remains constant.

9.1.2 File Name Directory

The File Name Directory is two sectors in length (240 words.) There are two physical directories, comprising a single logical file name directory. The second of the two physical directories is a shadow directory that contains attribute information for each file entry.

The directory for each partition has a variable number of entries arranged in n sectors, 19 entries per sector.

A file has the same corresponding entry in each of the two physical directories, i.e., if a file is the third entry in the first directory, it is also the third entry in the shadow directory.

Each RMD partition contains a file-name directory. The directory for each partition begins in the first sector of the partition. Sectors containing directory information are chained by pointers in the last word of each sector. Thus, directory sectors do not have to reside contiguously. The first of the two physical directories has the following format:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	File name
Word 1	File name
Word 2	File name
Word 3	Current position of file
Word 4	Beginning file address
Word 5	Ending file address

The file name comprises six ASCII characters packed two characters per word, left justified, with blank fill. Word 32, which contains the current address at which the file is positioned, is initially set to the ending file address, and is manipulated by I/O control macros (section 5). The extent of the file is defined by the address set in words 4 and 5 when the file is created, and remains constant.

The shadow directory has the following format:

Bit	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Word 0	Not Used
Word 1	Not Used
Word 2	Not Used
Word 3	Not Used | Extension Number | X | File Type
Word 4	Date File Accessed
Word 5	Data File Created

Words 0, 1 and 2 are reserved for future use. Word 3 has the following variable format. The lower 9 bits contain the File type field as described below:

Bit 0	set indicates	System Binary
Bit 1	set indicates	Load Module
Bit 2	set indicates	Data file
Bit 3	set indicates	ICS file
Bit 4	set indicates	Compressed 8 bit ASCII
Bit 5	set indicates	Compressed 7 bit ASCII

Bit 6, 7, and 8 are reserved for future use.

Bits 9 through 12 of word 3 contain the extension number field. The extension number specifies the extension number of the specified file.

Word 4 of the shadow directory contains the date a file was last accessed. This field is updated on an OPEN request to a file (except when made by SAL.)

Word 5 of the shadow directory contains the date the file was created. The date, in words 4 and 5, is in the following format:

Bits 0-3 contain the "MONTH"
Bits 4-8 contain the "DAY"
Bits 9-15 contain the "YEAR"

The first sector of each partition is assigned to the file-name directory. FMAIN allocates RMD space forward in contiguous sectors, skipping bad tracks. Following the last entry in each directory sector is a one-word tag containing either the value 01 (end of directory), or the address of the next sector of the file-name directory.

The file-name directories are created and maintained by the file-maintenance component for the use of the I/O control component (section 3). User access to the directories is via the I/O control component.

Special entries: A **blank entry** is created when a file name is deleted, in which case the file name is ****** and words 3 through 5 give the extent of the blank file. A **zero entry** is created when one name of a multiname file is deleted, in which case the deleted name is converted to a *blank entry* and all other names of the multiname file are set to zero.

WARNING

To prevent possible loss of data from the file-name directory during file-maintenance operations, FMAIN sets the **lock bit** (bit 12 of word 2 of the DST) before any directory operation, thus inhibiting all foreground requests for I/O with the partition being modified. Upon completion of the directory operation, FMAIN clears the lock bit. Except for the use of protection codes, **this is the only protection for the file-name directory**. Manipulation of foreground files with FMAIN is at the user's risk. For example, VORTEX does not prevent deletion of a file name from a file-name directory that has been opened and is being written into by a foreground program. Therefore, foreground files should be reassigned prior to manipulation by FMAIN.

9.1.3 Relocatable Object Modules

Outputs from both the DAS MR assembler and the FORTRAN compiler are in the form of relocatable object modules. Relocatable object modules can reside on any VORTEX-system logical unit. Before object modules can be read from a unit by the FMAIN INPUT and ADD directives (sections 9.2.7 and 9.2.8), an I/O OPEN with rewinding (section 3.5.1) is performed on the logical unit, i.e., the unit (except paper-tape or card readers) is first positioned to the beginning of device or load point for that unit. Object modules can then be loaded until an end-of-file mark is found.

The system generator (section 15) does not build any object-module library. FMAIN is the only VORTEX component used for constructing user object-module libraries.

A VORTEX physical record on an RMD is 120 words. Object-module records are blocked two 60-word records per VORTEX physical record. However, in the case of an RMD assigned as the SI logical unit, object modules are not blocked but assumed to be one object-module record per physical record.

9.1.4 Output Listings

FMAIN outputs four types of listing to the LO logical unit:

- **Directive listing** lists, without modification, all FMAIN directives entered from the SI logical unit.
- **Directory listing** lists file names from a logical unit file-name directory in response to the FMAIN directive LIST (section 9.2.5).
- **Deletion listing** lists file names deleted from a logical unit file-name directory in response to the FMAIN directive DELETE (section 9.2.2).
- **Object-module listing** lists the object-module input in response to the FMAIN directive ADD (section 9.2.8).

All FMAIN listings begin with the standard VORTEX heading.

The *directory listing* is further described under the discussion of FMAIN directive LIST (section 9.2.5), the *deletion listing* under DELETE (section 9.2.2), and the *object-module listing* under ADD (section 9.2.8).

9.2 FILE-MAINTENANCE DIRECTIVES

This section describes the file-maintenance directives:

- CREATE file
- DELETE file
- RENAME file
- ENTER new file name
- LIST file names
- INIT (initialize) directory
- INPUT logical unit for object module
- ADD object module

File-maintenance directives comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between the individual character strings of the directive, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period.

The general form of a file-maintenance directive is

directive,lun,*p(1),p(2),...,p(n)*

where

directive	is one of the directives listed above in capital letters
lun	is the number or name of the affected logical unit
each *p(n)*	is a parameter defined under the descriptions of the individual directives below

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of the directives, optional periods, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted.

Error messages applicable to file-maintenance directives are given in Appendix A.9.

9.2.1 CREATE Directive

This directive creates a new file on the specified logical unit, allocates RMD space to the file, adds a corresponding entry to the file-name directory, and sets the current end-of-file value to one greater than the address of the last sector assigned to the new file.

The directive has the general form

CREATE,lun,*key*,name,words,records

where

lun	is the number or name of the logical unit where the new file is to be created
key	is the protection code, if any, required to address **lun**
name	is the name of the file being created
words	is the number of words in each record of the file
records	is the number of records in the file

The CREATE directive sets up the date in Word 5 of the corresponding shadow directory. It also sets up the "File Type" variable in Word 3 of the shadow directory to "Data File" (bit 2 is set.)

Size parameters merely allocate space for the file and do not limit file use to the specified record size. To each record in the created file, FMAIN assigns n records of 120 words each where n is the smallest integer such that **words**/120 is less than or equal to n. The file size is n times **records** words. This value is converted to a sector count to make assignments. Neither the file size value nor the sector count value is saved.

Example: Create the file XFILE with ten records of 120 words each on logical unit 112, whose protection code is K.

```
CREATE,112,K,XFILE,120,10
```

9.2.2 DELETE Directive

This directive deletes the designated file and all file-name directory references to it from the specified logical unit. It converts the specified file-name directory entry to a blank entry (name field = ******, section 9.1.2) and all other directory references to this file to zero entries (all fields = zero, section 9.1.2), and outputs a listing of deleted file-names on the LO logical unit. The directive has the general form

DELETE,lun,*key*,name

where

lun	is the number or name of the logical unit from which the file is being deleted
key	is the protection code, if any, required to address **lun**
name	is the name of the file being deleted (in the case of a multiname file, any one of the names can be used, all names are deleted)

The DELETE directive also deletes any extensions under this file name.

The output format has, following the FMAIN heading, a two-line heading

```
DELETE LISTING FOR lun
FILE NAME    START    END    CURRENT
```

where lun is the number of the logical unit from which the file is being deleted. This heading is followed by a blank line and a listing of all file-names being deleted, one per line. Words 0-2 of the file-name directory entry (section 9.1.2) are placed in the FILE NAME column; word 3, (in octal) in the CURRENT column; word 4, (in octal) in the START column; and word 5, (in octal) in the END column. After the last file name, there is an entry describing the blank file created by the deletion, where the FILE NAME column contains ******, the START column contains the next available address (word 2 of the PST entry), and both the CURRENT and END columns contain the last address + 1 (word 3 of the PST entry).

Example: Delete the file ZFILE (and all file-name directory entries referencing it) from logical unit 112, whose protection code is P).

```
DELETE,112,P,ZFILE
```

The name ZFILE is replaced in the file-name directory by ******, and the space allocation for this blank entry extended in both directions to include adjacent blank entries, if any. Any blank entries thus absorbed are converted to zero entries, as are all other entries that reference the file ZFILE. All affected file-name directory entries are listed on the LO logical unit.

9.2.3 RENAME Directive

This directive changes the name of a file, but does not otherwise modify the file-name directory. The directive has the general form

RENAME,lun,*key*,**old,new**

where

lun	is the number or name of the logical unit where the file to be renamed is located
key	is the protection code, if any, required to address **lun**
old	is the old name of the file being renamed
new	is the new name of the file being renamed

Following RENAME, **old** can no longer be used to reference the file.

Example: On logical unit 112, whose protection code is P, change the name of the file XFILE to YFILE.

```
RENAME,112,P,XFILE,YFILE
```

9.2.4 ENTER Directive

This directive adds a new file name to be used in referencing an existing file, but does not otherwise modify the file-name directory. ENTER thus permits multiname access to a file. The directive has the general form

ENTER,lun,*key*,**old,new**

where

lun	is the number or name of the logical unit where the affected file is located
key	is the protection code, if any, required to address **lun**
old	is an old name of the affected file
new	is the new name by which the file can also be referenced

This directive will also set up the creation date and extension numbers date in the corresponding shadow directory. It also sets the "file type" variable to "Data File".

9.2.5 LIST Directive

This directive outputs to the LO logical unit the file-name and shadow directories of the specified logical unit. The output comprises the file name, file extent, current end-of-file position, logical unit name or number, extent of unassigned space in the partition, file type, file extension number, and the dates the file was created and last accessed. All numbers are in octal except for dates and extensions. The directive has the general form:

LIST,lun,key

where

lun	is the number or name of the logical unit whose contents are to be listed.
key	is the protection code, if any, required to access lun.

The output format has a two line heading:

```
FILE DIRECTORY FOR LUN XXX
FILE NAME START END CURRENT F-TYPE EX CREATED
ACCESSED
```

where

XXX	is the number or name of the logical unit whose contents are being listed.

The header is followed by a blank line and a listing of all file name from the directory. See section 9.1.2 for a description of header items. After the last file name, if there is any unassigned space in the partition, there is an entry describing the unassigned space in the partition, where the FILE NAME column contains *UNAS*, the START column contains the next available address, and both the CURRENT and END columns contain the last address +1. All numerical values are octal sectors.

Example: List the file name directory of logical unit 114 which has no protection code.

```
LIST,114
```

9.2.6 INIT (Initialize) Directive

This directive clears the entire file-name directory of the specified logical unit, deletes all file names in it, and releases all currently allocated file space in the partition by reducing the file-name directory to a single end-of-directory entry. The directive has the general form

INIT,lun,*key*

where

lun	is the number or name of the logical unit being initialized
key	is the protection code, if any, required to address **lun**

Example: Initialize the file-name directory on logical unit 115, which has protection code X.

```
INIT,115,X
```

9.2.7 INPUT Directive

This directive specifies the logical unit from which object modules are to be input. Once specified, the input logical-unit number is constant until changed by a subsequent INPUT directive. The directive has the general form

INPUT,lun,*key,file*

where

lun is the number or name of the logical unit from which object modules are to be input

key is the protection code, if any, required to address **lun**

file is the name of the RMD file containing the required object module(s)

Neither *key* nor *file* are required unless **lun** is a RMD partition.

NOTE

There is no default value. Thus, if an attempt is made to input an object module (ADD directive, section 9.2.8) without defining the input logical unit by an INPUT directive, an error message will be output.

Example:

Open and rewind the file ARCTAN on logical unit 104, which has protection code D.

```
/PFILE,104,D,ARCTAN
/FMAIN
INPUT,104,D,ARCTAN
```

```
INPUT,104,D,ARCTAN
```

9.2.8 ADD Directive

This directive reads object modules from the INPUT unit (section 9.2.7) and writes them onto the SW logical unit, checking for entry names and validating check-sums, record sizes, loader codes, sequence numbers, and record structures. Reading continues until an end of file is encountered. Entry names are then added to the file-name directory of the specified logical unit and the object modules are copied from the SW logical unit onto the specified logical unit. The ADD directive also sets up the date in word 5 of the corresponding shadow directory and sets up the "file type" variable in word 3 of the shadow directory to "object module" (bit 0 is set). The LADD directive has the general form

ADD,lun,*key*

where

lun is the number or name of the logical unit onto which object modules are to be written

key is the protection code, if any, required to address **lun**

The specified logical unit **lun** references a system or user object-module library.

The names of the object modules and their date of generation, size in words (zero for FORTRAN modules), entry names, and referenced external names are listed on the LO logical unit.

To recover from errors in object-module-processing, reposition the logical unit to the beginning of the module.

Example: Add object modules to logical unit 104, which has protection code D.

```
ADD,104,D
```

Note: When using the INPUT and ADD directives with an RMD device, the files must be previously positioned using the /PFILE directive.

9.3 VORTEX FILE MAINTENANCE DRIVER (VZFMA)

The VORTEX File Maintenance driver provides a user-programmable subset of the VORTEX FMAIN services. VZFMA operates as a system driver assigned to logical unit 115. All requests to VZFMA must be made through the OM library resident interface routine, V$FILE. Direct calls to VZFMA are not allowed. This is because conflicts arise in calling sequences if VZFMA services should be augmented.

The calling sequence to request a file service is as follows:

```
EXT     V$FILE
LDAI    code
LDBI    fmcb
JSR     V$FILE,X
```

where

code is the operation code for the requested service
- 0 = create
- 1 = delete
- 2 = rename
- 3 = enter
- 4 = unused
- 5 = find

fmcb is the address of the file maintenance control block (see table 9-1)

The create, delete, rename and enter requests perform the same operations as in the VORTEX FMAIN program. The unused request releases the unused portion of the named file which is that area of the file beyond the current end-of-file.

Upon exit from a file request the A register contains the completion status code.

The completion status codes are as follows:

0	request completed without error
1	invalid request code
2	name already in directory
3	name not found
4	unsufficient space
5	input/output error occurred
6	directory structure error
15	file is empty

Note: Completion code 5 can also indicate invalid LUN, invalid "CREATE" sector count, (≤ 0) or invalid protection key.

The file maintenance control blocks for the requests must be arranged as shown in Table 9-1.

Table 9-1. File Maintenance Control Block

The file maintenance control blocks for the requests must be arranged as follows:

Word	Create	Delete, Unused, Find	Rename, Enter
0	logical unit	logical unit	logical unit
1	key	key	key
2	file name	file name	current file name
3			
4			
5	number of sectors		new file name
6	0		
7	0		

Words 0 and 1 are right justified and zero filled.

The file name (words 2-4) consists of two characters per word, left justified and blank filled.

For CREATE, word 6 must be zero, and word 5 is right justified and zero filled.

9.3.1 IOC FUNC Requests to VZFMA

Note: In most instances, the user should call VZFMA via V$FILE as describes in Section 9.3

Requests to VZFMA may be via an IOC FUNC request of the form

FUNC fsb,lun,wait

where

fsb is the address of the file specification block

lun is the VZFMA logical unit number (usually 115)

wait is Ø for wait until request is complete

The FSB has the format:

Word	Contents		
0	Opcode		
1	LUN Range		
2	Key		
3	Record Count		
4	Secondary File Name		
5			
6			
7	Primary File Name		
8			
9			
10	File Attributes	file type	optional
11		access date	
12		creation date	

9.3.1.1 Exit Conditions

Upon exit, VZFMA returns **lun** in high byte of FSB word 2 for FIND.

9.3.1.2 Errors

Error codes are returned in bits 9-14 of I/O request block status word. Error codes are:

1 = invalid opcode
2 = invalid lun or high lun not ≥ low lun
3 = lun not assigned to RMD
4 = insufficient RMD space
5 = I/O error
6 = directory structure error
7 = file name already in directory
8 = file name not found
9 = invalid "CREATE" sector count (i.e. 0)
10 = partition locked out too long
11 = invalid protect key

9.3.1.3 Explanation of FSB Contents

Opcodes

0 = Create
1 = Delete
2 = Rename
3 = Enter
4 = Delete Unused
5 = Find
6 = Find extension file
7 = Create extension file
8 = Create file using supplied attributes
9 = Enter file using supplied attributes

LUN Range
High byte = lowest lun of range of FIND
= lun for other opcodes
Low byte = highest lun of range for FIND

Key
Partition protection key in low byte

Record Count
Number of records for CREATE

Secondary file name
Name of new file new RENAME and ENTER

Primary file name
Name of old file for RENAME and ENTER. Name of file for other opcodes.

File attributes
The format of words 10-12 of the FSB is the same as that of words 3-5 of the shadow directory (Section 9.1.2).

SECTION 10
INPUT/OUTPUT UTILITY PROGRAM

The **I/O utility program** (**IOUTIL**) is a background task for copying records and files from one device onto another, changing the size and mode of records, manipulating files and records, and formatting the records for printing or display.

10.1 ORGANIZATION

IOUTIL is scheduled for execution by inputting JCP directive /IOUTIL (section 4.2.20) on the SI logical unit. If the SI logical unit is a Teletype or a CRT device, the message **IU**** is output to indicate that the SI unit is waiting for IOUTIL input. Once activated, IOUTIL inputs and executes directives from the SI unit until another JCP directive (first character is a slash) is input, at which time IOUTIL terminates and the JCP is again scheduled.

IOUTIL has the option of calling V$RSW (multi-volume reel-switch routine), when using a copy file, copy record, skip file, skip record, format and dump, position file, and pack binary.

Error Messages applicable to IOUTIL are given in Appendix A.10. Recovery from an error is by either of the following:

a. Input the character C on the SO unit, thus directing IOUTIL to go to the SI unit for the next directive.

b. Input the corrected directive on the SO unit for processing. The next IOUTIL directive is then input from the SI unit.

If recovery is not desired, input a JCP directive (section 4.2) on the SO unit to abort IOUTIL and schedule the JCP for execution.

10.2 I/O UTILITY DIRECTIVES

This section describes the IOUTIL directives:

- COPYF — Copy file
- COPYR — Copy record
- SFILE — Skip file
- SREC — Skip record
- DUMP — Format and dump
- PRNTF — Print file
- WEOF — Write end of file
- REW — Rewind
- PFILE — Position file
- CFILE — Close file
- PACKB — Pack binary

IOUTIL directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between individual character strings of the directive, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period.

The general form of an IOUTIL directive is

name,*p(1)*,*p(2)*,...,*p(n)*

where

name is one of the directive names given above

each *p(n)* is a parameter defined below under the descriptions of the individual directives

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of the directives, optional periods, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted.

The IOUTIL buffer is usually 1024 words long. The /MEM directive can be used to increase this size by increments of 512 words.

When output is directed to a listing device (TY, CT, LP), a carriage control blank is prefixed onto the output buffer. When output is directed to the multitask spooler, the output LUN must be equal to 5 if a carriage control blank is to be prefixed.

10.2.1 COPYF (Copy File) Directive

This directive copies the specified number of files from the indicated input logical unit to the given output logical unit(s). The directive has the general form

COPYF,**f**,**iu**,**im**,**irl**,**ou(1)**,**om**,**orl**,*ou(2)*,*ou(3)*,...,*ou(n)*

where

f is the number of input files to be copied (must be 1 for RMD)

iu is the name or number of the input logical unit

im is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted input files

irl is the number of words in each record of the input files. If a value of zero is specified then the record length is set to the maximum buffer size. Following the

read the actual physical record length (word 5 of the RQBLK) is used as the input record length.

ou(n) is the name or number of an output logical unit

om is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted output files

orl is the number of words in each record of the output files. If a value of zero is specified then the output record length is equal to the input record length.

Any RMD involved with copying files, whether as input or output medium, must have been previously positioned with a PFILE directive (section 10.2.9).

If a difference in record lengths **irl** and **orl** causes a partial record to remain when an end of file is encountered, the part-record is filled with blanks and thus transmitted to the output unit(s).

The following relation holds for input/output record lengths:

Input RCL	Output RCL	Output Format
fixed	fixed	As defined (blocked or unblocked)
random (0)	fixed	As defined (blocked or unblocked)
fixed	random (0)	Unblocked only
random (0)	random (0)	Unblocked only

Record lengths of zero are useful in copying mixed ASCII and binary data from cards to another media or vise versa. ASCII read must be specified for this operation.

Example: Copy three files containing 120-word records from the PI logical unit onto logical units LO, 50, and 51 in 40-word records.

```
COPYF,3,PI,1,120,LO,1,40,50,51
```

When specifying random length on input, the input unit should not be an RMD device. Also, when specifying blocking/deblocking, the input and output record lengths should be multiples of each other.

10.2.2 COPYR (Copy Record) Directive

This directive copies the specified number of records from the indicated input logical unit to the given output logical unit(s). The directive has the general form

COPYR,r,iu,im,irl,ou(1),om,orl,*ou(2),ou(3),...,ou(n)*

where

r is the number of input records to be copied, or 0 if copying is to continue to the end of file

iu is the name or number of the input logical unit

im is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted input records

irl is the number of words in each record of the input files. If a value of zero is specified then the record length is set to the maximum buffer size. Following the read the actual physical record length (word 5 of the RQBLK) is used as the input record length.

each **ou(n)** is the name or number of an output logical unit

om is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted output records

orl is the number of words in each record of the output files. If a value of zero is specified then the output record length is equal to the input record length.

Any RMD involved with copying records, whether as input or output medium, must have been previously positioned with a PFILE directive (section 10.2.9).

If a difference in record lengths **irl** and **orl** causes a part-record to remain when an end-of-file mark is encountered, the part-record is filled with blanks and thus transmitted to the output unit(s).

Example: Copy 25 unformatted records of 200 words each from the SS logical unit to the BO and PO units in binary format with 40 words per record.

```
COPYR,25,SS,3,200,BO,0,40,PO
```

It may be necessary to copy from one file on an RMD partition to another file on the same partition. This can be accomplished by assigning two *different* logical units to this RMD partition, and then issuing two PFILE directives (section 10.2.9), positioning one logical unit to the beginning of one file and the second logical unit to the beginning of the other file. Additional positioning within the files can be specified by SREC directives (section 10.2.4).

The following relation holds for input/output record lengths:

Input RCL	Output RCL	Output Format
fixed	fixed	As defined (blocked or unblocked)
random (0)	fixed	As defined (blocked or unblocked)

Input RCL	Output RCL	Output Format
fixed	random (0)	Unblocked only
random (0)	random (0)	Unblocked only

Record lengths of zero are useful in copying mixed ASCII and binary data from cards to another media or vise versa. ASCII read must be specified for this operation.

Example: Copy the first ten records from file EDIT1 to record 11 through 20 of file EDIT2. Both files are on RMD partition D00K, have record lengths of 120 words, are in mode 1, and have no protection key (default value = 0). Assign the BI and BO logical units to the disc.

```
/ASSIGN,BI=D00K
/ASSIGN,BO=D00K
/IOUTIL
PFILE,BI,,120,EDIT1
PFILE,BO,,120,EDIT2
SREC,BO,10
COPYR,10,BI,1,120,BO,1,120
```

10.2.3 SFILE (Skip File) Directive

This directive, which applies only to magnetic-tape units, and card readers, causes the specified logical unit to move the tape *forward* the designated number of end-of-file marks. The directive has the general form

SFILE,lun,neof

where

lun is the name or number of the affected logical unit

neof is the number of end-of-file marks to be skipped

If the end-of-tape mark is encountered before the required number of files has been skipped, IOUTIL outputs to the SO and LO logical units the error message **IU05,nn**, where **nn** is the number of files remaining to be skipped.

Example: Move tape on unit PI past three end-of-file marks.

```
SFILE,PI,3
```

10.2.4 SREC (Skip Record) Directive

This directive, which applies only to magnetic-tape units, card readers and RMDs, causes the specified logical unit to skip *forward* the designated number of records. The directive has the general form

SREC,lun,nrec

where

lun is the name or number of the affected logical unit

nrec is the number of records to be skipped

Note that, unlike JCP directive /SREC (section 4.2.8), the IOUTIL directive SREC cannot skip records in reverse.

If **lun** designates an RMD partition, the device must have been previously positioned with a PFILE directive (section 10.2.9).

If a file mark, an end-of-tape mark, or an end-of-device mark is encountered before the required number of records has been skipped, IOUTIL outputs to the SO and LO logical units the error message **IU05,nn**, where **nn** is the number of records remaining to be skipped.

Example: Skip 40 records on the BI logical unit.

```
SREC,BI,40
```

10.2.5 DUMP (Format and Dump) Directive

This directive copies the specified number of records from the indicated input logical unit, formats them for listing, and dumps the data onto the output unit in octal format, ten words per line, with one blank between words. The directive has the general form

DUMP,r,iu,im,irl,ou

where

r is the number of input records to be dumped or is zero if dumping is to continue to an end-of-file

iu is the name or number of the input logical unit

im is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted input records

irl is the number of words in each record of the input

ou is the name or number of the output unit, which cannot be an RMD partition

The first line of the dump contains the record number before word 1, but subsequent lines do not have the record number.

If ASCII mode is specified by **im** then an ASCII scan and dump will be made in addition to the octal dump. Printable

character bytes will appear to the right of each line of the octal dump. Non-printable characters will appear as ASCII blanks. ASCII scan and dump is suppressed if dump is to a TY or CT device regardless of the mode.

Example: Dump 40 binary, 50-word records from the SW logical unit onto the LO unit.

```
DUMP,40,SW,0,50,LO
```

10.2.6 PRNTF (Print File) Directive

This directive prints the specified number of files from the indicated input logical unit to the list output logical unit(s) specified. The directive has the general form

PRNTF,f,iu,ou(1),*ou(2),...ou(n)*

where

f	is the number of files to be printed
iu	is the name or number of the input logical unit
each **ou(n)**	is the name or number of a list output logical unit

If an RMD is specified as the input logical unit, it must have been previously positioned with a PFILE directive (section 10.2.9) and only one file may be printed at a time (i.e., if it is greater than 1, it is defaulted to 1), because the end-of-file terminates printing.

This directive is designed to print list output files directed to devices other than a line printer (i.e., magnetic tape or disc). Therefore, the input file is read in ASCII mode (1), 132 characters, and the list output records are written also in ASCII mode.

Example: Print two (2) files on magnetic tape unit 18 on LO.

```
/IOUTIL
REW,18
PRNTF,2,18,LO
/ENDJOB
```

Example: Print an RMD file called SYSOUT in logical unit 25 to LO.

```
/IOUTIL
PFILE,25,,120,SYSOUT
PRNTF,1,PI,LO
/ENDJOB
```

10.2.7 WEOF (Write End of File) Directive

This directive writes an end-of-file mark on each logical unit specified. The directive has the general form

WEOF,lun,*lun,...,lun*

where each **lun** is the name or number of a logical unit upon which an end-of-file mark is to be written.

Example: Write an end-of-file mark on the BO logical unit and on the PO logical unit.

```
WEOF,BO,PO
```

10.2.8 REW (Rewind) Directive

This directive, which applies only to magnetic-tape units, causes the specified logical unit(s) to rewind to the beginning of tape. The directive has the general form

REW,lun,*lun,...,lun*

where each **lun** is the name or number of a logical unit to be rewound.

Example: Rewind the BI and PO logical units.

```
REW,BI,PO
```

10.2.9 PFILE (Position File) Directive

This directive, which applies only to rotating-memory devices, causes the specified logical unit to move to the beginning of the designated file, and opens the file. The directive has the general form

PFILE,lun,*key*,**recl,name**

where

lun	is the name or number of the affected logical unit
key	is the protection code required to address **lun**
recl	is the number of words in each record of the file
name	is the name of the file to which the logical unit is to be positioned

Since IOUTIL has only six FCBs, there can be a maximum of six files open at any given time.

WARNING

IOUTIL uses the "recl" parameter to create the proper file extent. This parameter should match the record length parameter of the COPY directive if the record length is greater than 120 words, otherwise data beyond the specified file may be overwritten.

Example: Position the PI logical unit, using protection code Z, to the beginning of the file FILEXY, which contains 60-word records.

```
PFILE,PI,Z,60,FILEXY
```

10.2.10 CFILE (Close File) Directive

This directive, which applies only to RMD partitions, closes the specified file. The directive has the general form

CFILE,lun,*key*,**name**,*add*

where

lun is the name or number of the logical unit containing the file to be closed

key is the protection code required to address **lun**

name is the name of the file to be closed

add is 0 (default value) if the current end-of-file address on the RMD file-directory is to remain unchanged, or 1 if it is to be replaced by the current record (i.e., actual) address

A PFILE directive (section 10.2.9) must have been used to position **lun** before the CFILE directive is issued. Closing a file frees the associated FCB for use with another file. Since IOUTIL has only six FCBs, there can be a maximum of six files open at any given time.

Example: Close the file WORK on the SW logical unit (protection code B) and update the file directory.

```
CFILE,SW,B,WORK,1
```

10.2.11 PACKB (Pack Binary) Directive

This directive copies the specified number of files from the indicated input logical unit to the given output logical unit(s). It causes each new system binary program to start on a record boundary. The directive has the general form

PACKB,f,iu,im,irl,ou(1),om,orl,ou(2),...ou(n)

where

f is the number of input files to be copied

iu is the name or number of the input logical unit.

im is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted input files.

irl is the number of words in each record of the input files. If a value of zero is specified then the record length is set to the maximum buffer size. Following the read the actual physical record length (word 5 of the RQBLK) is used as the input record length.

ou(n) is the name or number of an output logical unit.

om is 0 for binary, 1 for ASCII, 2 for BCD, or 3 for unformatted output files.

orl is the number of words in each record of the output files. If a value of zero is specified then the output record length is equal to the input record length.

The following relation holds for input/output record lengths:

Input RCL	Output RCL	Output Format
fixed	fixed	As defined (blocked or unblocked)
random (0)	fixed	As defined (blocked or unblocked)
fixed	random (0)	Unblocked only
random (0)	random (0)	Unblocked only

Any RMD used in this directive must have been previously positioned with a PFILE directive (section 10.2.9).

This directive can be used for any output media and any record length. It is primarily intended to be used for RMD output of 120 words. Use with non-RMD output may not produce the intended effect.

Example: Pack one binary file from the card reader onto a RMD file on logical unit 25 in 120 word blocks:

```
PACKB,1,CR,0,60,25,0,120
```

10.3 MULTI-VOLUME TAPE HANDLING (V$RSW)

IOUTIL provides the operator with interfaces necessary for handling multi volume (i.e., multi-reel), magnetic tape files. The routine directs the operator to unload the current magnetic tape volume and mount a new one whenever end-of-tape is encountered.

The magnetic tape unit to be unloaded is given a rewind directive and the following message is output to the operator:

```
IOUTIL: UNLOAD LUN nn
IOUTIL: MOUNT NEXT VOLUME
```

where

nn	is the logical unit number of the magnetic tape to unload

After the message for mounting a new magnetic tape has been output to the operator, the subroutine issues a suspend request. When the new volume has been successfully mounted, the operator can continue execution by keying in the following:

```
;RESUME, IOUTIL
```

If the mounting of a new magnetic tape volume is not needed, the operator will key in the message **;ABORT, IOUTIL** on the OC device, which will return control to JCP.

SECTION 11
VSORT (SORT/MERGE)

The VORTEX Sort/Merge (VSORT) task constructs a sorted file in the order determined by fields selected by the user.

11.1 ORGANIZATION

VSORT is scheduled as a background task by the Job-Control Processor (JCP, section 4.2.19) upon input of the JCP directive

```
/LOAD,VSORT
```

Once activated, VSORT inputs the sort parameters from the SI logical unit. The maximum number of VSORT directives is five records. The directive ENDSORT terminates the input of VSORT directives within five records. Upon completion of the sort/merge, VSORT exits to JCP.

VSORT has a buffer area large enough for most sort/merge operations. To increase the size of the buffer, input a /MEM directive (see section 4.2.3) immediately preceding the /LOAD,VSORT directive.

Inputs to VSORT comprise

a. VSORT directives (section 11.2) input through the SI logical unit

b. File to be sorted, input through the INPUT logical unit

c. Additional file to be sorted, input through the ALTIN logical unit.

Outputs from VSORT comprise

a. Sorted file on the OUTPUT logical unit

b. Listing of VSORT directives on the LO logical unit

c. Listing of VSORT totals for the sort/merge on the LO logical unit

d. Error messages, if any, on the LO logical unit

Error messages applicable to VSORT are given in Appendix A.11.

VSORT performs either a full-record sort or a tag sort. In a full-record sort the entire records are moved in central memory in order to accomplish the sort. In a tag sort, only the concatenated sorting control fields and the record numbers are manipulated in central memory. VSORT will perform the more efficient tag sort unless one of the following conditions occurs:

a. INPUT file is not an RMD

b. The file used for INPUT is also used for another file in the sort, either as a WORK or OUTPUT file

c. A user input exit routine is specified (by the INEXIT directive)

d. An alternate input has been defined

Workspace Requirements: Each work file must be large enough to contain a number of work records equal to the number of input records. For tag sorts, the length of the work records is equal to the sum of the length of the control fields plus one word. On full-record sorts, the sum of the control fields plus one input record length is needed.

Work records are blocked with a blocksize equal to a fourth or third of the central memory workspace for the merge phase.

Work space for the sort phase in central memory is allocated dynamically to overlay the initialization routine (about 2K), which occupies the highest memory locations of VSORT. Work space for the merge phase occupies an additional 1K in central memory. Additional work space may be allocated for a background sort by using the /MEM directive (JCP, 4.2.3).

11.2 VSORT DIRECTIVES

This section describes the VSORT directives.

a. Required Group

• SORT	Sort directives follow
• INPUT	Define logical unit for input
• OUTPUT	Define logical unit for output
• WORK	Define work file(s)
• SORTKEY	Define sorting field(s)
• ENDSORT	Begin sorting

b. Optional Group

• ALTIN	Describe alternate sort input file
• ALTSEQ	Define collating sequence
• INCLF	Include this record by field comparison
• INCLC	Include this record by constant comparison

•	OMITF	Omit this record by field comparison
•	OMITC	Omit this record by constant comparison
•	MOVEF	Move Field
•	MOVEC	Move Constant
•	LOT	Output sorted tags (Record Numbers)
•	INEXIT	Use input preprocessor
•	OUTEXIT	Use output preprocessor

The general form of a VSORT directive is

name = *p(1),p(2),...,p(n)* terminator

where

name	is one of the VSORT directives
p(n)	is a parameter required by VSORT and defined below under the descriptions of the individual directives
terminator	is a blank or right parenthesis

11.2.1 SORT Directive

This directive signals the start of the sort directives. The general form is

SORT

The word **SORT** must be followed by at least one blank. The SORT directive must be the first directive on the first control record.

11.2.2 INPUT Directive

This directive describes the sort input file which contains the records to be sorted. It has the general form

INPUT = (**lun**,*filename*,*key*,**recordlength**,*blocking factor*)

where

lun	is a 1- to 3-character decimal number specifying the logical unit of the file
filename	is a 1- to 6-character name of the file as it exists on the RMD file directory (required for all RMD files)
key	is the single character file protection key, as contained in the file directory for the file (required only if the filename is present and the RMD is protected)
recordlength	is a 1- to 4-digit decimal number specifying the length in words of the logical records in the file.
blocking-factor	is a 1-4 character decimal number specifying the number of logical records per physical record.

Example: Describe a sort input file on magnetic tape on logical unit 18, which has 200-word records.

```
INPUT=(18,,,200)
```

11.2.3 ALTIN Directive

This optional directive describes an alternative input which contains additional records to be stored. It has the form

ALTIN = (lun)

where

lun	is a 1-3 character decimal number specifying the logical number of the file (cannot be an RMD).

Note: In this directive, the record length and blocking factor defaults to the input file read (refer to the INPUT directive).

Example: Describe an alternate input file on logical unit 13.

```
ALTIN = (13)
```

11.2.4 OUTPUT Directive

This directive describes the output file which will ultimately contain the sorted records. It has the general form

OUTPUT = (**lun**,*filename*,*key*,**recordlength**,*blocking factor*)

where **lun**, *filename*, *key* **recordlength** and *blocking factor* are the same as they are described in the INPUT directive (section 11.2.2).

Example: Describe a sort output file on a line printer logical unit 5, which has a 60-word record length.

```
OUTPUT=(5,,,60)
```

Note: The record length does not include the printer line control character which is added by SORT.

11.2.5 WORK1-3 Directives

WORK $\left\{ \begin{matrix} 1 \\ 2 \\ 3 \end{matrix} \right\}$ = (**lun**,*filename*,*key*)

where **lun**, *filename*, and *key* are the same as described for the INPUT directive (section 11.2.2).

Example: Describe intermediate sort files named W1, W2, and W3 on RMD logical unit 25. These files do not have protection keys.

```
WORK1=(25,W1),WORK2=(25,W2),WORK3=(25,W3)
```

Note: The work files must be RMD files. Each file must have sufficient space to contain the intermediate work records equal to the number of records in the input file for the sort.

11.2.6 SORTKEY Directive

This directive describes one to 29 control fields to be used to sequence the records of the sort input file. It has the general form

SORTKEY = (**sc(1)**,**ec(1)**,**order(1)**,...,sc(29),ec(29),order (29))

where each

sc(n) is a one- to four-digit decimal number specifying the starting character (or byte) position of the control field as it exists in the input record, or, if there positions are modified by an INEXIT routine, as they exist in the modified input record.

ec(n) is a one- to four-digit decimal number specifying the ending character (or byte) position of the control field. It must be greater than or equal to the preceding starting character position

order(n) is a single character A or D for ascending or descending sequence, respectively, for sorting the control field

At least one control field specification must be given. Each control field specification must have all three parameters specified.

Control fields may overlap.

Character positions are numbered starting with one.

The significance of a control field depends on its placement in the SORTKEY directive. The first control field defined is the most important (or major) control field. The next is the secondary (used in cases of matches in the first) control field. Similarly, until the last specification given is the least important.

Collating sequence: An algebraic collating sequence is used to sort the data. Each word (in numeric data) or each byte (in character data) is interpreted as an octal number having an algebraic sign. Thus, ASCII characters have the collating sequence from 0240 (low) to 0337 (high). If characters are other than ASCII, the sign bit (bit 7) of each 8-bit character must be the same for all the characters.

Word-boundary data are treated as signed octal numbers and have the collating sequence from 0100000 (low) to 077777 (high). Thus, FORTRAN variables of integer, real, complex or logical types may be sorted with SORT control fields. FORTRAN double-precision numbers cannot be sorted because the sign of the number is not in the first word.

Example: Describe two control fields, one is bytes 27 and 28 in ascending order, and the other is byte 1 through 4 to be sorted in descending order.

```
SORTKEY=(27,28,A,1,4,D)
```

11.2.7 ALTSEQ Directive

This optional directive allows specification of alternate values from existing characters to be found in the file to be sorted, thus providing a direct means of specifying an alternate value for each character of concern when sorting. It has the form

ALTSEQ = (x)

where

x is a 64-character string

Example: Redefine the collating sequence where the vowels (a,e,i,o, and u) will be replaced with blanks for sorting purposes.

```
ALTSEQ = ( !"#$% &'()*,-./0123456789
:;<=>?  BCD FGH JKLMN PQRST VWXYZ[/]↑←),
```

11.2.8 INCLF Directive

This optional directive provides for including an input record by comparing one ASCII field against another ASCII field. It has the form

INCLF = (fs1, fe1, rel, fs2)

where

fs1 is the first byte of the first field.

fe1 is the last byte of the first field.

rel is one of the following relation tests (required to include this record):

Relation Test	Include if
EQ	fs1 = fs2
NE	fs1 ≠ fs2
LT	fs1 < fs2
GT	fs1 > fs2
LE	fs1 ≤ fs2
GE	fs1 ≥ fs2

fs2 is the first byte of the second field.

Example: Accept any input record where byte 11 and 12 are equal to bytes 26 and 27.

```
INCLF = (11,12,EQ,26)
```

11.2.9 INCLC Directive

This optional directive provides for including an input record by comparing an ASCII Field against an ASCII constant. It has the form

INCLC = (fs1, fe1, rel, con)

where

fs1 is the first byte of the field.

fe1 is the last byte of the field

rel is one of the following relation tests (required to include this record):

Relation Test	Include if
EQ	fs1 = con
NE	fs1 ≠ con
LT	fs1 < con
GT	fs1 > con
LE	fs1 ≤ con
GE	fs1 ≥ con

con is a constant of up to ten characters excluding comma and right parenthesis.

Example: Accept any record where byte 46 is not a 7.

```
INCLC = (46,46,NE,7)
```

11.2.10 OMITF Directive

This optional directive provides for rejecting an input record by comparing one ASCII field against another ASCII field. It has the form

OMITF = (fs1, fe1, rel, fs2)

where

fs1 is the first byte of the first field.

fe1 is the last byte of of the first field.

rel is one of the following relation tests (required to reject this record):

Relation Test	Reject if
EQ	fs1 = fs2
NE	fs1 ≠ fs2
LT	fs1 < fs2
GT	fs1 > fs2
LE	fs1 ≤ fs2
GE	fs1 ≥ fs2

fs2 is the first byte of the second field.

Example: Delete any input record where bytes 1 and 2 are equal to bytes 6 and 7.

```
OMITF = (1,2,EQ,6)
```

11.2.11 OMITC Directive

This optional directive provides for rejecting an input record by comparing an ASCII field against an ASCII constant. It has the form

OMITC (fs1, fe1, rel, con)

where

fs1 is the first byte of the field.

fe1 is the last byte of the field.

rel is one of the following relation tests (required to reject this record):

Relation Test	Reject if
EQ	fs1 = con
NE	fs1 ≠ con
LT	fs1 < con
GT	fs1 > con
LE	fs1 ≤ con
GE	fs1 ≥ con

con is a constant of up to ten characters excluding comma and right parenthesis.

Example: Delete any record where byte 26 is not a 2.

```
OMITC = (26,26,NE,2)
```

11.2.12 MOVEF Directive

This optional directive provides for moving a data field within a record to another field within the record. It has the form

MOVEF = (fs1, fs2, fe2)

where

fs1 is the first byte of the **from** field.

fs2 is the first byte of the **to** field.

fe2 is the last byte of the **to** field.

Example: Move the data in bytes 30 through 40 to bytes 70 through 80.

```
MOVEF = (30,70,80)
```

If the field to be moved is part of a SORTKEY directive, the position named in SORTKEY must be the "to" position since the move is done first.

11.2.13 MOVEC Directive

This optional directive provides for moving an ASCII constant to a field within the record. It has the form

MOVEC = (con, fs1, fe1)

where

con is a constant of up to ten characters, excluding comma and parenthesis.

fs1 is the first byte of **to** field.

fe1 is the last byte of the **to** field.

Example: Move the constant SORTED to bytes 13 through 18.

```
MOVEC = (SORTED,13,18)
```

11.2.14 LOT Directive

This optional directive specifies that a list of sorted record numbers (the record number portion of the tag) is to be output.

LOT

The directive is applicable when a tag sort is performed.

The format of the output record numbers is one record number per word. The number of words in the record is specified by the OUTPUT directive (record length) or is defaulted to the record length of the INPUT directive if no record length is specified in the OUTPUT directive. Unless blocked, the records are written one per sector (record length specified by OUTPUT directive or defaulted to INPUT directive) with the remainder of the sector padded with the last record number output. For example, if the INPUT directive specifies 40 word records, and no record length is specified by the OUTPUT directive, the first 40 record numbers will be on the first sector followed by 80 pads, the next sector will contain 40 records followed by 40 pads etc.

11.2.15 INEXIT Directive

This optional directive specifies whether a user-written input-exit routine is to be called at the time the input file is

being read by the sort part of VSORT. The general form of the directive is

INEXIT = { YES / NO }

The equal sign may be followed by a string of up to four alphabetic characters. Unless YES is specified, the default is NO (a user routine is not called). YES or NO must be followed by at least one blank.

11.2.16 OUTEXIT Directive

This optional directive specifies whether a user-written output exit routine is to be called at the time the final file output file is being created by the merge phase of VSORT. It has the general form

OUTEXIT = { **YES** / NO }

The meaning of YES and NO is the same as described for the INEXIT directive (section 11.2.15).

11.2.17 ENDSORT Directive

This directive signals the end of the sort directives. The general form of this directive is

ENDSORT

The word ENDSORT must be followed by at least one blank as the last directive on the last control record for VSORT.

11.3 USER EXITS

User exits provide for the insertion, deletion, or modification of input and output records by user-written routines. Exits are requested by the VSORT directives, INEXIT = YES and/or OUTEXIT = YES. The exit routines written by the user are added to VSORT at load-module generation time.

The input exit routine, if provided, is called for each input record before it enters the sort. Possible uses of the input exit are

- Add input records
- Delete input records
- Create part or all of the input file
- Change input records, such as control fields

The input record length may be changed to the output record length specified on the OUTPUT directive.

The output exit routine, if provided, is called for each output record before it is written on the output file. Possible uses for the output exit are

- Add output records, effectively merging one or more files with the sorted file
- Delete sorted output records, such as duplicates
- Change the sorted output records

If output records are added or changed, it's the user's responsibility to ensure that the control fields of the output records remain in sequence.

11.3.1 Calling Sequence

VSORT uses the following calling sequence for user exits:

Word 1	JMPM XITn
Word 2	input buffer address
Word 3	output buffer address
Word 4	flag

where

n is 1 for input exit and 2 for output exit

input buffer address is the address of input record passed to the user routine (INEXIT) or the address to which the user must move a record if it is to be inserted before the output record (or EOF) passed to the user routine (OUTEXIT)

output buffer address is the address of the output record passed to the user routine (OUTEXIT) or the address to which the user must move a record if it is to be inserted before the input record (or EOF) passed to the user routine (INEXIT)

flag is set by VSORT as 0 for an EOF encountered, 1 for INEXIT, or 2 for OUTEXIT; otherwise it is set by the user routine as follows

Bit 0 = 1 accept input record (INEXIT) or insert record in input buffer before output record (OUTEXIT)
= 0 is ignore the record in the input buffer

Bit 1 = 1 accept the output record (OUTEXIT) or insert record in the output buffer before the input record (INEXIT)
= 0 ignore the record in output buffer

After EOF notification has been given to the user input (output) exit routine, the user routine may continue to pass records to VSORT in the buffer, but the contents of the buffer are ignored.

11.3.2 Implementation

The exit routines written by the user must have the following external names

XIT1 User input exit entry point

XIT2 User output exit entry point

To build a load module using user exits, place the user exit modules in front of the VSORT object module and proceed to generate a single load module.

11.4 VSORT MESSAGES

In addition to listing the VSORT directives, VSORT outputs the following totals:

a. End of sort phase totals

```
SORT PHASE COMPLETE,TOTAL MERGE
RECORDS=XXXXX

INPUT XXXXX ACCEPTED=XXXXX
INSERTED=XXXXX DELETED=XXXXX
```

b. End of merge phase totals

```
SORT COMPLETE,OUTPUT RECORDS
COUNT=XXXXX

MERGE=XXXXX ACCEPTED=XXXXX
INSERTED=XXXXX DELETED=XXXXX
```

11.5 FOREGROUND SORT

VSORT may be scheduled as a foreground task on any V75 compatible processor. To schedule VSORT as a foreground task; load the required registers, and execute SCHED as follows:

label **SCHED level,** *wait,* **lun,** *key,* **'VS','OR','T'**

Upon return, the R0 register contains the sort status (R0 = 0, — error free sort — R0 ≠ 0; error)

Parameter Registers:

R0 bit 14 = 0: No parameters in registers, use SI to read in sort directives.

R0 bit 13 = 1: List of tags to be output (see 11.2.14).

R0 bit 14 = 1: Sort directives are on a logical unit other than SI. Information on this unit contains parameters in registers as follows:

R0 = logical unit number (set bit 12 for open without rewind).

R2 = protect key (if RMD).

R3 = record length.

R4 = ASCII file name (if RMD).

R5 = ASCII file name (if RMD).

R6 = ASCII file name (if RMD).

Status:

R0 = 0 sort complete.

R0 ≠ 0 error encountered:

R0 bit 0 = 1: IO04 or IO10 error (see A.3).
R0 bit n = 1: STn error (see A.11).

SECTION 12
DATAPLOT II

DATAPLOT II is a collection of FORTRAN callable subroutines that provide the user with interface to the STATOS 31 and STATOS 33 electrostatic printer/plotters.

Using DATAPLOT II, the programmer can specify the desired graphic output at the functional level. For example, DATAPLOT II enables the STATOS printer/plotter to

- Draw a vector between two given points
- Produce a scaled set of axes for a given magnitude
- Produce a plot from a set of input data, using specified plot point markers

12.1 SYSTEM FLOW OUTLINE

DATAPLOT II consists of FORTRAN and DAS MR subroutines which permit STATOS 31 or STATOS 33 printer/plotters to draw lines, numbers, letters, symbols, and chart axes. Provision is also made for plotting lines from existing X-Y arrays and/or data from an external data base.

Figure 12-1 shows the relationship between the user and the DATAPLOT II Graphics System.

12.2 HARDWARE REQUIREMENTS

DATAPLOT subroutines can be linked to either foreground or background tasks under VORTEX (see VORTEX installation manual for memory requirements). DATAPLOT can be used with the following considerations:

a. The STATOS equipment that is supported under VORTEX is:

Unit	Model	Width
STATOS 31	70-6602	14-7/8 inches
STATOS 31	70-6608	11 inches
STATOS 33	70-6611/21	8-1/2 inches
STATOS 33	70-6613/23	11 inches
STATOS 33	70-6615/25	14-7/8 inches
STATOS 33	70-6617/27	22 inches
STATOS 42	70-6661	8-1/2 inches
STATOS 42	70-6662	8-1/2 inches
STATOS 42	70-6663	11 inches
STATOS 42	70-6664	11 inches
STATOS 42	70-6665	14-7/8 inches
STATOS 42	70-6666	14-7/8 inches
STATOS 42	70-6667	22 inches
STATOS 42	70-6668	22 inches
STATOS 41	70-6651	8-1/2 inches
STATOS 41	70-6652	8-1/2 inches
STATOS 41	70-6653	11 inches
STATOS 41	70-6654	11 inches
STATOS 41	70-6655	14-7/8 inches
STATOS 41	70-6656	14-7/8 inches
STATOS 41	70-6657	22 inches
STATOS 41	70-6658	22 inches

b. The STATOS unit must be operated under BIC control with PIM assigned interrupts. In addition, the STATOS 31 printer/plotters will support the single-line Input Buffer Option (Model 31-152); except, those without a hardware character generator.

c. DATAPLOT II does not support any of the Hardware Character Generator options, the Simultaneous Print/Plot options, or the High Speed option.

12.3 GENERAL DESCRIPTION

12.3.1 DATAPLOT II Organization

DATAPLOT II is organized into the following five logical operations:

- Defining the Plot File and Initialization
- Building the Plot File
- Sorting the Plot File
- STATOS Paper Control
- Outputting the Plot File in STATOS Raster Format

These are shown schematically in figure 12-2.

Defining the Plot File: Subroutine DPINIT defines which VORTEX logical unit will contain the Plot File, the logical size of the plot file records, and the block size of the output device for the plot data. If DPINIT is not called, the plot file will default to System Scratch (SS) with 120-word records, and plot data will be output in blocks of 88 words for the 14-7/8 inch STATOS. Subroutine DPINIT must be called when Dataplot is operating in a foreground mode to prevent a possible conflict with background programs which may use System Scratch.

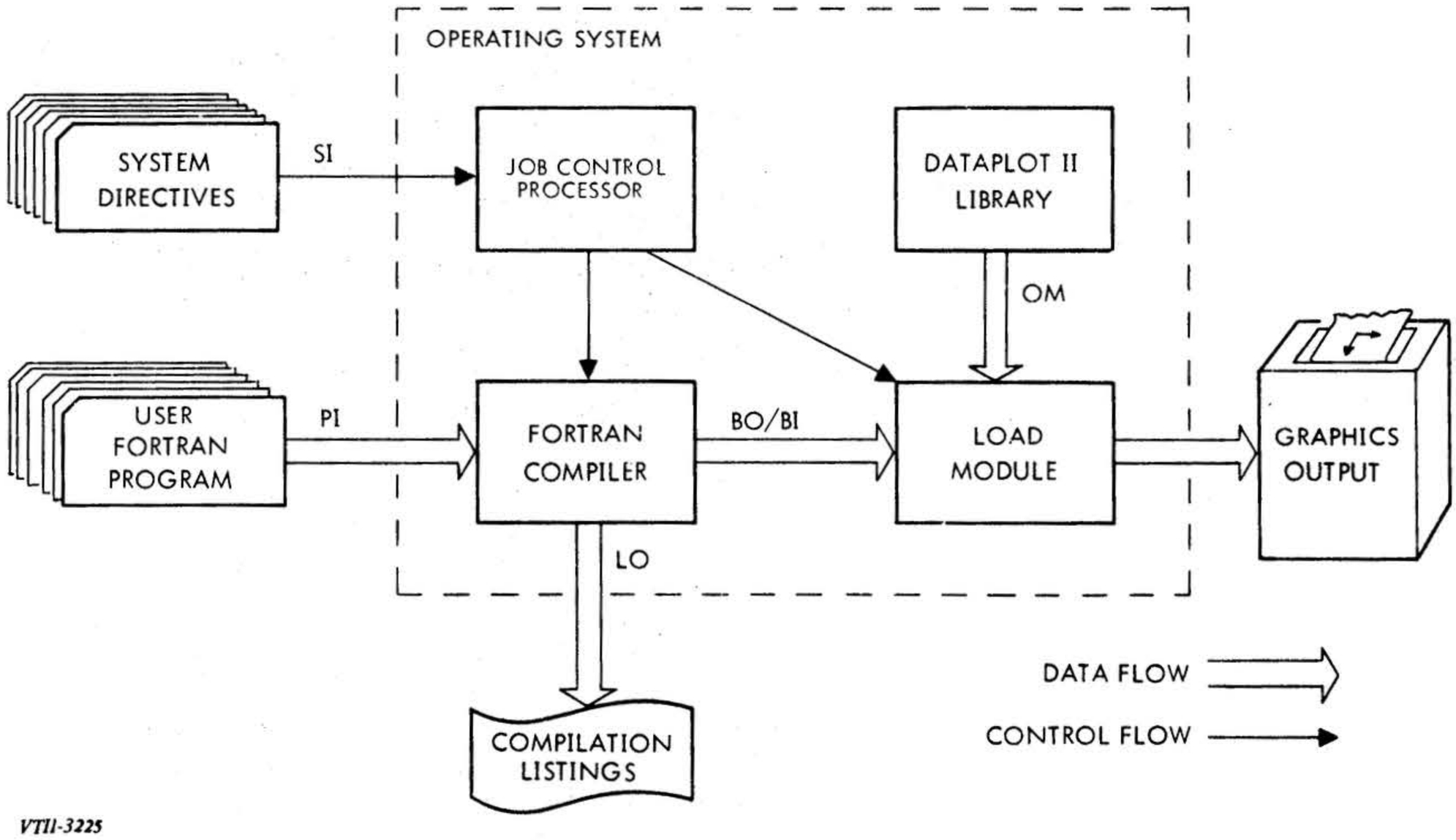


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Figure 12-1. DATAPLOT II Graphics System Data Flow

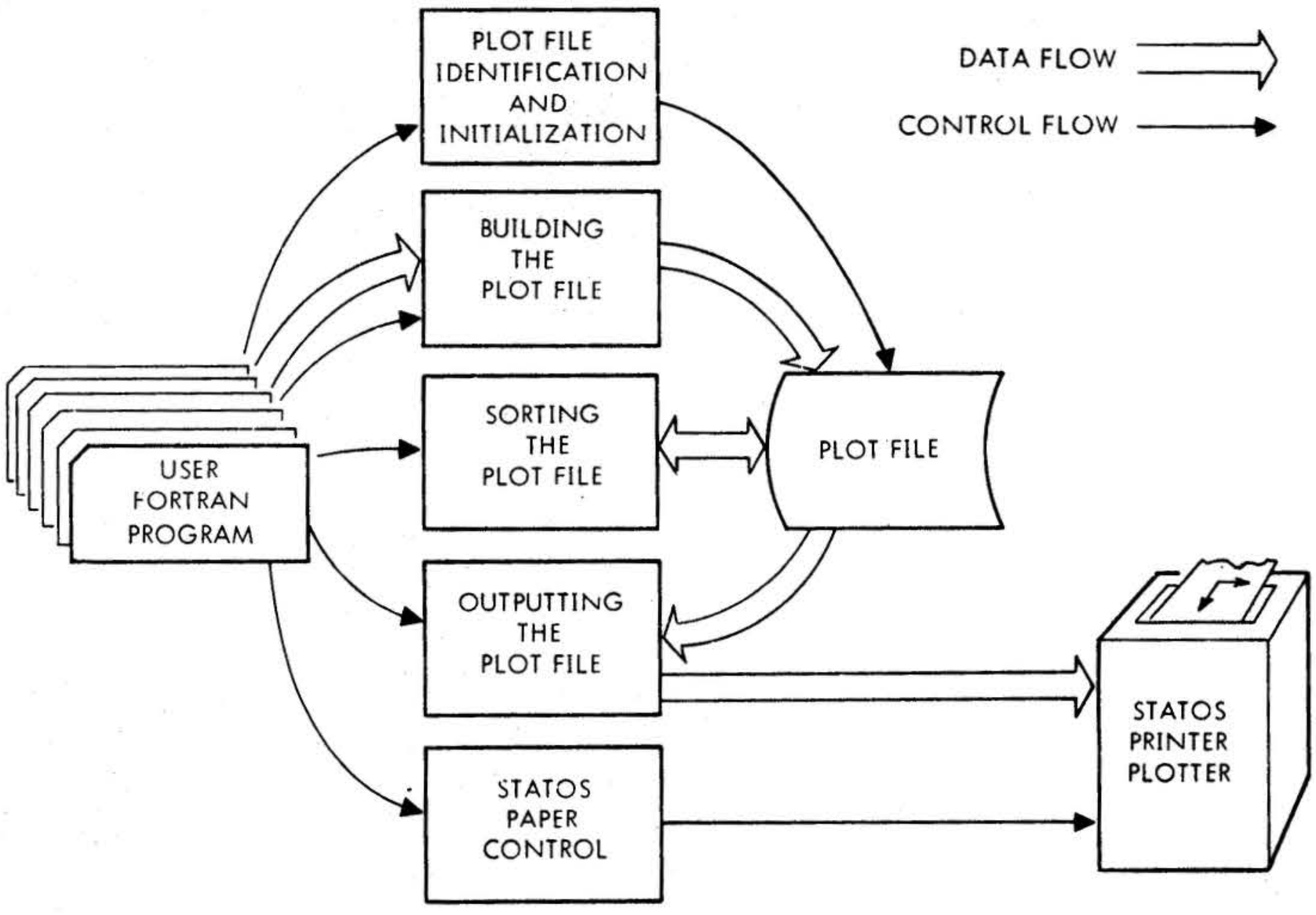

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Figure 12-2. DATAPLOT II Organization

Building the Plot File: If the plot file is to be built through calls to Dataplot subroutines ORIG, CHAR, PLOT, VECT, NUMBER, SCALE, AXIS, DATA, SYMBOL, APPEND, and LINE, the plot file must be assigned to an RMD device or the sort subroutine will not work.

STATOS Paper Control: Subroutine CUT, ENDCUT, and TOPFRM are auxiliary paper control subroutines. These subroutines issue FUNC commands to the output driver and will be processed as applicable to the driver.

Outputting the Plot File: Subroutine DPPLOT outputs STATOS raster format data. DPPLOT is called by subroutine PLOT when the plot is terminated.

12.3.2 System Considerations

DATAPLOT II is supplied as three groups of object module routines. The first group is the basic Dataplot Object Module (BDPOM). It contains the subroutines for initializing the plot file, drawing lines, sorting and outputting the plot file, and paper control. The second group is the VORTEX (pen-plotter compatible) Dataplot Object Module (VDPOM). It contains higher level routines for building the plot file. The third group is the MOS (compatible) Dataplot Object Module (MPBOM). It contains calls which are compatible to the MOS Dataplot II.

DATAPLOT II is put onto the object module library as a combination of either the BDPOM and VDPOM, or the BDPOM and MDPOM, depending on which set of higher level subroutines the user wishes to call. The VDPOM routines offer axes, character and number strings at any angle, while the MDPOM offers only two angles (0 degrees and 90 degrees). The MDPOM subroutines are provided for users who have already written MOS programs calling DATAPLOT II.

The MDPOM routines may be placed on an alternate object module library and the VDPOM routines may be placed on the standard OM library. Programs using the MDPOM routines may search the alternate library before the standard OM library, but this also prevents a load-and-go operation.

When converting programs written for MOS DATAPLOT II, a call to PLOTS must be substituted for the calls to OPEN, HOPEN, and DOPEN. The call CALL PLOT (0.0,0.0,999) must be substituted for calls to CLOSE, HCLOSE, and DCLOSE. There is a shift in the logical plot origin if the pseudo-pen encounters a plot boundary in VORTEX DATAPLOT II (incl MDPOM). There is no such shift in the MOS DATAPLOT II routines.

Users of STATOS 42 models 70-6661 through 70-6668 (200 stylii/inch) must include CALL DENSTY(200) prior to the call to PLOTS. Omission of the call to DENSTY for 200 stylii/inch models will result in a plot size one-half that expected from the program.

DATAPLOT II subroutines are listed below:

Dataplot II initialization

DPINIT	**BDPOM**	
PLOTS	**BDPOM**	
DENSTY	**BDPOM**	(STATOS 42 models)

Building the Plot File

PLOT	**BDPOM**
VECT	**BDPOM**
ORIG	**BDPOM**
FACTOR	**BDPOM**
WHERE	**BDPOM**
MLTPLE	**BDPOM**
APPEND	**BDPOM**
NUMBER	**MDPOM**
NUMBER	**VDPOM**
SCALE	**MDPOM**
SCALE	**VDPOM**
AXIS	**MDPOM**
AXIS	**VDPOM**
DATA	**MDPOM**
LINE	**VDPOM**
SYMBOL	**MDPOM**
SYMBOL	**VDPOM**
CHAR	**MDPOM**

Sort and Output

DPSORT	**BDPOM**
DPPLOT	**BDPOM**

Paper Control

TOPFRM	**BDPOM**
CUT	**BDPOM**
ENDCUT	**BDPOM**

12.3.3 VORTEX Considerations

Plot File Assignment: The user must supply a secondary storage file sufficiently large enough to hold the plot file when the plot file is unsorted or generated by calls to DATAPLOT II subroutines ORIG, VECT, CHAR, NUMBER, SCALE, DATA, AXIS, LINE, PLOT, SYMBOL, or APPEND. Four 16-bit words are used for each vector or character to be plotted, and four 16-bit words are used for the end-of-plot indicator. An error (DP00) will be reported if the plot file is overflowed.

The user may supply a sorted plot file in vector-end-point format. Sorted data may be plotted directly from the plot file by assigning the plot file to the logical unit containing the data during the call to DPINIT.

User-Supplied Central Memory Buffers: DATAPLOT II may use up to three types of buffers which the user must supply by a FORTRAN DIMENSION statement. The buffer types are:

- DATAPLOT II Working Buffer -- defined in call to PLOTS
- Append FILE I/O Buffer -- defined in call to APPEND
- Data Array Buffer(s) -- used by DATA and SCALE subroutines

DATAPLOT II Working Buffer: The DATAPLOT II Working Buffer is used in building, sorting, and outputting the plot file.

The algorithm for determining the size of the DATAPLOT II working buffer is:

$$22 + PFIO + RO + 6(VEC_{max})$$

where

PFIO is the size of the plot file I/O buffer

RO is the size of the raster (STATOS) output buffer

$\mathbf{VEC_{max}}$ is the maximum number of vectors or characters on any one STATOS scan line

The plot file I/O buffer size is a multiple of the physical record length of the plot file, and is specified in the call to DPINIT.

The raster output buffer size is determined by the width of the STATOS printer/plotter for which the plot is intended, as shown in the following table, and is specified in the call to DPINIT.

STATOS Model	Width	No. Stylii/Line	Raster Buffer Size
70-6608	11 inches	1056	66
70-6602	14-7/8 inches	1408	88
70-6611, 70-6621, 70-6651, and 70-6652	8-1/2 inches	800	50
70-6613, 70-6623, 70-6653, and 70-6654	11 inches	1056	66
70-6615, 70-6625, 70-6655, and 70-6656	14-7/8 inches	1408	88
70-6617, 70-6629, 70-6657, and 70-6658	22 inches	2048	132
70-6661 and 70-6662	8-1/2 inches	1600	100
70-6663 and 70-6664	11 inches	2112	132
70-6665 and 70-6666	14-7/8 inches	2816	176
70-6667 and 70-6668	22 inches	4096	264

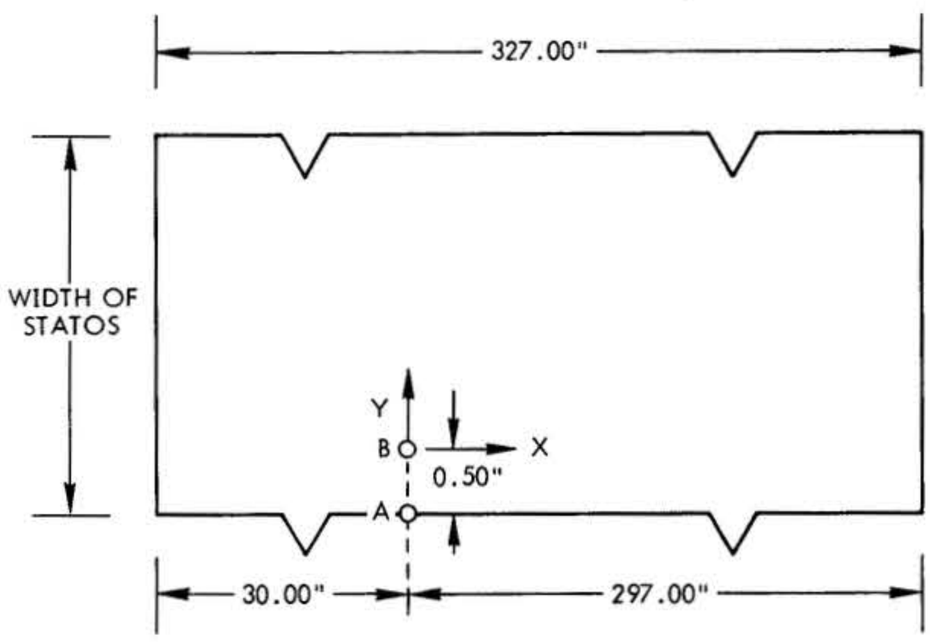
The buffer is also used to hold vectors and characters at the time they are being converted to STATOS raster format. A six-word entry will be placed in this buffer when the vector or character is first to appear on a STATOS scan line. The entry remains until the vector or character reaches its last STATOS scan line.

An error (DP01) will be reported if the concurrent vector buffer is overflowed.

Example: DATAPLOT II is going to plot from a plot file whose record length is 120, to a STATOS printer/plotter whose width is 14-7/8 inches. The maximum number of vectors or characters expected on any one raster line is 130. The length of the working buffer should be:

$$22 + 120 + 88 + 780 = 1010$$

Minimum and Maximum Plot Values: The minimum x value is -30.00 inches. The maximum x value is +297.00 inches. The maximum y value is determined by the width of the STATOS for which the plot is intended. These values are shown in figure 12-3.



A = Physical origin (0.0,0.0)
B = Starting logical origin (0.0,0.0) or (0.0,0.5) physical.

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Figure 12-3. Minimum and Maximum Plot Values

The logical origin may be moved by calling subroutine PLOT or ORIG. Subroutine PLOT will move the logical origin referenced to the last logical origin. Subroutine ORIG will move the logical origin referenced to the physical origin.

If the plot boundaries are encountered while building the plot file, the logical origin will be effectively shifted in a manner similar to a pen plotter. An error (DP04) will be reported.

12.4 DATAPLOT II SUBROUTINES

The general form of the DATAPLOT II functions is:

(statement number) CALL S (p(1),p(2),...p(n))

where:

(statement number)	is the optional statement number.
S	is the name of the subroutine.
p(1),...p(n)	are the parameters, if any.

12.4.1 DPINIT (System File Initialization)

This function enables the user to specify certain initial conditions relating to the plot file and plot file I/O buffer. In the absence of this function, the default parameter values shown in the parameter description will exist.

The function has the general form

CALL DPINIT (lun,key,name,ipltbf,outsiz)*
***BDPOM**

where

		Default
lun	is the number or variable of the plot file logical unit (Integer).	8
key	is the protection key, if any.	None
name	RMD: is the six-character name of the plot file. It may be given as an array name or a Hollerith constant non-RMD: Not used.	SS (background scratch file)
ipltbf	is the length, of the plot file I/O buffer. (Integer)	120
outsiz	is the block size of the output plot data as given in section 12.3.3 (Integer).	88

Error Conditions: None

Example: Select logical unit 25, file name PLTFIL, protection key Z, length 120 as the plot file. The output is to go to a STATOS, width 14-7/8 inches.

CALL DPINIT (25,2HbZ,6HPLTFIL,120,88)

12.4.2 PLOTS (Work Buffer Initialization)

The PLOTS function is used to initialize the DATAPLOT II work buffer. It must be called prior to any calls to the PLOT subroutine and prior to calls to higher level plot subroutines. STATOS models 70-6661 through 70-6668 are 200 stylii/inch models and hence require CALL DENSTY(200) prior to the call to PLOTS.

The function has the general form

CALL PLOTS (ibuf,nloc,lun)*

***BDPOM**

where

ibuf	is the name of the user-supplied storage area to be used as a work buffer by DATAPLOT II. This array should be dimensioned by the user in his FORTRAN program.
nloc	is the number which identifies the size of the work buffer (ibuf). It will normally be the same number used in the DIMENSION statement. The size is determined by the algorithm supplied in section 12.3.3 (Integer).
lun	is the logical unit number of the output device (Integer).

Error Conditions:

Condition:	Work buffer size is too small
Action:	Incomplete Plot
Message:	DP01
Conditions:	PLOTS not called
Action:	Abort Plot
Message:	DP05

Example:

```
DIMENSION IBUF (1500)

CALL PLOTS (IBUF,1500,5)
```

The above defines logical unit number 5 as the output device for the data in STATOS raster format. Buffer IBUF, of length 1500 words, will be used as a central memory work area by DATAPLOT II.

12.4.3 PLOT (Generate Plot)

The PLOT function is basic to the generation of graphic output. It may be used to draw lines between points, define new plot origins, sort plot data, cause the transfer of plot information to the output device and terminate plot generation.

The function has the general form

CALL PLOT (x,y, ±idraw)*

***BDPOM**

where

x,y are the x and y coordinates, in inches from the currently defined origin (Real).

± draw is an integer which determines whether or not a line is drawn from the "current" x,y coordinates to the coordinates defined in the call. It may also be used to define a new plot origin or to terminate the plot generation process and cause transfer of plot information to the output device.

If IDRAW = 2, a line is drawn from the current x,y coordinates to the coordinates defined in the call. The new coordinates then become the current x,y coordinates.

If IDRAW = 3, the coordinates in the call become the current x,y coordinates, but no line is drawn.

If IDRAW = -2 or -3, a new origin is defined at the call coordinates and the operation is completed as if IDRAW were positive. The current x and y coordinates are set to zero with respect to the new origin. If no call has been made to MLTPLE, or if the last call to MLTPLE was made with IND = 0, the current plot will be terminated and subsequent plotting will be defined with reference to a new origin on the paper. If the last call to MLTPLE was made with IND = 1, a redefinition of the origin will occur and subsequent plot definitions will be treated as belonging to the current plot.

If IDRAW = 999, the plot generation process will be terminated and all accumulated plot information will be transferred to the output device. Further calls to PLOT are not processed.

Following a **plot** function, the X coordinate is reset to zero.

Error Conditions:

The normal pen plotter routines do not keep track of the actual location of the pen, but instead always assume that the pen can be moved from the current location to the new location and that enough commands are output to accomplish this. If a mechanical stop is encountered during plotting, the motion in that direction is simply inhibited by the plotter. Because the mechanical stops are not precise, errors will be produced if a mechanical stop is encountered during plotting. However, this is sometimes done before initiating a plot in order to position the pen in a known location before beginning the actual plot.

DATAPLOT II routines have software stops contained internally and attempt to produce the same effect as a mechanical stop. If a plot boundary is encountered, an error (DP04) will be reported, the line will extend toward the boundary and follow the boundary to the final position, and the origin will be effectively shifted in a manner similar to the pen plotter.

Examples:

```
CALL PLOT (1.0,2.0,3)
CALL PLOT (2.0,2.0,2)
```

The above calls will draw a line between (1,2) and (2,2).

```
CALL MLTPLE (1)
CALL PLOT (1.0,2.0,3)
CALL PLOT (2.0,3.0,-2)
CALL PLOT (1.0,1.0,2)
```

The above calls will draw a line in absolute coordinates from (1,2) to (3,4) and redefine the plot origin (0,0) to (2,3) in absolute coordinates.

12.4.4 SCALE (Generates Scale Factor)

This subroutine scales data by computing a scale factor and a displacement factor.

The subroutine has the general form

CALL SCALE (arr,npts,pgsz, + int)*

or

CALL SCALE (arr,pgsz,npts, ± int)**

***MDPOM**

****VDPOM**

where

arr is the name of the (real) array to be scaled.

npts is the number of points to be scaled in the array. Normally, all points are scaled (Integer).

pgsz is the size of the page (linear interval in inches) within which the data must fall. It must be greater than 1.0 inch (Real).

± int is the interval at which the array is to be sampled.

If INT is positive, the selected displacement approximates a minimum, and the scale factor is positive.

If INT is negative, the selected displacement approximates a maximum, and the scaling factor is negative (VORTEX call only).

The array must be dimensioned at least two elements larger than the actual number of data values it contains. The calculated displacement will be stored in ARR(NPTS+1), and the calculated scale factor will be stored in ARR(NPTS+2).

The subroutine scales data within the following constraints:

a. The scale factors is 1., 2., 4., 5., or 8. times 10E(n).

b. The displacement is an integral multiple of the scale factor.

c. The displacement is .LE. the minimum value in the array.

d. The displacement + the scale factor (units/inch)* axis length is .GE. the minimum value in the array.

Examples are shown in the sample programs (section 12.6).

Error Conditions: None

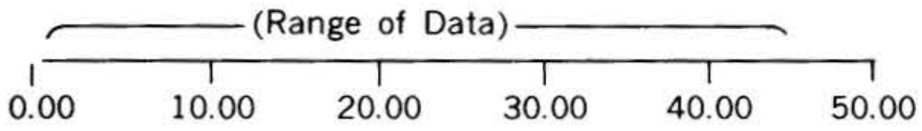
Examples:

1. Given an array of 24 data values to be plotted over a 5-inch axis, assume the minimum value in the array is 1.00 and the maximum is 42.00. The statement CALL SCALE (ARR,5.0,24,+1) would give the following results:

   Units/inch = (42.00-1.00)/5.0 = 8.2
   SF (scale factor) = 10.0
   VLO (first value plotted) = 0.0

   VLO value is stored in ARR(25)
   SF value is stored in ARR(26)

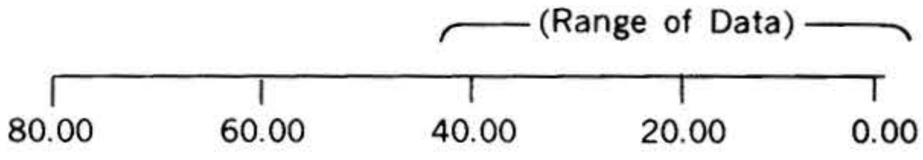
Using these values, AXIS would draw the following axis line:



2. Assume that the array of Example 1 is to be plotted on a 4 inch axis, from maximum to minimum. CALL SCALE (ARR,4.0,24,-1) would give these results:

   SF = (1.00-42.00)/4.0 = -10.25, which is adjusted to -20.
   Minimum multiple = 0.00; VLO = Minimum + (AXLEN * SF) = 80.00

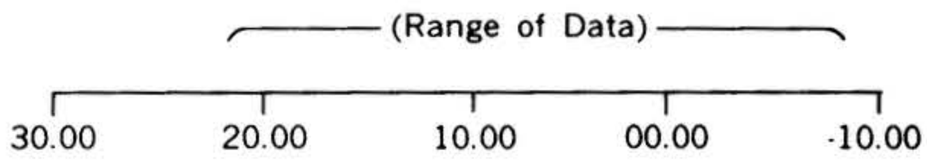
In this case the following axis would be drawn:



3. Assume 100 points are to be plotted on a 4 inch axis from maximum (+22) to minimum (-9), using every other data value in the array. The DIMENSION statement should specify ARR(204), and the calling sequence is CALL SCALE (ARR, 4.0,100,-2).

Initial SF = (-9 -22)/4 = -7.75, adjusted to -8.
Initial VLO = +16.00; last value on axis = -16.00.
The axis range is inadequate for the data range, so SF is revised to the next higher interval.
Revised SF = -10., stored in ARR(203).
Revised VLO = 30.00, stored in ARR(201).

The resulting axis would appear as follows:



12.4.5 AXIS (Generate Segmental Axis)

Subroutine AXIS produces entries into the plot file for an axis with the markers every inch, an axis label and number labels for each tic mark, using the results of the SCALE subroutine if desired.

The subroutine is of the general form

CALL AXIS (**x,y,axlh,idir,bcd,±** nch,vlo,sf)*
or
CALL AXIS (**x,y,bcd,±** nchar,axlh,angle,vlo,sf)**

*MDPOM
**VDPOM

where

x,y is the starting point on the page of the axis to be drawn (Real).

axlh is the length of the axis in inches. The value given will be truncated to the next smallest integer value (Real).

idir is the axis direction. Zero for x direction. Non-zero for y direction (Integer).

bcd is the first word address of a character string to be plotted as a label for the axis. If there is no label, use a dummy space.

±nchar NCHAR is the number of letters contained in the character string to be plotted as a title (Integer).

If NCHAR < 0: the title, tic marks and interval labels will be plotted on the clockwise side of the axis.

If NCHAR ≥ 0: the title, tic marks and interval labels will be plotted on the counter-clockwise side of the axis.

±nch NCH is the number of letters contained in the character string to be plotted as a title (Integer).

If NCH ≥ 0, the title, tic marks, and interval labels will be plotted on the clockwise side of the axis.

If NCH ≥ 0, the title, tic marks, and interval labels will be plotted on the counter-clockwise side of the axis.

vlo is the number to be plotted at the starting point of the axis (Real).

sf is the scale factor (units/inch) to be used in labelling the 1-inch intervals. By making SF = ARR(NPTS + 2) (see SCALE routine), the axis and data will have the same scale factor (Real).

angle is the angle at which the axis is to make with the x axis.

The interval labels will be scaled by powers of 10 if they are too large or too small to fit into two decimal place accuracy. Thus, assuming a scale factor of 1000./inch, 12000. would be printed 12.00 on the interval tic mark, but a note would be added to the axis label: "x10^{3}."

The SCALE routine should be used prior to using AXIS if SF = ARR(NPTS + 2).

Error Conditions: **None**

Example:

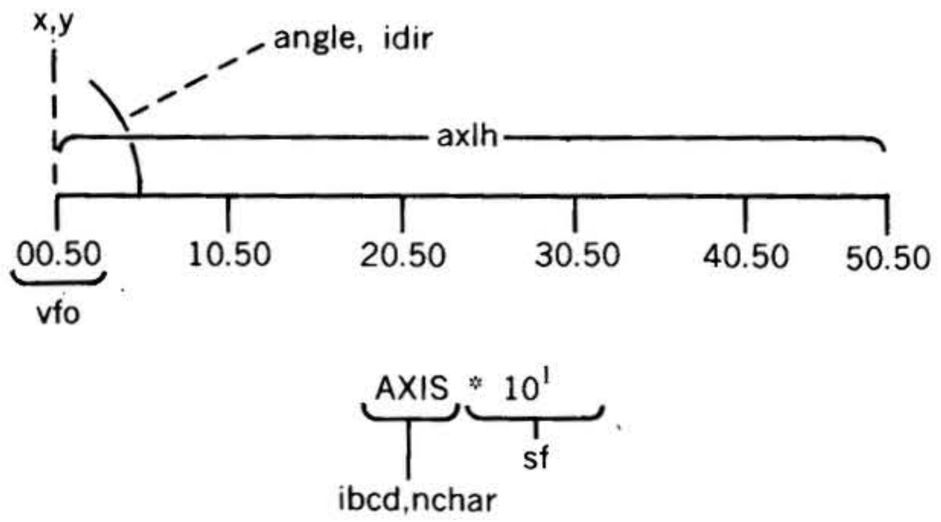
```
CALL AXIS (0.0,0.0,5.0,0,4HAXIS,
           4,5.0,100.0)*

CALL AXIS (0.0,0.0,4HAXIS,-4,5.0,
           0.0,5.0,100.0)**
```

* MDPOM

** VDPOM

The resulting axis would appear as follows:



12.4.6 SYMBOL (Generate Symbols)

This function generates plot file entries defining printable characters. Each entry contains an x and a y coordinate, a code which specifies that the entry is for a character, a code identifying the character and codes for size and orientation. The characters are software generated dot matrix characters in two sizes (5 x 7 and 10 x 14) and four orientations.

The function is of the general form

CALL CHAR (x,y,ibcd,isoar,+nchar,ispac)*

or

CALL SYMBOL (x,y,height,ibcd,angle,±nchar)**

* MDPOM

** VDPOM

where

x,y are the x and y coordinates (in inches) of the first letter to be plotted. x will be the minimum x value of the character and y will be the minimum y value of the character (Real).

ibcd is the address of the first word containing the ASCII character string to be plotted. It can be given as an array name or a Hollerith constant.

isaor is the size and orientation:

- 0 = small, +90 degrees rotation from x direction.
- 1 = small, 0 degrees rotation from x direction.
- 2 = large, +90 degrees rotation from x direction.
- 3 = large, 0 degrees rotation from x direction.

height selects the character height. If height ≤ 0.10, the characters will be 0.07 inches high. If height > **0.10,** characters will be 0.14 inches high (Real).

angle is the angle, in degrees from the x-axis, at which the character string is to be plotted. The individual characters will be plotted at 0, 90, 180, or 270 degrees depending on the value of "angle" (Real).

ispac is the spacing constant in styli or scans from the starting coordinate of the previous character. A negative number causes default standard spacing (Integer).

nchar is the total number of characters to be plotted in the string (Integer).

if NCHAR = 0, one character will be plotted from the low order byte of the word containing the string. (VORTEX call only)

If NCHAR = -1, one symbol will be plotted. The symbol must be identified by setting IBCD to an integer (0 through 5). (VORTEX call only)

If NCHAR = -2 or less, one symbol will be plotted along with a vector from the previous current location to the symbol starting location. (VORTEX call only)

IBCD (when NCHAR 0)	Symbol
1	□
2	◇
3	○
4	■
5	●

Character Orientation and Coordinates:

Angle (in degrees)	-44 to 45	46 to 135	136 to 225	226 to 315
Isaor	1,3			
VORTEX				
MOS				

The dot references the starting coordinate of the character.

Error Conditions: None

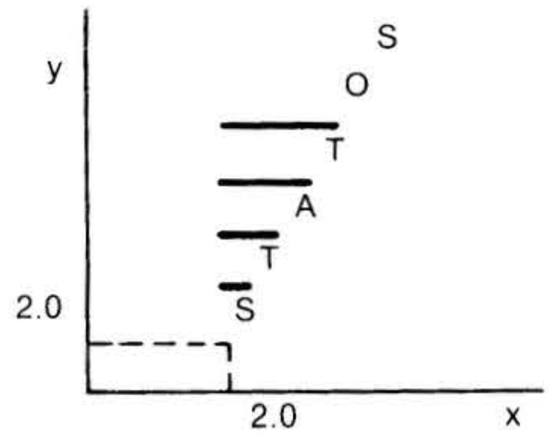
Example:

```
      3 DIMENSION LABEL (3)
        DATA  LABEL/2HST,2HAT,2HOS/
17 CALL CHAR (5.0,5.0,6HSTATOS,2,6,-1)
20 CALL CHAR (5.0,5.0,LABEL,2,6,-1)
```

Statement 17 will place six entries for large letters, 90 rotation from the x axis, standard spacing, into the plot file. Statement 20 will do likewise. The characters "STATOS" will be printed starting at 5.0,5.0 from the last origin.

25 CALL SYMBOL (2.0,2.0,0.14,6HSTATOS,45.0,6)

Statement 25 will place six entries for large letters into the plot file. "STATOS" will be printed as follows:



12.4.7 NUMBER (Generate Number)

This function converts single precision real numbers to character codes and places corresponding entries into the plot file.

This function has the general form

CALL NUMBER (x,y,fpn,isaor,±ndec)*

or

CALL NUMBER (x,y,height,fpn,angle,±ndec)**

* MDPOM
** VDPOM

where

x,y are coordinates (in inches) of the first number in the string (Real).

fpn is the real number to be plotted. If negative, will be prefixed with a minus sign. Leading zeros will be suppressed, except the zero to the left of the decimal point. The real number is rounded by adding five to the digit to the right of the last digit to be plotted, then truncating the result (Real).

isaor is size and orientation:

0 = small, +90 degrees rotation from x direction (Default).

1 = small, 0 degrees rotation from x direction.
2 = large, +90 degrees rotation from x direction.
3 = large, 0 degrees rotation from y direction.

height selects the character height. If height = >0.10, the characters will be 0.07 inches high. If height = 0.10, characters will be 0.14 inches high (Real).

angle is the angle, in degrees from the x axis, at which the character string is to be plotted. The individual characters will be plotted at 9, 90, 180, or 270 degrees depending on the value of "angle" (Real).

ndec If this parameter is larger than zero, it defines the number of digits to be plotted to the right of the decimal point.

If NDEC = 0, the integer part will be plotted followed by a decimal point only.

If NDEC = −1, only the integer part will be plotted.

If NDEC is less than −1, (NDEC) −1 digits are truncated from the integer part (Integer).

The following table illustrates the use of the NDEC parameter.

Suppose FPN = 123.4567; how the number actually will appear is a function of the parameter NDEC.

NDEC	Number Plotted	Comments
4	123.4567	
3	123.457	Note rounding action
2	123.46	
1	123.5	
0	123.	
-1	123	
-2	12	Note truncation action
-3	1	
-4		Nothing is plotted

Error Conditions: None

Example:

```
CALL NUMBER (1.0,2.0,12.3,3,1)*
CALL NUMBER (1.0,2.0,0.14,12.3,
             0.0,1)**
```

The above will produce the number 12.3 at location x = 1.0,y = 2.0 in 10 x 14 character matrix, zero degrees from the x axis.

* MDPOM ** VDPOM

12.4.8 LINE (Generate Graph Line)

Subroutines DATA and LINE produce a data line with one call. Prior to the call, the data must be placed in two arrays which have been dimensioned to provide two extra locations in each array. These must be placed at the end of the arrays and contain the displacement and scale factors in that order. The two arrays must be of equal size, one containing x values and the other y values.

The subroutine is of the general form

CALL DATA (xarr,yarr,npts,inc,± lty,ieq)*

or

CALL LINE (xarr,yarr,npts,inc,± lty,ieq)**

* MDPOM

** VDPOM

where

xarr is the name of the array from which x values are to be extracted.

yarr is the name of the array from which the y values are to be extracted.

npts is the number of data points to be plotted from each array to the end of the array (Integer).

inc is the increment at which the arrays are to be sampled. INC = 1 means every x,y pair is plotted. INC = 2 means every other pair, etc. (Integer).

±lty indicates the type of line desired (Integer).

LTY<0: A symbol will be plotted at each selected point but no lines will connect the symbols.
LTY = 0: A line will be drawn connecting each selected point. No symbols will be drawn.
LTY>0: A symbol will be plotted at each selected point and a line will connect all symbols.

ieq is the positive integer designating symbol to be produced (1,2,3,4, or 5).

If LTY = 0, IEQ has no meaning.

Plot values will be generated by the following algorithm:

$$\text{Plot Value} = \frac{\text{array value} - \text{displacement}}{\text{scale factor}}$$

Error Conditions:

Condition:	The scale factor in the data array = 0.0
Action:	Incomplete plot
Message:	ARITH OVFL

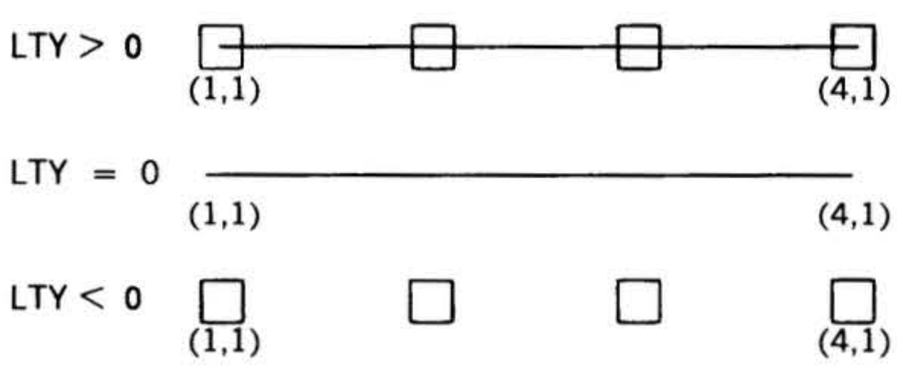
Examples:

```
DIMENSION XAR (6), YAR (6)
DATA XAR/1.0,2.0,3.0,4.0,1.0,1.0/
DATA YAR/1.0,1.0,1.0,1.0,1.0,1.0/
.
.
.
CALL DATA (XAR,YAR,4,1,LTY,1)
```

or

```
CALL LINE (XAR,YAR,4,1,LTY,1)
```

The above will produce the following plots:



12.4.9 MLTPLE (Multiple Plot)

The sign of the PLOT parameter IDRAW is used to indicate whether a new logical origin is to be defined. The MLTPLE call allows the user to change the origin without terminating his current plot definition. If no call has been made to MLTPLE, the PLOT origin change is treated as the completion of the current plot and the start of the new plot.

The subroutine is of the general form

CALL MLTPLE (ind)

*BDPOM
where

ind +1 = on future calls to PLOT, a redefinition of the logical origin will not be treated as the end of the plot, and multiple logical plots will be treated as belonging to the same real plot.

0 = on future calls to PLOT, a redefinition of the logical origin will also be treated as the end of the plot.

−1 = Same as +1 except that the accumulated information from past PLOT calls defines a complete plot and it should be output. Note that the statement CALL MLTPLE (−1) is exactly equivalent to:

```
CALL WHERE (x,y,fact)
CALL MLTPLE (0)
CALL PLOT (0.0,0.0,-3)
CALL MLTPLE (+1)
CALL PLOT (x,y,+3)
```

Error Conditions: None

Examples:

```
CALL PLOT (1.0,2.0,3)
CALL PLOT (2.0,2.0,-2)
CALL PLOT (3.0,3.0,3)
CALL PLOT (4.0,4.0,2)
CALL PLOT (0.0,0.0,999)
```

The above sequence will output two physical plots of one line each.

```
CALL MLTPLE (1)
CALL PLOT (1.0,2.0,3)
CALL PLOT (2.0,,2.0,-2)
CALL PLOT (3.0,3.0,3)
CALL PLOT (4.0,4.0,2)
CALL PLOT (0.0,0.0,999)
```

The above sequence will output one physical plot with two lines on the plot.

12.4.10 FACTOR (Alter Plot Size)

This function is used to alter the overall size of the plot by changing the ratio of the desired plot size to the normal size.

The function is of the general form

CALL FACTOR (fact)

*BDPOM
where

fact is the ratio of the desired plot size to normal plot size. If FACTOR is not called, fact = 1.0 (Real).

Error Conditions: None

Example: Make plot one-half normal size.

```
CALL FACTOR (0.5)
```

12.4.11 WHERE (Locate Coordinates)

This function returns information to the user. The three variables designated in the calling sequence are set to the current x and y coordinates and the current plot sizing factor.

The function is of the general form

CALL WHERE (rx,ry,rfact)*

*BDPOM

where

rx is the variable which will be set to the current x coordinate.

ry is the variable which will be set to the current y coordinate.

rfact is the variable which will be set to the current plot sizing factor.

Error Conditions: None

Example:

```
CALL MLTPLE (1)
CALL FACTOR (2.5)
CALL PLOT (1.0,2.0,3)
CALL WHERE (XA,YA,F)
CALL PLOT (3.0,1.0,-2)
CALL WHERE (XB,YB,F)
```

The above sequence will set the variables as follows:

```
XA = 1.0
YA = 2.0
F  = 2.5
XB = 0.0
YB = 0.0   new origin defined
```

12.4.12 APPEND (Append File)

Previously generated files in vector-end-point format may be added to the plot file and merged during the sort. A call to APPEND must be made after the call to PLOTS. If the file to be appended is not on an RMD device, it must be previously positioned.

The function is of the general form

CALL APPEND (lun,key,name,abuff,iabuff)*

*BDPOM

where

lun is the variable or number of the logical unit containing the file to be appended (Integer).

key is the protection key, if any.

name is the six-character name of the file to be appended. It may be given as an array name or a Hollerith constant.

abuff the name of the APPEND file input buffer.

iabuff is the length of abuff (Integer).

Error Conditions:

Condition:	Wrong protection key
Action	Append call is ignored
Message:	I004,xxxxxx

Condition:	File name not found
Action:	Append call is ignored
Message:	I010,xxxxxx

xxxxxx is the task name.

Examples:

```
117 CALL APPEND (18,0,0,BUFF,1024)
136 CALL APPEND (132,2HbP,6HMAPbb,
                 ABUFF,960)
```

Statement 117 will cause the file on logical unit 18 to be appended to the plot file. BUFF will be used as the input buffer. Statement 136 will cause the file named MAP on logical unit 132, with protection code P, to be appended to the plot file. ABUFF will be used as the input buffer. Data will be input in blocks of 960 words (8 sectors).

12.4.13 TOPFRM (Top-of-Form)

TOPFRM subroutine will advance the paper to the next TOP-OF-FORM mark or eleven inches, whichever occurs first (FUNC code = 0). A Top-of-Form command will be output to the output driver at the time the subroutine is called.

The subroutine is of the general form

CALL TOPFRM*

*BDPOM

Error Conditions: None

Example:

```
CALL TOPFRM (Outputs FUNC (0)
to the plot output device)
```

12.4.14 CUT (Cut Paper)

The CUT subroutine issues a cut command (FUNC code = 20) to the output driver when the subroutine is called.

The subroutine is of the general form

CALL CUT*

*BDPOM

Error Conditions:

Condition:	Paper cutter option not connected.
Action:	Command ignored
Message:	none

Example:

```
CALL CUT
```

A cut command (FUNC (20)) is sent to the plot output device.

12.4.15 ENDCUT (Eject and Cut Paper)

The ENDCUT subroutine issues a FUNC code equal to 21 (cut command) to the output device and moves the paper approximately 34 inches.

The subroutine is of the general form

CALL ENCUT*

*BDPOM

Error Conditions:

Condition:	Output device not STATOS.
Action:	Command ignored
Message:	None

Example:

```
CALL ENDCUT
```

The above issues a cut and move paper command to the plot output device.

12.4.16 DPSORT (Sort Plot File)

This function sorts an RMD plot file. No sort is attempted if the plot file is not assigned to an RMD.

DPSORT is also called by subprogram DPPLOT when IDRAW = 999, or when IDRAW 1, or when MLTPLE is set 0.

The function is of the general form

CALL DPSORT*

*BDPOM

Parameter Description: None

Error Conditions:

Condition:	Data Plot working buffer too small.
Action:	Abort program
Message:	DP01
Condition:	Plot file not assigned to RMD.
Action:	Abort program
Message:	DP07

Example:

```
CALL DPSORT
```

12.4.17 DPPLOT (Output File)

DPPLOT subroutine converts the plot file to STATOS raster format and outputs the raster data to the output device specified in the call to PLOTS. DPPLOT is called by subroutine PLOT when IDRAW = 999 or when IDRAW <0, and MLTPLE = 0 or when MLTPLE is set <0, to output the plot data.

This subroutine is of the general form

CALL DPPLOT*

*BDPOM

Parameter Description: None

Error Conditions:

Condition:	Working buffer overflow
Action:	Incomplete plot
Message:	DP01
Condition:	Attempted to plot from unsorted File.
Action:	Abort plot
Message:	DP02
Condition:	End-of-plot indicator not detected.
Action:	Abort plot
Message:	DP03
Condition:	Min/Max x/y values exceeded.
Action:	Line will follow plot boundary, plot origin will be shifted.
Message:	DP04
Condition:	PLOTS not called.
Action:	Abort plot
Message:	DP05

Example:

```
DIMENSION IBUF (1200)
CALL PLOTS (IBUF,1200,5)
CALL DPINIT (107,2HbF,6HPLTFIL,
             120,88)
CALL DPSORT } or CALL PLOT
CALL DPPLOT } (0.0,0.0,999)
```

The above program will output raster plot data to logical unit 5, block size 88, from an unsorted plot file residing on logical unit 107, protection code of F, name PLTFIL, block size of 120.

If the plot file is sorted, the call to DPSORT may be eliminated.

If the plot file is on system scratch (SS) and the STATOS is 14-7/8 inches wide, the call to DPINIT may be eliminated.

12.4.18 DPCLOS (Close Plot File)

DPCLOS subroutine closes and updates the plot file and writes an end-of-file if the plot file is on magnetic tape. The first three words of DPFCB (data plot file control block) are set to zero, and the plot file cannot be referenced until a call is made to DPINIT to restore DPFCB.

The subroutine is of the general form

CALL DPCLOS*

*BDPOM

Parameter Description: None

Error Conditions:

If the plot file is assigned to a device other than an RMD or magnetic tape, the close request will be ignored.

Example:

```
170    CALL DPCLOS
```

Statement 170 closes the plot file.

12.4.19 ORIG -- Offsetting the Origin Entry Point

This function offsets the origin entry point of the plot.

The origin of the plot is the lower left hand corner of the plot area, with the +y axis towards the right and the +x axis pointing into the plotter.

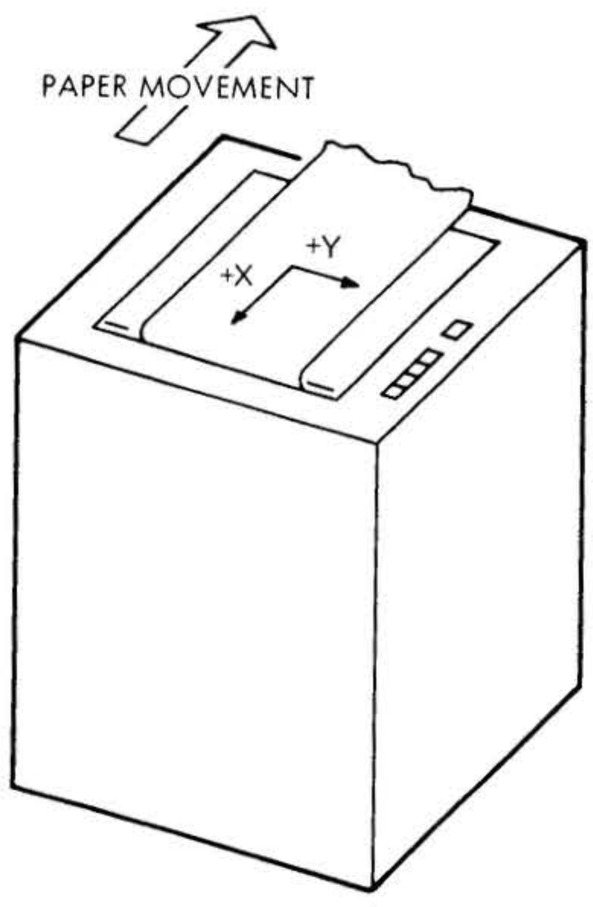


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Figure 12-4. +x Axis and +y Axis Relative to Paper Direction

The absolute y displacement may not go negative. If it is desired to offset the origin in order to allow (relative) negative numbers, or to allow large positive values to be plotted without wasting paper, it is possible to offset both x and y coordinates of the (relative) origin by the following call of the general form:

CALL ORIG (x,y)*

*BDPOM

where

x	is the distance (in inches) along the x axis which the new (relative) origin will be offset (Real).
y	is the distance (in inches) along the y axis which the new (relative) origin will be offset (Real).

The coordinates used in locating plot elements are always relative to the origin location.

Error Conditions: None

Example:

```
170  CALL ORIG (7.0,3.1)
```

Statement 170 offsets the origin 7.0 inches in the x direction and 3.1 inches in the y direction from the physical origin (0.0,0.0).

12.4.20 VECT -- Vector Entry Point

This subroutine generates plot file entries defining straight lines between two points. Four parameters define the points in the following order:

x1, y1, x2, y2. The parameters are single precision, real numbers representing inches from the origin. Provision is made for retaining the "current" (or last defined) point. When x1 = 999.0, a file entry is produced to generate a line between the "current" point and the point defined by x2 and y2.

The subroutine is of the general form

CALL VECT (x1,y1,x2,y2)*

*BDPOM

where

x1	is the starting x coordinate of line.
y1	is the starting y coordinate of line.
x2	is the ending x coordinate of line.
y2	is the ending y coordinate of line.

Error Conditions: The normal plotter routines do not keep track of the actual location of the pen, but instead always assume that the pen can be moved from the current location to the new location and that enough commands are output to accomplish this. If a mechanical stop is encountered during plotting, the motion in that direction is simply inhibited by the plotter. Because the mechanical stops are not precise, errors will be produced if a mechanical stop is encountered during plotting. However, this is sometimes done before initiating a plot to position the pen in a known location before beginning the actual plot.

DATAPLOT II routines have software stops contained internally in order to produce the same effect. If a plot boundary is encountered, an error (DP04) will be reported, the line will extend toward the boundary and follow the boundary to the final position, and the origin will be effectively shifted in a manner similar to the pen plotter.

Example: 5 CALL VECT (3.2,1.0,4.0,1.0)

Statement 5 will place an entry in the plot file for the vector x = 3.2 to 4.0 and y = 1.0.

12.4.21 Special SYMBOL Subroutine

Subroutine SYMBOL produces special symbols on the plot.

The subroutine is of the general form

CALL SYMBOL (x,y,ieq)*

* MDPOM

where

x,y are the x and y coordinates of the center of the symbol (Real).

ieq is the positive integer designating the symbol to be produced.

IEQ	SYMBOL
1	□
2	◇
3	○
4	■
5	●

Error Conditions: None

Example:

```
CALL SYMBOL (1.0,2.0,4)
```

The above will place a filled in square (■) at location x = 1.0, y = 2.0.

12.4.22 DENSTY (Alter Stylii/Inch)

This function is used to set the system stylii/inch constants to 200 for STATOS 42 models 70-6661 through 70-6668. The function is of the specific form

CALL DENSTY(200)

*BDPOM

where

200 is the number of stylii/inch. If DENSTY is not called or if any raster density other than integer 200 is specified, the system will default to 100 stylii/inch.

Error Conditions:

a. Condition--resultant plots will be one-half the size expected from the program.

b. Action--include or correct the call to DENSTY.

12.5 PLOT FILE DATA FORMAT

12.5.1 Vectors

X values represent distances from the beginning of the plot in the opposite direction of paper movement. A unit of x corresponds to one step of paper movement in the machine.

Y values represent stylus numbers.

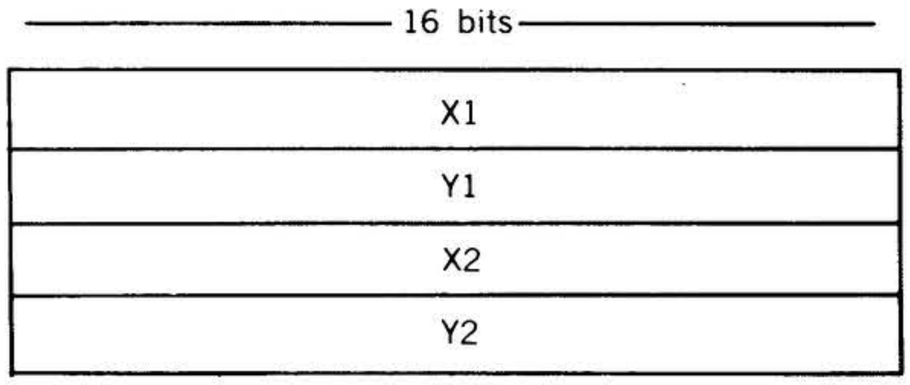


Figure 12-5. Vector-Data Format

where

$X2 \leq X1 \leq 32,700$

Y1 and Y2 number of STATOS stylii

12.5.2 Characters

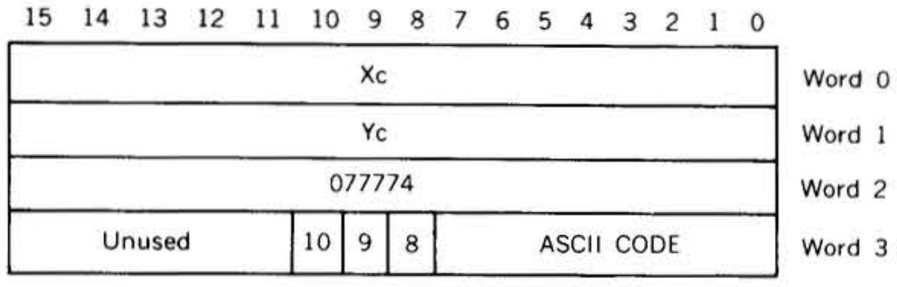
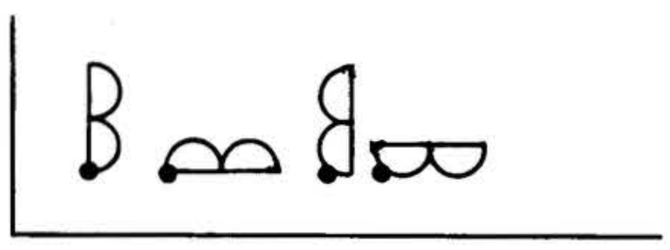


Figure 12-6. Character Data Format

Word 3, Bit 9 = 0 for small character (5x7)
= 1 for large character (10x14)

Word 3, Bit 8 and 10 determine the character orientation. The x and y coordinates refer to the lower left-hand corner of the character.



Bit 8	1	0	1	0
Bit 10	0	0	1	1

Figure 12-7. Character Orientation Data Format

12.5.3 End-of-Plot Indicator

The end of the plot indicator is shown in figure 12-8.

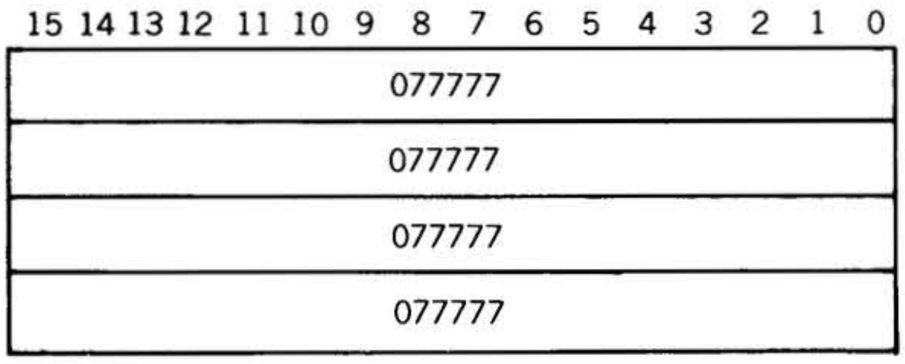


Figure 12-8. End-of-Plot Indicator

12.6 EXAMPLE OF APPLICATION OF DATAPLOT II

12.6.1 Program to Generate Sine Wave

```
C
C          SAMPLE PLOT (BDPOM/VDPOM CALLS)
C
           DIMENSION XAR (34),YAR(34),
           IBUFF(1000)
           XAR (33) = 0.0
           XAR (34) = 1.0
           YAR (33) = -100.0
           YAR (34) = 100.0
           CALL PLOTS (IBUFF,1000,5)
           CALL MLTPLE (1)
           CALL PLOT (1.0,1.0,-3)
           XVA = 0.0
           DO 200 I = 1,32
           XVA = XVA + 0.25
           XAR (I) = XVA
      200  YAR (I) = 100.0 + 200.0 * SIN(XVA)
C
C          PLOT AXES, DATA
C
           CALL AXIS (0.0,0.0,6HY-AXIS,
           6,4.0,90.0,YAR(33),YAR(34)
           CALL AXIS (0.0,0.0,6HX-AXIS,
           -6,8.0,0.0,XAR(33),XAR(34))
           CALL LINE (XAR,YAR,32,1,-1,1)
           CALL PLOT (0.0,0.0,999)
           CALL EXIT
           END
(END-OF-FILE)
```

12.6.2 Program to Generate Communication Network

```
C
C          SAMPLE COMMUNICATIONS NETWORK
C
           DIMENSION IBUFF (1000),
           XAR(12),YAR(12)
           CALL PLOTS (IBUFF,1000,5)
```



```
C
C          SAMPLE PLOT (BDPOM/MDPOM CALLS)
C
           DIMENSION XAR (34), YAR (34),
                     IBUFF (1000)
           XAR (33) = 0.0
           XAR (34) = 1.0
           YAR (33) = -100.0
           YAR (34) = 100.0
           CALL PLOTS (IBUFF, 1000, 5)
           CALL ORIG (1.0, 1.0)
           XVA = 0.0
           DO 200 I = 1, 32
           XVA = XVA + 0.25
           XAR (I) = XVA
      200  YAR (I) = 100.0 + 200.0 * SIN (XVA)
C
C          PLOT AXES, DATA
C
           CALL AXIS (0.0, 0.0, 4.0, 1,
                     6HY-AXIS, -6, YAR (33),
                     YAR (34))
           CALL AXIS (0.0, 0.0, 8.0, 0,
                     6HX-AXIS, 6, XAR (33),
                     XAR (34))
           CALL DATA (XAR, YAR, 32, 1, -1, 1)
           CALL PLOT (0.0, 0.0, 999)
           CALL EXIT
           END
```

```
C     BUILD END-POINTS
            DO 10 I = 1,12
            X = 6.283 * FLOAT (I)/12.0
            YAR(I) = 5.0 * SIN (X)+7.0
      10    XAR(I) = 5.0 * COS(X)+7.0
C           DRAW THE LINES
            DO 30 I1 = 1,11
            K = I1 + 1
            DO 30 I2 = K, 12
      30    CALL VECT (XAR(I1),YAR (I1),
            XAR(I2),YAR(I2))
            CALL PLOT (0.0,0.0,-3)
            CALL EXIT
            END
(END-OF-FILE)
```

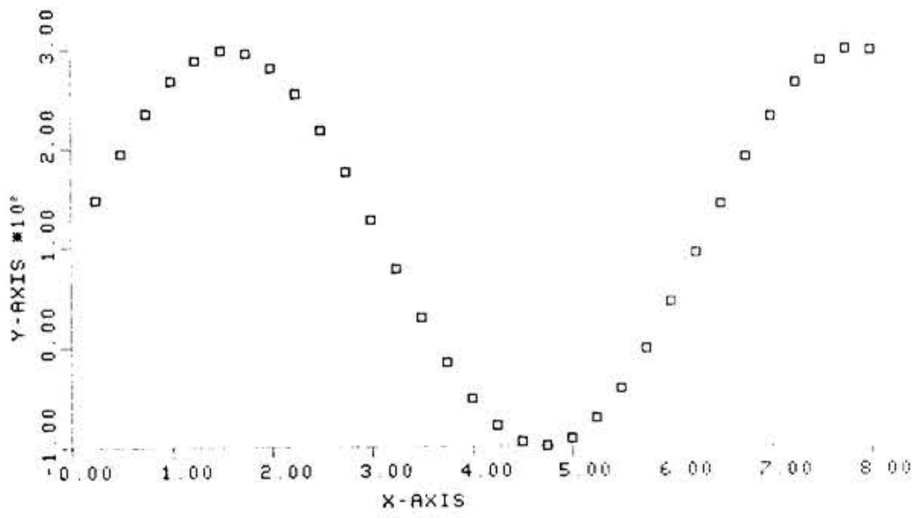


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Figure 12-9. Sine Wave Plot Generated by DATAPLOT II

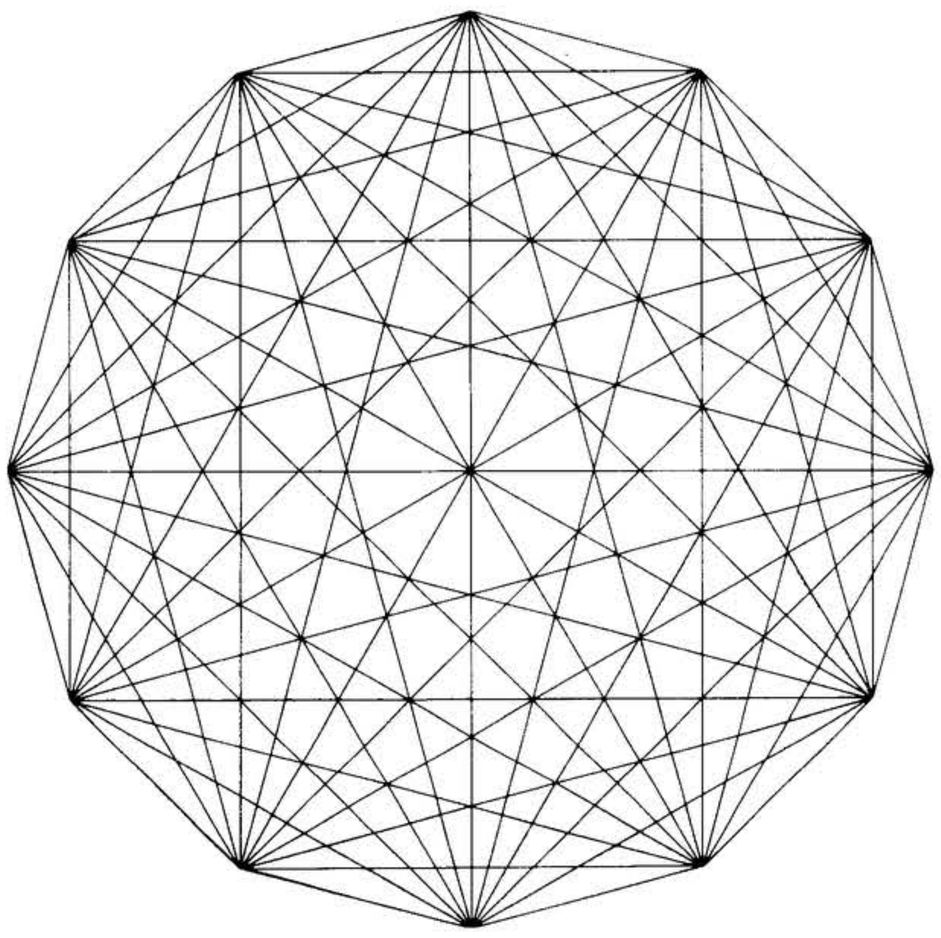

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Figure 12-10. Communication Network Plot Generated by DATAPLOT II

12.7 OPERATING PROCEDURES AND ERROR MESSAGES

12.7.1 VORTEX Operating Procedures

Use of the DATAPLOT II plot generation routines requires the preparation of FORTRAN programs which make appropriate calls to the FORTRAN and SPERRY UNIVAC 70/620 assembly language programs.

The user may execute in a compile-and-go mode by ending his program with a call to PLOT (x,y,999) or PLOT (x,y,-i) and the plot output device assigned to the STATOS printer/plotter (Ref. paras 12.4.2).

If a STATOS printer (using fanfold paper) is out of adjustment, or the paper mark is not correctly sensed, the driver may appear to lose track of the top of form. If this occurs, the following patch may be used to correct the situation (for fanfold paper only):

V$CLPS+576,17777

12.7.2 Unsorted Plot Files

Unsorted plot files may be output by VORTEX DATAPLOT II by transferring the plot file to an RMD (if not already there) by IOUTIL or the APPEND subroutine, and calling the following subroutines:

```
DIMENSION
CALL DPINT      (           ) if necessary
CALL DENSTY     (           ) if necessary
CALL PLOTS      (           ) if necessary
CALL DPSORT
CALL DPPLOT
CALL EXIT
END
```

12.7.3 Presorted Plot Files

Files which have been presorted may be in physical records whose length is any multiple of four 16-bit words. There is no restriction on the number of records which may be processed, other than the physical capacity of the peripheral device. The file must have been sorted on the numerical value of the X1's, in descending order. Each X1 must be greater than or equal to its associated X2. An end-of-plot indicator (four words containing 077777) must appear at the end of the significant data in the last record.

Presorted plot files may be output by VORTEX DATAPLOT II by assigning the plot file to the physical unit containing the plot file (DPINIT) and calling the following routines:

```
DIMENSION
CALL DPINIT     (           ) if necessary
CALL DENSTY     (           ) if necessary
CALL PLOTS      (           ) if necessary
CALL DPPLOT
CALL EXIT
END
```

12.7.4 VORTEX Special Procedures

The VORTEX DATAPLOT II package may be executed in one, two, or three sections. No special modifications are necessary to build, sort, and output the plot file in one module.

Sorting and outputting the plot file may be separated from building the plot file by supplying dummy sorting and outputting routines. For example, this method may be used if it is desired to build the plot file in the background and output the plot file from the foreground. Subroutine PLOTS must be included in each section or an error (DP05) will be output. For STATOS models 70-6661 through 70-6668, CALL DENSTY(200) must precede the call to PLOTS or the resulant plot will be half the expected size.

Example:

```
/FORT,B,L,M
C     BUILD THE PLOT FILE
      DIMENSION IBUFF (142)
      CALL DPINIT (25,2HbK,6HFILEbb,
      120,88)
      CALL PLOTS (IBUFF,124,27)
      CALL AXIS (1.0,1.0,4HAXIS,4,5.0,
      0.0,0.0,1.0)
      CALL PLOT (0.0,0.0,999)
      CALL EXIT
      END
C     DUMMY SUBROUTINES
      SUBROUTINE DPSORT
      RETURN
      END
      SUBROUTINE DPPLOT
      RETURN
      END
/FORT,B,L,M
C     SORT AND OUTPUT THE PLOT FILE
      DIMENSION IBUFF (1000)
      CALL DPINIT (25,2HbK,6HFILEbb,
      120,88)
      CALL PLOTS (IBUFF,1000,27)
      CALL DPSORT
      CALL DPPLOT
      CALL EXIT
      END
(END-OF-FILE)
```

The above programs referenced the plot file named FILE on logical unit number 25, protection code K.

The IBUFF in the first program only needs to be the plot file record size (120) plus 22. The size of IBUFF in the second program may be increased to provide faster sorting when large plot files are generated.

SECTION 13

SUPPORT LIBRARY

The VORTEX system has a comprehensive subroutine library directly available to the user. The library contains mathematical subroutines to support the execution of a program, plus many commonly used utility subroutines. To use the library, merely code the proper call in the program, or, for the standard FORTRAN IV functions, implicitly reference the subroutine (e.g., A = SQRT(B) generates a CALL SQRT(B)). All calls generate a reference to the required routine, and the load-module generator brings the subroutine into memory and links it to the calling program.

The performance of several routines in the support library is improved through the use of the V70 series Floating Point Firmware on V70 series systems having Writable Control Store (WCS). The necessary firmware and library routines which call the firmware are added to the Object Module Library (OM) by executing the supplemental WCS job stream supplied with the System Generation Library.

13.1 CALLING SEQUENCE

The subroutines in the support library are called through DAS MR or FORTRAN IV.

DAS MR: *General form:*

label **CALL S,p(1)**,*p(2)*,...,*p(n)*

Expansion:

```
label   JMPM    S
        DATA    p(1)
        DATA    p(2)
        .
        .
        .
        DATA    p(n)
```

FORTRAN IV: *General form:*

statement number **CALL S(p(1)**,*p(2)*,...,*p(n)*)

Generated code:

```
        JMPM    S
        DATA    q(1)
        DATA    q(2)
        .
        .
        .
        DATA    q(n)
```

Where q(i) = p(i) if p(i) is a single variable or array name. Otherwise, q(i) = address containing p(i).

13.2 NUMBER TYPES AND FORMATS

Integers use one 16-bit word. A negative number is in two's complement form. An integer in the range -32,768 to +32,767 can be stored as an integer.

Real numbers use two consecutive 16-bit words. For a positive real number, the exponent (in excess 0200 form) is in bits 14 to 7 of the first word. The mantissa is in bits 6 to 0 of the first word and bits 14 to 0 of the second word. The sign bit of the second word is zero. The negative of this number is created by one's complementing the first word. Any real number in the range $10^{\pm 19}$ can be stored as a single-precision floating-point number having a precision of more than six decimal digits.

Single-Precision Floating-Point Numbers

```
Bit   15   14 13 12  11 10 9   8  7  6   5  4  3   2  1  0
n)    s    -------Exponent---------  ----High Mantissa----
n+1)  0    -----------------Low Mantissa-----------------
```

Double-precision floating-point numbers use four consecutive 16-bit words. The exponent (in excess 0200 form) is in bits 7 to 0 of the first word. The mantissa of a positive number is in the second, third, and fourth words. Bit 15 of the second, third and fourth words and bits 15 to 8 of the first word are zero. The negative of this number is created by one's complementing the second word. Any real number in the range $10^{\pm 38}$ can be stored as a double-precision floating-point number having a precision of more than 13 decimal digits.

Double-Precision Floating-Point Numbers

```
Bit   15   14 13 12  11 10 9  8  7  6   5  4  3   2  1  0
n)    0    0  0  0   0  0  0  0  --------Exponent--------
n+1)  s    -----------------High Mantissa-----------------
n+2)  0    -----------------Mid Mantissa------------------
n+3)  0    -----------------Low Mantissa-----------------
```

13.3 SUBROUTINE DESCRIPTIONS

The following definitions and notation apply to the subroutine descriptions given in this section:

Notation	Meaning
AB	Hardware A and B registers
AC	Four-word software accumulator for double-precision numbers
ACCZ	Four-word accumulator for complex numbers (the real part is in AB and the imaginary part is in a temporary cell in subroutine V$8G)
d	Address of a double-precision number
f	Address of a two-word, fixed-point number
i	Address of an integer
r	Address of a real number
S	A six-character ASCII string
X	Hardware X register
z	Address of a complex number
**	Exponentiation

An additional name in parentheses indicates a replacement by standard firmware. For example, $SE(FSE) indicates the firmware routine FSE replaces $SE on 70 series systems using standard firmware. Section 20.2 describes standard firmware.

Section 19.4.2 describes the bit string operations OR, AND, NOT, XOR, and SHIFT.

The external references in table 13-3 refer to items in tables 13-1 and 13-2. A subroutine with more than one name is indicated by multiple calls under Calling Sequence.

Table 13-1. DAS Coded Subroutines

Name	Function	Calling Sequence	External References and Return Conditions
$HE	Given: A contains i1, in A compute i1**i2.	CALL $HE,i2	$SE(FSE), $HM
$PE	Given: AB contains r, in AB, compute r**i.	CALL $PE,i	$SE(FSE), $QM, $QN
$QE	Given: AB contains r1, in AB, compute r1**r2.	CALL $QE,r2	ALOG, $QM, EXP, $SE(FSE)
ALOG	In AB, compute ln r. If r ≤ 0, output message FUNC ARG and exit with A = B = 0 and overflow = 1.	CALL ALOG,r	$EE, $QK(FAD), $QM, XDMU, XDAD, $NML, XDDI, XDSU, $SE(FSE), $PC, $QL(FSB), $QN
EXP	In AB, compute e**r. If there is underflow, AB = 0. If overflow, AB = maximum real number and the message FUNC ARG is output. In both cases, overflow = 1.	CALL EXP,r	XDMU, $QK(FAD), $NML, $EE, $QM, $QN, $SE(FSE)
ATAN	In AB, compute arctan r	CALL ATAN,r	$QM, $QL(FSB), $QN, $QK(FAD) $SE(FSE)
SINCOS	In AB, compute cos r with COS, or sin r with SIN	CALL COS,r CALL SIN,r	$QK(FAD),$QL(FSB), $QM, $QN, $SE(FSE)
SQRT	In AB, compute square root of r	CALL SQRT,r	XDDI, $FSM, $SE(FSE)
FMULDIV	Given: AB contains r1, in AB, compute r1*r2 with $QM, or r1/r2 with $QN. If there is underflow, AB = 0. If overflow, AB = maximum value and the message ARITH OVFL is output. In both cases, overflow = 1.	CALL $QM,r2 CALL $QN,r2	XDMU, $FMS, XDDI, $SE(FSE), $EE, $NML

Table 13-1. DAS Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References and Return Conditions
FADDSUB	Given: AB contains r1, in AB, compute r1 + r2 with $QK, or r1 − r2 with $QL. If there is underflow, AB = 0. If overflow, AB = maximum value and the message ARITH OVFL is output. In both cases, overflow = 1.	CALL $QK,r2 CALL $QL,r2	$SE(FSE), $FSM, $NML, $EE
SEPMANTI	Separate mantissa and characteristic of r into AB and X, respectively	CALL $FMS CALL $FSM	None
FNORMAL	In AB, normalize r	CALL $NML	XDCO
XDDIV	In AB, compute f1/f2	CALL XDDI,f2	XDSU, XDCO
XDMULT	In AB, compute f1*f2	CALL XDMU,f2	XDAD, XDCO
XDADD	In AB, compute f1 + f2	CALL XDAD,f2	None
XDSUB	In AB, compute f1 − f2	CALL XDSU,f2	None
XDCOMP	In AB, compute negative of f	CALL XDCO	None
$FLOAT	In AB, convert the i in A to floating-point and, for $QS, store result in r	CALL $PC CALL $QS,r	$SE(FSE)
$IFIX	In A, convert the r in AB to i and, for $HS, store result in i	CALL $IC CALL $HS,i	$SE(FSE), $EE
IABS	In A, compute absolute i	CALL IABS,i	$SE(FSE)
ABS	In AB, compute absolute r	CALL ABS,r	$SE(FSE)
ISIGN	Set the sign of i1, in A, equal to that of i2	CALL ISIGN,i2	$SE(FSE)
SIGN	Set the sign of r1, in AB, equal to that of r2	CALL SIGN,r2	$SE(FSE)
$HN	Given: A holds i1, in A, compute i1/i2	CALL $HN,i2	$SE(FSE), $EE
$HM	Given: A holds i1, in A compute i1*i2	CALL $HM,i2	$SE(FSE), $EE
DSINCOS	In AC, compute sin d or cos d	CALL $DSI,d CALL $DSIN,d CALL $DCO,d CALL $DCOS,d	$STO,$DNO, $ZC, $ZK, $ZL, $SE(FSE), $ZM, $ZN, AC $DLO
DATAN	In AC, compute arctan d	CALL $DAN CALL DATAN,d	$DLO, $STO, $DAD, $DSU, IF, $SE(FSE), AC, $DMP, $DDI, POLY

Table 13-1. DAS Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References and Return Conditions
DEXP	In AC, compute exponential d	CALL $DEX CALL DEXP,d	$DLO, $STO, $SE(FSE), AC, $DNO, $EE, $ZC, $ZK, $ZL, $ZM, $ZN
DLOG	In AC, compute In d	CALL DLOG,d CALL $DLN	$DLO, $STO, $DNO, $EE $SE(FSE), $ZK, $ZL, $ZM, $ZN
POLY	In AC, compute double-precision polynomial with t terms, coefficient list starting at address c, and argument at address y	CALL POLY,t,c,y	$DLO, $DAD, $DMP
CHEB	In AC, compute shifted Chebyshev polynomial series with t + 1 terms and coefficient list starting at address c	CALL CHEB,t,c	$DLO, $STO, $DAD, $DSU, $DMP
DSQRT	In AC, compute square root of d	CALL $DSQ,d CALL DSQR,d	$DLO, $STO, $DNO, $DAD, $DMP, $DDI, $SE(FSE), AC
$DFR	In AC, compute fractional part of d	CALL $DFR,d	$DLO, $DNO, $DSU, $DIT, AC, $SE(FSE)
IDINT	In AC, compute integral part of d	CALL $DIT,d CALL IDINT,d	$DNO, $SE(FSE)
DMULT	In AC, compute d1*d2	CALL $DMP,d2 CALL $ZM,d2	$DLO, $STO, $DNO, $DAD, AC, $SE(FSE)
DDIVIDE	In AC, compute d1/d2	CALL $DDI,d2 CALL $ZN,d2	$DLO, $STO, $DNO, $DSU, AC, $SE(FSE)
DADDSUB	In AC, compute d1 + d2 with $DAD, or d1 - d2 with $DSU	CALL $DAD,d2 CAL $DSU,d2 CALL $ZK,d2 CALL $ZL,d2	$STO, $DLO, $DNO, AC, $SE(FSE), $EE
DNORMAL	In AC, normalize d	CALL $DNO	$SE(FSE)
DLOADAC	Load AC with d	CALL $DLO,d CALL $ZF,d	AC, $SE(FSE)
DSTOREAC	Store AC in d	CALL $STO,d CALL $ZS,d	AC, $SE(FSE)
RLOADAC	Load A with double-precision mantissa sign word from AC	CALL $ZI	AC
SINGLE	In AB, convert the d in AC to r	CALL $RC	AC
DOUBLE	In AC, convert the r in AB to d	CALL $YC	AC
DBLECOMP	In AC, compute negative of the d in AC	CALL $ZC	AC
$3S	Store AB in memory address m	CALL $3S,m	$SE(FSE)

Table 13-1. DAS Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References and Return Conditions
A2MT	Translate in memory a character string of length n starting at s and ending at e from eight-bit ASCII to six-bit magnetic tape BCD code s is the start of the ASCII block and e is the start of the BCD block.	CALL A2MT,n,s,e	None
MT2A	Translate in memory a character string of length n starting at s and ending at e from six-bit magnetic tape BCD code to eight-bit ASCII . s is the start of the BCD block and e is the start of the ASCII block.	CALL MT2A,n,s,e	None
EXIT	Formats and executes an RTE EXIT macro	CALL EXIT	V$EXEC
SUSPND	Formats and executes an RTE SUSPND macro with parameter i.	CALL SUSPND(i)	V$EXEC
RESUME	Formats and executes an RTE RESUME macro to resume task s.	CALL RESUME(s)	V$EXEC, $RTENM
ABORT	Formats and executes an RTE ABORT macro to abort task s.	CALL ABORT(s)	V$EXEC, $RTENM
ALOC	Formats and executes an RTE ALOC macro to call reentrant subroutine s.	CALL ALOC(s)	V$EXEC
PMSK	Formats and executes an RTE PMSK macro to operate on PIM i1 with line mask i2 and enable/disable flag i3.	CALL PMSK(i1, i2,i3)	V$EXEC
DELAY	Formats and executes an RTE DELAY macro with the 5-millisecond count in i1, the minute count in i2, and delay mode in i3.	CALL DELAY(i1, i2,i3)	V$EXEC
LDELAY	Formats and executes an RTE DELAY type 1 with additional parameters to specify the LUN from which the task (lun in i4 key in i5) is to be reloaded.	CALL LDELAY (i1,i2,i3, i4, i5)	V$EXEC
TIME	Formats and executes an RTE TIME macro with the minute count in i1, and 5-millisecond count in i2.	CALL TIME(i1,i2)	V$EXEC

Table 13-1. DAS Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References and Return Conditions
OVLAY	Formats and executes an RTE OVLAY macro with i1 = 0 to execute, i2 = 0 to load, and s is the overlay name.	CALL OVLAY(i1, i2,s)	V$EXEC, $RTENM
SCHED	Formats and executes an RTE SCHED macro with i1 = priority, i2 = wait flag, i3 = logical-unit number, s1 = key and s2 = task name.	CALL SCHED(i1, i2, i3,s1,s2)	V$EXEC, $RTENM
$RTENM	Moves the six-character name from X to B	CALL $RTENM	None
$EE	Outputs error messages on the SO device.	CALL $EE	VIOC, VIOST, V$EXEC
$SE	Fetches n parameters from a subroutine call	CALL $SE, n BSS n	None
V$RSW	Handles multi-reel volume files and information.	LDA = LUN to unload. LDX<0 for no mount. LDX = 0 for mount next volume. LDX>0 addr. of filename for mount. B = next volume number if X>0 CALL V$RSW	A = Restored B = Restored X = Restored
V$HDR	To format a standard VORTEX header.	CALL V$HDR DATA page number address DATA program name address DATA program title address (= 0 if not used)	A,B,X restored Header in 38 word external buffer V$HBUF

Table 13-2. OM Library Subroutines

Name	Function	Calling Sequence	Return Conditions
CB2A	Covert a 16-bit binary value (positive or negative) to an ASCII character string (octal or decimal) with leading zeros suppressed and right justified minus sign on negative decimal values.	LDA = 0 for octal conversion ≠ 0 for decimal conversion, (i.e., any positive integer) JSR CB2A,X DATA Address of binary value	(A) = Address of ASCII string (3 words) (B) = Restored
CA2B	Convert a decimal or octal ASCII number (positive or negative decimal) to a 16-bit binary value. **Note:** The data termination block lists termination characters as octal integers, one per word (0001-0255). For example, for COMMA and BLANK DATA 0254 COMMA DATA 0240 BLANK DATA 0 END OF BLOCK FLAG	JSR CA2B,X DATA ASCII string address (compl = left byte, pos = right byte) DATA Address of termination character block **The termination block format is** DATA Legal termination character (right justified) DATA Legal termination character (right justified) • • • DATA 0 (end of block)	(A) = Binary value (B) = Next byte address OVFL = Set if an illegal character encountered
MOVE	Move a block of **n** words from address **f** to address **t**. If an overlap move, then; move in reverse.	JSR MOVE,X DATA **n** (word count) DATA **f** (from address) DATA **t** (to address)	(A) = Restored (B) = Restored
CTIME	Convert the time of day to an ASCII string of the form: HH:MM:SS:III where III is miliseconds	JSR CTIME,X	(A) = Address of ASCII string (6 words) (B) = Restored

Table 13-3. FORTRAN IV Coded Subroutines

Name	Function	Calling Sequence	External References
$9E	Compute ACCZ**i	CALL $9E(i)	$SE(FSE), IABS, $8F, $8M, $8N, $8S
CCOS	In ACCZ, compute cos z	CALL CCOS(z)	$SE(FSE), CSIN, $8F, $8K, $8S
CSIN	In ACCZ, compute sin z	CALL CSIN(z)	$SE(FSE), EXP, $QN, SIN, $QK(FAD), $QM, COS, $QL(FSB), $8F
CLOG	In ACCZ, compute ln z	CALL CLOG(z)	$SE(FSE), ALOG, $QM, $QK(FAD), $QN, ATAN2, $8F
CEXP	In ACCZ, compute exponential z	CALL CEXP(z)	$SE(FSE), EXP, COS, $QM, SIN, $8F
CSQRT	In ACCZ, compute square root of z	CALL CSQRT(z)	$SE(FSE), SQRT, CABS $QK, $QN, $8F
CABS	In AB, compute absolute z	CALL CABS(z)	$SE(FSE), SQRT, $QM, $QK(FAD)
CONJG	In ACCZ, compute conjugate of z	CALL CONJG(z)	$SE(FSE), $8F
$AK	Add r to real part of ACCZ	CALL $AK(r)	$SE(FSE), $8S, $QK(FAD), $8F
$AL	Subtract r from the real part of ACCZ	CALL $AL(r)	$SE(FSE), $8S, $QL(FSB), $8F
$AM	Multiply ACCZ by r	CALL $AM(r)	$SE(FSE), $8S, $QM, $8F
$AN	Divide ACCZ by r	CALL $AN(r)	$SE(FSE), $8S, $QM, $8F
$AC	Convert AB to z and store in ACCZ	CALL $AC	$3S, CMPLX
CMPLX	Load ACCZ with a value having a real part r1 and an imaginary part r2	CALL CMPLX(r1,r2)	$SE(FSE), $8F
$8K	Add z to ACCZ	CALL $8K(z)	$SE(FSE), $8S, $QK(FAD), $8F
$8L	Subtract z from ACCZ	CALL $8L(z)	$SE(FSE), $8S, $QL(FSB), $8F
$8M	Multiply ACCZ by z	CALL $8M(z)	$SE(FSE), $8S, $QM, $QL(FSB), $QK(FAD), $8F

Table 13-3. FORTRAN IV Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References
$8N	Divide ACCZ by z	CALL $8N(z)	$SE(FSE), $8S, $QM, $QK(FAD), $QN, $QL(FSB), $8F
$ZD	Compute negative of z	CALL $ZD	$8S, $8F
AIMAG	Load AB with the imaginary part of z	CALL AIMAG(z)	$SE(FSE)
$OC	Load AB with the real part of ACCZ	CALL $OC	$8S
REAL	Load AB with the real part of z	CALL REAL(z)	$SE(FSE)
$8F	Load ACCZ with z	CALL $8F(z)	$SE(FSE)
$8S	Store ACCZ in z	CALL $8S(z)	$SE(FSE), $3S
$XE	Compute d**i where d is in AC	CALL $XE(i)	$SE(FSE), $ZF, MOD, $ZM, $HN, $ZN, $ZS
$YE	Compute d**r where d is in AC	CALL $YE(r)	$SE(FSE), $ZS, DBLE, $ZE, $ZF
$ZE	Compute d1**d2 where d1 is in AC	CALL $ZE(d2)	$SE(FSE), $ZS, DEXP, DLOG, $ZM
DATAN2	In AC, compute arctan (d1/d2)	CALL DATAN2(d1,d2)	$SE(FSE), $ZF, $ZS, $ZI, $ER, $ZN, $ZL, $ZK, DATAN
DLOG10	In AC, compute log d	CALL DLOG10(d)	$SE(FSE), DLOG, $ZM
DMOD	In AC, compute d1 modulo d2	CALL DMOD(d1,d2)	$SE(FSE), DINT, $ZF, $ZN, $ZS, $ZM, $ZL, $ZC
DINT	In AC, compute integer portion of d	CALL DINT(d)	$SE(FSE), $ZF, $JC, $XC
DABS	In AC, compute absolute d	CALL DABS(d)	$SE(FSE), $ZF, $ZI, $ZC
DMAX1	In AC, select the maximum value in the set d1, d2,...,dn	CALL DMAX1(d1,d2 ...,dn,0)	$SE(FSE), $ZF, ZS, IFA, $ZL, $ZI
DMIN1	In AC, select the minimum value in the set d1, d2,...,dn	CALL DMIN1(d1,d2 ...,dn,0)	$SE(FSE), $ZF, ZS, IFA, $ZL, $ZI
DSIGN	Set the sign of d1 equal to that of d2	CALL DSIGN(d1,d2)	$SE(FSE), $ZF, $ZI, $ZN
$YK	Add r to AC	CALL $YK(r)	$SE(FSE), $ZS, DBLE, $ZK
$YL	Subtract r from AC	CALL $YL(r)	$SE(FSE), $ZS, DBLE, $ZL, $ZC
$YM	Multiply AC by r	CALL $YM(r)	$SE(FSE), $ZS, DBLE, $ZM

Table 13-3. FORTRAN IV Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References
$YN	Divide AC by r	CALL $YN(r)	$SE(FSE), $ZS, DBLE, $ZF, $ZN
DBLE	In AC, convert r to d	CALL DBLE(r)	$SE(FSE), $YC
$XC	In AC, convert i to d where i is in A	CALL $XC	$PC, $YC
TANH	In AB, compute tanh r	CALL TANH(r)	$SE(FSE), $QK(FAD), EXP, $QL(FSB), $QN
ATAN2	In AB, compute arctan (r1/r2)	CALL ATAN2(r1,r2)	$SE(FSE), $ER, ATAN, $QK(FAD), $QL(FSB), $QN
ALOG10	In AB, compute log r	CALL ALOG10(r)	$SE(FSE), ALOG, $QM
AMOD	In AB, compute r1 modulo r2	CALL AMOD(r1,r2)	$SE(FSE), AINT, $QN, $QM, $QL(FSB)
AINT	In AB, truncate r	CALL AINT(r)	$SE(FSE), $IC, $PC
AMAX1	In AB, select the maximum value in the set r1,r2,...,rn	CALL AMAX1(r1,r2) ...,rn,0)	$SE(FSE), I$FA, $QL(FSB)
AMIN1	In AB, select the minimum value in the set r1, r2,...,rn	CALL AMIN1(r1,r2) ...,rn,0)	$SE(FSE), I$FA, $QL(FSB)
AMAX0	In AB, select the maximum value in the set i1,i2,...,in and convert to r	CALL AMAX0(i1,i2, ...,in,0)	$SE(FSE), I$FA, FLOAT
AMIN0	In AB, select the minimum value in the set i1,i2,...,in and convert to r	CALL AMIN0(i1,i2, ...,in,0)	$SE(FSE), I$FA, FLOAT
DIM	In AB, compute the positive difference between r1 and r2	CALL DIM(r1,r2)	$SE(FSE), $QL(FSB)
FLOAT	In AB, convert i to r	CALL FLOAT(i)	$SE(FSE), $PC
SNGL	In AB, convert d to r	CALL SNGL(d)	$SE(FSE), $ZF, $RC
MAX0	In A, select the maximum value in the set i1,i2,...,in	CALL MAX0(i1,i2, ...,in,0)	$SE(FSE), I$FA
MIN0	In A, select the minimum value in the set i1,i2,...,in	CALL MIN0(i1,i2, ...,in,0)	$SE(FSE), I$FA
MAX1	In A, select the maximum value in the set r1,r2,...,rn and convert to i	CALL MAX1(r1,r2, ...,rn,0)	$SE(FSE), I$FA, $QL(FSB), IFIX
MIN1	In A, select the minimum value in the set r1,r2,...,rn and convert to i	CALL MIN1(r1,r2, ...,rn,0)	$SE(FSE), I$FA, $QL(FSB), IFIX
MOD	In A, compute i1 modulo i2	CALL MOD(i1,i2)	$SE(FSE), $HN, $HM

Table 13-3. FORTRAN IV Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References
INT	In A, truncate r and convert to i	CALL INT(r)	$SE(FSE), $IC
IDIM	In A, compute the positive difference between i1 and i2	CALL IDIM(i1,i2)	$SE(FSE)
IFIX	In A, convert r to i	CALL IFIX(r)	$SE(FSE), $IC
$JC	In AC, convert d to i and store result in A	CALL $JC	$RC, $IC

13.4 DECIMAL SUBROUTINE

The decimal subroutine performs requested decimal operations (add, subtract, multiply, divide, move, or compare). Besides operand addresses and sizes, the user may specify pre-shifting of operands and post-shifting and rounding of result. Note that pre-shifting is decimal alignment and does not imply physical shifting. Operands may be signed or unsigned.

Decimal compare sets the user result condition word as follows:

=0	if operand A< operand B
=1	if operand A = operand B
=2	if operand A > operand B

Decimal compare arithmetically compares two decimal operands.

On entry register R0(A) contains the address of an 85 word temporary storage block available to firmware, R1(B) contains the address of the user result condition word, and R2(X) contains the address of the users descriptive parameter block. Decimal math may be accessed either via

```
JMPM    V$DECM
```

or

```
JMP     C$DECM
```

If C$DECM is used, return will be made to user supplied location VC$RTN. If V$DECM is used, the user must still define VC$RTN.

Parameter Block

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	CODE						P	LA			UB	LA				LB
1	BN_A							displacement$_A$								
2	BN_B							displacement$_B$								
3							Q	DA			DB	SA				SB
4							R	UC			DC	LC				SC
5	BN_C							displacement$_C$								

Parameter Description:

CODE — represents operation to be performed:

0 = opA + opB
1 = opA - opB
2 = compare opA: opB
3 = move opA to opB
4 = opA * opB
5 = opA/opB

P	= 1	for presence of word 3.
	= 0	for absence of word 3.
UA	= 1	if operand A is unsigned.
	= 0	if operand A is signed.
UB	= 1	if operand B is unsigned.
	= 0	if operand B is signed.
LA	=	length of A in digits (1 to 31).
LB	=	length of B in digits (1 to 31).
BN_A	=	main storage base register number of operand A.
BN_B	=	main storage register number of operand B.
Q	= 1	if returned in third operand (words 4 and 5 present).
	= 0	if third operand not present (words 4 and 5 absent).
DA	= 1	pre shift operand A left
	= 0	pre shift operand A right
DB	= 1	pre shift operand B left
	= 0	pre shift operand B right
SA	=	Operand A shift amount
SB	=	Operand B shift amount
R	= 1	if rounding to be applied to result (only if result returned in third operand)
	= 0	if rounding not applied to result
UC	= 2	if result unsigned
	= 0	if result signed
DC	= 1	to shift result left
	= 0	to shift result right
LC	=	length of result field
SC	=	result shift amount
BN_C	=	main storage base register number of result
Displacement A, B, or C	=	Byte count used to calculate byte address of decimal operands.

Error Conditions:

(Note that on an error, register R2 will be incremented past the parameter block, and results will be unreliable.)

a. Result operand overflow - if the result operand has an inadequate number of digits to contain the result, the condition result word (CONDIT) will be set to the value 3.

b. Invalid digit - if the number portion of a digit (bits 2^3 - 2^0) contains a value other than 0 - 9_{10} or the zone portion (bits 2^7 - 2^4) contains a value other than 11_{10}, the conditions result word will be set to the value 4. This is also true of values specified as signed having signs other than blank (octal 240), minus (octal 255), or plus (octal 253).

c. If the base word related to respective BN field is zero then the condition result word CONDIT will be set to 5.

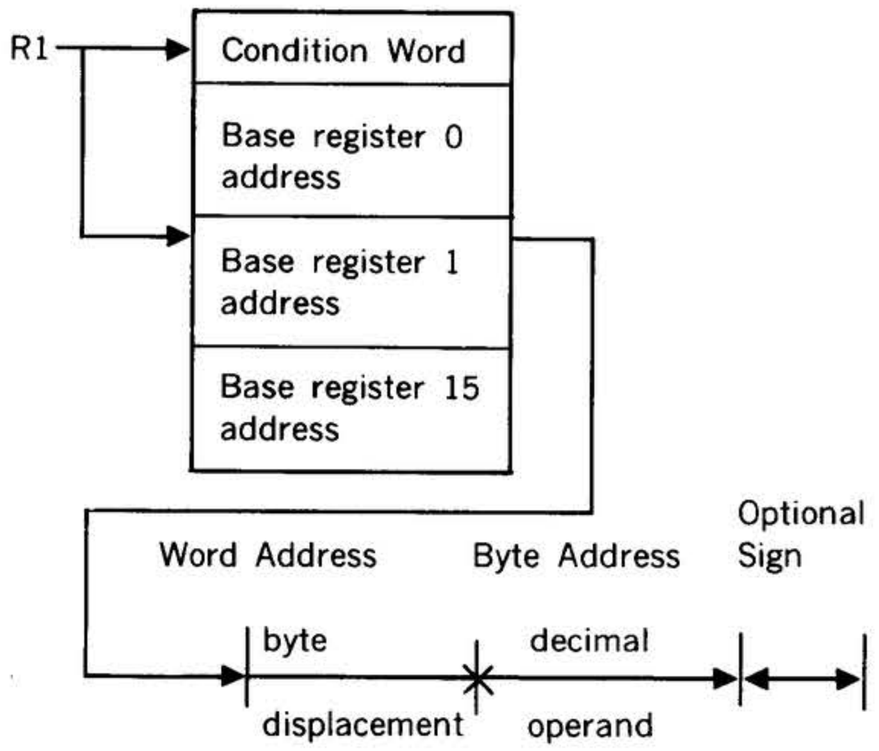
d. Attempted division by zero results in CONDIT being set to 3.

Notes

If operand C is not specified, the result will be returned in operand A, except for move. Decimal move moves operand A to operand B. Note that for a decimal move, the parameter block may be a maximum of 4 words. In this case, the Q bit is used to specify rounding, rather than a third operand.

Parameter byte addresses are calculated as follows: (R1 + 1 + BN) *2 + displacement = byte address of least significant byte of decimal operand.

This represented pictorially as follows:



When pre-shifting is specified, this does not imply physical shifting of operands. Only the operand designated for result is modified by a decimal operation.

When the operation is complete, only the integrity of register R2 and R1 are maintained. R2 will be incremented to the address of the next word following the parameter block.

This is meant to imply all other V75 registers are volatile. The user must save and restore any registers R3 through R7 he requires to be maintained when executing the decimal operation.

Examples:

Note: The following may be used to create decimal parameter blocks:

```
                        FOLLOWING ARE FORMS OF DECIMAL
                        INSTRUCTION.

DWORD0 FORM     3,1,11,5,5
DWORD1 FORM     4,12
DWORD2 FORM     4,12
DWORD3 FORM     3,1,1,1,5,5
DWORD4 FORM     3,1,1,1,5,5
DWORD5 FORM     4,12

                        DECIMAL OPERATION MACRO (DECIMAL
                        PARAMETER BLOCK)

DECOP   MAC
        IFT     P(12)-P(13)-P(5)-P(6)+P(14)     Select appropriate Word 0
        GOTO    DECWD1                          (Note no third, fourth,
        DWORD0  P(7),0,P(1),P(3),P(4),P(11)     or fifth word)
        GOTO    DECWD2
DECWD1  COUNT
        DWORD0  P(7),1,P(1),P(8),P(4),P(11)     (Parameter block includes
DECWD2  CONT                                    at least word 3)
        DWORD1  P(2),P(3)
        DWORD2  P(9),P(10)
        IFF     P(12)+P(13)+P(5)+P(6)+P(14)
        GOTO    DECWD3                          (Terminate if no word 3)
        DWORD3  0,P(14)P(5),P(12),P(6),P(13)
        IFF     P(14)
        GOTO    DECWD3                          (Terminate if no third
        DWORD4  0,P(15),P(16),P(20),P(19),P(21)      operand words 4 and 5)
        DWORD5  P(17),P(18)
DECWD3  CONT
        EMAC
```

INTERPRETIVE PARAMETER BLOCK DEFINED AS FOLLOWS:

P(01)	OP1	SIGNED (S) OR UNSIGNED (U)
P(02)	OP1	REG
P(03)	OP1	DISPLACEMENT
P(04)	OP1	LENGTH
P(05)	OP1	SHIFT LEFT (L) OR RIGHT (R)
P(06)	OP1	SHIFT AMOUNT
P(07)		OPERATION (DADD, DSUB, SMULL, DDIV, DMOV, DCMP)
P(08)	OP2	SIGNED (S) OR UNSIGNED (U)
P(09)	OP2	REG
P(10)	OP2	DISPLACEMENT
P(11)	OP2	LENGTH
P(12)	OP2	SHIFT LEFT (L) OR RIGHT (R)
P(13)	OP2	SHIFT AMOUNT
P(14)	=EQ	IF RESULT IN THIRD OPERAND
P(15)	F	FOR ROUNDING
P(16)	OP3	SIGNED (S) OR UNSIGNED (U)
P(17)	OP3	REG
P(18)	OP3	DISPLACEMENT
P(19)	OP3	LENGTH
P(20)	OP3	SHIFT LEFT (L) OR RIGHT (R)
P(21)	OP3	SHIFT AMOUNT

Following are equates to be used with the above macro:

```
BN0     EQU  0    BASE NUMBER 0
BN1     EQU  1    BASE NUMBER 1
BN2     EQU  2    BASE NUMBER 2
BN3     EQU  3    BASE NUMBER 3
BN4     EQU  4    BASE NUMBER 4
BN5     EQU  5    BASE NUMBER 5
BN6     EQU  6    BASE NUMBER 6
BN7     EQU  7    BASE NUMBER 7
BN8     EQU  8    BASE NUMBER 8
BN9     EQU  9    BASE NUMBER 9
BNA     EQU  10   BASE NUMBER 10
BNB     EQU  11   BASE NUMBER 11
BNC     EQU  12   BASE NUMBER 12
BND     EQU  13   BASE NUMBER 13
BNE     EQU  14   BASE NUMBER 14
BNF     EQU  15   BASE NUMBER 15
DADD    EQU  0    DECIMAL ADD
DSUB    EQU  1    DECIMAL SUBTRACT
DCMP    EQU  2    DECIMAL COMPARE
DMOV    EQU  3    DECIMAL MOVE
DMUL    EQU  4    DECIMAL MULTIPLY
DDIV    EQU  5    DECIMAL DIVIDE
EQ      EQU  1    RESULT RETURNED IN C
F       EQU  1    ROUND (ADJUST)
R       EQU  0    SHIFT RIGHT
L       EQU  1    SHIFT LEFT
S       EQU  0    SIGNED
U       EQU  1    UNSIGNED
```

The above macro may be used as follows:

```
1. DECOP U, BN1,2,4,R,1,DAD,U,BN2,0,4,L1
```

generates four word parameter block

```
16204
10002
20000
02041
```

Explanation: Operand A is an unsigned decimal string residing in memory accumulator 1. It begins (most significant digit) two bytes into accumulator 1 with a length of four bytes. Operand A will be logically reshifted right one digit. Operand B is an unsigned decimal string beginning in memory accumulator 2 with a length of four bytes. Operand B will be logically pre-shifted left one digit. The result of addition will be returned in operand A. If operand A = 4310 and operand B = 0129, result of the above operation would be 1721.

Note following register settings:

	Before Operation	After Operation
R0(A)	1016	1016
R1(B)	3100	3100
R2(X)	4102	4106

```
2. DECOP U,BN5,0,4,,,DMUL,S,BNE,0,3,,,
     EQ,F,U,BN1,0,7,R,1
```

generates six word parameter block

```
114203
050000
160000
010000
014341
010000
```

Explanation: An unsigned 4 digit decimal string in memory accumulator 5 is multiplied by a signed 3 digit decimal string in memory accumulator 14. The result will be right shifted one digit position, rounded, and stored in memory accumulator 1 (note maximum resulting digit string length is 7). If operand A = 0321 and operand B = 987 + result of above operation would be 0003168.

Note following register settings:

	Before Operation	After Operation
R0(A)	1200	1200
R1(B)	1105	1105
R2(X)	3506	3514

```
3.   DECOP S,BNC,0,3,,,DCMP,S,BN1,0,4
```

generates three word parameter block

```
040144
150000
010000
```

Example 3 compares decimal digit string in memory accumulator D with decimal digit string in memory accumulator 1. If operand A = 123 + and operand B = 9871-, condition word pointed to by R1(B) would be set to 20.

Note following register settings:

	Before Operation	After Operation
R0(A)	13012	13012
R1(B)	6512	6512
R2(X)	1234	1237

SECTION 14
REAL-TIME PROGRAMMING

VORTEX real-time applications allow the user to interface directly with special devices, develop software that is interrupt-driven, and utilize reentrant subroutines. Four areas are covered in this section:

- Interrupts
- Task-scheduling
- Coding reentrant subroutines
- Coding I/O drivers

14.1 INTERRUPTS

14.1.1 External Interrupts

Priority interrupt module (PIM) hardware: A PIM comprises a group of eight interrupt lines and an eight-bit register. The register holds a mask where each set bit disarms a line. VORTEX allows up to eight PIMs for a maximum of 64 lines. The system of PIMs and lines is called the *external interrupt system.*

The processing of external interrupts is controlled by the programmed status of the line. The lines are continuously hardware-scanned, regardless of the status.

If more than one interrupt is detected on a single scan, the highest-priority line is acknowledged, and, if the PIM is enabled and the line armed, the interrupt is taken. If no conflict occurs, the lines are acknowledged on a first-in/ first-out basis. If a signal is received on a disabled PIM, it is stored by the PIM, and causes an interrupt when the PIM is enabled.

Disabling the external interrupt system prevents any interrupt from entering the computer. Enabling the entire system allows acknowledgement of all interrupts. Enable/ disable selection on a PIM basis allows for more selected control of the system. Individual line selection prevents receiving a second interrupt while a line is still processing the first.

Program setting of PIM registers causes the PIM to ignore interrupts received on lines that are busy processing an interrupt or held off because of priority.

All PIMs and interrupt lines to be used in VORTEX are specified at system-generation time and their status specified when VORTEX is loaded and initialized. VORTEX does not disable any line unless so directed by RTE service request PMSK (section 2.1.6).

When a PIM interrupt signal is acknowledged and the interrupt taken, the computer executes the instruction in a selected memory location. Under VORTEX, PIM addresses are from 0100 to 0277. Linkage to VORTEX interrupt-processing routines is accomplished by a jump-and-mark instruction in the interrupt location. Unspecified lines are preset in VORTEX with no-operation instructions that ignore unspecified or spurious interrupts.

Since VORTEX always includes memory protection, certain instruction sequences cannot be interrupted and acknowledgement is delayed until they are complete. These include the instruction following an external control, halt, execution, or any instruction manually executed in step mode.

VORTEX interrupt line handlers: At system-generation time, a user specifies all interrupt-driver tasks. These include those that allow VORTEX to service the interrupt, as well as those that are directly connected and service the interrupt themselves. Then, VORTEX constructs a line-handler for each interrupt in the system (figure 14.1).

Directly connected routines preempt VORTEX and are thus used only when response time demands it. Section 14.4.5 describes directly connected interrupt handlers in detail.

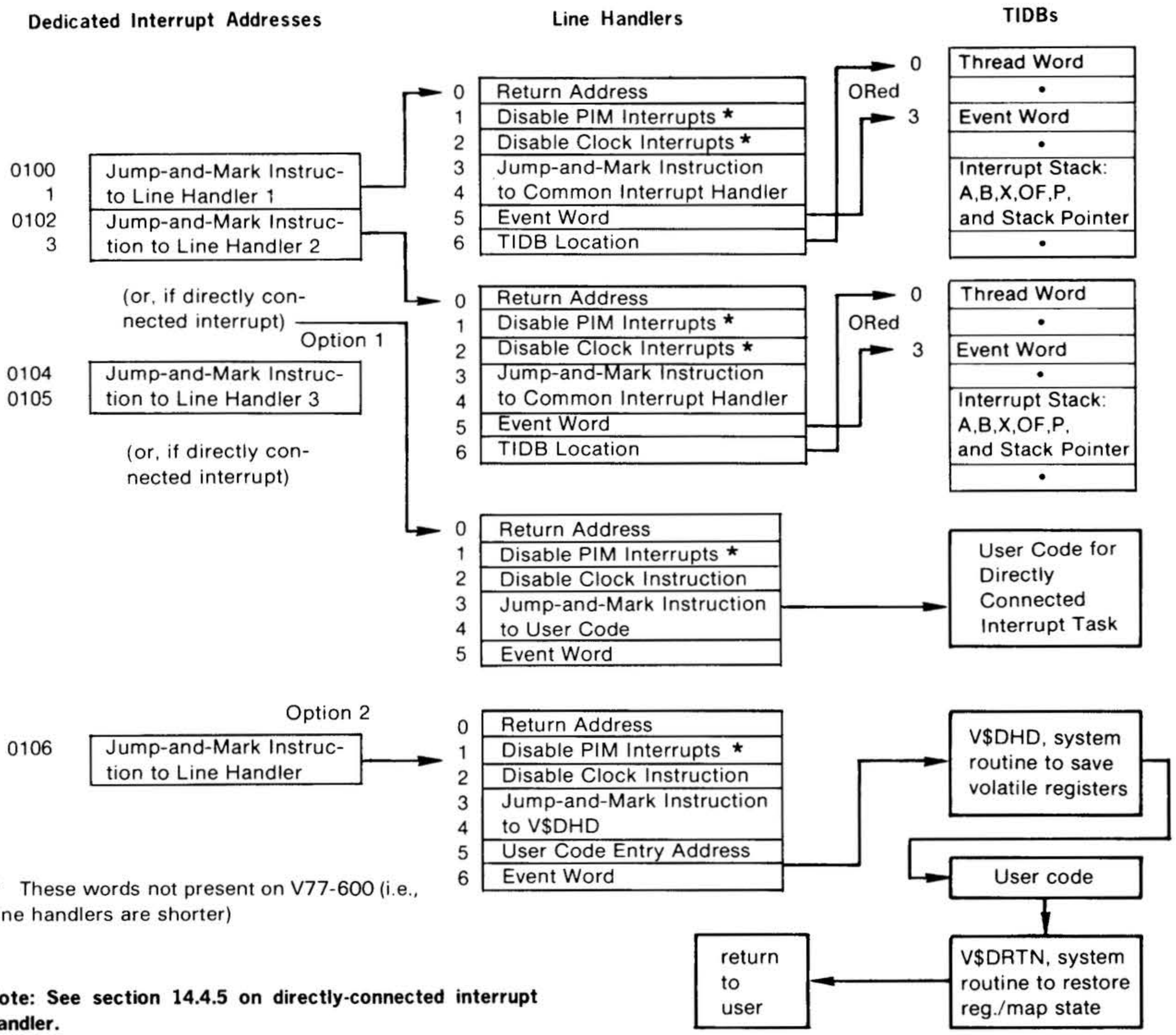
Common interrupt handler: The common interrupt handler is the interface between PIM interrupts (via the line handlers) and system or user interrupt-processing tasks. Upon entry, the contents of the volatile registers are saved and the interrupt event word is inclusively ORed into the event word of the specified TIDB. A check then determines whether to return to the interrupted task or to enter the interrupt-processing task, depending upon priority. All interrupts are enabled upon leaving the common interrupt handler.

Interrupt-processing tasks: A task is activated by an interrupt when: (1) task's TIDB interrupt-expected status bit is set, (2) the interrupt event word contains a nonzero, and (3) the task is suspended.

The interrupt-processing task can be memory-resident or RMD-resident, In either case, the processing task clears the event word. The event word distinguishes different interrupt lines that could activate the same task. The dispatcher clears the interrupt expected bit and time delay activity for all tasks except TTY and CRT drivers.

An interrupt-processing task can exit with one of the following options:

a. Issue a suspend RTE (type 1 or 2) service call that suspends the task and sets the interrupt-expected status bit. Upon receiving the external interrupt or simulated interrupt (TBEVNT word in TIDB is set to 1) caused by IOC or I/O completion events (type 2 only), the task continues execution following the request.



* These words not present on V77-600 (i.e., line handlers are shorter)

Note: See section 14.4.5 on directly-connected interrupt handler.

Figure 14-1. Interrupt Line Handlers

b. Issue a delay RTE (type 2 or 3) service call that suspends the task and sets the interrupt-expected and time-delay active status bits. The task is reactivated when time-delay expires or upon receipt of external interrupt or a simulated interrupt caused by IOC or I/O completions (type 3 only).
   Upon entry, the event word non-zero indicates interrupt activation by external or simulated interrupt (1). Since IOC set the TIDB event word to a 1, the event word in line handlers for external interrupts should be set to something other than 1 if a type 3 delay is to be used. The word also clears the time-delay status bit upon reactivation.
   It should also be noted that for supspend (type 2) and delay (type 3) service calls, bit 6 of TBPL word of task's TIDB is set to cause IOC to set TBEVNT word to 1 on I/O completion events. This bit is reset whenever a suspend or delay service call of a type other than the ones mentioned above.

c. If RMD-resident, set the interrupt-expected status bit and call EXIT to release space. (TIDB must be resident.)

Timing Considerations: The time necessary to process an interrupt through the common interrupt handler depends on when the interrupt occurred:

a. If a task is interrupted and the interrupt-processing task has a lower priority, the interrupt is posted, and VORTEX returns control to the interrupted task in approximately 56 cycles.

b. If a task is interrupted and the interrupt-processing task has a higher priority, the interrupt is posted, and VORTEX transfers control to the dispatcher (section 14.2.3) to start the higher-priority interrupt-processing task (if all its conditions are met). The posting time is 66 cycles, approximately.

c. If an interrupt occurs during a dispatcher scan, the posting time is about 32 cycles. VORTEX returns to the dispatcher to restart the scan.

d. If the real-time clock interrupts the interrupt handler, the RTC interrupt handler posts the interrupt and the common interrupt handler returns to the clock processor in approximately 40 cycles.

14.1.2 Internal Interrupts

VORTEX recognizes and services internal interrupts related to various hardware components. The processing routines are all directly connected and are the highest-priority tasks in the system.

Memory protection interrupt: Memory protection interrupts are generated when a task attempts to execute a privileged instruction such as external control or halt, or attempts to violate the access mode. The memory protection routines process all protection violation interrupts which are the highest priority interrupts in the system. When the interrupt occurs, the system is forced to the executive mode, state 0 (see table 1-1). Section 1.3 describes the memory map concept and the access modes which can be assigned to each virtual page.

VORTEX uses the memory protection interrupt for switching from the user mode to the executive mode when an I/O (section 3) or RTE (section 2) request is made.

The memory protection interrupt addresses for the various violations are shown in table 14-1.

Table 14-1. Memory Protection Interrupt Addresses

Error	Interrupt Address	Map Active Access Control Status
HALT	020	Attempt was made to execute HALT instruction.
I/O	022	A map number other than 0 attempted to execute an I/O instruction.
WRITE	024	Attempt was made to write into read-only or execute-only location.
JUMP	026	Attempt was made to jump into read operand only location.
UNASSIGNED	030	Attempt was made to read or write into unassigned location.
INSTRUCTION FETCH	032	Attempt was made to fetch instruction from read operand only location.

Power failure/restart interrupt: An interrupt occurs when the system detects a power failure. The VORTEX power failure processor saves the contents of volatile registers and the status of the overflow indicator, sets a power failure flag, and halts with the I register set to 077.

Following the power-up sequence, the PF/R hardware generates an interrupt. Upon entry to the VORTEX power-up procesor, the power-failure flag is checked. A power-down sequence must have occurred or else a fatal error condition is assumed to have occurred and VORTEX halts with the I register set to 077.

Hooks are provided to the user to supply additional power failure/restart functions. These hooks consist of user supplied (in place of provided dummy routines) nucleus routines. The power-down routine entry must be V$PDTK and the power-up routine entry must be V$PUTK. Both routines must be callable by a JSR, by X register instructions, and should save and restore registers.

If a **power-down sequence** had occurred, the power-failure flag is cleared, the PIM mask registers are set, the real-time clock's variable interrupt interval is set, the saved volatile registers are restored, the clock and PIMs are enabled (if enabled upon interrupt), and control is returned to the location before the interrupt. Any input or output data transfers in operation at the time of the power failure result in the loss of data.

For peripheral devices such as magnetic tapes and RMDs, the I/O operation is automatically retried.

For other peripheral devices, such as the card reader, paper-tape system, card punch and lineprinter, a retry is not attempted.

The error message posted depends upon the error detected by the respective I/O driver, such as abnormal BIC stop, parity error, interrupt time-out, etc. Data losses on the RMD due to power failure could cause VORTEX to malfunction, but other devices which are not system-resident are recoverable.

The power failure-restart routines operate at the second-highest priority level in the system, which has memory protection at the highest priority level.

The power-up routine reloads the volatile memory map registers by scanning the TIDB thread and outputting the map image for each task which has an assigned, non-checkpointed map. Each task's map key number is contained in TBKEY and the map image adddress contained in TBMING.

The power-up routine also automatically reloads the writable control store for systems with WCS. Sections 20.1.3 and 20.1.4 describe the manner in which the microutility task saves the WCS image in the OM library file named WCSIMG and how the WCS reload task, WCSRLD, utilizes the file to restore the WCS content. The power-up routine checks location 017 to determine if WCS has been

loaded. A zero value indicates no WCS. A non-zero value is assumed to be the WCSRLD TIDB address. The FL library logical unit number and protect key are stored in TBRSTS and the WCSRLD TIDB (resident TIDB, non-resident task) is set active. See Section 14.4.8.1 for details of WCS reloading under micro-VORTEX.

Real-time clock interrupt: The real-time clock interrupt provides the basis for timekeeping in VORTEX. It can be set to a minimum resolution of 5 milliseconds. However, a value greater than 5 milliseconds (i.e., 10-20 milliseconds) reduces overhead when the system does not have high-resolution timekeeping requirements. Upon receipt of an interrupt, the time-of-day is updated and the TIDBs are scanned for any time-driven task requiring activation. PIMs are disabled for approximately 18 cycles during real-time clock interrupt-processing. The clock routine is the third-highest priority interrupt in VORTEX.

Parity Interrupt: If ERCC or parity memory is installed, the parity interrupt will occur whenever a parity error is detected. This interrupt cannot be disabled, and will cause the scheduling of task PAROUT to display an error message on the operator's console. If a parity error occurs in a user task, the task will be aborted. If an error occurs in the nucleus, an error message will be displayed. Six locations, starting at label V$PERA, are provided in which patches may be placed to halt the system upon nucleus parity error detection.

14.1.3 Interrupt-Processing Task Installation

To install an interrupt-processing task that is not directly connected, at system-generation time provide line handlers and resident TIDBs by using a PIM directive (section 15.5.11) with **s(n)** zero and a TDF directive (section 15.6.2) using the same task name in both directives. Additional dummy TIDBs can be added during system generation. (Once a TIDB is in the system, OPCOM directive ;ATTACH can be used to connect different interrupt-processing tasks to an interrupt line.)

Then, code the interrupt-processing task and add the task via system generation to the VORTEX nucleus as a resident task.

Then, use the ;ATTACH directive to link the resident task to the interrupt line (if PIM directive not used).

14.1.4 Interrupt State

When a memory-protection, real-time (RT) clock or PIM interrupt occurs, the system is forced to the executive mode, state 0. The interrupts are enabled or disabled as follows:

a. Memory-Protection Interrupt
   1. RT clock is unaffected and remains in the enabled state.
   2. Memory protection is disabled and is enabled prior to exiting the memory- protection processing routine (EXC 0646).
   3. PIMs are disabled when the JMPM instruction is executed and PIMs are enabled prior to exiting (EXC 0244).

b. PIM Interrupt
   1. RT clock is unaffected and remains in the enabled state. The common interrupt line handler routine disables and enables the RT clock. The clock is not enabled if the PIM interrupted out of the RT clock processor (see section 14.4.5 for directly connected interrupt handlers).
   2. Memory protection is unaffected and remains in the enabled state.
   3. PIMs are disabled when the JMPM instruction is executed. The common interrupt line handler routine enables the PIMs upon exiting.

c. RT Clock Interrupt
   1. The RT clock processor disables and reenables the RT clock.
   2. Memory protection is unaffected and remains in the enabled state.
   3. The PIMs are disabled when the JMPM instruction is executed. The RT clock processor enables the PIMs.

14.2 SCHEDULING

14.2.1 System Flow

VORTEX is designed around the TIDB (table 14-1). This block contains all of the information about a task during its execution. The setting and clearing of status bits in the TIDB causes a task to flow through the system. Two register stacks are saved within the TIDB: a reentrant (suspend register) stack, and an interrupt stack.

The dispatcher (section 14.3) is the prime mover of tasks through the system. When any function has reached a termination point or has to wait for an I/O operation, the task gives control to the dispatcher, which then finds another task to execute. A task maintains control until it gives control to the dispatcher, or to the interrupt task if the interrupt-processing task has a higher priority. The contents of the interrupted task's volatile registers are saved in its TIDB interrupt stack and control goes to the dispatcher, which searches for the highest-priority active task for execution.

Each TIDB is placed in sequence by priority level and threaded. Two stacks are maintained in the system: a busy stack and an unused stack. When a task is scheduled for execution, a TIDB is allocated from the unused stack and threaded onto the busy stack according to priority level.

The status word of each TIDB, starting with the highest-priority task, is scanned. Depending upon the setting of status bits, the task is activated, passed over, or made to activate a related system task.

Two resident system tasks are activated by the dispatcher to process functions relating to the execution of a task: (1) search, allocate, and load (SAL), and (2) common system errors (ERROR). SAL searches, allocates,

loads, and exits a scheduled task. ERROR posts common system error messages. These two tasks are not reentered once they start execution, so the dispatcher holds tasks requiring identical functions until they are completed. Then, the highest-priority waiting task is given control of the required function.

In VORTEX, SAL assigns a map (1-15) to each non-resident task scheduled to be executed. If a map is not available, SAL: (1) checkpoints any executing background task's map (memory is checkpointed as required only); (2) checkpoints a lower priority foreground task's map; or (3) checkpoints a higher priority foreground task's map (if TBST bit 8 is set); or (4) exits and does not execute the task until a map becomes available.

Each map defines a logical memory space of 32K words which is segmented into 512-word pages (see section 1.3). SAL sets each logical page to one of four access modes: unassigned, read only, read operand only, or read-write. Each logical page which is assigned an access mode other than unassigned is linked to a physical page of memory. If the access mode is violated by the executing task, a memory protect interrupt occurs. The memory protection interrupt processing is described in section 14.1.2. Page 0 (logical addresses 0-0777) is always assigned to physical page 0, which is the system data region as defined in table 14-1.

Each task, foreground or background, executes within its own logical memory space. The amount of logical memory space available to a task is reduced by: (1) page 0 for system data; and (2) the VORTEX nucleus module accessed by the task and mapped into its logical memory (see section 2.2). If none of the VORTEX nucleus module is accessed, the task has available all but one page (page 0) of the 32K logical memory space. Each task is loaded and executed from logical address 01000. Section 1.3 describes in greater detail available logical memory space.

SAL allocates physical memory by pages. SAL maintains a table designating the allocatability of each physical page within the system as defined during system generation.

If space is not available and the background is in operation, the background task is checkpointed on the RMD checkpoint file and its space allocated to foreground. Upon release of this space by the foreground tasks, the background is read in from the RMD and reactivated.

If space is required to load a program and the background has already been checkpointed, the task waits for a currently running task to exit and release memory.

A task may dynamically request more memory space via the ALOCPG and MAPIN RTE requests. Sections 2.1.15 and 2.1.17 further describe these RTE requests.

The background memory allocation depends on the size of the background task being loaded. Only the amount needed is so allocated automatically, although the JCP/MEM directive can allocate extra memory for a background task.

Figure 14-2 shows the priority structure, Table 14-1 shows the TIDB layouts, Table 14-2 is a description of a TIDB, and Table 14-3 is a detailed description of lower memory.

14.2.2 Priorities

Thirty-two priority levels (0 through 31) are provided in the VORTEX system. Levels 2 to 31 are reserved for protected foreground usuage. Level 26 is reserved for SAL2. Level 25 is reserved for the two VORTEX system tasks, SAL and ERROR. Levels 24 and 23 are reserved for I/O drivers. All other foreground levels are available to the user. More than one task per level can be scheduled.

Levels 1 and 0 are reserved for tasks running in the background allocatable memory and residing in the background library. Level 1 is reserved for VORTEX system protected tasks, e.g., the job-control processor, the load-module generator, the FORTRAN compiler, the DAS MR assembler, etc. These tasks run with memory protection disabled and can be checkpointed when their space is needed by a foreground task. Level 0 tasks cannot modify or destroy the system (figure 14-3).

Only one background task can be active and in memory at any given time. If other background tasks have been scheduled, the active background task must execute an EXIT service request before the scheduled task(s) can be loaded and executed. If a background task calls EXIT and no tasks are scheduled for the background area, and the requesting task is not the job-control processor, the JCP is scheduled. Otherwise, there is a normal exit.

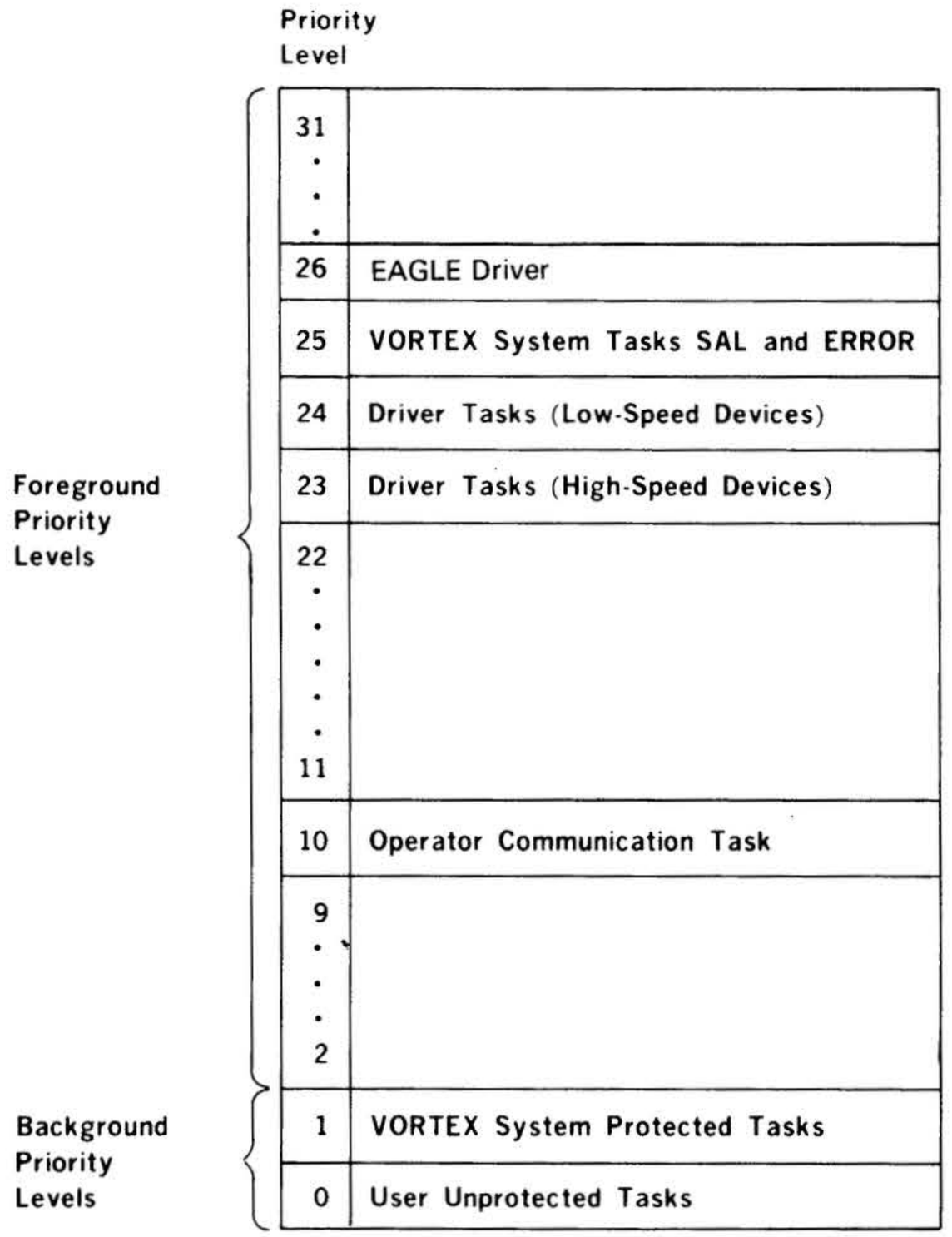


Figure 14-2. VORTEX Priority Structure

Table 14-1. TIDB Layout V77-400/600

Symbol	Word	Bits 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
TBTRD	0	Task Thread
TBST	1	Task Status
TBPL	2	Task Status | Priority Level
TBEVNT	3	Interrupt Event
TBRSA	4	A Register (Reentrant and Suspension Stack)
TBRSB	5	B Register (Reentrant and Suspension Stack)
TBRSX	6	X Register (Reentrant and Suspension Stack)
TBRSP	7	OF | P Register (Reentrant and Suspension Stack)
TBRSTS	8	Temporary Storage (Reentrant and Suspension Stack)
TBENTY	9	Task Entry Address (or RECOV)
TBTMS	10	Time Counter - Clock Resolution Increments
TBTMIN	11	Time Counter - Minute Increments
TBISA	12	A Register (Interrupt Stack)
TBISB	13	B Register (Interrupt Stack)
TBISX	14	X Register (Interrupt Stack)
TBISP	15	OF | P Register (Interrupt Stack)

Table 14-1. TIDB Layout V77-400/600 (Continued)

Symbol	Word	Bits 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
TBISRS	16	Reentrant Stack Address (Interrupt Stack)
TBIO	17	No. of I/O Requests Threaded | No. of I/O Requests Active
TBKN1	18	Task Name
TBKN2	19	Task Name
TBKN3	20	Task Name
TBTLC	21	First Address in Allocatable Memory
TBCPTH	22	Background Task Queue
TBATSK	23	Address of Scheduling TIDB
TBRSE	24	Task Error Code
TBSIZ	25	Task Size | Unused
TBNUCL	26	Nucleus Module Indicators | Un-used | RECOV | ITC | Map Key
TBMING	27	Map Image Address
TBIST	28	Interrupt Status
TBRSR3-TBRSR7	29-33	V75 Registers (reentrant and suspension stack)
TBISR3-TBISR7	34-38	V75 Registers (interrupt stack)
TBABP	39	Shared Procedure Table Block Pointer
TBEXTN	40	TIDB Extension Block Thread
TBORDS	41	15 Permanent VNO ORD 8 | 7 Current VNO ORD 0

Table 14-1. TIDB Layout V77-800 (Continued)

Symbol	Word	Bits 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
TBTRD	0	Task Thread
TBST	1	Task Status
TBPL	2	Task Status | Priority Level
TBEVNT	3	Interrupt Event
TBRSA	4	A Register (Reentrant and Suspension Stack)
TBRSB	5	B Register (Reentrant and Suspension Stack)
TBRSX	6	X Register (Reentrant and Suspension Stack)
TBRSP	7	OF | P Register (Reentrant and Suspension Stack)
TBRSTS	8	Temporary Storage (Reentrant and Suspension Stack)
TBENTY	9	Task Entry Address
TBTMS	10	Time Counter - Clock Resolution Increments
TBTMIN	11	Time Counter - Minute Increments
TBISA	12	A Register (Interrupt Stack)
TBISB	13	B Register (Interrupt Stack)
TBISX	14	X Register (Interrupt Stack)
TBISP	15	OF | P Register (Interrupt Stack)
TBISRS	16	Reentrant Stack Address (Interrupt Stack)
TBIO	17	No. of I/O Requests Threaded | No. of I/O Requests Active
TBKN1	18	Task Name
TBKN2	19	Task Name
TBKN3	20	Task Name

Table 14-1. TIDB Layout V77-800 (Continued)

TBTLC	21	First Address in Allocatable Memory
TBCPTH	22	Background Task Queue
TBATSK	23	Address of Scheduling TIDB
TBRSE	24	Task Error Code
TBSIZ	25	Task Size / Unused
TBNUCL	26	Nucleus Module Indicators / Unused / ITC / Map Key
TBMING	27	Map Image Address
TBIST	28	Interrupt Status
TBRSR3-TBRSR7	29-33	V75 Registers (reentrant and suspension stack)
TBISR3-TBISR7	34-38	
TBABP	39	Shared Procedure Table Block Pointer
TBMSC1	40	Reserved for future use
TBTRCE	41	Trace mode word. Bit 15 set if task in trace mode. Bits 0-14 contains trace address
TBPRST	42	V77-800 processor status
TBRPSW	43	PSW IOC and serv storage

Table 14-1. TIDB Layout V77-800 (Continued)

TBAFAU	**44**	Bits 0-5 Arithmetic fault setup Bits 15-14 Fault enable status storage
TBAEXT	**45**	Pointer to arithmetic fault exit address
TBISFP	**46**	Floating Point
TBISF2	**47**	register
TBISF3	**48**	save area in
TBISF4	**49**	interrupt stack
TBEXTN	**50**	TIDB extension block thread
TBORDS	**51**	VNO task ordinal status LHW=normal, RHW=current

Table 14-2. TIDB Description

Key:

Symbol	Word	Bits	Set =	Description
TBTRD	0	15-0	Task thread	Points to next TIDB in chain. V$TB points to the highest-priority active task. Last TIDB on queue has zero in TBTRD.
TBST	1	15-0	Task status	See Table 14-4.
TBPL	2	15	Task opened	Bit set when SAL has opened task but not loaded it (memory not available).
		14	Long TIDB	Bit set if V75 SYSGEN and task had a long TIDB created. Ten words are allocated at the end of TIDB to save extra registers.
		13	Load overlay	RTE overlay request made by task with overlay name in user request. 1 = overlay load.
		12	Background checkpoint I/O wait	Foreground task waiting for background I/O to complete so it can be checkpointed to make allocatable memory available. 1 = yes.
		11	Allocation override flag	Overrides bits 9 and 12 of TBPL and bit 5 of TBST. When FINS routine of SAL releases memory and/or a TIDB, sets bit 11 for tasks having bits 9 and 12 of TBPL and bit 5 of TBST set. SAL then tries to allocate memory; or the scheduler will try to allocate a TIDB block. 1 = override.
		10	Background being checkpointed	Background task being written on checkpoint file. 1 = yes.
		9	TIDB not available	Schedule request made but no TIDBs available for allocation. The task is suspended until one becomes available. 1 = TIDB not available.
		8		Task waiting for available map. 1 = map has been assigned to task.

Table 14-2. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
		7		Task map checkpoint. 1 = task's map has been checkpointed.
		6	Delay type 3 request	Set by RTE when a delay, type 3 request is made. Cleared by IOC upon completion of I/O request.
		5-0	Task priority level	Specifies priority level (0-31) of task to be executed.
TBEVNT	3	15-0	Interrupt event	Matches bits in interrupt-handler calling sequence. Interrupt-handler event inclusively ORed into TIDB word 3 when processed by line handler. If a bit sets while status bits 3 and 14 are set, dispatcher activates task. Clear event word before exiting.
TBRSA	4	15-0	A register (reentrant and suspension stack)	IOC and RTE calls store volatile register contents in this stack (words 4-8).
TBRSB	5	15-0	B register (reentrant and suspension stack)	
TBRSX	6	15-0	X register (reentrant and suspension stack)	
TBRSP	7	15	OF (overflow) register (reentrant and suspension stack)	
		14-0	P register (reentrant and suspension stack)	
TBRSTS	8	15-0	Temporary storage (reentrant and suspension stack)	
TBENTY	9	15-0	Task entry	Absolute address of first executable data of a task.
			Recovery routine	Set by RTE RECOV request

Table 14-2. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
TBTMS	10	15-0	Time counter (clock resolution increments)	Words 10 and 11 indicate time left before execution. (Clock routine increments both words when bit 6 or 7 is set in status 1.)
TBTMIN	11	15-0	Time counter (minute increments)	
TBISA	12	15-0	A register (interrupt stack)	Words 12-16 store volatile register contents during interrupt by higher-priority task. (Upon reactivation, words 12-16, volatile register contents, and reentrant stack pointer are restored and execution is continued.)
TBISB	13	15-0	B register (interrupt stack)	
TBISX	14	15-0	X register (interrupt stack)	
TBISP	15	15	OF (overflow) register (interrupt stack)	
		14-0	P register (interrupt stack)	
TBISRS	16	15-0	Reentrant stack pointer (interrupt stack)	
TBIO	17	15-8	Number of I/O requests threaded	Incremented by IOC when I/O request is received, and decremented upon completion. (A task cannot exit or abort until counter is zero.)
		7-0	Number of active I/O requests	Incremented by IOC when it sets an I/O driver active, and decremented upon completion.
TBKN1	18	15-0	Task name	First two characters of six-character task name.

Table 14-2. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
TBKN2	19	15-0	Task name	Second two characters of six-character task name.
TBKN3	20	15-0	Task name	Final two characters of six-character task name.
TBTLC	21	15-0	First address in allocatable memory	Points to first address allocated for use by task. After a task has been loaded, SAL save the read-only page number and number of pages in TBTLC as described for TBNUCL, bit 12.
TBCPTH	22	15-0	Background task queue	Any background task waiting to be loaded in background allocatable memory is queued through this word. (A running background task can schedule other background tasks, but cannot load them until space is available.)
TBATSK	23	15-0	Address of scheduling task's TIDB	Stores this address, and upon EXIT or ABORT (if bit 1 of TBST set) reactivates scheduling.
TBRSE	24	15-0	Task error	Upon error, system routines store error codes here and set error status bit (4 of TBST). ERROR routine decodes and prints message.
TBSIZ	25	15-10	Task size	Number of pages of memory to be allocated to task.
		9	Shared procedure flag.	
		8	Reserved for future use	
TBNUCL	26	15-8	Nucleus indicator	Bit 8 reserved for future VORTEX use. Bit 9 when set indicates map foreground blank common in task; read-write access mode. Bit 10 when set indicates map nucleus table module in task; priority 0 tasks are mapped with module set to read operand only. All other priority tasks are mapped with the module set to read-write access mode.

Table 14-2. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
				Bit 11 when set indicates map global FCB in task; this module is mapped read-write access mode. Bit 12 when set indicates map pages read-only specified by LMGEN. Read only pages have been designated during load module generation. The logical page number and the number of pages are set in the load module pseudo TIDB and temporarily stored in TBTMIN bits 15-8 and bits 7-0 respectively. After the task is loaded in memory, the page numbers are stored in TBTLC, SAL sets the specified pages to read-only access mode.
		7-6	Reserved for future VORTEX use	
		5	RECOV	RECOV RTE request has put recovery address in TBENTY.
		-4	ITC	Task has active ITC request.
TBKEY	26	3-0	Key	Task map key. This is the map number (0-15) assigned to the task by SAL or SGEN.
TBMIMG	27	15-0	Map image	Address of task map image. This is the map 0 logical address of the task's map image. Normally it would be immediately following the task's TIDB.
TBIST	28	15-0	Interrupt status	Bit 15 is 0 if V$KEY to be set to zero and is 1 if V$KEY to be set to TBIST (bits 3-0). Bits 14-0 are the map status as input from hardware.
TBRSR3	29	15-0	V75 register 3 (reentrant and suspension stack)	IOC and RTE call store volatile register contents in this stack (words 29-34).
TBRSR4	30	15-0	V75 register 4	
TBRSR5	31	15-0	V75 register 5	
TBRSR6	32	15-0	V75 register 6	
TBRSR7	33	15-0	V75 register 7	

Table 14-2. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
TBISR3	34	15-0	V75 register 3	Words 31-35 store volatile register contents during interrupt by higher priority task (see description of TBISA).
TBISR4	35	15-0	V75 register 4	
TBISR5	36	15-0	V75 register 5	
TBISR6	37	15-0	V75 register 6	
TBISR7	38	15-0	V75 register 7	
TBABP	39	15-0		Pointer to first shared procedure table block
(V77-400/600)				
TBEXTN	40	15-0		Pointer to first TIDB extension block (used by ALOC requests)
TBORDS	41	15-8		Permanent VNO ordinal
		7-0		Current VNO ordinal
(V77-800)				
TBMSC1	40	15-0		Reserved
TBTRCE	41	15-0		Trace mode storage
TBPRST	42	15-0		Processor Status Word (inter.)
TBRPSW	43	15-0		Processor Status Word (Exec and I/O calls)
TBAFAU	44	15-14		Arithmetic fault enable
		13-6		Reserved
		5-0		Arithmetic fault flags
TBAEXT	45	15-0		Arithmetic fault service add
TBISFP	46-49	15-0		FPP register storage
TBEXTN	50	15-0		same as for V77-400/600
TBORDS	51	15-8		same as for V77-400/600
		7-0		same as for V77-400/600

Table 14-3. Map of Lowest Memory Sector

Address	Symbolic Name	Description
00-01		CPU interrupt code (preset to NOP)
02-015		Unassigned: available to the user
016		Unassigned. Reserved for future VORTEX II use
017		TIDB address for WCS reload task
020,021		Memory protection interrupt: halt (jump-and-mark to V$MPER) (V77-400/800 Non-jump memory protect)
022,023		Memory protection interrupt: I/O (jump-and-mark to V$MP3) V77-800 Trace interrupt (jump-and-mark to V$TRAC)
024,025		Memory protection interrupt: write (jump-and-mark to V$MP2) (V77-800, 24 = Processor Status Word) (V77-800, 24 = Cache Status Word)
026,027		Memory protection interrupt: jump (jump-and-mark to V$MAP2)
030,031		Memory protection interrupt: unassigned (jump-and-mark to V$MAP1) (V77-800, 30 = Arithmetic fault address) (V77-800, 31 = System PSW setting)
032,033		Memory protection interrupt: instruction fetch (jump-and-mark to V$MAPE) Bit 15 = FPP available flag (V77-800) Bits 14-0 Reserved (V77-800)
034,037		Reserved for future VORTEX II use. Jump-and-Mark to V$MPI0 to ignore spurious interrupts
040,041		Power-down interrupt (jump-and-mark to V$PFDN)

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
042,043		Power-up interrupt (jump-and-mark to V$PFUP)
044,045		Variable-interval interrupt address (jump-and-mark to V$CLOK)
046	V$CRDM	Keypunch (0 = 026, 1 = 029): Bit 0 SGEN nominal keypunch Bit 1 Set to 1 (if V75 system) Bit 4-2 =0 for V77-600 (software) = 1 for V77-400 = 2 for V77-600 (micro) = 3 for V77-800 (soft) = 4 for V77-800 (micro) Bit 8 Current keypunch specified by JCP /KPMODE directive (/JOB, /FINI, or /ENDJOB resets the current value to nominal value)
047	V$JCTM	JCP Temporary Storage
050-053	V$JNAM	Eight-character job name
054	V$LCNT	Line count (set by a JCP /FORM directive): used by DAS MR assembler and FORTRAN compiler to determine the number of lines printed before a top of form is issued.
055	V$JCFG	JCP flags: Bits 15-10 Number of extra memory blocks to be allocated with background task (cleared after loading) Bits 9-7 Unused. Bit 6 (V77-800 trace selected) Bit 5 JPDUMP active Bit 4 Dump flag if load and go Bit 3 Dump flag (if set, the background dumps after a normal EXIT or abortion) Bits 2-0 Load-and-go flags
056-057		Reserved for future use (Micro, 56 = Address of dispatcher) (Micro, 57 = Size of background task) (ERCC memory interrupt)
060-061		Memory parity trap
062		V77 memory protect error address
063	V$TCTL	Bit 0 VIDEO control Bits 1-15 Reserved

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
064		Reserved for future use
065		Bits 8-15 VOLA page Bits 0-7 VOLA size (in pages)
066		RPG II control flag
067		V$VOLT address
070-073	V$DATE	Eight-character date set up by OPCOM directive ;DATE,mm/dd/yy
074	V$PLCT	Permanent line count set up at system-generation time
075	V$BGLB	Protection code and logical unit number of the BL unit
076-077		FPP (Floating-Point Processor) interrupt (jump and mark to V$FPP)
0100-0117		PIM 0 jump-and-mark to individual line handlers. Unassigned lines are set to JMPM V$MPI0 to ignore spurious interrupts
0120-0137		PIM 1* jump-and-mark to individual line handlers
0140-0157		PIM 2* jump-and-mark to individual line handlers
0160-0177		PIM 3* jump-and-mark to individual line handlers
0200-0217		PIM 4* jump-and-mark to individual line handlers
0220-0237		PIM 5* jump-and-mark to individual line handlers
0240-0257		PIM 6* jump-and-mark to individual line handlers
0260-0277		PIM 7* jump-and-mark to individual line handlers
0300	V$CTL	Address of currently executing task TIDB (0177777 = dispatcher, 037, = real-time clock routine)
0301	V$CPL	Priority level of currently executing task
0302	V$CRS	Address of current reentrant stack (zero if the currently executing task is not executing a reentrant subroutine)

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0303	V$TB	Address of highest-priority TIDB in the active stack
0304	V$UTB	Address of dynamically allocated page. If zero, no page yet allocated. This is the top of the thread for pages allocated for dynamic memory allocation as required for TIDB space, I/O request, etc. (not used in micro-VORTEX)
0305		Reserved for future use
0306		Reserved for future use
0307		Reserved for future use
0310	V$CKPT	Checkpoint flag (set if background checkpoint. Not used in micro-VORTEX)
0311	V$OPCL	Address of TIDB for OPCOM task
0312	V$LSAL	Address of TIDB for system SAL task (not used in micro-VORTEX)
0313	V$LER	Address of TIDB for system ERROR task
0314	V$TJCP	Address of TIDB for JCP task
0315	V$BTB	Address of current active background task TIDB (zero if no background task active)
0316	V$NPAG	Number of available physical pages remaining in V$PAGE for allocation
0317	V$LLUP	Logical address specifying the end of the execution background tasks allocated memory space
0320	V$IM	Interrupt mask for PIM 0 (0 = enable, 1 = disable) (bit 0 = line 0)
0321		Interrupt mask for PIM 1
0322		Interrupt mask for PIM 2
0323		Interrupt mask for PIM 3
0324		Interrupt mask for PIM 4
0325		Interrupt mask for PIM 5
0326		Interrupt mask for PIM 6
0327		Interrupt mask for PIM 7
0330	V$MAP	Map key availability flag word. Bit 0 = map 0, bit 1 = map 1, etc. A zero indicates that the map is unavailable for assignment, a 1 = map is available for assignment

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0331	V$BTBM	Base address of nucleus table module. Top of nucleus table module defined by V$GFCB
0332	V$GFCB	Base address of global FCBs
0333	V$MIMG	Map 0 image address
0334-0337	V$ST0, V$ST1, V$ST2, V$ST3	FUNCI word for executive mode states 0, 1, 2, 3. Used by map 0 tasks to switch executive mode states. See section 1.3 for description on the use of V$STO-V$ST3. These words are set up by the dispatcher. Bits 0-3 are set to the map number in TBKEY. If the task has been interrupted, the map number in bits 0-3 of TBIST is used
0340	V$KEY	VORTEX currently executing map key
0341	V$CRDR	Reserved for future use
0342	V$TBGT	Top of thread of background tasks waiting for allocation (not used in micro-VORTEX)
0343	V$TMS	Time-of-day in 5-millisecond increments (fractions of a minute stored in this word; upon reaching 1-minute V$TMN increments, V$TMS resets). The range is 0 to 12000.
0344	V$TMN	Time-of-day in minutes (full minutes up to 24 hours stored in this word; upon reaching 24 hours (24 x 60 minutes). V$TMN resets). The range is 0 to 1440.
0345	V$LUNT	Address of logical-unit name table
0346	V$OPCF	OPCOM lockout flag (busy)
0347	V$FGLB	Protection code and logical-unit number of the FL unit
0350	V$FREE	Reserved for future VORTEX use
0351	V$CTMS	Clock resolution in 5-millisecond increments (user-specified millisecond interrupt rate/5) specified at system-generation time
0352	V$SCV	Selected clock count (1 to 4095) ([user-specified millisecond interrupt rate] x [1000/V$CKB])
0353	V$LPP	Pointer to last tested word in V$PAGE
0354	V$CRM	Clock resolution increments for fractions of a minute in 5-millisecond increments

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0355	V$DSTB	Address of DST block
0356	V$LIT	Last address in background literal pool
0357	V$PGT	Address of V$PAGE, physical page availability mask.
0360	V$CTAD	Base address for controller address table
0361	V$SCTL	Current controller in scan
0362	V$NCTR	Number of controllers
0363-0372	V$PIMN	External device address table for PIMs
0373-0374	JUMP V$IOST	VORTEX II link for IOC STAT CALL
0375	V$SLFG	System SAL task busy flag (1 = busy) (not used in micro-VORTEX)
0376	V$ERFG	Error task busy flag (1 = busy) (not used in micro-VORTEX)
0377	V$JOP	JCP operating flag (1 = busy)
0400	V$LUT1	Starting address of logical-unit table for JCP/OPCOM-assignable logical units (1 - 100)
0401	V$LUT2	Starting address of logical-unit table for unreassignable logical units (101-179)
0402	V$LUT3	Starting address of logical-unit table for OPCOM-assignable logical units (180-255)
0403	V$1MIN	Clock constant set up by SGEN where V$1MIN = 32767 - (60000/(5*V$CTMS)) + 1
0404-0405	JUMP V$IOC	VORTEX II link to IOC
0406,0407	JUMP V$EXEC	VORTEX II link to RTE
0410	V$IOA	I/O algorithm
0411	V$CKIT	Clock interrupt PIM before it could be locked out (common interrupt handler and clock-processor flag. Not used in micro-VORTEX)
0412	V$JCB	Address of 41-word JCP buffer (all system background programs and JCP input directives into this sytem buffer)

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0413	V$OCB	Address of 41-word OPCOM buffer (OPCOM reads operator key-in requests into this buffer; if JCP is not active and a slash record is read, OPCOM moves the directive to V$JCB before scheduling JCP)
0414	V$BVN	Bottom of VORTEX nucleus. SGEN sets to virtual address. Initializer sets to page number
0415	V$BFC	Bottom of foreground blank common
0416	V$TFC	Top of foreground blank common, top of VORTEX nucleus core
0417	V$PST	Maximum RMD partitions per unit in system
0420	ZERO	Zero word
0421	BS0	Bit mask contents 0000001
0422	BS1	Bit mask contents 0000002
0423	BS2	Bit mask contents 0000004
0424	BS3	Bit mask contents 0000010
0425	BS4	Bit mask contents 0000020
0426	BS5	Bit mask contents 0000040
0427	BS6	Bit mask contents 0000100
0430	BS7	Bit mask contents 0000200
0431	BS8	Bit mask contents 0000400
0432	BS9	Bit mask contents 0001000
0433	BS10	Bit mask contents 0002000
0434	BS11	Bit mask contents 0004000
0435	BS12	Bit mask contents 0010000
0436	BS13	Bit mask contents 0020000
0437	BS14	Bit mask contents 0040000
0440	BS15	Bit mask contents 0100000
0441	BR0	Bit mask contents 0177776
0442	BR1	Bit mask contents 0177775
0443	BR2	Bit mask contents 0177773

Table 14-3. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0444	BR3	Bit mask contents 0177767
0445	BR4	Bit mask contents 0177757
0446	BR5	Bit mask contents 0177737
0447	BR6	Bit mask contents 0177677
0450	BR7	Bit mask contents 0177577
0451	BR8	Bit mask contents 0177377
0452	BR9	Bit mask contents 0176777
0453	BR10	Bit mask contents 0175777
0454	BR11	Bit mask contents 0173777
0455	BR12	Bit mask contents 0167777
0456	BR13	Bit mask contents 0157777
0457	BR14	Bit mask contents 0137777
0460	BR15	Bit mask contents 0077777
0461	NEG	Bit mask contents 0177777
0462	LHW	Left-half word mask (0177400)
0463	RHW	Right-half word mask (0000377)
0464	THREE	Data word (000003)
0465	FIVE	Data word (000005)
0466	SIX	Data word (000006)
0467	SEVEN	Data word (000007)
0470	NINE	Data word (000011)
0471	TEN	Data word (000012)
0472	BM17	Bit mask word (000017)
0473	BM37	Bit mask word (000037)
0474	BM77	Bit mask word (000077)
0475	BM177	Bit mask word (000177)
0476	BM777	Bit mask word (000777)
0477	BM1777	Bit mask word (001777)
0500-0777		Background literals and pointers

Table 14-4. TIDB Status-Word Bits

Bit	When Set Indicates	Explanation
15	Interrupt suspended	The task is suspended during the processing of a higher-priority task. The contents of volatile registers are stored in TIDB words 12-16 (interrupt stack).
14	Task suspended	The task is suspended because of I/O or because it is waiting to be activated by an interrupt, time delay, or another task. The task is activated whenever this bit is zero, or if TIDB word 3 has an interrupt pending and the task expects the interrupt.
13	Task aborted or exited if under micro-VORTEX	The task is not activated. All stacked I/O is aborted, but currently active I/O is completed.
12	Task exited or task under nucleus control of micro- VORTEX	The task is not activated. All stacked and currently active I/O is completed.
11	TIDB resident	The TIDB (drivers, task-interrupt processors, resident tasks, and time-scheduled tasks) is resident and not released when the task is aborted or exited.
10	Task resident	The task is resident and not released when aborted or exited.
9	Foreground task	The task is a foreground task (priority 2-31).

Table 14-4. TIDB Status-Word bits (continued)

Bit	When Set Indicates	Explanation
8	Check-point flag	Set: may be check-pointed by a lower priority task. Reset: may not be check-pointed by a lower priority task.
7	Task scheduled by time increment	The task will be loaded when a specified time interval is reached.
6	Time delay active	The clock decrements the time counter that, upon reaching zero, clears bit 14, thus resuming the task.
5	Task checkpointed	The background task is check-pointed and suspended. I/O is not activated.
4	Error in task	The task contains an error that will cause an error message to be output.
3	Task interrupt expected	A task interrupt is expected.
2	Overlay task	The task contains overlays.
1	Task-schedule this task	The scheduling task is suspended until the scheduled task exits or aborts.
0	Task searched, allo-cated and loaded	The task is loaded in memory and is ready for execution.

14.2.3 Timing Considerations (Approximate)

Real-time clock interrupt processor: At each incrementation of the real-time clock, there is a TIDB service scan requiring

$$x + 8y + 7z \text{ cycles}$$

where

- x — is 48 when the scan interrupts the dispatcher, or 63 when it interrupts a task and must establish a reentrant stack and store the contents of the volatile registers
- y — is the number of TIDBs searched
- z — is the number of tasks having time- or schedule-delay status bits set

The clock interrupt is disabled during the execution of the clock processor, and PIM interrupts are disabled for 26 cycles following the initial entry of the clock processor.

Dispatcher interrupt processor: The time required to begin execution of a task through the dispatcher is a function of the number of TIDBs searched before execution. The time required to begin execution of the **nth** task is

$$t + 14u + 17v + 12w + 18x + 25y + z$$

where

- t — is 17 or 25, depending on the entry to the dispatcher
- u — is the number of tasks with task-suspended bits (TBST bit 14) set
- v — is the number of tasks with events expected but event word reset
- w — is the number of tasks with error bits (TBST bit 4) set but error task busy
- x — is the number of tasks with either task-aborted (TBST bit 13) or task-exited (TBST bit 12) set but I/O not completed
- y — is the number of tasks active but not loaded
- z — is one of the following values:

  107 to activate the ERROR task
  110 to activate the SAL task on aborting or exiting
  114 to activate a loaded task that is not suspended, or to activate the SAL task to load the requested task
  104 to activate an interrupted, suspended task
  62 to activate a task when the event word is set and the interrupt suspended

Search, allocate, and load:

Load processing requires, for a foreground task

$$852(k) + v(k) + w(k) + x + y + ny$$

where

- k — is the cycle time
- v — is the nucleus module required by the task and is 28 + A + B + C cycles

  where

  A is 28 + 8 times the size of common, in pages
  B is 81 cycles as an average for the nucleus table module
  C is 11 + 11 times the number of specified read-only pages

- x — is the time to process an OPEN request
- y — is the time to read an RMD record (pseudo TIDB)
- ny — is the time to read a task from RMD into memory (variable depending on RMD device and task size)
- w — is the page allocation 45 + 35 times the task size, in pages

For a background task, load processing requires

$$945(k) + v(k) + w(k) + x + y + ny$$

where

- k — is the cycle time
- w — is the page allocation and is 45 + 35 times the task size, in pages
- v — nucleus module required by task and is 28 + A + B + C

  where

  A is 53 cycles (global FCB module)
  B is 81 cycles (average, nucleus table module)
  C is 11 + 11 times the number of specified read-only pages

x, y and ny are as defined for foreground task.

Resident task load processing requires

$$(533 + 9(x) + y)k$$

where

- k — is the cycle time
- x — is the task size, in pages

y is the nucleus module required by task 48 + A + B + C + D

where

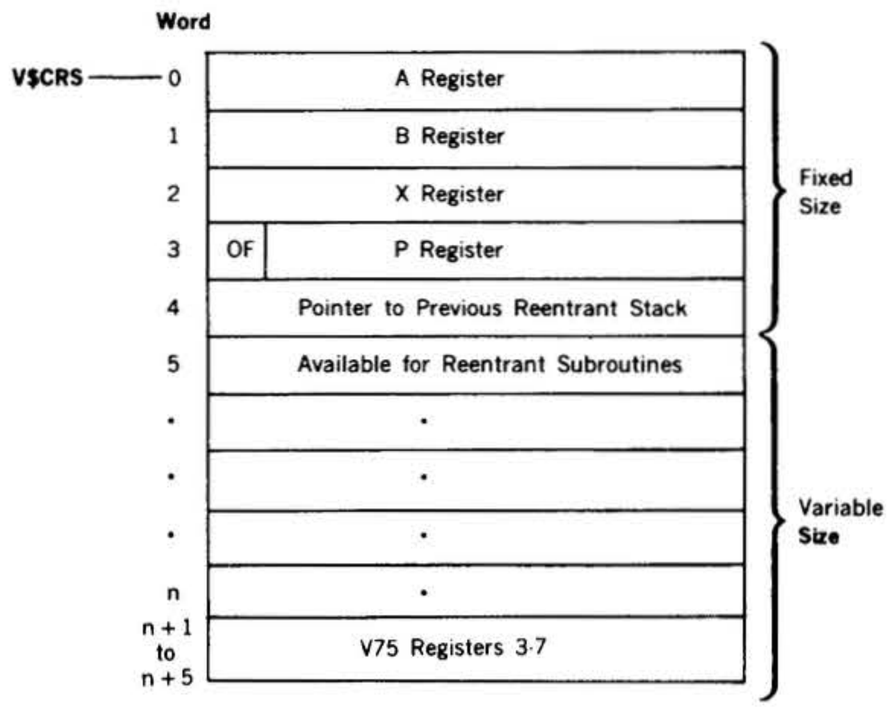
A is 28 + 8 times the size of common, in pages
B is 53 cycles for global FCB
C is 81 cycles for nucleus table module
D is 11 + 11 times the number of read-only pages

14.3 REENTRANT SUBROUTINES

The user can write a reentrant subroutine and add it to the VORTEX nucleus. RTE service requests ALOC and DEALOC interface between a task and a reentrant subroutine.

A task calls a reentrant subroutine via an ALOC request that allocates a variable-length push-down reentrant stack with the external name V$CRS. The reentrant subroutine address is specified in the ALOC calling sequence. The first word of the reentrant subroutine contains the number of words to be allocated.

A reentrant stack generated by the ALOC request has the format:



When writing a reentrant subroutine, ensure that the entry location contains the number (≥5) of words to be allocated, execution starts at the address (entry address + 1), and that V$CRS contains the reentrant-stack address. No IOC or RTE calls except DEALOC can be made while in a reentrant subroutine. The subroutine makes a DEALOC service request to return control to the calling task. DEALOC releases the reentrant stack, restores the A, B, and OF register contents, and returns control to the address following the ALOC request. No temporary storage is available for the reentrant subroutine except that allocated in the reentrant stack.

Parameters or pointers can be passed to the reentrant subroutine in the A and/or B (and V75 if present) registers, as well as in-line after the ALOC macro.

Two tasks make ALOC calls to RSUB. RSUB reserves six words of allocatable memory with the sixth word as temporary storage. The A register (reentrant stack) returns a value to the calling task. If task A is on priority level 5 and task B is on level 6, RSUB running on level 5 is interrupted and the level 6 task B executed. This, in turn, makes an ALOC request and executes RSUB. RSUB then executes to completion before RSUB on level 5 can be completed.

Example:

Task A

```
          ALOC    RSUB
          JAZ     ----
          .
          .
          .
          END
```

Task B

```
          ALOC    RSUB
          JAZ     ----
          .
          .
          .
          END
```

Reentrant Subroutine

```
          NAME    RSUB
V$CRS     EQU     0302
RSUB      DATA    6          Allocate six-word
          LDX     V$CRS      Stack (one temporary
                             location)
          .
          .
          .
          STA     5, 1       Save A in temporary
                             storage
          .
          .
          .
          LDA     5, 1       Get temporary storage
                             value
          .
          .
          .
          STA     0, 1       Modify return in A
                             register
          .
          .
          .
          DEALOC             Return to location
                             following ALOC call
          .
          .
          .
          END
```

14.4 CODING AN I/O DRIVER

The IOC (section 3) activates I/O drivers. When a user task makes an I/O request, it executes a JSR 0404,X instruction. IOC then makes validity checks on the parameters specified in the request block (RQBLK) that immediately follows the JSR instruction. IOC queues RQBLK to the I/O driver controller table (CTBL), and activates the corresponding controller-table TIDB. The TIDB contains the entry address for the I/O driver. To determine the proper CTBL and corresponding TIDB, IOC obtains the logical-unit number from RQBLK. By referring to the logical-unit table (LUT), IOC then finds the device assigned to that logical unit. Each device has a device specification table (DST) associated with it, and each DST has a corresponding controller table.

In VORTEX all RQBLKs are moved to map 0 dynamically allocable space. Upon completion of the I/O request, IOC moves the RQBLK to the requesting task's logical memory.

14.4.1 I/O Tables

Not all the data discussed in this section are required for coding every special-purpose driver, but it is presented to provide maximum flexibility in defining driver interfaces.

When an I/O driver is entered, it has the data, system pointers, and table address necessary for the I/O driver processing. At system-generation time, additional working storage space can be assigned to the I/O driver as an extension of the controller table. The data available are:

a. V$CTL (lower-memory system symbol defining the current TIDB) = address of TIDB associated with the I/O driver controller table.

b. TBRSTS (word 8 of controller TIDB) = address of controller table CTBL.

c. Within CTBL, the following:
(1) CTIDB (word 0) = controller TIDB address (V$CTL)
(2) CTDST (word 3) = address of DST
(3) CTRQBK (word 4) = address of RQBLK to be processed
(4) CTDVAT (word 6) = controller device address
(5) CTSTAT (word 8) = temporary storage available for driver
(6) CTBICB (word 9) = address containing assigned BIC address (e.g., 020,022)
(7) CTFCB (word 10) = FCB or DCB address for I/O request specified in CTRQBK (word 4)
(8) CTWDS (word 11) = contains, upon exit, number of words transferred
(9) CTSTSZ (word 13) = number of words per RMD sector
(10) CTTKSZ (word 14) = number of sectors per RMD track
(11) CTPST0 (word 15) = base address of the RMD for unit 0 on this controller
(12) CTPST1, CTPST2, and CTPST3 (words 16, 17, and 18) = PST addresses for units 1, 2, and 3

d. Device specification table (DST):
(1) DSUNTN (bits 13 and 14 of word 2) = number (0-3) of this device on its controller
(2) DSPSTI (bits 6-10 of word 2) = RMD partition number (1-20) used to access the PST

e. Request block (RQBLK): Contains user task I/O request information. The address of RQBLK is contained in CTRQBK (word 4 of the controller table). Word 1 of RQBLK contains the operation code in bits 8-11 and the mode specification in bits 12-14. Word 0 bits 5-14 contain the status.

f. File control block (FCB): The FCB is used for RMD devices. CTFCB contains the address of FCB.
(1) FCRECL (word 0) = record length
(2) FCBUFF (word 1) = user buffer
(3) FCACM (word 2) = bits 8-15, access method, and bits 0-7, protection code
(4) FCCADR (word 3) = current record number (relative within file)
(5) FCCEOF (word 4) = current EOF record number (relative within partition)

(6) FCIFE (word 5) = beginning-of-file record number (relative within partition)
(7) FCEFE (word 6) = end-of-file record number (relative within partition)
(8) FCNAM1, FCNAM2, and FCNAM3 (words 7, 8, and 9) = file names in ASCII

g. Data control block (DCB): The DCB is used for non-RMD devices. CTFCB contains the address of DCB.
(1) DCRECL (word 0) = record length
(2) DCBUFF (word 1) = user buffer
(3) DCCNT (word 2) = function count

h. V$CTL, TIDB, CTBL, DST, and the RQBLK reside in map 0. The FCB and DCB reside in the user's logical memory and to access the data, the I/O drivers must switch to the proper executive mode state (see section 1.3).

14.4.2 I/O Driver System Functions

Each I/O driver under IOC performs certain system pre- and post- processing functions.

Pre-interrupt processing: The I/O driver must switch executive mode states to fetch or store data from user mode (see section 1.3). If the I/O driver uses a BIC, the driver calls V$BIC with the X and A registers set to the initial and final buffer addresses respectively to build and execute the initial BIC transfer instruction. If the BIC is shared, the interrupt line handler is modified to the proper interrupt event word setting (TBEVNT) and TIDB address. V$BIC performs this modification if the word immediately following the call (JSR V$BIC,B) is nonzero, since this is assumed to be the interrupt event word setting. If it is zero, no line handler modification is performed. The I/O driver clears the interrupt event word (TBEVNT) in the controller TIDB immediately preceding a DELAY (type 2) call. To wait

for an interrupt, the I/O driver executes a DELAY (type 2) call with a time-out. The return to the driver, either from a time-out or interrupt is to the address immediately following the call. The contents of the X register is not restored following a DELAY call but the A and B registers are. Executing a TXA immediately preceding and a TAX following the DELAY call X restores the value in the X register.

Interrupt processing: The driver clears the time-delay flag (TBST bit 6) set by the DELAY call, and checks TBEVNT to determine if an interrupt occurred (TBEVNT = 0 indicates a time-out). Following the interrupt processing, the driver clears TBEVNT and calls DELAY (type 2) for the next instruction.

Post-interrupt processing (no errors): Upon the completion of interrupt processing, the driver sets the status bits (5-14) of RSTPR (word 0) in RQBLK, and enters the number of words transferred in CTWDS. The driver then relinquishes control and exits to IOC by executing JMP V$FNR.

Post-interrupt processing (errors): If an error is encountered during interrupt processing, the driver sets the status bits (5-14) of RSTPR, according to the type of error. The driver then sets the A register to zero if the unit is not ready, negative if there is a parameter error, or positive if there is a hardware error. Finally, the driver exits to the IOC error routine by executing JMP V$ERR.

Use of RTE services: Certain RTE services (SCHED, OVLAY and DELAY 1) use TBRSTS. V$IOC requires TBRSTS of the drivers TIDB to contain the controller table address. Therefore, drivers using the RTE services must save and restore TBRSTS.

14.4.3 Adding an I/O Driver to the System File

System-generation directives: The following directives are required for linkages to the controller table, controller TIDB, I/O driver entry location, DST, PST, and the PIM line handler (section 15):

Directive	Description
EQP	DSTs are generated by SGEN, one for each unit specified by the EQP directive. All DSTs generated for a controller point indirectly to the controller table specified by EQP. The pointer is to the entry name in the controller table assembly.
PIM	A PIM directive is required for each PIM line where an interrupt is expected. The PIM directive causes the system initializer to enable the mask for that line (except for the TTY or CRT output line, in which case it is initially disabled). If the driver processes both input and output interrupts, it may be advantageous for processing to set the interrupt event word for the input line to one value (e.g., 01) and the interrupt event word for the output line to another value (e.g., 02). The PIM directive also specifies if a directly connected interrupt handler is to be used (see section 14.4.5).
ASN	This directive assigns logical units to physical units. If a new device is being added and it is necessary to assign that device to a logical unit when the system is initialized, an ASN is input. Otherwise, the JCP or OPCOM ASSIGN directive can be used. The logical-unit table is established by these directives.
PRT	This directive for RMDs specifies the size and the mnemonic name of each partition. A PST and DST are created for each partition.
TDF	This VORTEX nucleus-generation control record directive defines and builds the controller TIDB. It specifies the name of the driver, status word (TBST) setting, and priority level.

Adding controller tables: A controller table is assembled as a separate entity and added to the system-generation library (SGL) for loading at system-generation time. The controller table name is CT followed by the three- or four-character ASCII name of the controller, e.g., CTTY0A, CTMT0A, and CTD0B.

VORTEX Input/Output Control (IOC) assumes the first 13 words of all non-RMD controller tables to be identical, i.e., word 0 = CTIDB; word 1 = CTADNC, etc. For RMDs the first 18 words are assumed to be identical. Additional words may be added to the controller table by use by the individual I/O driver.

The controller table comprises parameters that are constant for a controller, and parameters that are variables for SGEN and can change with system configuration.

Constants are assembled as DATA statements. DATA statements can be added to the controller table to provide additional working space for an I/O driver.

The following standard items are required by IOC:

Word Item — Description

0 **CTIDB** = Name of the related controller TIDB (TB followed by the same three or four-character name used in the controller table e.g.,. TBD0B (for CTD0B). An EXT statement must specify the TIDB name as an external name.

```
EXT  TBD0B
DATA TBD0B
```

1 **CTADNC** = This word is used by IOC as temporary storage.

2 **CTOPM** = The operation code mask specifying the type of I/O operation the driver is capable of processing 1 = driver is capable of processing.

Bit	Operation
0	Read
1	Write
2	Write EOF
3	Rewind
4	Skip record
5	Function
6	Open
7	Close
8-16	Reserved for future use

Example: DATA 037
For all operations excluding Function, Open, and Close.

3 **CTDST** = Set by IOC to DST address
Example: DATA 0

4 **CTRQBK** = Set by IOC to I/O request block being processed.
Example: DATA 0

5 **CTRTRY** = Error retry count. # T followed by the name of the controller.
```
Example: DATA    #TTY0A
         EXT     #TTY0A
```

6 **CTDVAD** = Controller device address. # A followed by the name of the controller
```
Example: DATA    #ATY0A
         EXT     #ATY0A
```

7 **CTIOA** = I/O algorithm. The ratio of device transfer rate to DMA transfer rate + 10 percent of the result times 32767. Zero for all non-BIC devices.
Example: when a disc transfer rate is 100K words per second and DMA rate is 300K words per second, the ratio is about .33. Set CTIOA to: DATA 030000
If ratio is .25 or 25 percent set CTIOA (DATA 020000); 50 percent set CTIOA (DATA 040000), etc.
To make CTIOA a SGEN selectable parameter (refer to section 15.5.2, EQP directive) assemble as an external e.g., EXT # D followed by the name of the controller:

```
EXT     #DCIOA      for process I/O
DATA    #DCIOA
```

8 **CTSTAT** = DATA 0, for driver use.

9 **CTBICB** = Address of BIC flag table. B followed by the name of the name of controller,
```
Example:  DATA BD0B
          EXT  BD0B
```
When the driver is entered the item points to a cell containing the BIC device address, 020, 022, 024, etc.

10 **CTFCB** = Set by IOC to the DCB or FCB address. Set to DATA 0

11 **CTWDS** = DATA 0. Driver use for number of words transferred.

12 **CTFRCT** = I/O algorithm frequency count. The number of retires to be attempted by IOC before suspending all subsequent I/O operations until the request in CTRQBK (word 4) is activated. DATA 0 for non-BIC devices.

13 **CTSTSZ** = RMD only. Number of words in an RMD sector.
Example: DATA 120

14 **CTTKSZ** = RMD only. Number of sectors in an RMD track
Example: DATA 48

15 **CTPST0** = RMD only. Base address of the PST for RMD unit 0 connect to this controller. P followed by the four character device name.
```
Example: DATA    !PD00B
         EXT     !PD00B
```

16 **CTPST1** = RMD only. Base address of the PST for RMD unit 1.
```
Example: DATA    !PD01B
         EXT     !PD01B
```

17 **CTPST2** = RMD only. Base address of PST for RMD unit 2.
```
Example: DATA    !PD02B
         EXT     !PD02B
```

18 **CTPST3** = RMD only. Base address of PST for RMD unit 3.
```
Example: DATA    !PD03B
         EXT     !PD03B
```

14.4.4 Enabling and Disabling PIM Interrupts

The disable and enable PIMs and RT clock instructions (EXC 0147, EXC 0747, EXC 0244, EXC 0444) are privileged instructions and cannot be executed in a user map (non-map 0) without creating a memory protect interrupt. The memory protect processor recognizes the interrupts caused by the disable/enable instructions and returns to the foreground task in the proper disabled or enabled state. The following restrictions apply:

a. Only foreground tasks are permitted to execute the disable/enable PIMs and RT clock instructions. EX21 error message is output of a background task attempts to execute those instructions.

b. The return to the foreground task is at location n + 2. In other words, both the disable PIMs and clock instructions (EXC 0747, EXC 0444 or vice versa) or enable PIMs and clock instructions (EXC 0147, EXC 0244 or vice versa) must be together. The second EXC instruction is not executed.

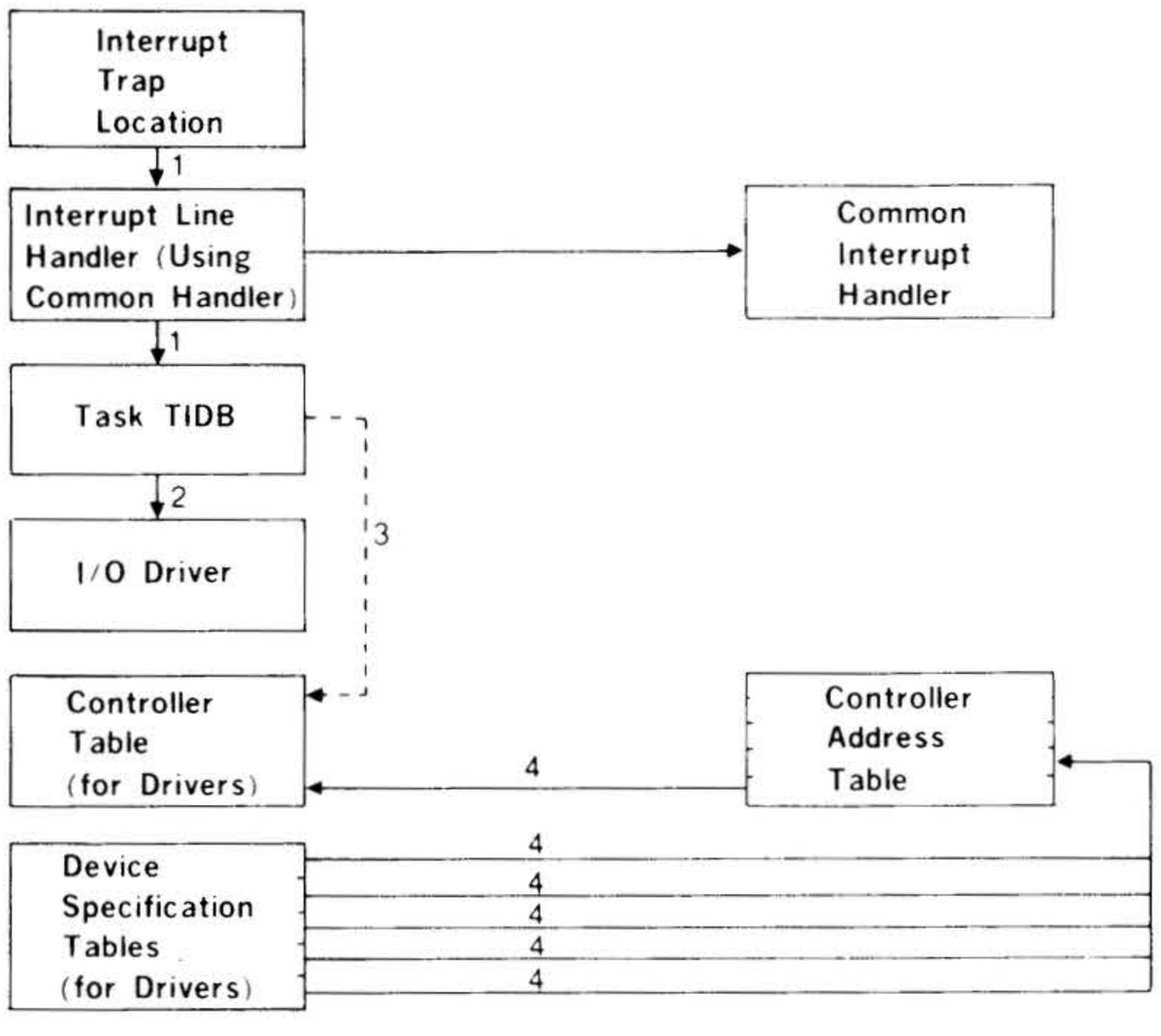
Example:

Location	Instruction	
n	EXC 0444	Disable RT clock instruction creates interrupt.
n+1	EXC 0747	This instruction is not executed.
n+2		Return location from the memory protect processor with PIMs and RT clock disabled.

EXC 0444 disables all PIM interrupts. EXC 0244 enables all PIM interrupts that are not masked. There is a PIM directive for each PIM line at system-generation time. The system initializer enables PIM lines. The mask is enabled unless the I/O driver specifically disables it. If a PIM directive is omitted, the linkage between the trap and the interrupt line handler cannot be established. If a PIM line mask is enabled or disabled by a driver, the system mask is updated to reflect the current status. The system mask configuration is given at low memory address V$IM (0320 for PIM1, 0321 for PIM2, etc.).

EXC 0747 disables the real-time clock interrupt and EXC 0147 enables it.

Figure 14-4 shows the standard VORTEX driver interface.



KEY:

1. The trap address corresponding to the PIM number (from PIM directive) points to the SGEN-generated line handler. The line handler points to the TIDB (named in PIM directive), using the matching TIDB name (on TDF control record).
2. The TIDB name (on TDF control record) points to the task, using the entry name in the assembly of the task.
3. *For OPCOM device drivers only.* The task TIDB points to the device controller table name (on TDF control record), using the entry name in the controller table assembly.
4. The DSTs are generated by SGEN, one for each unit specified on the EQP directive. All DSTs generated for a controller point indirectly to the controller table (named in EQP directive), using the entry in the controller table assembly.

Figure 14-4 . Driver Interface

14.4.5 Directly Connected Interrupt Handler

VORTEX provides a user two options of specifying directly connected interrupt handlers. The use of a directly connected interrupt handler, in lieu of the VORTEX common interrupt handler, is specified on the PIM directive during system generation (section 15.5.11). The interrupt handlers must be resident in executive mode, map 0.

Option 1 (specifying 1 as the s(n) parameter on the PIM directive) requires the user to:

a. Save and restore the overflow indicator and all volatile registers used by the directly connected interrupt routine before returning to the interrupted task.

b. Not allow IOC and RTE calls.

c. Minimize execution time.

d. Continue to lockout interrupts during processing, then enable the PIMs upon exiting. The RT clock is enabled in all cases except when the real time clock processor has been interrupted. Location 0300, V$CTL, will contain 037 if the RT clock processor had been interrupted. The interrupt handler must provide a check for interruption out of the RT clock processor and enable or disable the RT clock accordingly.

e. Restore the VORTEX system to the proper pre-interrupted state, executive or user mode. Any interrupt forces the system to executive mode, state 0 (see table 1-1). The interrupt handler must return to the proper state. V$KEY, location 0340, contains the map key number of the interrupted task. If the interrupt task is the user mode ($1 \leq$ **V$KEY** ≤ 15), the switch from "executive to user mode enable" instruction (EXC2 0246) must be executed. The "clear executive mode state mask" instruction (EXC2 0546) must also be executed.

Example:

```
          .
          .
          .
          LDB    D5000
          LDA    0300       Check location 0300
          SUB    0473       System constant = 037
          JAZ    DIH10      Zero = interrupt out of
          LDBI   0104546    RT clock
          LDAI   0100147    Otherwise enable clock
          JMP    DIH10+1
DIH10     LDA    D5000      = 5000
          STA    DIH40      Enable clock instruction
          STB    DIH30      Enable mask instruction
          ROF
          LDA    ROV        Restore overflow
          JANZ   *+3
          SOF
          LDB    D5000      NOP instruction
          LDA    0340       V$KEY check interrupts
          ANA    0472       Task map key
          JAZ    DIH20      0 = map 0
          LDB    0104246    Switch to user map
DIH20     STB    DIH30+1
          LDB    RB         Now restore A, B, X
          LDX    RX
          LDA    RA
DIH30     EXC2   0546       Modified to clear mask
          EXC2   0246       Modified to switch to
                            user map
          EXC2   0646       Enabled memory protect
          EXC    0244       Enable PIM
DIH40     EXC    0147       Modified to enable clock
                            or NOP
          JMP    *          Modified to return
                            address
D5000     DATA   05000
```

f. Obtain the interrupted task return address. The directly connected interrupt line handler is entered via a JMPM instruction from the line handler (see figure 14-1) and as such the first word in the interrupt handler must be a mark location. The return address of the interrupted task is found in word 0 of the line handler, which is obtained by subtracting four from the contents of the interrupt handler's mark location.

Option 2 (specifying 2 as the s(n) parameter on the PIM directive) permits the user to use system routines to save (V$DHD) the volatile registers and overflow indicator and restore (V$DRTN) the volatile registers, overflow indicator, and reset the system to the proper pre-interrupted state as described above. Option 2 relieves the directly connected interrupt handler of the housekeeping chores. The A, B, X registers, overflow indicator are saved, PIM and clock interrupts are disabled prior to entering the user code (via JMPM), (see figure 14-1). The user code is entered with the A register set to the TBEVNT value and the X register set to the user code entry address.

Upon completion of processing, the directly connected interrupt handler exits to system routine, V$DRTN.

Example:

```
          NAME   TASK
TASK      ENTR
          STA    EVNT       Save TBEVNT word
          .                 Do processing
          .                 .
          .                 .
          EXT    V$DRTN
          JMP    V$DRTN     Exit to common
                            processor
```

where task must be specified on SGEN PIM directive, e.g., PIM,010,TASK,01,2.

14.4.6 VORTEX Use of BICs and BTCs

VORTEX supports a maximum of 15 BICs or BTCs. The practical system limit may be considerably less than ten depending on the availability of device addresses, the type

and number of peripherals, and other configuration considerations. The BIC or BTC transfer complete interrupts must be assigned by ascending BIC or BTC numbers (020, 022, 024, 026, 070, 072, etc.) starting with the first PIM and the first interrupt i.e., PIM 0, line 0 assigned to BIC 020; PIM 0, line 1 assigned to BIC 022, etc. The first BIC must have a device address of 020; the second, 022; the third, 024; the fourth, 026; the fifth, 070; the sixth, 072; etc. Unless the special DEF control directive is used.

I/O drivers utilizing BICs or BTC must call the common BIC routine V$BIC. The X register is set to the initial buffer address and the A register set to the final buffer address. The call to V$BIC is:

```
JSR     V$BIC,B
DATA            Interrupt event word or 0 if no
                line handler modification to be
                performed.
DATA            Map number
```

14.4.7 VORTEX II and VORTEX Compatibility

User programs written to operate under VORTEX will be operable under VORTEX II under the following conditions:

a. Programs which contain any RTE service requests or Input/Output Control requests must be assembled by the VORTEX II version of DAS MR. Any program which builds these requests without the DAS MR macros must be modified so that the requests conform to the VORTEX II calling sequence.

b. Any foreground task which executes hardware I/O instructions except disabling and/or enabling PIMs and RT clock, see section 14.4.4, must be included as part of the resident nucleus when the system is generated. Foreground library tasks which are made resident during system generation by use of the TSK directive are not considered nucleus tasks and therefore must not contain any hardware I/O instructions (see section 14.4.8 for discussion on resident tasks).

c. Intertask communications can be accomplished: through the use of foreground blank common; by establishing named tables and buffers in the nucleus table module and referencing the named block by an external statement; by use of the RTE PASS request between a user map and map 0; by switching executive mode states (see section 1.3); by sharing the same physical pages utilizing the MAPIN and/or PAGNUM RTE requests.

d. User tasks (except priority 1 system tasks) may not write into or execute instruction from the first physical page. This page is the VORTEX II low memory area. It is mapped as read-operand only into all user tasks (see figure 2-2), except priority 1 tasks where page 0 is mapped as read-write access mode.

e. User tasks (non-nucleus) must not communicate with the nucleus except through the use of standard executive service and I/O requests or by referencing entry points which are contained in the core-resident library.

f. A user task can request a transfer of a block of data from map 0 to the user may by executing a RTE PASS request.

g. Direct connect interrupt handlers must restore the system to the pre-interrupted map state after servicing the interrupt. An alternative is to utilize the SGEN PIM directive, option 2, as described in section 14.4.5.

h. I/O drivers written for VORTEX operation must be modified for VORTEX II as follows:
   1. The map number must be passed when calling V$BIC, common BIC/BTC routine (see section 14.4.6).
   2. The I/O drivers must switch executive mode states (see section 1.3) to fetch/store data from a user map (DCB, FCB, buffer). RQBLK data are stored in map 0 by dynamic memory allocation.
   3. Rotating memory device (RMD) drivers must determine if a data transfer (read, write) I/O request is by SAL (search-allocated-load task). If it is a SAL request, the map number is obtained from TBEVNT of the TIDB for SAL. Otherwise, the requestor's map number is obtained from TBKEY. SAL is the RTE component which loads non- resident tasks into memory. The check may be accomplished as follows:

```
        LDA     RTIDB,B     RTIDB = word 4 of RQBLK
        SUB     V$LSAL      V$LSAL = location 0312 = SAL TIDB
        JANZ    XXX         Jump if not SAL
        LDB     V$LSAL      Yes SAL.  Get map key
        LDA     TBEVNT, B   From TBEVNT
        JMP     YYY         Now common processing
XXX     LDB     RTIDB,B     I/O request not by SAL
        LDA     TBKEY,B     Get map key from TBKEY
YYY     ANA     BM17        Mask bits 4-0
```

   4. Following a BIC transfer complete interrupt the I/O driver sense for a map memory protection I/O data transfer error:

```
SEN         0101+da,er
```

   where **da** is the BIC device address (which is found in word 011 of the controller table), and **er** is the address of the error processing routine which must set up an IO46 error code prior to calling V$ERR.

i. If a user wants to fetch/store from the nucleus tables, the user must ensure that the nucleus table module is mapped into the user's logical memory. He does this through an external reference to a symbol, TIDB, controller table, etc., within the nucleus module. Example -- have an "EXT TBTYOA."

j. TIDBs for non-resident tasks -- except JCP and OPCOM -- are dynamically allocated in map 0. Hence a foreground user task cannot load a register (B,X) from location 0300 (V$CTL or an address from any other low-core location) and directly fetch the TIDB data. In VORTEX, it is possible; in VORTEX II, such an attempt would result in a memory protect interrupt. The foreground user can fetch the TIDB data by use of the PASS macro. Except for clearing the TBEVNT word, via the RTE TBEVNT request, a foreground user task cannot modify the TIDB.

14.4.8 MICRO-VORTEX (CPU-3) AND VORTEX II COMPATABILITY

The micro-VORTEX option (CPU-3) replaces certain VORTEX II nucleus modules with modules that have been recoded to make BCS (branch to control store) calls to a 2 page firmware set. These modules reduce system overhead by 20 to 40 percent (depending on the system configuration and usage) and reduce the nucleus space requirements by approximately 7 pages. The micro-VORTEX version of VORTEX remains fully user compatable at the RTE and IOC levels but does contain some internal changes that might affect the system level programmer. The following paragraphs describe these changes. The descriptions are not intended to provide full internal information but rather to provide a starting point for further investigation if warranted.

Micro-VORTEX contains unique versions of the following system tasks:

V$LMEMBK
System Initializers (disc models C, D, E, F H only)
WCS Loading Tasks (replaces WCSRLD)
V$SYTACSK
V$FUNC
V$SERV
V$IOC

Whereas these modules have been significantly recoded they still perform the same basic functions. Where full subroutines (i.e., V$MALC) have been coded in microcode, a software "envelope" still exists that uses the same calling sequence to perform the function of the subroutine. The user may directly use the BCS for the function or he may continue to perform the function using a call to the software envelope. The firmware support for micro-VORTEX requires 2 pages of V77-600 WCS and may reside in either pages 1 and 2 or in pages 3 and 4 (user option). The firmware uses BCS entry points B and C and does not contain any user available micro space.

14.4.8.1 Functional Changes

The memory pool allocation scheme for nucleus dynamic memory has been changed so that dynamic memory fragmentation has been reduced. Nucleus dynamic memory is allocated from logical page 2, up with the thread header located in location 02000 and 02001 (not pointed to by V$UTB). The thread scheme remains the same as for software VORTEX II. Dynamically allocated blocks of memory are allowed to cross a page boundary. If the block must reside within a physical page then the user should call a new routine V$MALP to insure such a requirement. Also, physical pages are allocated out of V$PAGE from the top of memory down instead of the bottom up as in software VORTEX II.

The TSK option and special SAL processing has been removed (from software VORTEX II as well). The Search-Allocate-Load code has been rewritten to be reentrant and runs at the priority of the task being loaded. Thus, a high priority task to be loaded does not have to wait for a low priority task to be loaded as in software VORTEX II. Because the core resident directory (TSK tasks) has been eliminated, the user can no longer schedule a foreground library task by specifying logical unit zero.

Logical page zero is set ot read-operand-only mode for all priorities of tasks (it was set to read-write for priority one tasks). This elminates the special mapping of the nucleus program region into priority one tasks but does prevent such a task from storing into page zero logical space directly. If the user must do this, then he should use the V$STR subroutine in V$FUNC.

The background job thread has been eliminated. The threading of TIDB by the TIDB allocation routine has been changed so that tasks of either priority zero or one are threaded after the active background task and the dispatcher prevents the activation of a background task if one is already loaded.

Checkpointing for the background is handled by a separate task. When it is determined that checkpointing is required, a separate resident TIDB is added to the top of the TIDB thread. This task takes care of writing the background to the checkpoint file and setting the proper values in the background TIDB. When it is finished this TIDB is moved to the bottom of the TIDB thread where it is activated to reload the background when memory becomes available. Upon completion of the reload, the checkpointing task exits.

JPDUMP (invoked by either /DUMP or /EXEC,D) runs as a background task after the current active background task has completed I/O and is ready for exiting.

Loading of overlays is handled by reentrant code in the overlay call of V$SERV. The overlay is loaded at the priority of the task making the overlay request. Dynamic memory is used to save the task context (registers and overflow indicator) during the overlay load.

If a memory protect violation occurs that is determined to be a valid violation, the violating task's context is saved in the TBI register stack space in the violation TIDB instead of local storage in V$FUNC.

The loading of WCS during system boot and after a powerfail has been changed due to the critical nature of WCS under micro-VORTEX. WCS is loaded by the power up routine and by a nucleus resident standalone routine prior to the activation of VORTEX II, but after the nucleus is loaded. A unique version of a standalone disk I/O routine exists for each model code RMD for this purpose. Systems that are using a nonstandard RMD as the system disk must contain the appropriate standalone driver in order to use micro-VORTEX II. The system initializers branch to the power up routine to activate VORTEX II instead of the dispatcher as in software VORTEX II.

The STAT IOC request has been fully microcoded and the initial execution of the request replaces the JSR 373,X in the request block with a BCS call. This is the only case of user code modification in micro-VORTEX. The replacement is made only in the memory resident instance of the program and not in the load module image on disk.

14.4.8.2 Restrictions

Extreme care should be taken when using MIUTIL under Micro-VORTEX. Any micro patches to the micro-VORTEX pages or to the BCS entry point area must be made with caution so that the vital microcode is not jeopardized. It is suggested that the MIUTIL "R" command not be used until the micro patch has been verified. Instead, the user should abort MIUTIL during testing and thus not cause the WCSIMG file to be changed. If an error is made, the system need only be rebooted to restore WCS to a working state. Also, the user must take care not to delete or move the WCSIMG file on LUN 116. This file must start on the third sector of the partition. If FMUTUL is used to reload LUN 116, then the user must use the L,lun,key,ALLNEW command if the partition contains more than 19 files. If the L,lun,key,ALL command is used, FMUTIL may reorganize the directory sectors and thus move the WCSIMG file. If the WCSIMG file is corrupted and the system will not boot the user will have to perform either a new SYSGEN or a standalone disk reload in order to restore the contents of the WCSIMG field. If a new SYSGEN is performed, the user may perform a nucleus only SYSGEN by using the EDR,N option (if the requirments of that option are met).

14.4.9 Resident Tasks

Executive Mode, Map 0 Resident Tasks reside in the Nucleus Program Module in Map 0. No special SGEN directive is required to include these tasks as part of the nucleus. The VORTEX II user specifies the generation of these resident tasks by adding the program object modules on the SGL between the CTL,21 and CTLPART3 control records. The program name should not start with the characters "VZ--" as these are reserved for I/O drivers. SGEN processes I/O drivers selectively and ignores all I/O driver object modules unless a SGEN EQP directive specified the corresponding peripheral. These executive mode resident tasks: (1) are permitted to execute I/O type instructions; (2) cannot normally be scheduled via the OPCOM or RTE SCHED request, but are activated by resetting bit 14 of the TIDB status word TBST as are the I/O drivers and SAL; (3) must have a resident TIDB created by a SGEN TDF directive. An alternate means of executing these tasks is via an OPCOM RESUME request. However, caution must be exercised as the RESUME request activates the highest priority task with a matching name.

14.4.10 Purge Cache Command

Multi-processor systems which include shared memory, cache, and map hardware in their configurations need the ability to purge cache memory. This capability is provided by the PURGE CACHE function. The PURGE CACHE function code, which is 04000, is output to the map device by an OME instruction. This feature is restricted to foreground tasks only.

The overflow indicator determines the state of the CLOCK and PIM interrupts following the execution of a PURGE CACHE function. If the overflow indicator is reset, the CLOCK and PIM interrupts are enabled; and if the overflow indicator is set, the CLOCK and PIM interrupts are disabled following the execution of the OME instruction.

Example: Purge cache memory and leave the CLOCK and PIM interrupts enabled.

```
ROF                         reset overflow to indicate
                            interrupts enabled.

OME,046,PCACHE              output purge cache function
                            code to map device.
.
.
.
PCACHE DATA 04000           purge cache function code
```

14.5 INTERTASK COMMUNICATION

The Intertask Communication Module (ITC) provides a means by which concurrently running tasks in a VORTEX II system may communicate with one another. The ITC module consists of a group of reentrant subroutines called through the VORTEX ALOC service request. The module, which resides in map 0, can only be used in systems having the extended instruction set.

The following functions are provided by the module:

MAILBOX	Establishes the ownership of a mailbox entry in the mailbox list. This request must be issued by a receiving task before it can receive mail items.
FREEM	Releases ownership of a mailbox entry.
POST	Queues a mailbox item to a receiver's mailbox and conditionally activates the receiving task.
COPYM	Copies a message from a sender's map to a receiver's.
FIND	Returns the TIDB address of a specified task.
AWAKE	Set the TBEVNT word of a specified task.

The receiving task would provide a mailbox header and a list of empty mailbox items prior to establishing a mailbox entry. Sending tasks may then POST mail items to the receiver's mailbox. The receiving task may serially process the mail item, issuing COPYM or MAPIN requests to receive information from the receiving tasks.

14.5.1 ITC Module Operation

The ITC module has been given a driver-like name (VZITC) so it may be excluded from systems not needing this feature. In order to incorporate the ITC module into the nucleus, the user must include the following directive at system generation:

EQP,ITOC,0,1,0,0

The entry names of the individual reentrant subroutines (VI$MBX, VI$FRE, VI$PST, VI$CPY, VI$FND, VI$AWK) will be placed in CL at system generation.

A receiving task will initialize its mailbox headers, queueing a sufficient number of empty mailbox items to the free list. It will then perform one or more MAILBOX calls to establish ownership of entries in the mailbox list. A sending task may then communicate with the receiver using the POST call, specifying a mailbox key. (If the receiver's TIDB address is used as the key, the sender may acquire this through the FIND call.) The POST will dequeue a mail item from the receiver's free list, insert the message control information into it and queue to the receiver's active list. If the receiving task is in a type 2 or type 3 delay, the POST will activate it by setting its TBEVNT word. (If this mechanism is used, the receiving task must reset the TBEVNT word and the interrupt expected bit by using the TBEVNT macro.) The POST will also logically-OR the activity mask into the activity flag so the receiving task may identify on which mailbox header the activity took place. The receiving task would then dequeue the mail item and use its contents to transfer a message by means of a MAPIN or COPYM call. The task would then return the processed mail item to the free list. If the sending task were suspending itself until the completion of the message transfer, the receiving task could activate it with an AWAKE call.

14.5.2 ITC Calling Sequences

The following are ITC calling sequences:

MAILBOX Establish mailbox list entry ownership

Call: R0 = mailbox key
R1 = mailbox header pointer

label **ALOC VI$MBX**

Return: R0 = completion status
Where:
0 = Successful completion
1 = Memory not available for extending list
2 = Duplicate mailbox key found

The mailbox key may be any one-word non-zero value mutually agreed upon by the sending and receiving tasks. The receiving task's TIDB address may be used since this uniquely identifies any task in the system A function (FIND), which is described below, has been provided to return the TIDB address of a named task. Since multiple copies of a task in the system, all bearing the same name, cannot be uniquely identified by the FIND request, the SCHED request has been modified to include a new parameter. The new form is:

SCHED level, *wait,* **lun,** *key,* **'xx', 'yy', "zz" ,** *flag*

Where flag = 1 the TIDB address of the scheduled task is returned in R0, and if 0 (or omitted) the original contents of R0 will be retained. This permits a task scheduling multiple copies of another task to uniquely identify each one.

Duplicate keys are not permitted and any request specifying one will be rejected.

There is a permanently allocated block of memory in the ITC module for the mailbox list which will support ten list entries. If more entries are required, a block of memory from the system's allocatable memory pool will be obtained for mailbox list extensions. The user is cautioned, however, that the mailbox list is manipulated with interrupts disabled and an inordinately long list may create system problems.

Tasks having mailbox entries allocated to them will be so identified by the system. The task should deallocate all mailbox entries it had established prior to exiting using the FREEM requests, however, if it fails to do so the system will deallocate.

FREEM Free mailbox list entry

Call: R0 = mailbox key of entry to be deleted or if zero, all entries associated with calling task.

label **ALOC VI$FRE**

Return: R0 = completion date
Where:
0 = Successful completion
1 = Specified key not found in list, or if found, does not belong in this task.

If the calling task specifies a mailbox key for which it does not have responsibility (i.e., it did not perform MAILBOX request which established it), the FREEM request will be ignored.

POST Post mail item to the receiver's mailbox.

Call: R1 = pointer to 3-word message control block.

label **ALOC VI$PST**

Return: R0 = completion status
Where:
0 = Successful completion
1 = Mailbox key not found
2 = Mail item free list empty
3 = Map loading error

The message control block contains:

0	Mailbox key
1	Message address
2	Message size

Where the mailbox corresponds to the key used by the receiving task to establish a mailbox entry, the message address is a physical page number or the address of a message in the sender's map, and the message size is a page count or the number of words in the message.

If the receiving task is in a map-checkpointed state when the POST request is processed, the sender's map will be used to complete the posting and will be restored to the sending task before it is resumed.

The structure of the mailbox header in the receiver's map is as follows:

0	Free list front pointer
1	Free list rear pointer
2	Active list front pointer
3	Active list rear pointer
4	Activity flag pointer
5	Activity mask

The mailbox header points to the list of empty mail items (each item consisting of a four-word block), to a list of active mail items, to an activity flag, and contains an activity mask. A POST will remove an item from the free list, insert message control information into it and queue it to the active list. The POST will also logically OR the activity mask contained in the mailbox header into the activity flag

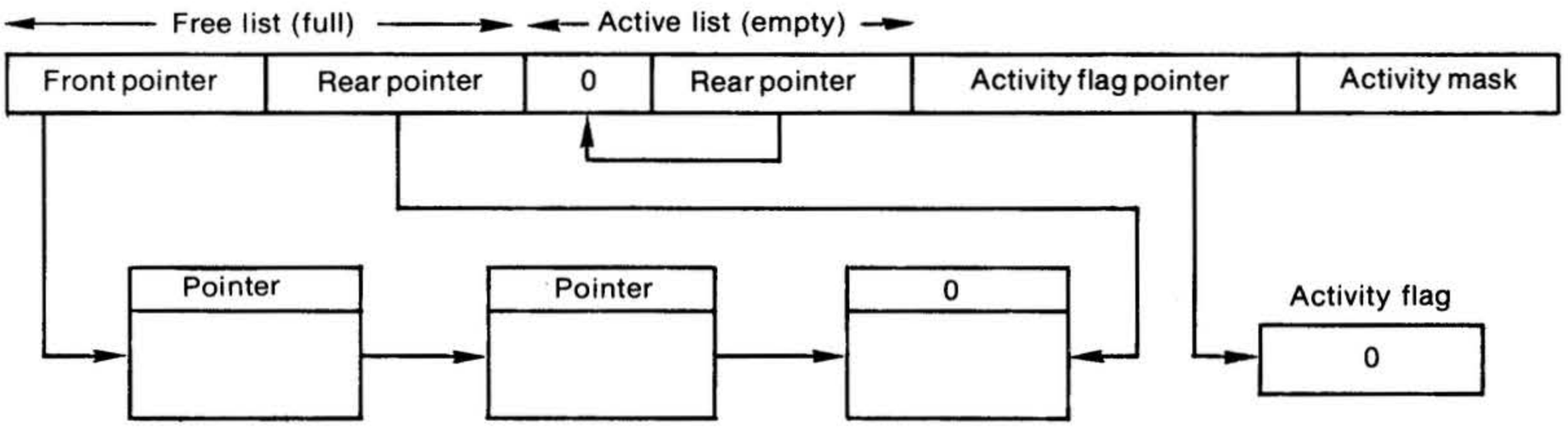
pointed to by the header. If the receiving task's interrupt expected bit is set when the POST is performed (denoting execution of a type 2 or type 3 delay), the POST will cause the receiving task's TBEVNT word to be set.

At the completion of a POST, a mail item in the active list would contain the following information:

0	Pointer to next mail item (0 if last item in list
1	Sender's TIDB address
2	Page number or message address
3	Page count or word count

When the receiving task has acted upon the information contained in a mail item, it would dequeue it from the active list and requeue it to the free list. The receiving task is also responsible for resetting the activity flag if this is required. Note that when queueing and dequeueing an item, or when reseting the activity flag, system interrupt must be disabled to avoid possible contention with POST. See section 14.4.4 regarding disabling/enabling interrupts.

The initial state of a mailbox header would be:



The receiving task must provide a list of linked empty items and an initialized mailbox header prior to establishing a mailbox list entry. The number of empty items to be provided is application dependent.

The following sample code illustrates how a mail item may be removed from the active list and requeued to the free list after it has been processed:

```
LDB1    HEADER+2
CALL    GETQ        Get item from active list
JXZ     NONE
STXE    ITEM
  .
  .
  .

  .
  .
  .
LDBI    HEADER
LDXE    ITEM        Return item to free list
CALL    PUTQ
  .
  .
  .
```

Get Item from Queue

Calling Sequence:

```
LDBI    (Queue header address)
CALL    GETQ
```

Return Conditions:

A = zero
B = no change
X = address of item dequeued, or zero if queue empty

```
GETQ    ENTR    0
        DISABL          Disable clock/PIMs
        LDX     0,B     Get pointer to item
        JXZ     GET2    None on list
        LDA     0,X     Get pointer to successor item
        STA     0,B     Put its address in header
        JANZ    GET2    Jump if list not empty,
        STB     1,B     else make rear pointer
GET2    ENABL           point to front
        JMP*    GETQ
```

Return Conditions:
A = zero
B = no change
X = no change

```
PUTQ  ENTR    0
      DISABL          Disable clock/PIMs
      STXE*   1,B     Update link in predecessor item
      STX     1,B     Update rear pointer in header
      TZA
      STA     0,X     Flag as last item in list
      ENABL           Enable clock/PIMs
      JMP*    PUTQ
```

Mailbox header

```
HEADER DATA    BLK1,BLK4,0,*-1,ACTFLG,ACTMSK

Free list
BLK1    DATA    BLK2,0,0,0
BLK2    DATA    BLK3,0,0,0
BLK3    DATA    BLK4,0,0,0
BLK4    DATA    0,0,0,0
```

COPYM Copy Message

Call: R1 = pointer to a 3-word array containing the address of a mail item, the receiver's buffer address, and the size of the receiver's buffer.

label **ALOC VI$CPY**

Return: R0 = completion status
where:
0 = Successful completion
1 = Sender's TIDB address specified in mail item not on active TIDB thread
2 = Memory unavailable for intermediate message storage
3 = Map loading error

R1 = number of words transferred

The number of words transferred is the smaller of the sender's message size or the receiver's buffer size. R0 upon entry points to a 3-word area containing:

0	Mail item pointer
1	Receiver's buffer address
2	Buffer size

Where the mail item contain the information (sender's TIDB address, etc.) regarding the message to be copied.

Put item on Queue

Calling Sequence:

```
LDXI    (item address)
LDBI    (Queue header address)
CALL    PUTQ
```

If the sending task is in a map-checkpointed state when the COPYM request is processed, the receiver's map will be used to transfer the message to intermediate storage (obtained from system allocatable storage). The receiver's map will be restored to complete the copying of the message.

FIND Find TIDB address of specified task

Call: R1 = address of 3-word area containing the specified task's name

label **ALOC VI$FND**

Return: R0 = completion status
where:
0 = Specified task not on active TIDB chain
0 ≠ TIDB address of specified task

If the specified task name is not unique, the TIDB address of the first task encountered with that name will be returned.

AWAKE Set the specified task's TBEVNT word

Call: R0 = TIDB address of task to be activated
R1 = Value to set in TBEVNT word

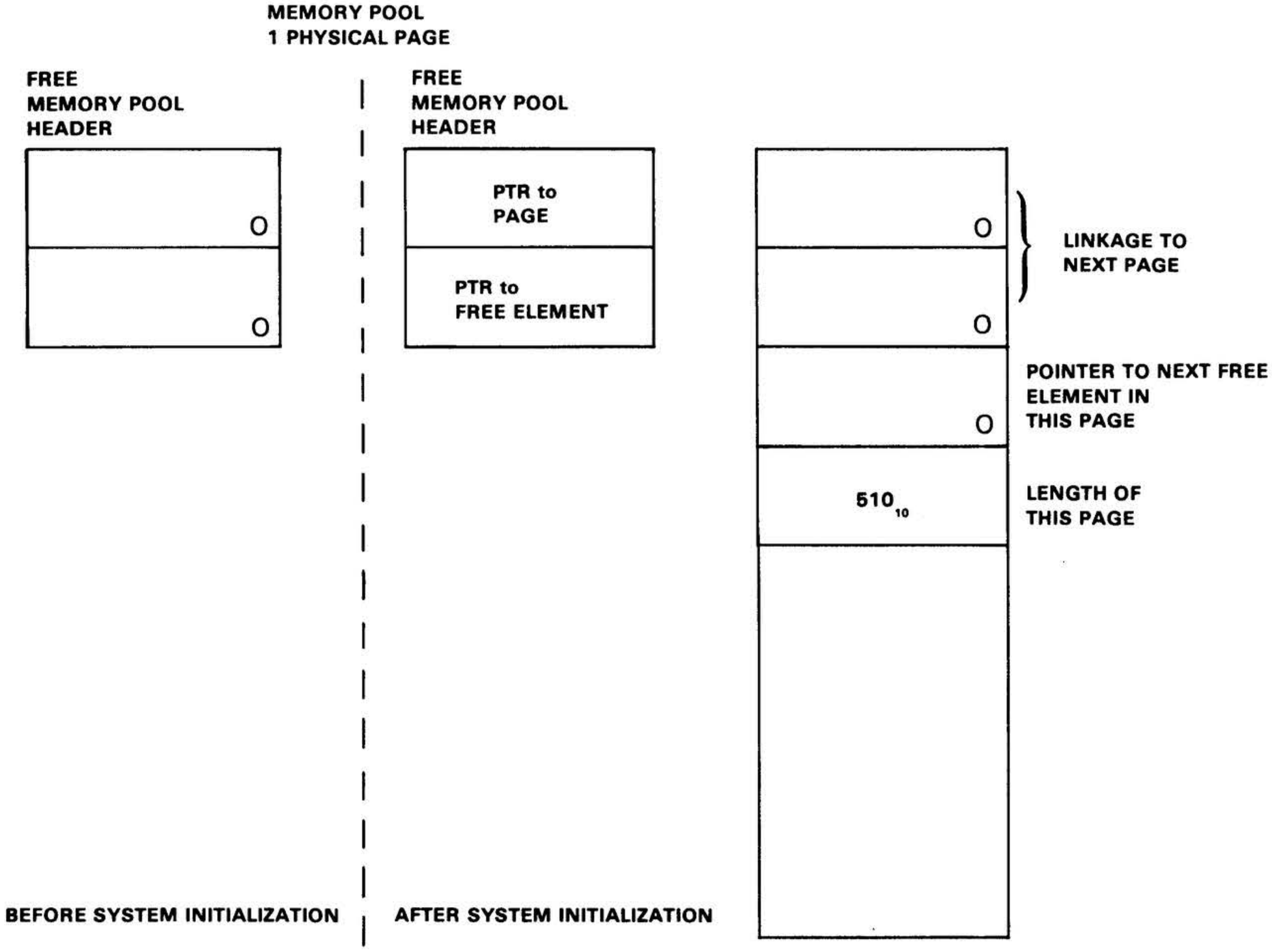
label **ALOC VI$AWK**

Return: R0 = completion status
where:
0 = Successful completion
2 = Specified task not an active TIDB chain

14.5.3 ITE Intertask Communication Module

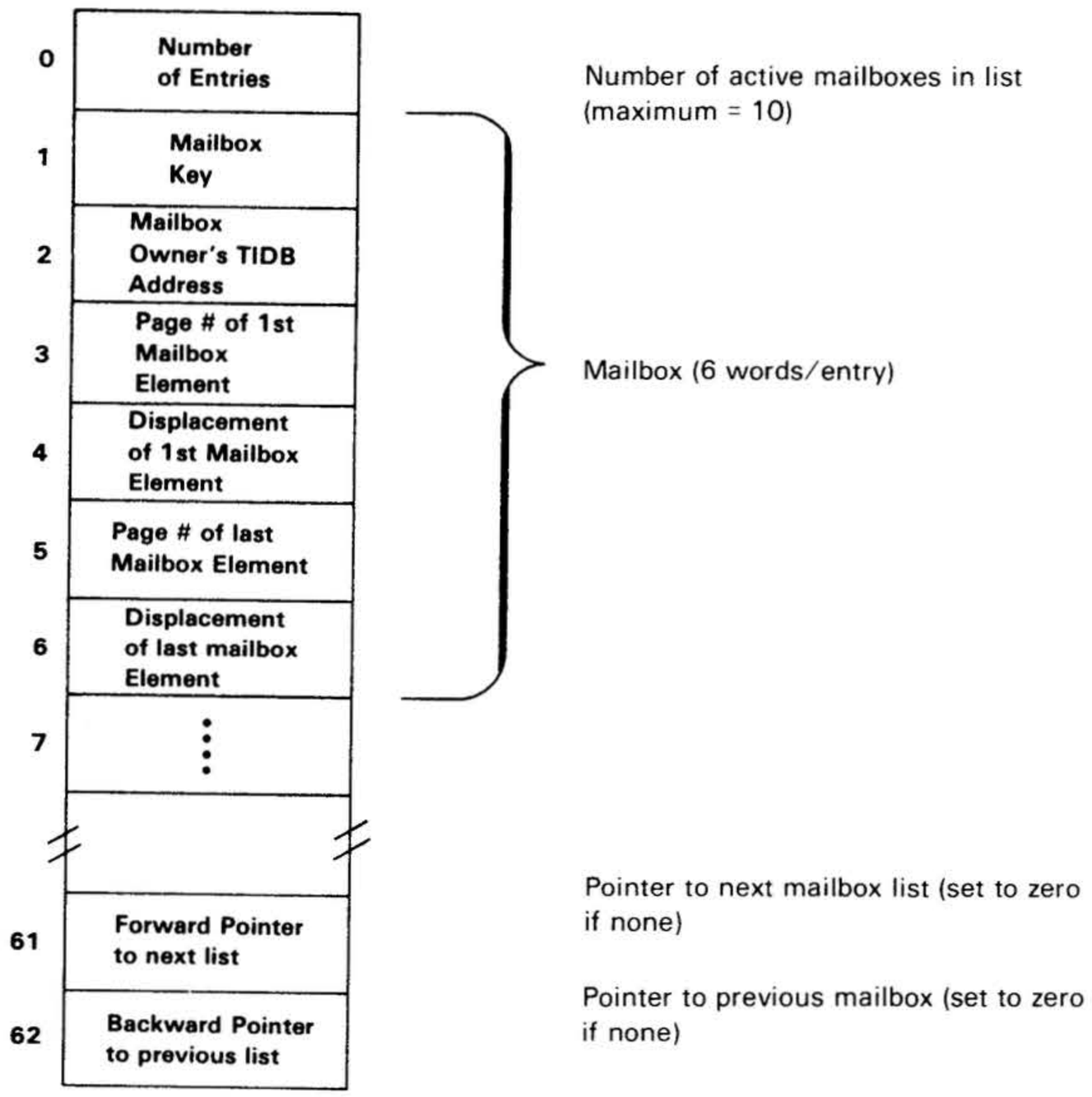
The ITE Module performs the equivalent functions of the ITC module, but has several unique conventions that are required by the 'D' revision of PRONTO.

ITE is a reentrant subroutine and resides in the nucleus. ITE consists of three areas: System Initialization, Mailbox Initialization and data transfers. ITE's memory pool initialization will occur at the first entry made by a task requesting a mailbox key. ITE will then request and link the physical page or pages to be used for ITE's internal message storage. Once physical memory has been allocated for ITE, it is ready for processing.

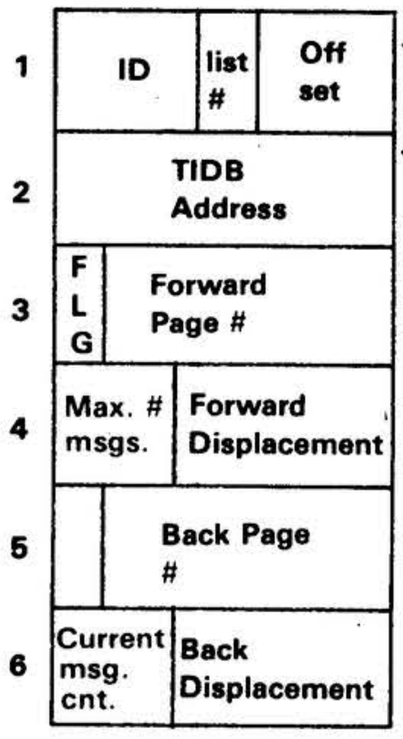


Mailbox initialization consists of calling ITE through the appropriate entry point to establish ownership of a mailbox. ITE will assign the mailbox key which will be associated with a mailbox. The mailbox will actually be an entry in the mailbox list.

Mailbox List Description:



Mailbox Entry Description



Word1
Mailbox Key

Bits 0 - 5: An offset value from the start of the table pointing to the start of this entry.

Bits 6 - 8: List segment sequence number. This field identifies in which segment the mailbox entry corresponding to this key resides.

Bits 9 - 15: Identification number used to ensure uniqueness between successive assingments of the key. The value is generated by taking the current value, incrementing by one, then taking the MOD 128, of it each time the key is reassigned.

Word 2
TIDB address of mailbox owner

Word 3

Bits 0 - 13 Physical map image of the first element in this mailbox queue

Bit 15: If set, message copied and page list pending

Word 4

Bits 0 - 9: Displacement of first element

Bits 10 - 15: Maximum number of messages that may be queued to this mailbox (currently set at 10

Word 5

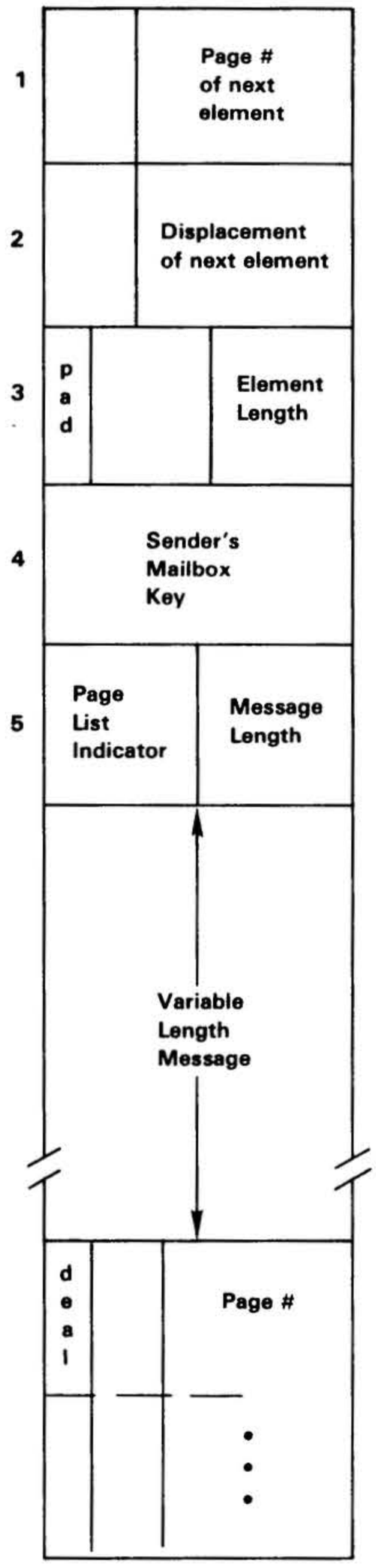
Bits 0 -13: Physical map image of the last element in this mailbox queue

Word 6

Bits 0 - 9: Displacement of the last element

Bits 10 - 15: current count of message queued to this mailbox

ITE's Internal Mailbox Element Description



Word 1

Bits 0 - 14: Physical map image of next element in the queue

Word 2

Bit 0 - 9: Displacement of next element

Word 3

Bits 0 - 5: Length of mailbox element in words

Bit 15: Pad Flag: 0 means no pad word added
1 means pad word added to prevent a free element with a length of 1

Word 4

Sender's mailbox key (the value placed in this word is not validated by ITE)

Word 5

Bits 0 - 5: Message length in words

Bits 8 - 13: Page list indicator 0 means to page list present, otherwise, the field contains the length of the page list.

The sum of message length and page list length must not exceed

Word 6 +: Message

Word 7 + Message Length: Page list if present

Bits 0 - 9: Physical Page number

Bit 15: Deallocation flag
1 means the page has been unliked from sender's map

0 means page is mapped to sender

ITE places the owners TIDB address in the entry point and initialized the pointers of the mailbox queue and increments the entry count of the mailbox list. The first list will reside within ITE. When that list is filled, memory from the dynamic pool will be used to form another list. These lists are linked forward and backward to allow deallocation of memory should a list at the end of the chain become empty.

The procedures for sending messages consists constructing a Message Control Block as shown below.

1	**Receiver's Mailbox Key**
2	**Sender's Mailbox Key**
3	**MSG WD 1**
4	**MGS WD 2**
5	**Page List Indicator**

Word 1: Destination mailbox key

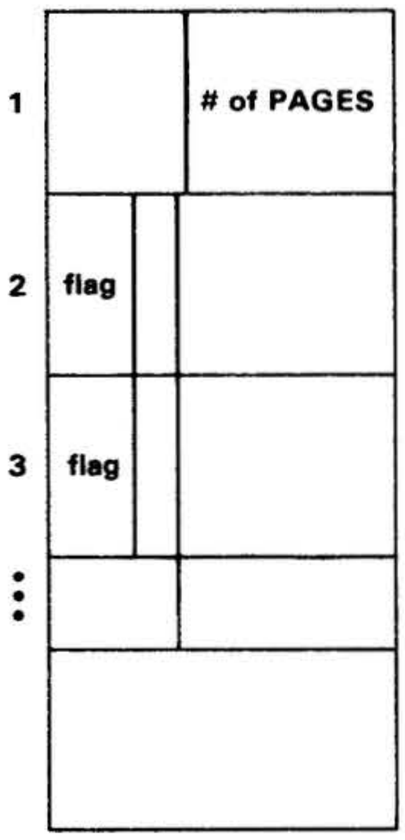
Word 2: Sender's mailbox key (the value in this word is not validated by ITE)

Word 3: If positive, this word contains the length in words, of the message to be posted. If negative, this and word 4 contain the message to be posted.

Word 4: If word 3 is positive, this word contains the address to the message. If word 3 is negative, this word contains data (i.e., message is embedded in MCB.)

Word 5: If positive, this word is the address to the page list, containing logical page addresses.
If negative, this word is the 1's complement of the address to a page list containing physical page numbers. If zero, no page list is to be posted.

The MCB will contain the destination mailbox key and optionally, the senders key. If the sending task does not have a mailbox, the senders mailbox key should be set to zero by the sending task. If the sending task has pages to transmit, the page list indicator is set to the address of a page list containing the page numbers. The following illustration shows the format of the physical page list.



Word 1

Bits 0 - 5: Number of pages to be transferred

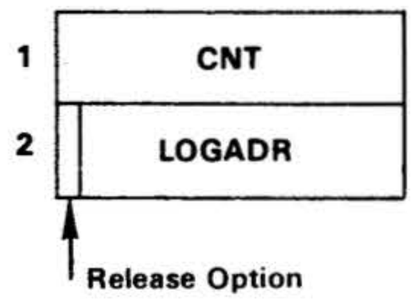
Word 2 - n

Bits 6 - 9: Physical page number, 1 page #/entry

Bit 15: Receiver mapping option flag. If zero: map the page (i.e., set bit 14 of the receivers map image word.)

If set to 1, reallocate the page to the receivers map (i.e., Bit 15 of the map image word will be set.)

A logical page list has the form:



Word 1 The number of pages to be transferred.

Word 2

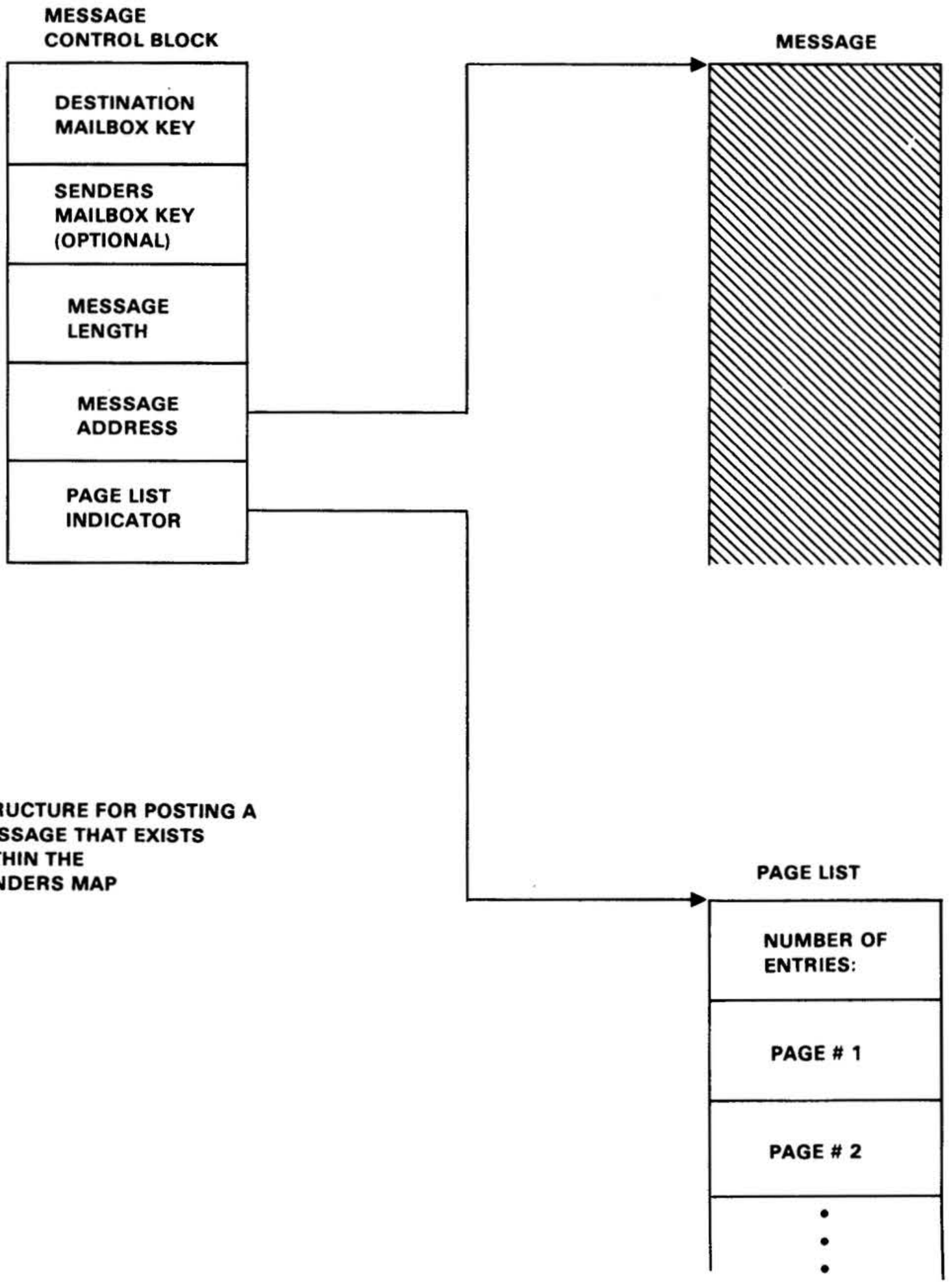
Bits 0 - 14: The starting logical address in the senders map modules 1000_8

(i.e., on a page boundary) from which the page or pages will be fetched.

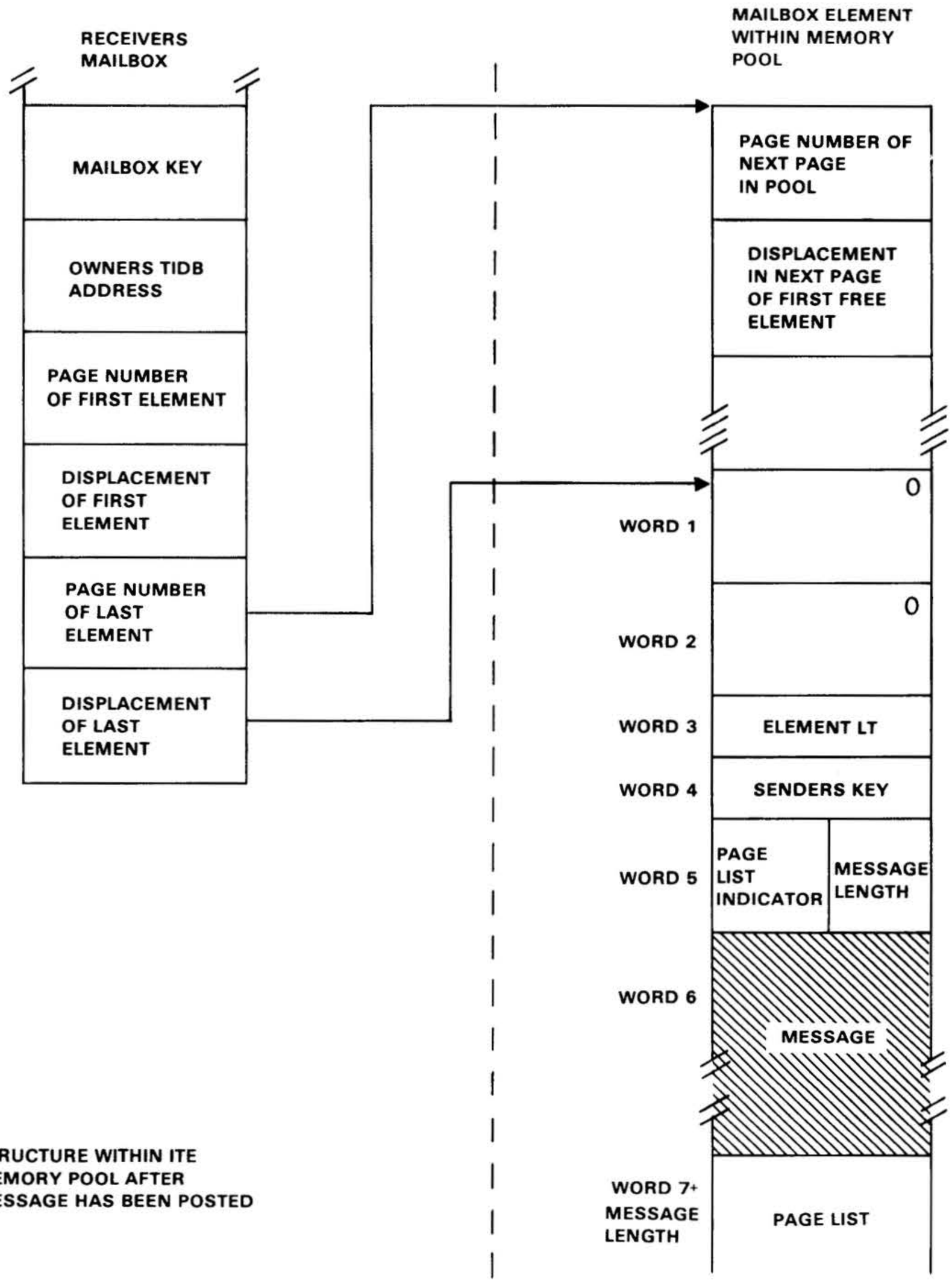
Bit 15: release option 0 = Release Pages (i.e., unmap from senders map)

1 = do not unmap pages.

ITE copies the MCB, message and page list, if one has been provided, into its memory pool to form a Mailbox Element. The Mailbox Element is queued to the mailbox indicated by the mailbox key. ITE will then set Bit 0 of the receiving tasks TBEVNT word and exit. If the page list is provided and the pages to be transferred are also to be unmapped from the senders map, ITE will perform the unmapping as part of the message posting procedure. The following is a data flow that occurs with the posting of a message.

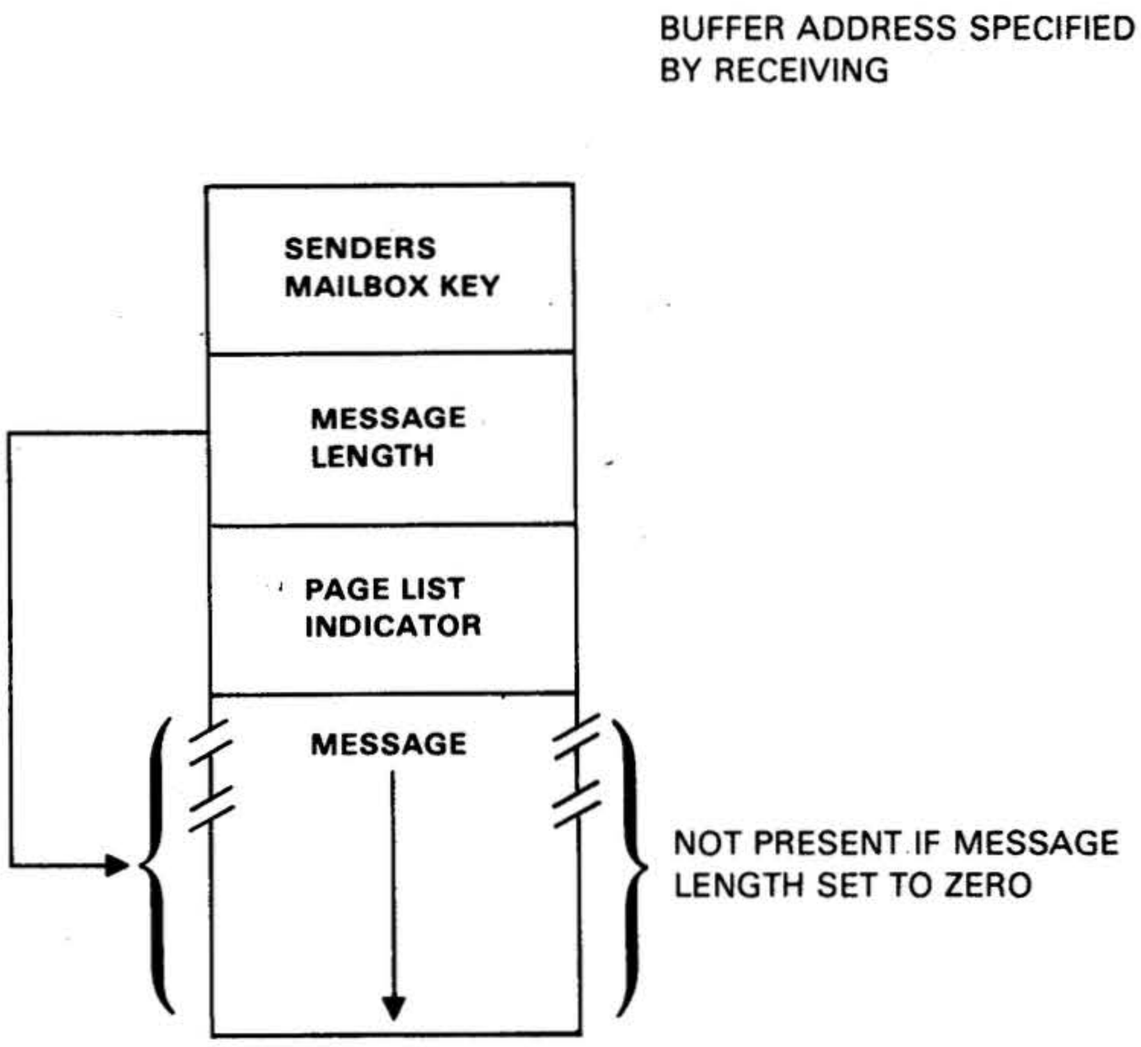


STRUCTURE FOR POSTING A MESSAGE THAT EXISTS WITHIN THE SENDERS MAP



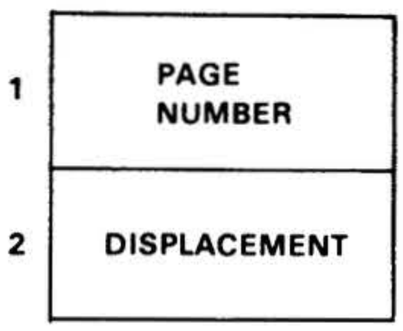
STRUCTURE WITHIN ITE MEMORY POOL AFTER MESSAGE HAS BEEN POSTED

To receive a message or to determine whether or not the queue is empty, a task will issue a request to ITE to copy a message. ITE will validate that the requesting task is the proper receiver by comparing the tasks TIDB address with that contained in the mailbox. ITE will then use the forward pointer words of the mailbox to locate and dequeue the next element. If the forward pointers are zero, ITE will return a completion status indicating that the queue is currently empty. If the queue is not empty, the length of the next element is compared with the length of the buffer specified by the receiving task. If the length of the buffer is too small, ITE will return a completion status to inform the task, and message will not be dequeued.



The previous illustration shows the format the message has when copied into the receiving tasks buffer. The space occupied by the mailbox element is returned to ITE's free memory pool. If the newly released element is next to another free element, the two are concatenated, forming one large free element space. This is done to limit the fragmentation within the memory pool.

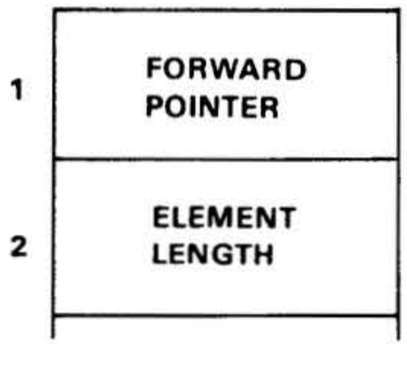
Free Memory Pool Header Description



Physical page map image of first page in memory pool

Displacement of the first available element within this page set to zero if the page has no elements available. This header is resident in the ITC Module. A similar header is located in the first two words of each page in the pool. the last page in the pool has these words set to zero.

Free Element Description

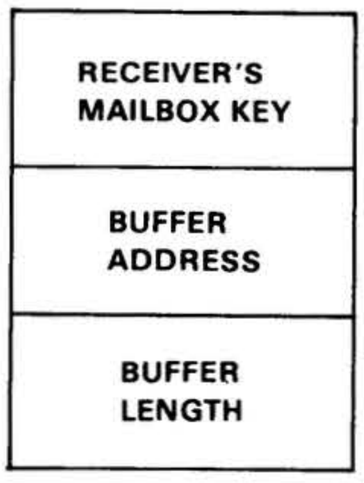


Pointer to the next availabe length within this page Set to zero if this element is the last in the page.

Length of this element (in words)

If the page list indicator is non-zero, the receiving task must get its pages before it can proceed to the next mailbox element. To check for a pages pending status, the sign bit of the forward page number word in the mailbox, for this task, will be set. This bit is not cleared until all pages have been processed or the receiving task requests that the remaining be dropped. Once the page list is entirely processed or dropped, the mailbox element is released back to ITE's memory pool.

Request Parameter Block to Get a Message



Receiving task's Mailbox Key

Logical address of receiver's message buffer

If positive, message buffer length in words

If negative, (1's complement of buffer length in words) indicates the page list is to be included in the message.

The receiving task will issue a request to ITE to retrieve a page or pages. If more than a single page is requested, the pages are linked to the receivers map contiguously beginning from the specified logical address. If the page(s) have been previously allocated to the sending task and the sender requested that the pages be unlinked, ITE allocates the pages to the receiving task's map (i.e., Bit 15 in the map image word(s) used, is set). Otherwise, the pages will only be mapped in (i.e., Bit 14 of the map image word(s) used will be set.)

In the event that the receiving task does not need to get the pages once it has copied the message, it can issue a request to drop those pages. This request will then dispose of the pages as required and release the mailbox element to the ITE memory pool.

The entry point VI$ITC is used as a housekeeping agent for the memory pool within which a task has exited or aborted. This entails checking the tasks queue for mailbox elements. If none are present, the mailbox is cleared. If the mailbox queue is not empty, ITE will release and consolidate the task's mailbox elements before clearing the mailbox. All other entry points which delete mailbox elements, first check to verify the presence of any mailbox elements. A completion status will be returned if there are elements left in the mailbox.

ITE utilizes several macros. In addition to the existing calls for ITC, ITE uses modified versions of VI$PST and VI$CPY. ITE also uses four unique calls of its own; VI$GTK (get a key), VI$GTP (get a page), VI$DRP (drop a page) and VI$RMB (Release a mailbox). ITE also uses the entry point VI$TRT; this will contain the logical starting address for mapping operations.

VI$PST

The calling sequence for the ITE VI$PST is:

R0 = address of the message control block
R1 = 0100000

Return:

R0 = Completion status, where

-1 = ITE is busy -- Go to sleep and try later
0 = Successful completion
1 = ITE memory pool has not been initialized
2 = Invalid or outdated mailbox key
3 = Map loading error
4 = Not enough or no free space available
5 = Receiving task's queue is full
6 = Message length error (too long or sum of PG list & MSG = 0)
7 = Page list error (page unassigned or not legal) or starting address together with number of pages exceeds map
8 = Page list specified with zero page count

If R0 = 7:
R1 = Starting logical address if page count exceeds map or logical

LABEL ALOC VI$PST

VI$CPY

The calling sequence for the ITE version is:

R0 = Pointer to 3 word block containing the calling task's mailbox key, the address of the buffer, and the lentht of the buffer.

R1 = 0100000

Return:

R0 = Completion status, where

-1 = ITE busy -- Go to sleep and try again later
0 = Successful completion
1 = ITE memory pool not initialized
2 = Invalid key
3 = Map loading error
4 = Buffer length too short
5 = Page list pending
6 = Mailbox queue is empty

R1 = Number of words required if R0 = 4

VI$GTK

The entry point VI$GTK is used by a task requesting a mailbox key. No entry parameters are used.

On Exit: R0 will contain the completion status

R0 = Completion status, where

-1 = ITE busy -- Go to sleep and try later
0 = Successful completion
1 = Memory not available for extending list
2 = No more segments available for extending mailbox list
3 = Map loading errors
4 = No pages have been specified for the ITE memory pool
5 = No physical pages available for memory pool
6 = Dynamic memory required for initialization unavailable
7 = No space available in map 0 for the ITE memory pool

R1 = Mailbox key if R0 is zero

VI$GTP

VI$GTP is used by the receiving task to get the page or pages sent with a message. If the page(s) were deallocated from the sender's map, the pages will be allocated to the receiver (Bit 15 of the corresponding map image word will be set). If the pages were not deallocated by the sender, ITE will map the pages (Bit 14 of the map image word will be set.)

Calling sequence:

R0 = address of the request parameter block, consisting of three words:

Word 1 = requestor's mailbox key
Word 2 = logical address from which to begin linking the page or pages
Word 3 = the number of pages to link

R1 = The number of pages to process

Return:

R0 = Completion status, where

-1 = ITE is busy -- Go to sleep and try again later
0 = Successful completion
1 = ITE memory pool has not been initialized
2 = Invalid mailbox key
3 = Map loading error
4 = No page list is pending
5 = Logical address or number of pages invalid

R1 = Number of pages processed if R0 = 0, or
The logical address in error if R0 = 5.

VI$DRP

VI$DRP is used by the calling task to drop the page list of the current message. This function enables the user to proceed to the next message without first processing the pages associated with the prior message.

Calling sequence:

R0 = Mailbox key

Return:

R0 = completion status, where

-1 = ITE is busy -- Go to sleep and try again later.
0 = Successful completion
1 = ITE memory pool not initialized
2 = Invalid mailbox key
3 = Map error
4 = No page list pending

VI$RMB

VI$RMB is used by the calling task to relinquish ownership of a mailbox.

Calling Sequence:

R0 = mailbox key of entry to be released or zero if all mailboxes belonging to the task are to be released.

Return:

R0 = Completion status, where

-1 = ITE is busy -- Go to sleep and try again later
0 = Successful completion
1 = ITE memory pool has not been initialized
2 = Invalid key
3 = Map error
4 = No mailboxes assigned to calling task
5 = A mailbox with an unempty queue encountered

R1 = Key of the mailbox if R0 = 5

LIMITATIONS, RESTRICTIONS & CONSIDERATIONS

1. Any task establishing ownership of an ITE mailbox will have the responsibility of checking the mailbox for messages prior to exiting and going to sleep.

2. A task which issues an I/O without wait and then issues a delay type 3 will have to determine for itself what event caused to be activated.

3. If a task exits or aborts prior to emptying its mailbox, ITE will release the mailbox elements but no notification will be made to the senders that messages were thrown away.

4. Four possible cases can occur in the disposition of a physical page when a sender requests that the page be transferred by ITE.

   a. The sender allocated the page and requests that the page be unlinked from his map.

   b. The sender allocated the page and does not want it unlinked.

   c. The sender mapped in the page and wants it unmapped.

   d. The sender mapped in the page and does not want it unmapped.

In the first case, the ownership of the page would be transferred to the receiving task (i.e., the receiving task would be able to deallocate the page and release it to VORTEX). In all the other cases, the page would merely be mapped into the receiving task's logical memory. Therefore, in the event that an abort occurs in the receiving task before it was able to get its pages, ITE will release to VORTEX only those pages which would have been allocated to the receiver, (Case A.)

SYSTEM GENERATION REQUIREMENTS

The following DEF directives are required:

DEF,VI$MXQ,n

where

n — Is the number of elements in the main box queue.
The value is placed in bits 9 - 15 and must be octal i.e., a value of 10 would be represented by DEF,VI$MXQ,012000.

DEF,VI$NPG,m

where

m — Is the number of physical pages to be used for ITE internal pool. This number of pages is made unavailable to VORTEX.

14.6 MEMORY PARITY CONSIDERATIONS

This paragraph describes VORTEX software handling of parity errors.

14.6.1 Memory Parity Considerations (V70/V77-600)

If is is desired to halt operations upon detection of a parity error inthe nucleus, six words are provided, starting at V$PERA, in which to place a halt patch.

If the parity routines are not desired, definitions for V$PERR and PARANY must be made.

14.6.2 Memory Parity Considerations (V77-200/400)

Memory parity detection is a supported feature under VORTEX on the V77 model 200/400. A parity error is reported by an EX35 error message (see appendix 11.2). The map tracking register contains the address being fetched when the parity error occurred. Memory parity is a feature of the SYSGEN selection parameter.

14.6.3 V77-600 Parity Error Handling

Parity Error Handling software on V77-600s consists of the following components:

- A nucleus module named V$PERR.
- Library load modules: DMPPAR, INITPR on the background and PAROUT, PARCHK and PERCHK on the foreground.
- An error log file named PARITY, 120 words long on logical unit FL.

The nucleus module V$PERR is created during SYSGEN. The library load modules DMPPAR, INITPR, PAROUT, PARCHK and PERCHK and the error log file PARITY can be loaded on disk by executing a segment of the post-SYSGEN job stream.

There are two types of parity errors associated with ERCC memory: single-bit (correctable) and double-bit (uncorrectable). Single-bit errors are transparent to the user except in the case of the log file overflow. Double-bit parity errors result in the current task being aborted and the operator being informed of an error.

Single-bit errors are ignored by the system, and automatically corrected by the hardware. The foreground task PARCHK will request the operator to input a testing interval, initialize the log file and schedule task PERCHK, which will do the actual testing and logging of single-bit errors. PARCHK (never PERCHK) should always be scheduled for single-bit error logging. The log file may be

reinitialized at any time by the execution of the background task INITPR. The file may be displayed at any time by the execution of another background task named DMPPAR. The output from DMPPAR is in the following format:

```
PARITY ERROR LOG          MM/DD/YY          HH/MM HOURS

ERROR COUNT = xxxxx

BOARD                     MODULE            SYNDROME
  X                         X                 XXX
                            •
```

The entries under BOARD and MODULE indicate the board number and module number where the parity error occurred. The entries under SYNDROME are a list of parity bit configurations which indicate the failing bit of a single bit error. For additional information, refer to Section 3 of the V77-600 128K Error Correction Memory Operation and Service Manual (UP-9008).

Whenever the log file overflows, a message appears on the console to inform the operator of the condition. When this message appears, the operator should (1) display the current log file, (2) reinitialize the log file, and (3) continue system operation with single-bit parity checking disabled (by aborting task PERCHK). Step (3) is desirable if single-bit errors occur in clusters. The PARCHK task might only be activated on a scheduled basis rather than continuously, to avoid unnecessary system overhead.

Double-bit errors or parity memory errors, if they occur during execution of either the dispatcher or the initializer, cause an error message to be displayed. Otherwise, the current task will be aborted, and a message of the following format will appear on the console:

```
DOUBLE BIT PARITY ERROR IN TASK XXXXXX

BOARD NUMBER = xx,   MODULE NUMBER = xx
```

Due to ERCC hardware design, the information in the above message may be incorrect if single-bit errors and double-bit errors occur together. The message, however, will only be displayed when double-bit errors occur, even if the contained information is incorrect.

Note: It is advisable to **always** schedule and run PARCHK to log single-bit errors, in order to take advantage of the ERCC hardware.

14.6.4 V77-800 Parity Error Handling

Parity-error-handling software on V77-800s consists of the following components:

a nucleus module named V$PERR,

library load modules: DMPARR, INITPR on the background, and PAROUT, PARUP, PARDWN on the foreground,

an error log file named PARITY which is 120 words long on unit 190.

Component (1) is created during SYSGEN, and components (2) and (3) can be loaded on disk by executing a segment of the post-SYSGEN job stream.

There are two types of parity errors: single-bit (correctable) and double-bit (uncorrectable). Single-bit errors are transparent to the user except in the case of the log file overflow. Double-bit parity errors result in the current task being aborted or the system being halted.

Upon entering any interrupt handler, single-bit parity errors are suppressed by hardware while double-bit errors will result in the machine going into step mode and the message "PE" appearing on the console.

For single-bit errors, the handler enters a one word information (containing the board number, the module number and syndrome pattern) in a system-resident queue and wakes up a resident task PARERR which, when executed, writes the information on the log file. The interrupt handler then resumes execution of the interrupted task. The log file may be reinitialized at any time by the execution of the background task INITPR. The file may be displayed at any time by the execution of another background task named DMPPAR. The output from DMPPAR is in the format

```
PARITY ERROR LOG          MM/DD/YY          HHMM HOURS

ERROR COUNT = XXXX

BOARD                     MODULE            SYNDROME
X                           X                 XXX
                            •
                            •
                            •
```

The entries under BOARD and MODULE indicate the number of the board and module where the error occurred. The entry under SYNDROME is the error syndrome pattern for single bit errors. Refer to Section 4 of the V77-800 Memory System Functional Analysis and Servicing Manual (UP-8704) for additional information.

Whenever the log file overflows, a message appears on the console to inform the operator of the overflow condition, upon which he should 1) display the current log file, 2) reinintialize log file, and 3) continue system operation with single-bit parity disabled (by executing the foreground task PARDWN). Step (3) should be executed if single-bit errors occur in clusters. The foreground task PARUP is available for re-enabling single-bit parity.

Double-bit errors, if they occur during execution of either the dispatcher or the initializer, cause the system to halt. Otherwise, the current task will be aborted, and a message of the following format appears on the console:

```
DOUBLE-BIT PARITY ERROR IN TASK XXXX
BOARD NUMBER = XX, MODULE NUMBER = XX
```

Section 15
THE PATCH PROGRAM

15.1 GENERAL

The PATCH program is a foreground utility program used to perform the following functions:

- On-line modification of the VORTEX nucleus in main memory or creation of a "patch image" file to be used to automatically patch the nucleus when VORTEX II is bootstrapped.

- Perform permanent modifications to a library task's load module file on disk.

These features allow the temporary correction of software problems without having to perform a new assembly and system generation or load module creation. In addition, PATCH can be used to adapt a standard VORTEX system to a specific user function. Because patches can be made on either a permanent or a temporary basis, potential corrections to software problems can be tested without having to perform lengthy system generations. Invalid patches can be removed easily, thus reducing the risk of disabling the system.

The PATCH program has the following types of input directives:

- Control Directives--These directives indicate the purpose of the change directives that follow.

- Change Directives--These directives specify the actual changes that are to be made to the nucleus or the load module file.

15.1.1 User Interface

The PATCH program interfaces with the following VORTEX logical units:

- DI — All directive inputs are solicited from the DI logical unit.

- DO — All print related outputs are directed to the DO logical unit with the exception of error messages and output from the .HIST directive.

- SO — All error messages and error recovery directives are directed to the SO logical unit.

- LO — All output from the .HIST directive is directed to the LO logical unit.

- FL — All output as a result of directives concerning the creation and listing of the "patch image" files is directed to the FL logical unit.

PATCH issues the prompt PT** when it is waiting for user input from the DI or SO logical units.

15.2 CONTROL DIRECTIVES

This paragraph describes the PATCH program control directives.

Note: The action specified by a particular control directive continues until another control directive is encountered, at which time the current process is terminated and the process specified by the new control directive begins.

15.2.1 .PTCH Directive

The .PTCH directive is used to test out possible changes to the VORTEX nucleus. After these changes are tested, they may be made permanent by adding them to the patch image file or by making a new assembly of the module being changed. The changes made by the .PTCH directive remain in effect until the VORTEX system is reloaded via a system bootstrap. Rebooting the VORTEX system clears all changes made by the .PTCH directive.

Note: Whenever possible, the .PTCH directive should be used when the VORTEX system is in a quiet and predictable state.

The .PTCH directive indicates that all the change directives up to the next control directive are to be used to modify the nucleus image which resides in main memory. The nucleus image which resides on the VORTEX system disk is unaffected by the changes specified by the .PTCH directive.

Patching specified by the .PTCH directive is done on a block process. A block is defined as the entries in one change directive record. Actual changes made to the nucleus image are performed with the real time clock (RTC) and priority interrupt module (PIM) interrupts disabled. Thus it is possible to make changes to code that is being executed.

Processing of the .PTCH directive continues until the next control directive is read. Change directives processed after the .PTCH directive do not have any effect on the patch image file.

15.2.2 .DUMP Directive

The .DUMP directive is used to create a patch image file. This control directive causes all change directives up to the next control directive to be placed in the patch image file. The patch image file must have the name PTCHIM and be located in the foreground library. Refer to paragraph 15.4 for a description and complete explanation of the patch image file.

The .DUMP directive causes the file PTCHIM to be opened and rewound. This action creates a new patch image file. The

.APND directive should be used if patches are to be added to an existing patch image file.

The .DUMP directive should be used to place a change directive in the patch image file only after the change has been tested using the .PTCH directive, it is determined that the change is valid, and the change is to be made whenever the system is loaded. Once a change has been added to the patch image file, it can only be removed by a new .DUMP directive. Change directives entered under control of the .DUMP directive do not have any effect on the nucleus image in main memory.

When the next control directive after the .DUMP directive is entered, the message:

DUMP COMPLETED

is output to the DO logical unit.

Note: The .DUMP directive may be used for nucleus changes only. It should not be used for changes to a load module file. All changes made under control of the .DUMP directive are treated as nucleus changes.

To clear an existing patch image file, enter the .DUMP directive followed immediately by another control directive.

15.2.3 .APND Directive

The .APND directive indicates that all change directives up to the next control directive are to be appended to the existing patch image file. Change directives currently in the patch image file are unaffected by the .APND directive.

The .APND directive causes the patch image file to be searched for the "end-of-image" indicator. When this indicator is encountered, the change directives following the .APND directive are appended to the patch image file.

The same rules and considerations which apply to the .DUMP directive also apply to the .APND directive.

If the .APND directive is used when the patch image file is empty, it functions in the same manner as the .DUMP directive.

15.2.4 .HIST DIRECTIVE

The .HIST directive is used to list the contents of the patch image file. Output from this directive is written on the LO logical unit in the following format:

address (original) new

where:

address
Is the address whose contents have been changed.

original
Is the original contents of **address**.

new
Is the new contents of **address**.

When the .HIST directive completes the listing of the patch image file, the contents of the patch directive log file is listed. This provides a complete "card image" record of all permanent patch activity on the system since the last time the patch directive log file was initialized. All patch activity is printed with the time and date it was entered.

After the patch directive log file is listed, the message

HISTORY COMPLETE

is output to the DO logical unit. If the patch directive log file is empty or is not valid, no history images are listed and the HISTORY COMPLETE message is printed.

The **original** parameter of the listing output may not reflect the actual contents of the memory location specified by **address** if the VORTEX system has not been reloaded since the patch image file was created. The value of **original** is set by the execution of the foreground library program BTPTCH. BTPTCH is automatically scheduled when the system is bootstrapped if SSW1 is set. The value of **original** may also be set by scheduling BTPTCH using OPCOM after the patch image file is created.

15.2.5 .BASE Directive

The .BASE directive is used to equate or display a base value associated with a user specified base symbol. This base symbol may then be used in the **addr** parameter of the change directives. (Refer to the paragraph entitled "Change Directives" later in this section for additional information regarding the **addr** parameter.)

The symbols defined by the .BASE directive may be any character, but it is suggested that the characters *,$,@ and other such special characters be used. Alphabetical and numeric characters should not be used.

After the .BASE control directive is entered, the user is prompted for a base symbol by the prompt:

BA=

There are two valid responses to this prompt:

- A symbol may be defined by entering the response:

  s = **value**

  where:

  s
  Is the base symbol.

value
Is the value equated to the base symbol.

- If the character "=" is entered, a list of the currently defined symbols and the values assigned to these symbols are displayed.

Each individual base symbol defined by the .BASE directive remains in effect until the symbol is redefined by another .BASE directive. No more than 5 base symbols may be defined at one time.

Example:

Define the character "%" to have the value of 3472.

```
.BASE
BA=
%=3472
```

15.2.6 .LIBR Directive

The .LIBR directive indicates that all change directives up to the next control directive are to be used to modify a specified load module file.

When this directive is executed, the system requests the logical unit, protect key, file name and overlay name (if referencing an overlay) by printing the prompt:

LUN,KEY,FILENAME,OVLY

Respond to this prompt by entering information in the form

lun,key,**filename**,ovly

where:

lun
Is the VORTEX logical unit number or name where the load module is located. This parameter may be entered in decimal, octal or as a logical unit name.

key
Is the protection key for **lun**. If **lun** does not have a protection key, this parameter may be an asterisk (*) or may be omitted.

filename
Is the name of the load module file that is to be modified. This entry must be from one to six ASCII characters and may not contain any embedded blanks.

ovly
Is the overlay name of the load module file that is to be modified. If the changes are to be made to the root segment or to a load module that does not contain overlays, this parameter, and the comma following **filename** must be omitted.

All change directives that follow this input apply to the load module specified by **filename**. Additional load modules may be modified by entering another .LIBR directive. Changes made to load modules need only be made once for each system generation or load module generation.

For each load module file location changed by the change directives which follow the .LIBR directive, a history output is written on the DO logical unit using the format described with the .HIST directive. The following exceptions apply to this output:

- The (**original**) field contains the exact value in the specified location and may or may not match the listing (assembly) value for that location. The match depends upon whether the load module is a foreground or background task, an overlay segment or root segment.

- When a change value is specified as a relocatable address, the letter R appears to the right of the change value given in the history. For example:

  address (original) newR — for a relocated address

  address (original) new — for absolute value or address

All addresses used in change directives associated with the .LIBR directive are addresses that appear in the assembly listing of the program involved. The PATCH program automatically adds the appropriate values to set the address to the address which would be set by the load module generator. All addresses within the load module program, excluding nucleus addresses, must be entered as numeric values. The PATCH program does not resolve labels or entry names associated with a particular load module program.

The format for the change directives under the control of the .LIBR directive is the same as the format for the control directives .PTCH, .DUMP, and .APND with one exception. Whenever the parameter **value(n)** contains a defined base symbol as part of its expression, **value(n)** is assumed to be a relocatable address which causes PATCH to adjust that value as the load module generator would, and to add the character R following the change value in the history output. The inclusion of the asterisk specification is the only way to specify a change value as a relocatable address. Care should be taken that the asterisk item has not been set to some non-meaningful value (it is set to zero upon the loading of PATCH) by the use of the .BASE directive.

A patch image file is not maintained for changes made under control of the .LIBR directive. Hence the control directives .DUMP, .APND, and .HIST do not apply to load module changes.

15.2.7 .EXIT Directive

The .EXIT directive indicates that the PATCH program has completed and is ready to exit. The .EXIT directive may follow

any control or change directive. The current process in effect is terminated in an orderly manner prior to the exit of PATCH.

Upon exiting, PATCH outputs the message

PATCH EXITING

to the DO logical unit.

15.2.8 .SLCT Directive

The .SLCT directive causes PATCH to automatically select and apply all applicable patches to the target system with PATCH input coming from the specified logical unit. The .SLCT directive has the general form:

.SLCT,lun

where:

lun
Is the logical unit name or number of the device containing the potential patches.

If **lun** is an RMD device, then **lun** must be a global logical unit and be properly opened prior to this command.

The patch directive stream must contain the appropriate .CNTL directives in front of each patch and must be terminated by a .EXIT directive. Under this mode, PATCH utilizes information on the .CNTL directive to compare system type (common or VORTEX II), CPU type (400, 600, micro-600, 800), and subject module to the target system attributes. Based on this comparison, the PATCH program either applies the patch or skips through the patch directive stream until a .CNTL or an .EXIT directive is encountered.

15.2.9 .MANL Directive

The .MANL directive performs the same function as the .SLCT directive except that user intervention is allowed at each patch. This user intervention permits specific exclusion of otherwise applicable patches. The .MANL directive has the general form

.MANL

where:

lun
Is the logical unit name or number of the device containing the potential patches.

When a .CNTL directive is encountered in this mode, PATCH outputs the parameters of the .CNTL directive to the SO logical unit in the format:

PATCH nnnn SYS { **CM** / **V1** / **V2** } **CPU** { **COMMON** / **600SFT** / **400SFT** / **600MIC** / **800SFT** / **800FPP** } { **NUCL** / **LIBR** } **MOD xxxxxx DATE MM/DD/YY**

If NO is entered on the SO logical unit, PATCH will bypass the current patch. Any other input including "YES" or carriage return causes PATCH to attempt to apply the patch if all parameters are applicable to the target system. If the parameters are not applicable to the target system, the patch is bypassed.

Note: The PATCH program may invoke IO10 diagnostics during determination of a patch applicability. This is a result of an unsucccessful CL library search and is a normal occurrence.

15.2.10 .RECD Directive

The .RECD directive is used to control the recording of all permanent PATCH activity on the target system. It has the general form

.RECD, { **OFF** / **ON** / **INIT** }

where:

OFF
Is used to temporarily turn off recording.

ON
Is used to turn the recording on.

INIT
Is used to initialize the log file.

The PATCH program always defaults to recording enabled (ON) but the OFF request may be used to disable recording during a period of exploratory PATCH activity. The OFF command is only in effect during a single PATCH invocation.

The INIT command may be used to clear the log file after a partial system generation or when a new file is created.

The PATCH program outputs the message

LOG FILE FULL

after each PATCH directive once the log file is full. The user must then either rename the old file and create a new file (i.e., with FMAIN) or initialize the current file to clear the full condition.

Note: The records (card image) written to the log file are written one per sector (no blocking). Thus, the log file needs to be of a significant size in order to avoid the full file condition. As a side benefit of unblocked format, the contents of the log file could be used as input to the PATCH program for the target system or another system of the same configuration.

15.2.11 .CNTL Directive

The .CNTL directive is used by the .SLCT and .MANL directives to provide system relative information about an individual patch. The .CNTL directive has the general form:

.**CNTL,patch number,**sys,**cpu,**type,module,date

where:

patch number
Is a 1 to 4 numeric value (null field also allowed) identifying the patch number

sys
Is the system type for the patch; omitted or 0 for common, 2 for VORTEX II

cpu
Is the cpu type (as per the SYSGEN cpu directive); null or 0 = common, 1 = V77-600 (software), 2 = V77-400, 3 = V77-600 (micro-VORTEX), 4 = V77-800 (no FPP), 5 = V77-800 (with FPP)

type
Is the patch type; N or omitted = nucleus, L = load module

module
Is a 1 to 6 character module name (used only on nucleus patches and then must be an entry name)

date
Is the patch date (optional)

This directive must precede each set of patch directives if the .SLCT or .MANL commands are to be used.

15.3 CHANGE DIRECTIVES

PATCH change directives do not begin with a period. They must begin in character position 1 and may not contain any embedded blanks. The occurrence of the first blank terminates the current change directive.

The format for the change directive is:

addr,**value(1)**,value(2),...,value(n)

where:

addr
Is the starting effective address for this change directive. The omission of this parameter causes the next sequential address from the previous change directive to be used. (If addr is omitted from the first change directive, an address of zero is assumed.)

value(n)
Is the value to be stored at the current effective address. **Value(1)** is stored at the address specified by **addr**. Subsequent **value(n)** entries are stored at the next sequential address. Omission of a **value(n)** entry results in the current effective address not being modified.

Note: The contents of an address can be examined by using a change directive preceded by an equals sign (=) and a single address parameter. This can be done under either the .PTCH or the .LIBR command.

All numeric entries in a change directive are treated as octal values. The parameters **addr** and **value(n)** may be formed in a variety of ways. These parameters may be expressed as a single value or as an expression containing addition (+) or subtraction (-) operations. Any length expression is acceptable; however, the expression may not overflow a record boundary. The expression evaluator checks for legal addresses or expression overflow. Embedded blanks are not allowed. The occurrence of the first blank character terminates the expression and the change directive record.

When the change parameter refers to an address, an expression item may be an absolute value (numeric) or a valid name in the VORTEX core resident library directory. (The core resident library directory contains all entry names in the nucleus programs and other system names.) If a core resident name is used, it must be from one to six ASCII characters.

If the change parameter refers to an instruction, the expression item may be an absolute value (numeric) or a valid instruction mnemonic as accepted by the VORTEX assembler. If an instruction mnemonic is used, it is looked up in a table in PATCH and the value retrieved. The table value **does not** contain the A or M field values for that instruction (they are set to zero). For example, referencing the instruction mnemonic LDA will result in a value of 010000 being fetched. To set the A or M fields of the instruction, an expression must be used. For example, to form an LDA with location 422 absolute, the parameter might be LDA+422. To form relative loads, the displacement must be calculated by the user, added to 04000, and formed into an expression. For example, to form a LDA relative here plus 35, the parameter might be LDA+4035.

To assist the user in forming instructions, some special instruction mnemonics have been added to the instruction table. For all indexed operations, an entry has been made specifying the index register. This entry consists of the three character instruction mnemonic followed by either X or B. For example, to form a load A indexed by the X register, the

parameter might be LDAX. To form an equivalent to the assembler entry "LDA 5,X", the parameters entry might be LDAX+5. For the JSR instruction the method is identical (i.e., to form a JSR indexed by X, the parameter might be JSRX).

Note: There are no equivalent entries for the IJMP instruction. For the bit test mnemonic (BT), four entries are included. These consist of BT followed by the register specification and the set/reset flag. For example, to form a bit test for the A register set, the parameter might be BTA1 and, for the B register reset, the parameter might be BTB0. The actual bit number can be included by forming an expression. Care should be taken to remember that **all numeric values are in octal**. Thus, to form a bit test on bit 11 in the A register set, the parameter might be BTA1+13.

For the extended instruction mnemonics, the X field is set to 7, (an LDAE results in a 6017). This means that indexed operations using extended instructions must subtract the appropriate value if the LDAE mnemonic is used. For example, to form a load A extended from X with a displacement of 06543, the parameter might be entered as LDAE-2,06543.

Table 15-1 gives all the special instruction mnemonics included in PATCH and the octal value associated with the entry.

It should be noted that PATCH modifies locations on a word basis; thus, each parameter of a change directive refers to one location. For example, a jump and mark to V$MALC would appear as JMPM,V$MALC and not as JMPM+V$MALC.

All alphabetic entries are first treated as an instruction mnemonic and, if not resolved, as a core resident library entry. Thus, an invalid instruction mnemonic will be treated as a core resident directory name and will produce a PT03 diagnostic.

When specifying noncontiguous locations, the skipped locations must be specified by entering null parameters in the change directive for **value(n)**, or by starting a new change directive record with the first entry specifying the new change address.

Table 15-1. Supplementary Defined Mnemonics

Mnemonic	Octal Value	Description
ADDX/ADDB	0125000/0126000	Add indexed by X or B
ANAX/ANAB	0155000/0156000	Logical AND indexed by X or B
BTA0/BTA1	06440/06400	Bit test A register for 0 or 1
BTB0/BTB1	06460/06420	Bit test B register for 0 or 1
DIVX/DIVB	0175000/0176000	Divide indexed by X or B
ERAX/ERAB	0135000/0136000	Exclusive OR indexed by X or B
INRX/INRB	045000/046000	Increment and replace indexed by X or B
JSRX/JSRB	06505/06506	Jump and set return in X or B
LDAX/LDAB	015000/016000	Load A register indexed by X or B
LDBX/LDBB	025000/026000	Load B register indexed by X or B
LDXX/LDXB	035000/036000	Load X register indexed by X or B
MULX/MULB	0165000/0166000	Multiply indexed by X or B
ORAX/ORAB	0115000/0116000	Inclusive OR indexed by X or B
STAX/STAB	055000/056000	Store A register indexed by X or B
STBX/STBB	065000/066000	Store B register indexed by X or B
STXX/STXB	075000/076000	Store X register indexed by X or B
SUBX/SUBB	0145000/0146000	Subtract indexed by X or B

15.4 PATCH IMAGE FILE FORMAT

The control directives .DUMP, .APND, and .HIST use the patch image file for building and listing patches. The patch image file must meet the following criteria:

- The file is supplied by the user prior to its first use and must reside in the system foreground library. The file name must be PTCHIM.

- The file must be large enough to hold all the patches that are to be made on an automatic basis. Each patch image record is 120 words in length and can hold 40 patch entries.

Each patch entry consists of a triplet with the following contents:

Word	Contents
1	Effective change address
2	Original contents of that address
3	New contents of that location

In order to indicate that a patch image file is valid, the first entry in the patch image file consists of a triplet containing a change address value and new contents value of -2 (0177776). This entry is placed in the file by the execution of either the .DUMP or .APND control directives. The user does not supply this entry. The final triplet of the patch image file consists of a change address and new contents of -1 (0177777). This entry is placed in the file by the termination of the .DUMP or .APND control directives. The user does not supply this entry.

Virtual nucleus overlay (VNO) control blocks may be embedded in the patch image file. The format of the triplet consists of word 1 = -3, word 2 = 0, and word 3 = the TIDB address of the TIDB associated with the VNO task being patched. These VNO control triplets are not listed by the .HIST control directive and are not supplied by the user.

The second word of a patch image triplet is set by the execution of the foreground program BTPTCH and hence, will remain zero until BTPTCH is executed. This means that requesting a history of the patch image file prior to the execution of BTPTCH will produce a history output with invalid entries for the original contents of the effective location.

Note: Terminating PATCH while under the control of .DUMP or .APND with the OPCOM directive ;ABORT may leave the patch image file without the proper terminator. Always terminate these directives with another PATCH control directive.

15.5 PATCH DIRECTIVE LOG FILE FORMAT

The PATCH directive log file must reside on the foreground library and have the name "PDLOG". All permanent PATCH directives (both control and change) are logged to this file in "card image" format (one record per logical sector). Each entry is also date and time stamped (ASCII format) in character positions 81 through 100. The last logged record is always followed by an EOF. Invocation of PATCH opens the log file (no rewind) and the .EXIT directive closes the file (with update). If the PATCH program is aborted instead of using the .EXIT command, the EOF pointer in the log file will not be updated and all patch activity logging for the PATCH session will be lost.

The .HIST directive may be used to list the contents of the log file. However, any ASCII list program (such as IOUTIL) may also be used. The contents of the PATCH log file may be used as inputs to the PATCH program for the target system or another identical system. The log file does not contain any patch directives that were rejected under .SLCT or .MANL control (except for the actual .CNTL directive), any temporary patches made under .PTCH control, any .HIST, .EXIT, or .READ directives, and thus is not a complete image of the entire "universal" patch directives.

The size of the PATCH directive log file, PDLOG, depends on the extimated patching of the target system. A minimum of 500 records is recommended. Using multiple change values on a single change directive will help conserve space on the log file. When a new file is created, it should be initialized with the directive .RECD,INIT prior to performing any patch activity on the system.

15.6 BTPTCH INTERFACE

The PATCH program has a companion program, BTPTCH, which utilizes the patch image file to perform patches without user intervention. This program resides on the system foreground library and can be scheduled in one of two ways.

- If SSW1 is not set before or during the execution of the VORTEX system bootstrap, BTPTCH is set active when the system is activated.

- BTPTCH can be scheduled with the OPCOM ;SCHED directive any time after the patch image file is created.

The first method allows a user to apply selected patches, without the need to enter patches with the .PTCH control directive, whenever the VORTEX system is loaded. The second method allows the user to select when the patches are to be made and make the patches without using the conversational mode of PATCH. The second method also allows the use of multiple patch image files by using FMAIN to rename the appropriate files, and then scheduling BTPTCH. When using BTPTCH by the second method, the user should ensure that the patches are not already in the nucleus. If the patches are in the nucleus, the second entry (original contents) of the history image will reflect the new value instead of the original value, since BTPTCH updates this entry every time it is executed.

BTPTCH does not have any effect on patches made to a load module file under control of the .LIBR directive.

BTPTCH opens and rewinds the patch image file, PTCHIM, checks for a valid file indicator, and performs the patches using

the patch entry triplets until the end of image indicator is encountered. When patching is completed, the message

PATCHING COMPLETED

is output to the OC logical unit. If the patch image file is empty or does not contain a valid file indicator, no patching is done and the previous message is output.

If the file PTCHIM does not exist, the messge

FILE PTCHIM NOT FOUND

is output to the OC logical unit and BTPTCH terminates. If the patch image file is invalid, BTPTCH terminates and does not output any message to the OC logical unit.

15.7 SYSTEM GENERATION INTERFACE

PATCH and its associated programs are included in the standard VORTEX II system generation libraries. If these programs are to be in the system, no user action is required. If these programs are not to be in the system, then they may be deleted by the SYSGEN directives:

```
DEL,V$$TWD
LDE,PATCH,BTPTCH
```

Note: The nucleus module of PATCH consists of less than 040 words. The PATCH program and its related programs may be required if a user requires a patch supplied by Sperry Univac. Hence, these modules should not be deleted unless it is absolutely necessary.

When patching the VORTEX nucleus, it may be necessary to jump out of in-line code to make a patch. Such changes require that the system have an area included within the nucleus region that may be used as a patch space. The SYSGEN DEF directive:

```
DEF,V$PTSZ,n
```

where:

n
: Is the number of words to be reserved

can be used to guarantee that a patch space of n words is available. The patch space is created at the bottom of the VORTEX nucleus just above the core resident directory for TSK defined tasks. The first word is specified by the CL name V$PSTR. The last word is specified by the CL name V$PEND. Neither PATCH, nor its related tasks limits the user to this area. However, the CL pointers are available to the user.

The word associated with V$PSTR is always set (by system generation) to the bottom of a memory page +1 and hence, the size of the reserved patch area may exceed the size requested with the DEF directive. If nucleus memory space is critical, care should be taken that the requested patch area size does not cause the nucleus to overflow into another memory page.

If the DEF directive is not used, the CL label V$PSTR is still generated and a patch space is created down to the bottom of the current last page of the nucleus. This means that some patch space may exist even if the DEF directive is not used. Of course, the size of this space may vary from 0 to 511 words.

In order to have all patch activity logged, the file PDLOG must be created on the foreground library. If this file is not created, PATCH will automatically disable directive logging.

15.8 PATCHING CONSIDERATIONS

The following considerations should be made when using the PATCH program:

- Whenever possible, the CL directory name should be used instead of an actual numeric number. This allows a patch to function independently of a particular system generation.

- When making patches that cause a jump out of the system code, it is advisable to create the patch area first and then patch in the jump to the patch area.

- When patching in a jump, make sure that both the jump instruction and the jump address are entered in the same PATCH change directive.

- Make patches while the system is in as calm and predictable state as possible to avoid possible complications while entering a patch.

- Use the .BASE directive to set a base symbol value when making patches to an external subroutine of a load module file.

- When entering more than one patch that is making use of the patch space generated by system generation, make sure that the patch space contents do not overlap. PATCH **does not** handle this for the user.

- Special diagnostic patches can be kept on an alternate foreground library file which can be renamed. When these patches are needed, BTPTCH can be scheduled without using the conversational mode of PATCH.

- When an asterisk is used as a defined base symbol, it should be remembered that the asterisk will keep its base value until it is reset. This may affect other patches.

- When a VNO task is to be patched, its entry name should be used--never its address or other task labels.

- The PATCH directive stream is in "card image" format and thus can be modified or added to by using any suitable line editor. This allows the

user to revise patches and add new patches to the system patch stream. When adding new patches, be sure to include the appropriate .CNTL directives and terminate the patches with a .EXIT directive if the patch stream is to be used under control of .SLCT or .MANL.

15.9 ERROR MESSAGES

Error messages output by PATCH have the following format:

PTnn, error

where:

nn
Is the error number

error
Is a brief descriptor of the error

In addition to the PTnn error messages, VORTEX may also generate an IO10 PATCH diagnostic if a directory search error is caused.

All error messages and error recovery are directed to the SO logical unit. After posting the appropriate error message, PATCH outputs the prompt PT** and awaits the appropriate recovery. Two options exist for error recovery:

- Enter a C on the SO logical unit to indicate that the directive in error is to be reread from the DI logical unit. Repositioning is automatic for magnetic tape and RMD devices.

- Enter the entire corrected directive on the SO logical unit. Upon completion of processing of the directive entered from SO, subsequent directives are read from the DI logical unit.

An error recovery directive may be either a control directive or a change directive regardless of the type of directive that caused the error.

PATCH error messages are listed in Appendix A.

15.10 EXAMPLES

The following examples illustrate several methods of making a patch to an operational VORTEX system.

Example 1: Define (reserve) a patch area of 30 words in the VORTEX nucleus region.

Enter the following system generation directive:

```
DEF,V$PSTR,30
```

Example 2: Change the nucleus locations 200,201,204, and 206 to contain 1,2,3, and 4 respectively.

Enter the following PATCH directives:

```
.PTCH
200,1,2,,,3,,4
```

Example 3: Continue the patch address into the next change directive.

The change directives might be:

```
200,1,2,,,3,,4
 5,6,7
```

(This would modify locations 200,201,204,206,207,210, and 211.)

Example 4: Place a patch in the nucleus program PROG1 to add a bit test after location 0123 relative to the start of the program. The code at location 0124 and 0125 must be saved and currently contains a LDA 4,X and a STA 9,B. Use the patch area created by system generation to hold the patch. The entry name PROG1 is located at the first loaded location of the program PROG1.

The PATCH directives might be:

```
.PTCH
V$PSTR,6451,PROG1+145,15004,56011
1000,PROG1+126,PROG1+124,1000,V$PSTR
.EXIT
```

Example: Make the same patch as in example 4 but use the instruction mnemonics.

The change directives might be:

```
.PTCH
V$PSTR,BTA0+11,PROG1+145,LDAX+4
STAB+11,JMP,PROG1+126
PROG1+124,JMP,V$PSTR
.EXIT
```

Example 6: Change locations 0245 and 0246 of the load module file on logical unit 25 (no protect key), filename TEST to a jump to program location 0310.

The PATCH directives might be:

```
.LIBR
25,,TEST
245,JMP,*+310
.EXIT
```

Example 7: Make another change to the program TEST in example 6 which places a jump at location 0276 to location 6 of the external subroutine SUBR that is linked with TEST on the load module file.

From the LMGEN map it is determined that subroutine SUBR is loaded at relative location 0544. The patch in example 6 has already been made.

The following PATCH directives might be used:

```
.LIBR
25,,TEST
276,JMP,544+6+*
```

or

```
.BASE
$+544
.LIBR
25,,TEST
276,$+6
```

Example 8: Display the current BASE value.

The PATCH directives would be:

```
.BASE
=
```

Example 9: Change location 0245 of the OPCOM overlay OPPRO to contain the relative address of 0247.

The PATCH directives might be:

```
.LIBR
FL,F,V$OPCM,OPPRO
245,*+247
.EXIT
```

SECTION 16
SYSTEM MAINTENANCE

The VORTEX **system-maintenance component** (**SMAIN**) is a background task that maintains the **system-generation library** (**SGL**). The SGL (figure 15-2) comprises all object modules and their related control records required to generate a generalized VORTEX operating system.

16.1 ORGANIZATION

SMAIN is scheduled for execution by inputting the job-control-processor (JCP) directive /SMAIN (section 4.2.21). Once SMAIN is so scheduled, loaded, and executed, SMAIN directives can be input from the SI logical unit to maintain the SGL. No processing of the SGL takes place before all SMAIN directives are input and processed. Then user-specified object modules and/or control records are added, deleted, or replaced to generate a new SGL.

SMAIN has a symbol-table area for 200 symbols at five words per symbol. To increase this, input a /MEM directive (section 4.2.5), where each 512-word block will increase the capacity of the table by 100 symbols.

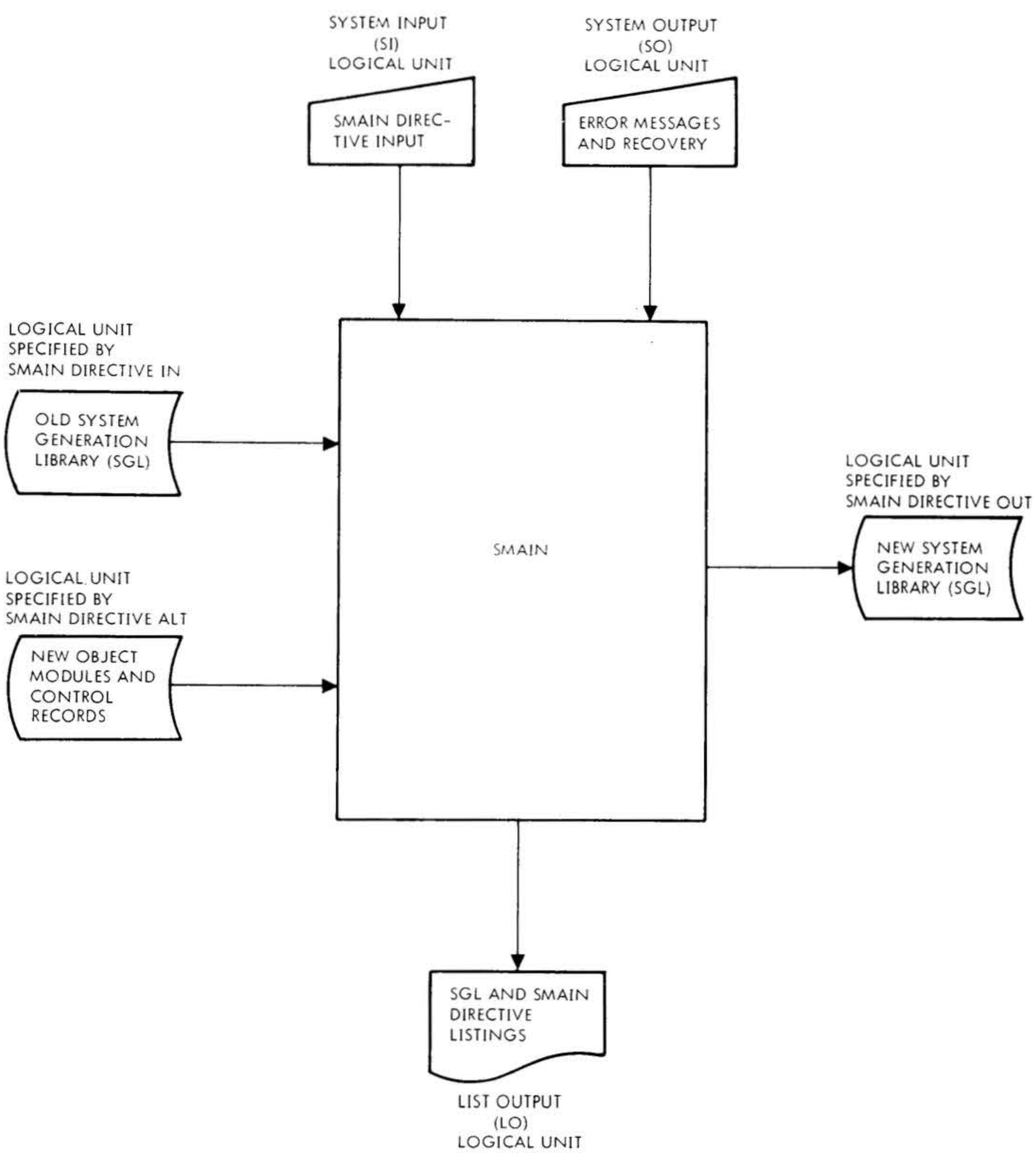


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Figure 16-1. SMAIN Block Diagram

INPUTS to the SMAIN comprise:

a. *System-maintenance directives* (section 16.2) input through the SI logical unit.

b. *The old SGL* input through the logical unit specified by the IN directive (section 16.2.1).

c. *New or replacement object modules and/or control records* input through the logical unit specified by the ALT directive (section 16.2.3).

d. *Error-recovery inputs* entered via the SO logical unit.

System-maintenance directives specify both the changes to be made in the SGL, and the logical units to be used in making these changes. The directives are input through the SI logical unit and listed, when specified, on the LO logical unit. If the SI logical unit is a Teletype or a CRT device, the message **SM**** is output to indicate that the SI unit is waiting for SMAIN input.

The old **SGL** contains three types of records: 1) control records and comments (ASCII), 2) the system-generation relocatable loader and BOOTLODR (the only SGL absolute core-image records), and 3) relocatable object modules such as are output by the DAS MR assembler and the FORTRAN compiler.

New or replacement object modules and/or control records have the same specifications as their equivalents in the old SGL.

Error-recovery inputs are entered by the operator on the SO logical unit to recover from errors in SMAIN operations. Error messages applicable to this component are given Appendix A.16. Recovery from the type of error represented by invalid directives or parameters is by either of the following:

a. Input the character C on the SO unit, thus directing SMAIN to go to the SI unit for the next directive.

b. Input the corrected directive on the SO unit for processing. The next SMAIN directive is then input from the SI unit.

Recovery from errors encountered while processing object modules and/or control records is by either of the following:

a. Input the character R on the SO unit, thus directing a rereading and reprocessing of the last record.

b. Input the character P on the SO unit, thus directing a rereading and reprocessing from the beginning of the current object module or control record.

In the last two cases, repositioning is automatic if the error involves a magnetic-tape unit or an RMD. Otherwise, such repositioning is manual.

If recovery is not desired, input a JCP directive (section 4.2) on the SO unit to abort the SMAIN task and schedule the JCP for execution.

OUTPUTS from the SMAIN comprise:

a. *The new SGL*

b. *Error messages*

c. *The listing of the old SGL*, if requested

d. *Directive images*

The new SGL contains object modules and control records. It is similar in structure to the old SGL.

Error messages applicable to SMAIN are output on the SO and on LO logical units. The individual messages, errors, and possible recovery actions are given in Appendix A.16.

The listing of the old SGL is output, if requested, on the LO unit. The output consists of a list of all control records and the contents of all object modules. At the top of each page, the standard VORTEX heading is output.

The image of an object module is represented by the identification name of the module, the date the module was generated, the size (in words) of the module (0 for a FORTRAN object module), and the external names referenced by the module, in the following format:

```
id-name   date   size   entry-names   external-names
```

Directive images are posted onto the LO unit, thus providing a hardcopy of the SMAIN directives for permanent reference.

16.1.1 Control Records

In SMAIN there are two types of control record:

a. *SGL delimiters*

b. *Object-module delimiters*

SGL delimiters divide the SGL into five parts. Each part is separated from the following part by a control record of the form

```
CTL,PART000n
```

where n is the number of the following part, and the SGL itself is terminated by a control record of the form

```
CTL,ENDOFSGL
```

Within SMAIN directives, these control records are referenced in the following format

```
PART000n
ENDOFSGL
```

Object-module delimiters precede and/or follow each group of object modules within the SGL. Each delimiter is of one of the forms

```
SLM,name
TID,name
OVL,name
TDF,name
ESB
END
```

The control records containing a name can be referenced by use of the name alone in SMAIN directives. These control records and their uses are described in the section on the system-generator component (section 15).

A set of object modules preceded by an SLM control record and followed by an END control record is known as a **load-module package** (**LMP**). To add, delete, or replace an entire LMP, merely reference the name associated with the SLM control record. Thus, if the directive specifies deletion and includes the name associated with the SLM record, the entire LMP is deleted. Additions and replacements operate analogously.

16.1.2 Object Modules

Relocatable object-module outputs from the DAS MR assembler and the FORTRAN compiler are described in appendix G.

16.1.3 System-Generation Library

The SGL is a collection of system programs in binary-object form, and of control records in alphanumeric form, from which a VORTEX system is generated. The structure of the SGL is described in section 15.

16.2 SYSTEM-MAINTENANCE DIRECTIVES

This section describes the SMAIN directives:

- IN — Specify input logical unit
- OUT — Specify output logical unit
- ALT — Specify input logical unit for new SGL items
- ADD — Add items to the SGL
- REP — Replace SGL items
- DEL — Delete items from the SGL
- LIST — List the old SGL
- END — End input of SMAIN directives

SMAIN directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). The directives are free-form and blanks are permitted between the individual character strings of the directive, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period.

The general form of an SMAIN directive is

name,*p(1)*,*p(2)*,...,*p(n)*

where

name — is one of the directive names given above (any other character string produces an error)

each *p(n)* — is a parameter defined below under the descriptions of the individual directives

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of the directives, optional periods, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted.

Error messages applicable to SMAIN directives are given in Appendix A.16.

16.2.1 IN (Input Logical Unit) Directive

This directive specifies the logical unit from which the old SGL is to be input. It has the general form

IN,lun,*key*,*filename*

where

lun — is the name or number of the logical unit to be used for the input of the old SGL

key — is the protection code, if any, required to address **lun**

filename — is the name of the input file only when **lun** is an RMD partition with a directory

There is no default value for **lun**. If it is not specified, any attempt at SGL processing will cause an error message output.

Once specified, the value of **lun** remains constant until changed by a subsequent IN directive. Each change of **lun** requires a new IN directive.

If **lun** specifies an RMD partition and no filename is specified, the RMD is rewound to the first sector following the start of the partition before any processing takes place.

Examples: The old SGL resides on logical unit 4, the PI unit. Specify this unit to be the SGL input unit.

```
IN,4
```

The old SGL resides on logical unit 107, which requires the protection code G. Specify this unit to be the SGL input unit. (This is a non-directoried partition.)

```
IN,107,G
```

16.2.2 OUT (Output Logical Unit) Directive

This directive specifies the logical unit on which the new SGL is to be output. It has the general form

OUT,lun,*key,filename*

where

lun	is the name or number of the logical unit to be used for the output of the new SGL
key	is the protection code, if any, required to address **lun**
filename	is the name of the output file when **lun** is an RMD partition

The default value of **lun** is zero. When **lun** is zero by specification or by default, there is no output logical unit.

Once specified, the value of **lun** remains constant until changed by a subsequent OUT directive. Each change of **lun** requires a new OUT directive.

If **lun** specifies an RMD partition and no filename is specified, the RMD is rewound to the first sector following the PST before any processing takes place. The PST comprises one entry defining the entire RMD.

Examples: Specify the PO logical unit, unit 10, to be the output unit for the new SGL.

```
OUT,10
```

Specify that there is to be no output logical unit.

```
OUT,0
```

16.2.3 ALT (Alternate Logical Unit) Directive

This directive specifies the logical unit from which new object module(s) and/or control record(s) are to be input to the new SGL. It has the general form

ALT,lun,*key,filename*

where

lun	is the name or number of the logical unit to be used for the input of new items to the SGL
key	is the protection code, if any, required to address **lun**
filename	is the name of the input file when **lun** is an RMD partition

There is no default value for **lun**. If it is not specified, any attempt to input new object modules or control records to the SGL will cause an error message output.

Once specified, the value of **lun** remains constant until changed by a subsequent ALT directive. Each change of **lun** requires a new ALT directive.

Examples: Specify that new object modules and control records are to be input to the SGL from the BI logical unit only.

```
ALT,6
```

Make the same specification where BI is an RMD partition without a protection code. Use file FILEX.

```
ALT,BI,,FILEX
```

Note: SMAIN expects binary input on RMD to be packed (two 60 word binary records per sector).

16.2.4 ADD Directive

This directive permits the addition of object modules and/or control records during the generation of a new SGL, the additions being made immediately after each of the items specified by the parameters of the ADD directive. The directive has the general form

ADD,p(1),*p(2),...,p(n)*

where each **p(n)** is the name of an object module or control record **after which** additions are to be made.

Each p(n) has the option of selecting the occurrence of the module (they must be contiguous). The form is:

p(n)/#

where # is the selected occurrence of the module (pin) as handled. For example, to add a new module after the second occurrence of V$IOC, enter:

ADD, V$IOC/2

SMAIN copies object modules and control records from the old SGL into the new SGL up to and including an item specified by one of the parameters, **p(n)**, of the ADD directive. After this item is copied, the message

```
ADD AFTER p(n)
 SM**
```

is output to indicate that SMAIN is waiting for a control character (Y or N) to be input on the SO logical unit.

If the control character input is **Y**, SMAIN adds the next object module or control record contained on the logical unit specified by the ALT directive (section 16.2.3), then repeats the message requesting another control character. This continues until the control character input is N.

If the control character input is **N**, SMAIN assumes the additions at this point are complete. It continues copying from the old SGL and outputs the message

```
END REPLACEMENTS
```

The entire process is repeated when the next item specified by one of the parameters, **p(n)**, of the ADD directive is found. The items in the directive need not be in the same order as they appear on the old SGL.

Example: During generation of a new SGL, add object module(s) and/or control record(s) after the old SGL control record PART0001 and after the old SGL object module LMP, the added items to be input from the logical unit specified by the ALT directive. Input

```
ADD,PART0001,LMP
```

then, when the message

```
ADD AFTER PART0001
 SM**
```

appears, input the control character **Y**. SMAIN then inputs the next item on the logical unit specified by the ALT directive, and again outputs the message

```
 SM**
```

and awaits another control character. If more is to be added here, input **Y**. If no more additions are required at this point, input **N**. After receiving the N, SMAIN outputs the message

```
END REPLACEMENTS
```

and continues to read the old SGL and copy it into the new SGL up to and including the object module LMP. SMAIN then outputs the message

```
ADD AFTER LMP
 SM**
```

at which time the process is repeated.

Note that PART0001 does not have to precede LMP in the old SGL. If the positions of the items are reversed relative to their order in the directive, the order of messages will be reversed. **In any case, the items on the logical unit specified by ALT must be in the order in which they are to be added to the SGL.**

16.2.5 REP (Replace) Directive

This directive permits the replacement of object modules and/or control records during generation of a new SGL. The directive has the general form

REP,p(1),*p(2)*,...,*p(n)*

where each **p(n)** is the name of an object module or control record that is to be replaced.

Each p(n) has the option of selecting the occurrence of the module (they must be contiguous). The form is:

p(n)/#

where # is the selected occurrence of the module p(n) as handled. For example, to replace all occurrences of V$FUNC and the second occurrence of V$IOC, enter:

REP, V$FUNC, V$IOC/2

SMAIN copies object modules and control records from the old SGL into the new SGL until it encounters one specified by one of the parameters, **p(n)**, of the REP directive. SMAIN then reads the item to be replaced, but does not copy it into the new SGL. After this is completed, the message

```
REPLACE p(n)
SM**
```

is output to indicate that SMAIN is waiting for a control character (Y or N) to be input on the SO logical unit. These control characters operate just as in the ADD directive (section 16.2.4), allowing the addition (in this case, replacement, since the parameter item was not copied into the new SGL) of new items to the SGL. The items in the directive need not be in the same order as they appear in the old SGL.

Example: During generation of a new SGL, replace the old

SGL object module IOCTL with object modules and/or control records from the logical unit specified by an ALT directive (section 16.2.3). Input

```
REPLACE,IOCTL
```

then, when the message

```
REP IOCTL
SM**
```

appears, continue as for an ADD directive (section 16.2.4).

16.2.6 DEL (Delete) Directive

This directive permits the deletion of object modules and/or control records during generation of a new SGL. The directive has the general form

DEL,p(1),*p(2)*,...,*p(n)*

where each **p(n)** is the name of an object module or control record that is to be deleted.

Each p(n) has the option of selecting the occurrence of the module (they must be contiguous). The form is:

p(n)/#

where # is the selected occurrence of the module p(n) as handled. For example, delete all occurrences of V$FUNC and the second occurrence of V$IOC, enter:

DEL, V$FUNC, V$IOC/2

SMAIN copies object modules and control records from the old SGL into the new SGL until it encounters one specified by one of the parameters, **p(n)**, of the DEL directive. SMAIN then reads the item to be deleted, but does not copy it into the new SGL. The items in the DEL directive need not be in the same order as they appear on the old SGL.

If a listing of the old SGL is specified either by a LIST directive (section 16.2.7) or by the L parameter of an END directive (16.2.8), the deleted items are preceded on the listing by asterisks (*).

Example: During generation of a new SGL, delete the following old SGL items: object module IOST and control record LMGENCTL.

```
DEL,IOST,LMGENCTL
```

16.2.7 LIST Directive

This directive lists, on the LO logical unit, the old SGL as found on the logical unit specified by the SMAIN directive IN (section 16.2.1). The LIST directive has the form

LIST

Example: List the old SGL.

```
LIST
```

Figure 16-2 shows the format of output from this directive.

16.2.8 END Directive

This directive indicates that all ADD (section 16.2.4), REP (section 16.2.5), and DEL (section 16.2.6) directives have been input. END initiates the SGL maintenance process. The directive has the general form

END,*L*

where *L*, if present, specifies that the old SGL is to be listed.

Examples: After all ADD, REP, and DEL directives have been input, initiate SGL maintenance processing.

```
END
```

Initiate the SGL maintenance processing as above, but list the old SGL.

```
END,L
```

16.3 SYSTEM-MAINTENANCE OPERATION

The normal SMAIN operation consists of copying an existing SGL from the logical unit specified by the IN directive (section 16.2.1) to the logical unit specified by the OUT directive (section 16.2.2), making the modifications specified by the ADD (section 16.2.4), REP (section 16.2.5), and DEL (section 16.2.6) directives, and thus creating a new SGL.

Input of the END directive (section 16.2.8) initiates the copying process. All ADD, REP, and DEL directives, if any, must precede the END directive.

Modifications to the SGL are made through the logical unit specified by the ALT directive (section 16.2.3). Such modifications are in the form of additions and/or replacements of object modules and/or control records. (These items can also be deleted, but this process does not, of course, require input on the ALT unit.)

When an object module is input, SMAIN verifies that there is no error with respect to check-sum, record size, loader codes, sequence numbers, or structure.

16.4 PROGRAMMING EXAMPLES

Example 1: Schedule SMAIN, copy the old SGL from logical unit 4 onto logical unit 9 without listing the old SGL, and return to the JCP.

```
/SMAIN
IN,4
OUT,9
END
/ENDJOB
```

Example 2: Schedule SMAIN; copy the old SGL from logical unit 4 onto logical unit 9, listing the old SGL and

deleting object modules A, B, C, D, and E; and return to the JCP.

```
/SMAIN
IN,4
OUT,9
DEL,A
DEL,B,C,D,E
END,L
/ENDJOB
```

Example 3: Schedule SMAIN, list the contents the old SGL on logical unit 4, and return to the JCP.

```
/SMAIN
IN,4
LIST
/ENDJOB
```

Example 4: Schedule SMAIN; copy the old SGL from logical unit 4 onto logical unit 9 without listing the old SGL; add object modules or control records from logical unit 6 after control record PART0002 and after object module A; replace load module LMGEN and control record JCPDEF; delete object modules B, C, D, and E; and return to the JCP.

```
/SMAIN
IN,4
OUT,9
ALT,6
ADD,PART0002,A
REP,LMGEN
DEL,B,C,D,E
REP,JCPDEF
END
/ENDJOB
```

```
PAGE     1   11/13/72          VORTEX  SMAIN


IN,M1
OUT,PU
LIST
HOUTLODR
 ID NAME      DATE       SIZE      ENTRY NAMES      EXTERNAL NAMES
 VSSGENLD   10/02/72      1551    SGLOR              TPROG    SGIBUF
                                                     BSTACK   SPUN
                                                     SPUB     SLUN
                                                     SLUB

 ID NAME      DATE       SIZE      ENTRY NAMES      EXTERNAL NAMES
 VSD00A1    02/24/72        36    D00A1              DRWEOF   DRSTAT
                                                     DRSKRD   DRSFIL
                                                     DRRITE   DRREWD
                                                     DRREAD

 ID NAME      DATE       SIZE      ENTRY NAMES      EXTERNAL NAMES
 VSD00A2    02/24/72        36    D00A2              DRWEOF   DRSTAT
                                                     DRSKRD   DRSFIL
                                                     DRRITE   DRREWD
                                                     DRREAD

 ID NAME      DATE       SIZE      ENTRY NAMES      EXTERNAL NAMES
 VSD00A5    02/24/72        36    D00A5              DRWEOF   DRSTAT
                                                     DRSKRD   DRSFIL
                                                     DRRITE   DRREWD
                                                     DRREAD

 ID NAME      DATE       SIZE      ENTRY NAMES      EXTERNAL NAMES
 VSD10A1    02/24/72        36    D10A1              DRWEOF   DRSTAT
                                                     DRSKRD   DRSFIL
                                                     DRRITE   DRREWD
                                                     DRREAD

 ID NAME      DATE       SIZE      ENTRY NAMES      EXTERNAL NAMES
 VSD10A2    02/24/72        36    D10A2              DRWEOF   DRSTAT
                                                     DRSKRD   DRSFIL
                                                     DRRITE   DRREWD
                                                     DRREAD

 ID NAME      DATE       SIZE      ENTRY NAMES      EXTERNAL NAMES
 VSD10A5    02/24/72        36    D10A5              DRWEOF   DRSTAT
                                                     DRSKRD   DRSFIL
                                                     DRRITE   DRREWD
                                                     DRREAD

 ID NAME      DATE       SIZE      ENTRY NAMES      EXTERNAL NAMES
 VSD20A1    02/24/72        36    D20A1              DRWEOF   DRSTAT
```

Figure 16-2. SMAIN LIST Directive Listing

SECTION 17
OPERATOR COMMUNICATION

The operator communicates with the VORTEX system through the **operator communication component** by means of *operator key-in requests* input through the *operator communication (OC) logical unit*.

17.1 DEFINITIONS

An **operator key-in request** is a string of up to 80 characters beginning with a semicolon. The request is initiated by the operator and is input through the OC unit. An operator key-in request is independent of I/O requests via the IOC (section 3) and, hence, is known as an *unsolicited request*.

The **operator communication (OC) logical unit** is the logical unit through which the operator inputs key-in requests. There is only one OC unit in the VORTEX system. Initially, the OC unit is the first Teletype, but this assignment can be changed by use of the ;ASSIGN key-in request (section 17.2.9).

17.2 OPERATOR KEY-IN REQUESTS

This section describes the operator key-in requests:

- ;SCHED Schedule foreground task
- ;TSCHED Time-schedule foreground task
- ;ATTACH Attach foreground task to PIM line
- ;RESUME Resume task
- ;TIME Enter or display time-of-day
- ;DATE Enter date
- ;ABORT Abort task
- ;TSTAT Test task status
- ;ASSIGN Assign logical unit(s)
- ;DEVDN Device down
- ;DEVUP Device up
- ;IOLIST List logical-unit assignments

Operator key-in requests comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or by equal signs (=). However, the key-in requests are free-form and blanks are permitted between the individual character strings of the key-in request, i.e., before or after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period. A carriage return is required to terminate any key-in request, however, regardless of whether it contains a period.

The general form of an operator key-in request is

;request,*p(1)*,*p(2)*,,...,*p(n)*cr

where

request	is one of the key-in requests listed above in capital letters
each *p(n)*	is a parameter defined under the descriptions of the individual key-in requests below
cr	is the carriage return, which terminates all operator key-in requests

Each operator key-in request begins with a semicolon (;) and ends with a carriage return. Parameters are separated by commas. A backarrow (←) deletes the preceding character. A backslash (\) deletes the entire present key-in request.

Table 17-1 shows the system names of physical I/O devices as used in operator key-in requests.

Peripherals for data communication are not used in OPCOM request, but are controlled with the Network Control Module (NCM) described in the VTAM Reference Manual.

For greater clarity, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted from the descriptions of the key-in requests.

Error messages applicable to operator key-in requests are given in Appendix A.17.

Table 17-1. Physical I/O Devices

System Name	Physical Device
DUM	Dummy
CPcu	Card punch
CRcu	Card reader
CTcu	Cathode ray tube (CRT) device
Dcup	Rotating-memory device (RMD) (disc/drum)
LPcu	Line printer or Statos
MTcu	Magnetic tape unit
PTcu	High-speed paper tape reader/punch
TYcu	Teletype printer/keyboard
ClmA, COmA	Process I/O

Table 17-1. Physical I/O Devices *(continued)*

System Name	Physical Device
MXcu	Communication Multiplexor
TCcO	Psuedo TCM
SPcO	Spool Unit

NOTES

c = Controller number. For each type of device, controllers are numbered from 0 as required.

u = Unit number. For each controller, units are numbered from 0 as required (within the capacity of the controller).

p = Partition letter. RMD partitions are lettered from A to T as required to refer to a partition on the specified device, e.g., D00A.

m = Multiplexor number

17.2.1 ;SCHED (Schedule Foreground Task) Key-In Request

This key-in request immediately schedules the specified foreground-library task for execution at the designated priority level. It has the general form

;SCHED,task,level,lun,*key, trace*

where

task is the name of the foreground task to be scheduled

level is the priority level (from 2 to 31) of the scheduled task

lun is the number or name of the foreground-library rotating-memory logical unit where the scheduled task resides

key is the protection code, if any, required to address **lun**

trace is T if the task to be scheduled is to be executed in TRACE mode. (Applies to V77-800 systems only) see paragraph 4.2.33

A dump of the contents of a library can be obtained by use of the VORTEX file-maintenance component (section 9).

Operator key-in examples: Schedule on priority level 3 the foreground task DOTASK residing on the FL logical unit. Use F as the protection key.

```
;SCHED,DOTASK,3,FL,F
```

Schedule on priority level 9 the resident foreground task COPYIO.

```
;SCHED,COPYIO,9,0
```

17.2.2 ;TSCHED (Time-Schedule Foreground Task) Key-In Request

This key-in request schedules the specified foreground-library task for execution at the designated time-of-day and priority level. It has the general form

;TSCHED,task,level,lun,*key,***time**

where

task is the name of the foreground task to be scheduled

level is the priority level (from 2 to 31) of the scheduled) task

lun is the number or name of the foreground-library rotating-memory logical unit where the scheduled task resides (0 for scheduling a resident foreground task)

key is the protection code, if any, required to address **lun**

time is the scheduled time in hours (from 00 to 23) and minutes (from 00 to 59), e.g., 1945 for 7:45 p.m.

Note: If a task has already been scheduled using a TSCHED command, a subsequent TSCHED request for the task replaces the first request.

Operator key-in examples. Schedule for execution at 11:30 p.m. on priority level 3 the foreground task DOTASK residing on the US logical unit. Use T as the protection key.

```
;TSCHED,DOTASK,3,US,T,2330
```

Schedule for execution at 8:30 a.m. on priority level 9 the resident foreground task TESTIO.

```
;TSCHED,TESTIO,9,0,0830
```

17.2.3 ;ATTACH Key-In Request

This key-in request attaches the specified foreground task to the designated PIM (priority interrupt module) line. It has the general form

;ATTACH,task,line,iew,*enable*

where

task is the name of the foreground task to be attached to the PIM line

line is the two-digit number of the PIM line to which the task is to be attached, with the tens digit specifying the PIM number (0-7) and the units digit the line number (0-7) on that PIM

iew is the value (from 01 to 0177777) of the interrupt event word (section 14 or appendix F) and identifies the bit(s) to be set in the task TIDB when an interrupt occurs on **line**

enable is E (default value) to enable the line, or D to disable it

The **task** can be resident or nonresident. However, its TIDB must have been defined at system-generation time. ATTACH provides a flexible way of altering interrupt assignments without having to regenerate the system.

Operator key-in example: Connect task INTRPT to PIM 0, line 3. Use 020 as the interrupt event word value (i.e., set bit 4 of the interrupt event word in TIDB if INTRPT is scheduled due to an interrupt on PIM 0, line 3).

```
;ATTACH,INTRPT,03,020
```

A PIM directive with the PIM line to be attached must have been specified during system generation to set up the link to the interrupt line handler region.

Note: This directive detaches the PIM from a previous task.

17.2.4 ;RESUME Key-In Request

This key-in request reactivates the specified task for execution at its specified priority level. It has the general form

;RESUME,task

where **task** is the name of the task to be resumed

Operator key-in example: Resume the task DOTASK.

```
;RESUME,DOTASK
```

17.2.5 ;TIME Key-In Request

This key-in request enters the specified time, if any, as system time-of-day. If no time is specified in the key-in request, ;TIME displays the current time-of-day. The key-in request has the general form

;TIME,*time*

where *time* is the time-of-day in hours (from 00 to 23) and minutes (from 00 to 59), e.g., 1945 for 7:45 p.m.

The time-of-day output for a ;TIME request without *time* is of the form

```
T      hhmm          HRS
```

where hhmm is the time of day in hours and minutes.

Operator key-in example: Set the system time-of-day to 3:00 p.m.

```
;TIME,1500
```

17.2.6 ;DATE Key-In Request

This key-in request enters the specified date as the system date. It has the general form

;DATE,mm/dd/yy

where

mm is the month (01 to 12)

dd is the day (01 to 31)

yy is the year (00 to 99)

Note that since the entire date is considered one parameter, there are no commas other than the one immediately following **DATE**. The components of the date are, however, separated by slashes as shown. VORTEX does not support date roll-over.

Operator key-in example: Set the system date to 25 December 1971.

```
;DATE,12/25/71
```

17.2.7 ;ABORT Key-In Request

This key-in request aborts the specified task. It has the general form

;ABORT,task

where **task** is the name of the task to be aborted

Operator key-in example: Abort the task DOTASK.

```
;ABORT,DOTASK
```

17.2.8 ;TSTAT (Task Status) Key-In Request

This key-in request outputs the status of the specified task, if any. If no task is specified, ;TSTAT outputs the status of all tasks queued on the active task identification block (TIDB) stack. This request is not applicable to tasks having no established TIDB. The request has the general form

;TSTAT,*task*

where task is the name of the task whose status is to be output, or * to display only non resident tasks.

The status-output for a ;TSTAT key-in request is of the form

task tidb addr Plevel Sstatus *TMin TSmilli*

where

task is the name of the task whose status is being output

tidb addr is the TIDB address of the subject task

level is the priority level (from 0 to 31) of the task

status is the status of the task as found in words 1 and 2 of the TIDB (table 17-2)

min is the value of the counter in TIDB word 11

milli is the value of the counter in TIDB word 10

The values of min and milli are printed only if bit 6 and/or 7 of TIDB word 1 (table 17-2) is set.

Table 17-2. Task Status (TIDB Words 1 and 2)

TIDB Word	Bit	Meaning of Set Bit
1	15	Suspend interrupt
1	14	Suspend task
1	13	Abort task
1	12	Exit from task
1	11	TIDB resident
1	10	Resident task
1	9	Foreground task
1	8	Protected task
1	7	Task scheduled by time-delay
1	6	Time-delay active
1	5	Task waiting to be loaded (check pointed)
1	4	Task error
1	3	Task interrupt expected
1	2	Overlay task
1	1	Scheduled task upon termination of active task
1	0	Task search-allocated-loaded
2	15	Task opened, but not loaded
2	14	Task loaded in background (checkpoint) area
2	13	Load overlay
2	12	Background checkpoint I/O wait
2	11	Allocation override flag
2	10	Background being checkpointed
2	9	TIDB not available
2	8	Unused
2	7	Unused
2	6	Delay type 3 request
2	5-0	Task priority level

Operator key-in examples: Request the output of the status of the task BIGJOB.

```
;TSTAT,BIGJOB
```

The output will be

```
BIGJOB A014000 P02 S000100, 000000 TM077777 TS077430
```

if the status BIGJOB is such that it is on priority level 2, contains a status of 0100 in TIDB words 1 and 2, with time counters (TIDB words 1 and 10) of 077777 and 077430, respectively. The latter two octal complement counters show zero minutes and 0347 5-millisecond increments.

Request the output of the status of all active tasks.

```
;TSTAT
```

and receive as a typical response

```
V$TYB  A074671 P23 S047511, 040400 TM 077777 TS 077650
V$TYB  A074743 P23 S047411, 040400
VZFMA  A073431 P22 S047401, 040400
S$SPO  A073503 P22 S045511, 040500 TM 077777 TS 077767
VZSDA  A073555 P22 S047401, 040400
VZCPA  A073627 P22 S047401, 040400
VZPTA  A073701 P22 S047401, 040400
VZLPB  A073753 P22 S047401, 040400
VZCPB  A074223 P22 S047401, 040400
VZCRA  A074275 P22 S047401, 040400
```

17.2.9 ;ASSIGN Key-In Request

This key-in request equates and assigns particular logical units to specific I/O devices. It has the general form

;ASSIGN,l(1) = r(1),*l(2) = r(2),...,l(n) = r(n)*

where

each **l(n)** is a logical-unit number (e.g., 12) or name (e.g., SI)

each **r(n)** is a logical-unit number or name, or a physical-device system name (e.g., TY00 or TY, table 17-1)

The logical unit to the left of the equal sign in each pair is assigned to the unit/device to the right.

An inoperable device, i.e., one declared down by ;DEVDN (section 17.2.10), cannot be assigned. A logical unit designated as unassignable (unit numbers 101 through 179) cannot be reassigned.

Operator key-in examples: Assign the card reader CR00 as the SI logical unit and the Teletype TY01 as the OC unit.

```
;ASSIGN,SI=CR00,OC=TY01
```

Assign a dummy device as the PI unit.

```
;ASSIGN,PI=DUM
```

17.2.10 ;DEVDN (Device Down) Key-In Request

This key-in request declares the specified physical device inoperable for system use. It is not applicable to the OC unit or to devices containing system libraries. The request has the general form

;DEVDN,device

where **device** is the system name of the physical device in four ASCII characters, e.g., LP00 (or LP), TY01, (table 17-1)

Operator key-in example; Declare TY01 inoperable for system use.

```
;DEVDN,TY01
```

17.2.11 ;DEVUP (Device Up) Key-In Request

This key-in request declares the specified physical device operational for system use. It has the general form

;DEVUP,device

where **device** is the system name of the physical device in four ASCII characters, e.g., LP00 (or LP), TY01 (table 17-1)

Operator key-in example: Declare TY02 operational for system use.

```
;DEVUP,TY02
```

17.2.12 ;IOLIST (List I/O) Key-In Request

This key-in request outputs a listing of the specified logical-unit assignments, if any. If no logical unit is specified, ;IOLIST outputs all logical-unit assignments with names. The key-in request has the general form

;IOLIST,*lun(1),lun(2),...,lun(n)*

where each *lun(n)* is the name or number of a logical unit, e.g., SI,5.

Where the ;IOLIST key-in request specifies a logical-unit name, the output is of the form

name (number) = device *D*

where

name is the name of the logical unit, e.g., LO

number is the number of that logical unit, e.g., 005

device is the name of the physical device assigned, e.g., LP00

D if present, indicates that the physical device has been declared down and is thus inoperable

If the key-in request specifies the number rather than the name of the logical unit, the output will repeat the number in both the **name** and **number** fields.

In a listing of all assignments, the output uses a name and number where applicable. Logical units without names assigned at system-generation time are not listed and must be individually specified by number.

Operator key-in examples: Request the output of the logical-unit assignments for the BI and BO units. Input

```
;IOLIST,BI,BO
```

and receive as a typical response

```
BI (006) = CR00
BO (007) = CP00 D
```

Request the output of the logical-unit assignment for logical unit 180. Input

```
;IOLIST,180
```

and receive as a typical response

```
180 (180) = D11H
```

Request the output of all logical-unit assignments. Input

```
;IOLIST
```

and receive as a typical response

```
OC (001) = TY00
SI (002) = TY00
SO (003) = TY00
PI (004) = CR00 D
LO (005) = LP00
BI (006) = CR00 D
BO (007) = PT00
SS (008) = D00H
PO (009) = D00H
CU (100) = D00E
GO (101) = D00G
SW (102) = D00F
CL (103) = D00A
OM (104) = D00D
BL (105) = D00C
FL (106) = D00B
```

17.3 BLDSKD

The standard VORTEX teletypewriter drivers support the foreground scheduling task BLDSKD. BLDSKD allows the operator to define selected control characters (A - Z excluding A, C, G, J,M) to cause scheduling of specified tasks without the lengthy OPCOM; SCHED format. Use of the defined control character as an unsolicited input from a device using the teletypewriter driver results in the previously defined task being scheduled.

Note: BLDSKD cannot be scheduled in this manner.

17.3.1 Set-Up Requirements

Before attempting to use BLDSKD, the operator must create a file called SCHDAD on the foreground library containing two 120-word records. This should be done with FMAIN. (Note: this is initially done by the BSCOM job stream).

Example:

```
/FMAIN
CREATE,FL,F,SCHDAD,120,2
```

17.3.2 Task Scheduling

To add, delete, or list tasks attached to control characters, BKDSKD must be scheduled through the OPCOM ;SCHED request from the foreground library.

Example:

```
:SCHED,BLDSKD,5,FL,F
```

BLDSKD will respond with:

```
ENTER ACTION LETTER A,D,L, or E
```

where

A = add
D = delete
L = list
E = exit

17.3.3 'A' Command (Attach a task to a control character)

This command is used to attach a specified task to a specified control character. BLDSKD will respond to this request with

DIRECTIVE FORMAT: LETTER,TASK.LIB,KEY,PRI

where

LETTER	is the alphabetic portion of the control character to be attached to.
TASK	is the task name to be attached (1 to 6 characters)
LIB	is the library on which the task resides. Input may be a logical name or number.
KEY	is the protection key associated with the logical unit, if any.
PRI	is the priority at which the task is to be scheduled.

17.3.4 'D' command (Delete a task)

This command is used to remove a task attachement to a specified control character. BLDSKD will respond to this requst with

ENTER LETTER TO BE DELETED

where

LETTER	is the alphabetic portion of the control character to be deleted.

17.3.5 'L' Command (List Assigned Tasks)

This command is used to list all assigned control characters and the tasks that have been attached to that control character. BLDSKD will respond to this request with a list in the following format:

a bbbbbb

where

a	is the defined control character
bbbbbb	is the task attached to character a

17.3.6 'E' command (Exit BLDSKD)

This command is used to exit from BLDSKD

17.4 TASK SCHEDULING

The input of any control character from a logical unit assigned to the system teletype writer driver causes BLDSKD to be scheduled. If the control character input has been attached to a task, then that task is scheduled and BLDSKD exits. If the control character has not been attached, BLDSKD merely exits.

Note: Control G (bell), control J (line feed), and control M (carriage return) cannot be used as attachable control characters. Control A is assigned automatically by BLDSKD to HASP. Control C is used by the teletypewriter driver for TSS. The use of these control characters under the A command will result in an "invalid character" response from BLDSKD.

After a control character has been assigned a task via BLDSKD 'A' command, it may at any time be deleted via the 'D' command.

SECTION 18
OPERATION OF THE VORTEX SYSTEM

This section explains the operation of devices in the VORTEX system, the loading of the system bootstrap loading and initializing of writable control store and procedures for changing and initializing the disc pack during VORTEX operation.

18.1 DEVICE INITIALIZATION

18.1.1 Card Reader
(Model 70-6200)

a. Turn on the card reader.

b. Place the input deck in the card hopper.

c. Press READY/ALERT.

18.1.2 Card Punch
(Model 70-6200)

a. Turn on the card punch.

b. Place blank cards in the card hopper.

c. If the visual punch station is empty, insert a card into it as follows:

(1) Place a card in the auxiliary feed slot.

(2) Clear all registers.

(3) Set the instruction register I to 0100131.

(4) Set REPEAT.

(5) Press STEP. The card should move from the auxiliary feed slot to the visual punch station.

(6) Reset REPEAT.

18.1.3 Line Printer
(Model 70-6701)

a. Turn on the line printer.

b. Wait for the READY light to come on.

c. Set the ON LINE/OFF LINE switch to ON LINE.

d. For manual paper ejection set to OFF LINE, then press the TOP OF FORM switch.

18.1.4 Statos-31 *(Model 70-6602 and -6603)*

a. Turn on plotter/printer

b. Set the ON LINE/OFF LINE switch to ON LINE

c. Select roll or z-fold paper switch for paper type used

d. For manual form feed press FORM FEED

18.1.5 33/35 ASR Teletype
(Models 70-6200 and 6201

a. Turn on the Teletype.

b. Set the Teletype in off-line mode and simultaneously press the CONTROL and D, then the CONTROL and T, finally the CONTROL and Q keys.

c. Set the Teletype on-line.

18.1.6 High-Speed Paper-Tape Reader
(Model 70-6320)

a. Turn on the paper-tape reader.

b. Position the input paper tape in the reader with blank leader at the reading station and close the reading gate.

c. Set the LOAD/RUN switch to RUN.

18.1.7 Magnetic-Tape Unit
(Models 70-7100,-7102, and 620-31

a. Turn on the magnetic-tape unit.

b. Mount the input magnetic tape.

c. Position the magnetic tape to the loading point.

d. Press ON LINE.

18.1.8 Magnetic-Drum and Fixed-Head Disc Units
(Models 620-47 through 620-49, 70-7702 and 70-7703

a. Turn on the drum unit.

b. Wait for the drum unit to reach operating speed.

18.1.9 Moving-Head Disc Units
(Models 70-7600 and 70-7610

a. Place the START/STOP switch in the STOP position.

b. Press POWER ON button and wait for the SAFE light to come on.

c. Mount the disc pack.

d. Place the START/STOP switch in the START position.

e. Wait for the disc unit to reach operating speed (READY indicator lights).

f. Turn off WRITE PROTECT.

18.1.10 Moving-Head Disc Units
(Model 70-7500)

a. Mount the disc pack

b. Press POWER-ON button and wait for unit to reach operating speed and for the heads to emerge

c. Press on-line button.

18.1.11 Moving-Head Disc Units
(Model 70-7510)

a. Mount the disc pack(s).

b. Turn power on and wait for the unit(s) to reach operating speed (unit-ready light comes on).

18.1.12 Moving-Head Disc Units
(Models 70-7603, 70-7613)

a. Mount disc pack.

b. Press START button and wait for Ready light.

18.1.13 Moving Head Disc Units
(Models 70-7520, 70-7530)

a. Mount disc pack.

b. Place in run.

c. Wait for unit to reach operating speed (run light will stop blinking).

18.2 SYSTEM BOOTSTRAP LOADER

System key-in loaders initiate loading of the VORTEX system from a drum or disc memory. The key-in loader loads the system initializer from the RMD to main memory (locations 000000 to 001127). The system initializer then loads and initializes the system. Table 18-1 contains the key-in loader programs.

Table 18-1. Key-In Loader Programs

Address	Drum -48,49	Disc 70-7510 -7220, -7530	Disc 70-7500	Disc 70-7600, -7610, -7603 or 7613, F3064 ←
001130	1000yy	005302	005302	1004zz
001131	006020	006030	006030	1040zz
001132	000002	000005	177773	1002zz
001133	005001	005001	005001	005001
001134	1031xx	1000zz	1000zz	1031zz
001135	006120	1031zz	1031zz	1010zz
001136	001127	1005zz	1005zz	001141
001137	1031yy	1010zz	1010zz	001000
001140	1000xx	001143	001143	001135
001141	1000zz	001000	001000	1025zz
001142	1032zz	001137	001137	151167
001143	1010xx	1025zz	1025zz	001016
001144	000600	001016	001016	001130
001145	001000	001200	001130	1000yy
001146	001143	005123	005122	1003zz
001147		006120	005021	005102
001150		000167	006120	1032zz
001151		004460	000167	1031xx
001152		1000zz	004460	006010
001153		1000yy	1000zz	001130
001154		1031xx	1000yy	1031yy
001155		1032yy	1031xx	1000xx
001156		1000xx	1032yy	1000zz
001157		005041	1000xx	1014zz
001160		1031zz	005041	001157
001161		1004zz	006150	1025zz
001162		1014zz	000007	151167
001163		001166	1031zz	001016
001164		001000	1004zz	001130
001165		001162	1014zz	001000
001166		1025ZZ	001171	000600
001167		001016	001000	007760
001170		000120	001165	
001171		005145	1025ZZ	
001172		006140	001016	
001173		000012	001130	
001174		001002	005144	
001175		000600	001040	
001176		001000	000600	
001177		001146	001000	
001200		000000	001146	

where xx = even BIC address, yy = odd BIC address, and zz = device address.

18.2.1 Automatic Bootstrap Loader

Where the automatic bootstrap loader option is available, the appropriate key-in loader is loaded from the required medium (high-speed paper-tape or Teletype reader) into locations starting with 001130. If the system contains a V70 RMD ABL the boot program is automatically loaded and executed.

To initiate the loader: (1) select the appropriate boot by setting the A register as indicated (2 = model B or F disk, or auxiliary ABL, 3 = model H disk), (2) with the computer in STEP, press the RESET switch on the front panel; (3) place the STEP/RUN switch in the RUN position; and (4) press and release the LOAD switch.

18.2.2 Control Panel Loading

The appropriate key-in loader is entered through the computer control panel. Refer to the hardware handbook for details.

To initiate the bootstrap, clear the A, B, X, and I registers, and load 001130 into the P register. Then, press RESET, place the STEP/RUN switch in the RUN position, and press START. See the VORTEX II System Generation User Guide/Programmer Reference, UP-9083, and Section 20.1.4 of this manual for details regarding system initialization messages.

NOTE: To facilitate reloading, the key-in loader may be dumped out on paper tape and then loaded by the binary loader (BLD II).

18.2.3 SYSTEM BOOT HALT

If an irrecoverable I/O error is detected during a system boot, the system initializer will halt (within the first 01400 words of memory depending upon the RMD type) with the RMD status word (see appendix H) in the A register. (For Model H RMD this is the primary status.)

18.3 DISC PACK HANDLING

VORTEX provides for dynamic mounting of disc packs during program execution by means of a system utility program called **rotating memory analysis and initialization** (**RAZI**). RAZI handles:

a. A disc pack not previously used with VORTEX that is replacing a disc pack presently in the system.

b. A disc pack previously formatted under VORTEX that is replacing a disc pack presently in the system.

The normal RAZI operating procedure is:

a. The task requiring the disc pack change issues an operator message directing him to switch packs.

b. The task suspends itself.

c. The operator makes the necessary pack changes.

d. The operator schedules and executes RAZI.

e. Upon completion of RAZI, the operator resumes the suspended task. The task can now perform I/O on the new pack.

RAZI is a foreground program residing in the foreground library (FL). It is scheduled by a request of the form:

;SCHED,RAZI,p,FL,F

where **p** is the priority level.

If the SI logical unit is a Teletype or a CRT device, the message **RZ**** is output to indicate that the SI unit is waiting for RAZI input.

Each directive is completely processed before the next is entered. All directives are output on the SO device. In addition, partitioning information is listed on the LO device when integration of the requested disc pack is complete.

OUTPUTS from the RAZI comprise:

a. *Error messages*

b. *The listing of the RAZI directives on the SO unit*

c. *Partition description listing*

Error messages applicable to RAZI are output on the SO and LO logical units. The individual messages and errors are given in Appendix A.18.

The partition description listing is output on the LO device upon completing the integration of a new disc pack into the VORTEX system. After the VORTEX standard heading, there are three blank lines followed by the RAZI heading:

```
PARTITION       FIRST       LAST        BAD
NAME            TRACK       TRACK       TRACKS
```

followed by one more blank line. Then the information concerning each partition of the device is output, one partition per line, as shown in the following example.

```
PARTITION       FIRST       LAST        BAD
NAME            TRACK       TRACK       TRACKS

D10A            0002        0019        0000
D10B            0020        0052        0001
D10C            0053        0082        0000
D10D            0083        0118        0000
D10E            0119        0126        0000
D10F            0127        0141        0000
D10G            0142        0156        0000
D10H            0157        0206        0002
D10I            0207        0242        0000
D10J            0243        0251        0000
D10K            0252        0256        0000
```

The RAZI directives are:

- PRT — Partition
- FRM — Format rotating memory
- INL — Initialize
- EXIT — Exit

RAZI directives begin in column 1 and comprise sequences of character strings having no embedded blanks. The character strings are separated by commas (,) or equal signs (=). The directives are free-form, and blanks are permitted between the individual character strings of the directive, i.e., before or after commas (or equal signs).

The general format of a RAZI directive is

name,*p(1)*,*p(2)*,...,*p(n)*

where

name is one of the directive names given above

each *p(n)* is a parameter required by the directive and defined below under descriptions of the individual directives

Numerical data can be octal or decimal. Each octal number has a leading zero.

For greater clarity in the descriptions of the directives, optional periods, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted.

The only two valid combinations of RAZI directives which may be used are:

- PRT followed by FRM for new unformatted disk packs
- INL alone for disk packs with good data

Table 18-1 summarizes the RAZI directives and the functions they perform.

Note: The disc pack containing the VORTEX nucleus cannot be replaced. Before any disc pack can be used with RAZI, it must be formatted under VORTEX as per the instructions in Sections 18.4 through 18.9.

18.3.1 PRT (Partition) Directive

This directive specifies the size and protection code for each RMD partition. It has the general form

PRT,p(1),s(1),k(1),*p(2),s(2),k(2),...,p(n),s(n),k(n)*

where

each *p(n)* is the RMD partition letter or number (A-T, 00-20). For Model H RMD the user should use the numeric format with the maximum = 63.

s(n) is the number (octal or decimal) of tracks in the partition. This value must be greater than zero.

k(n) is the protection code, if any, required to address **p**, or * if the partition is unprotected

While the partition specifications can appear in any order the set of partitions specified for each RMD must comprise a contiguous group, e.g., the sequence A, C, D, B is valid but, the sequence A, C, D, E constitutes an error. For Model H RMD the alternate sector partition may be specified by using a partition designator of "*".

Consecutive PRT directives redefine partitions, if p(n) has been specified, or adds partitions if p(n) is new partition letter.

Example: Define three partitions on an RMD. The first occupies ten tracks and uses protection code Q, the second two tracks and code S, and the third 48 tracks without protection.

```
PRT,A,10,Q,B,2,S,C,060,*
```

18.3.2 FRM (Format Rotating Memory) Directive

This directive causes RAZI to run a bad-track analysis on the specified RMD and build a new PST for it or accepts a previously constructed bad-track-table from the RMD and builds a new PST for it.* The directive has the general form

FRM,lu,size,flag

Table 18-1. RAZI Directives

Directive	Explanation	Writes PST in memory	Destroys data on disk	PST on subject disk	Writes PST in nucleus image and on system disk
PRT	Sets up partition information to pass to FRM processor.	---	---	---	---
FRM	Creates PST as specified and writes PST into memory, onto subject disk, and onto system disk.	yes	yes	write	yes
INL	Reads previous PST from subject disk and writes PST into memory and onto system disk.	yes	no	read	yes

where

lu is the logical-unit name or number to which the subject RMD is assigned. This must be assigned to the first partition.

size is the number (octal or decimal) of tracks on the RMD

flag is 1 to perform a complete bad-track analysis, or 0 to accept a bad-track-table from the RMD

*FRM clears all PSTs and directories. It should not be used when a unit contains a good BIT and files as these will be destroyed.

Caution: When performing a bad-track analysis or accepting a bad-track table from an RMD the bad-track table is positioned adjacent to the resident foreground task area. Unless there already exists an active bad-track table for the prior RMD, the bad-track table for the new RMD will be overlayed, if the resident foreground area is increased by means of a partial SYSGEN. Thus if a partial SYSGEN is performed which increases the resident foreground size, another RAZI must be performed.

Examples: Clear the RMD assigned to PO, having 203 tracks, and build a PST for it according to previously defined partition information.

```
FRM,PO,203,0
```

Run a complete bad-track analysis on the RMD assigned to 25, having 128 tracks, and build a PST for it according to previously defined partition information.

```
FRM,25,128,1
```

620-35 and 620-34 discs in a system require the formatting program (describe in section 18.4) to format disc and analyze bad tracks.

18.3.3 INL (Initialize) Directive

This directive causes RAZI to incorporate a PST and a bad-track table from the named RMD into the VORTEX nucleus. It has the general form

INL,lu,size

where **lu** and **size** have the same definition as in the FRM directive (section 18.3.2).

Example: Read the PST and bad-track table from the unit assigned to BO, having 128 tracks, and incorporate them into the VORTEX nucleus.

```
INL,BO,128
```

18.3.4 EXIT Directive

This directive terminates RAZI. It has the general form

EXIT

Example: Terminate RAZI.

```
EXIT
```

18.4 70-7500 (620-35) DISC PACK FORMATTING PROGRAM

Each 70-7500 (620-35) disc pack requiries formatting before any input or output operation can be performed on it. Before VORTEX can be prepared on a 70-7500 disc pack or any 70-7500 discs can be used under VORTEX, disc packs must be formatted. The formatting program forms 120-word sectors, which are grouped 24 per track. The program also examines the disc pack for bad tracks.

The formatting program operates in a stand-alone mode. It may be loaded and executed with either AID or BLD. Execution begins at location 01354. Upon execution the formatting program requests some parameters to be input from the keyboard. The following requests are made. An inappropriate response causes the request to be repeated.

Request

INPUT BTC NUMBER

Type a value and a carriage return. The acceptable values are octal 020, 022, 024, 026 and 070

INPUT DEVICE ADDRESS

Type a value in the range from octal 014 through 017 followed by a carriage return

INPUT VARIABLE SECTOR GAP

Type a value and carriage return. Acceptable values are 1, 2, 3, 4, 6, 8, 12, or their equivalent octal representations. This value determines the physical location on the disc pack of sequentially addressable sectors, as such sequential transfers may be accomplished without waiting for a full revolution of the disc unit. Recommended setting is 3. Another setting may be more effective depending upon various application parameters such as number of tasks, frequency of disc transfers, and types of disc transfers.

INPUT UNIT NUMBER

Type unit number followed by a carriage return. Acceptable values are 0 through 3. Up to four units can be connected to a single controller.

In addition the formatting program performs bad-track analysis and creates and maintains a bad-track table, which is entered on each disc pack at the completion of its formatting. The bad-track table is located on sectors 0 through 2 of the first track. The table is 254 words long, starting at word 64 of sector 0. The first 64 words of sector 0 reserve the necessary space for the PST. The remaining unused words of sector 2 are filled with zeroes. Each disc I/O error will generate a ten-event retry sequence, which upon failure will set the bad-track flag within the track header. The program also sets the corresponding bit in the bad-track table. No alternate tracks are assigned.

If the first track is determined to be bad, the bad-track table may not be placed there. The program prints the error message,

FIRST TRACK BAD

and aborts formatting the current disc pack. The program returns to the keyboard interrogation routine. After the bad-track table has been written on the disc pack, the formatting program resumes the keyboard interrogation to obtain parameters for formatting the next disc. In this way, more than one disc pack can be formatted in the same session. The formatting program may be terminated at this point when no disc packs (except those with bad first tracks) remain unformatted. If an unsafe condition (SELECT LOCK light on) occurs, reload and execute the program. Formatting disc packs is not necessary before every VORTEX system generation.

18.5 70-7510 (620-34) DISC PACK FORMATTING PROGRAM

Each 620-34 disc pack requires formatting before any input or output operation can be performed on it. Before VORTEX can be prepared on a 620-34 disc pack or these disc can be used under VORTEX, the packs must be formatted. The formatting program forms 120-word sectors, which are grouped 24 per track. The program also examines the disc pack for bad tracks.

The formatting program operates without an operating system. It may be loaded and executed either with AID II or BLD II. Its execution begins at location 01354. Upon execution the formatting program requests some parameters to be input from the keyboard. An inappropriate response causes the request to be repeated. The following requests are made.

INPUT BTC NUMBER

Type a value and a carriage return. The acceptable values are octal 020, 022, 024, 026 and 070.

INPUT DEVICE ADDRESS

Type a value in the range from octal 014 through 017 followed by a carriage return.

INPUT VARIABLE SECTOR GAP

Type a value and a carriage return. Acceptable values are 1, 2, 3, 4, 6, 8, 12, or their equivalent octal representations. This value determines the physical location on the disc pack of sequentially addressable sectors, as such sequential transfers may be accomplished without waiting for a full revolution of the disc unit. Recommended setting is 3. Another setting may be more effective depending upon various application parameters such as number of tasks, frequency of disc transfers, and types of disc transfers.

INPUT UNIT NUMBER

Type unit number followed by a carriage return. Acceptable values are 0 through 3. Up to four units can be connected to a single controller.

In addition the formatting program performs bad-track analysis and creates and maintains a bad-track table, which is entered on each disc pack at the completion of its formatting. The bad-track table is located on sectors 0 through 4 of the first track. The table is 508 words long, starting at word 64 of sector 0. The first 64 words of sector 0 reserve the necessary space for the PST. The remaining unused words of sector 4 are filled with zeros. Each disc I/O error will generate a ten-event retry sequence, which upon failure will set the bad-track flag within the track header. The program also sets the corresponding bit in the bad-track table. No alternate tracks are assigned.

If the first track is determined to be bad, the bad-track table may not be placed there. The program prints the error message:

FIRST TRACK BAD

and aborts formatting the current disc pack. The program returns to the keyboard interrogation routine. After the bad-track table has been written on the disc pack, the formatting program resumes the keyboard interrogation to obtain parameters for formatting the next disc. In this way, more than one disc pack can be formatted in the same session. The formatting program may be terminated at this point when no disc packs (except those with bad first tracks) remain unformatted. If an unsafe condition (SELECT LOCK light on) occurs, reload and execute the program. Formatting disc packs is not necessary before every VORTEX system generation.

18.6 70-7603/7613 DISC PACK FORMATTING PROGRAM

Each 70-7613/7613 disc pack requires formatting before any input or output operation can be performed on it. The formatter forms 120 word sectors which are grouped 48 per track. The program also performs a bad-track analysis.

The formatter (format F p/n 92A0205-030) operates under the MAINTAIN III executive. For instructions on loading from magnetic tape, cards or paper tape, see the MAINTAIN III Manual (98A9952-07x). Execution begins at location 500. Some parameters are requested from the keyboard. Inappropriate responses cause the request to be repeated. All inputs are terminated by periods.

INPUT BIC NUMBER

Enter an even value in the range octal 020 through 076.

INPUT DEVICE ADDRESS

Enter a value in the range octal 014 through 017.

INPUT UNIT

Enter a value in the range 0 through 7. This must be the physical unit number calculated as follows:

$UUP_{(2)}$

where

UU is unit number 0-3
P is platter 0 fixed
platter 1 removable
(Note: System RMD is always 000 regardless of which platter.

INPUT KNOWN BAD TRACKS

Enter octal track numbers in the range 0 through 0625 separated by commas and terminated by a period. If there are no known bad tracks, input only a period.

In addition, the formatting program performs bad-track analysis and creates and maintains a bad-track table, which is entered on each disc pack at the completion of its formatting. The bad-track table is located on sector 0 of the first track. The table is 26 words long, starting at word 64 of sector 0. The first 64 words of sector 0 reserve the necessary space for the PST. The remaining unused words of sector 0 are filled with zeros. Each disc I/O error will generate a five event retry sequence which, upon failure, will set the corresponding bit in the bad-track table. No alternate tracks are assigned.

If the first track is determined to be bad, the bad-track table may not be placed there. The program prints the error message,

FIRST TRACK BAD

and aborts formatting the current disc pack. The program returns to the keyboard interrogation routine. After the bad-track table has been written on the disc pack, the formatting program resumes the keyboard interrogation to obtain parameters for formatting the next disc. In this way, more than one disc pack can be formatted in the same session. The for- matting program may be terminated at this point when no disc packs (except those with bad first tracks) remain unformatted. Formatting disc packs is not necessary before every VORTEX system generation.

18.7 70-7520/7530 DISC PACK FORMATTING PROGRAM

Each 70-7520/7530 disc pack requires formatting before any input or output operation can be performed on it. The formatters form 120 word sectors which are grouped 48 per track. The program also performs a bad track analysis.

The formatter operates under the MAINTAIN III executive. For instructions on loading from magnetic tape, cards, or paper tape, see the MAINTAIN III Manual (98 A 9952-07x). Execution begins at location 500. Some parameters are requested from the keyboard. Inappropriate responses cause the request to be repeated. All inputs are terminated by periods.

INPUT BTC NUMBER

Enter an even value in the range octal 020 through 076.

INPUT DEVICE ADDRESS

Enter a value in the range octal 014 through 017.

INPUT UNIT

Enter a value in the range 0 through 3.

INPUT KNOWN BAD TRACKS

Enter octal track numbers in the range 0 through 017667 separated by commas and terminated by a period. If there are no known bad tracks, input just a period.

In addition, the formatting program performs bad track analysis and creates and maintains a bad track table, which is entered on each disc pack at the completion of its formatting. The bad track table is located at sector 0 of the first track. The table is 508 words long, starting at word 64 of sector 0. The first 64 words of sector 0 reserve the necessary space for the PST. Each disc I/O error will generate a three event retry sequence, which upon failure will set the corresponding bit in the bad-track table. No alternate tracks are assigned.

To bypass a full bad-track analysis, set SSW1 on. This option should not be used on new packs which require a full verification.

If the first track is determined to be bad, the bad-track table may not be placed there. The program prints the error message

```
FIRST TRACK BAD
```

and aborts formatting the current disc pack. The program returns to the key-board interrogation routine. After the bad-track table has been written on the disc pack, the formatting program resumes the keyboard interrogation to obtain parameters for formatting the next disc. In this way, more than one disc pack can be formatted in the same session. The formatting program may be terminated at this point when no disc packs (except those with bad first tracks) remain unformatted. Formatting disc packs is not necessary before every VORTEX system generation.

18.8 WRITABLE CONTROL STORE (WCS)

The writable control store must be loaded with the appropriate firmware. The WCS is loaded by the V73 WCS Microprogram Utility (MIUTIL). MIUTIL is a foreground program scheduled by a request:

;SCHED,MIUTIL,p,FL,F

where p is the priority level. Use of the MIUTIL program is described in detail in the Microprogramming Guide.

If the optional V70 series Floating Point Firmware is to be used, it must be loaded into page 1 of WCS. The WCS microprogram is catalogued into the OM library under the name WCSFP, and must be transferred to the BI device for loading by MIUTIL. The WCS should be initialized through the use of MIUTIL prior to loading the floating-point microprograms.

Section 20 gives additional information about writable control store.

18.9 70-755x DISK FORMATTING

A standalone 70-755x disk formatter enables a user to format diskpacks prior to generating a VORTEX II system. The formatter program is loaded into memory by the AID utility. Upon execution, the formatter output a prompt, "FH**". The following directive is entered to format a disk unit:

FORMAT,da,un

where

da = disk controller device address (even address only)

un = disk unit number

Upon completion of the formatting operation, the formatter outputs a prompt. The next unit may be formatted at this time. Appendix A lists error messages which may be output by the formatter.

18.10 F3064 FLEXIBLE DISKETTE FORMATTING PROGRAM

Each flexible diskette requires formatting before any input or output operation can be performed on it. Before a VORTEX system can be installed on a diskette, or the diskette can be used under VORTEX as a data disk, it must be formatted. The formatting program forms 120-word sectors, grouped 60 sectors per track, and examines the diskette for bad tracks.

The formatting program operates without an operating system. It may be loaded and executed with either the AID III or BLD II utilities. Execution begins at memory location 02000. After the formatter has been loaded, the prompt FJ** is output on the console.

In each of the directives which follow, the diskette controller device address and bic address must be input in octal format. To format a diskette, enter the directive

FORMAT,da,bic,unit,count

where

da	is the diskette controller device address
bic	is the diskette controller bic address
unit	is the desired diskette unit
count	is the number of times to perform bad track analysis

If the bad track analysis count is not specified, it will default to one time. If the value zero is specified for this parameter, bad track analysis will not be performed, but a bad track table will be built. However, if the controller reports difficulty in formatting the diskette, one bad track analysis is performed. The bad track table is entered on the diskette at the completion of the bad track analysis. It is located on sector 0 of the first track. The table is 5 words long and begins at word 64 of sector 0. A diskette I/O error generates a two event retry sequence, which upon failure sets the corresponding bit in the bad track table. No alternate tracks are assigned. Upon completion of the formatting operation, the prompt FJ** is output again. Refer to Appendix A.18 for applicable error messages.

Optional directives to set (SBT) or reset (RSBT) bits in the bad track table can be entered before the FORMAT directive. These have the form

SBT,t(1),t(2),...,t(n)

or

RSBT,t(1),t(2),...,t(n)

where each t(n) is a positive integer in the range 0-76, specifying the track number whose bit is to be set (indicating a bad track) or reset (cleared).

The formatting program also provides the capability to list or copy contents of a diskette. The PRINT directive is used to print records from flexible diskettes. Records printed are listed on the line printer (device address 035). The directive has the form

PRINT,da,bic,unit,strtnum,quan

where

da	is the diskette controller device address
bic	is the diskette controller bic address
unit	is the desired diskette unit
strtnum	is the starting record number in the range 1-2310
quan	is the number of records to be printed

The COPY directive is used to copy an entire flexible diskette to another flexible diskette. Diskettes containing bad tracks cannot be copied. The directive has the form

COPY,da,bic,munit,cunit

where

da	is the flexible diskette controller device address
bic	is the flexible diskette controller bic address
munit	is the master diskette unit
cunit	is the copy (scratch diskette) unit

The prompt FJ** appears at the console upon completion of each operation.

The HELP directive generates a descriptive list containing each of the preceding directives. This directive has the form

HELP

or

?

SECTION 19
PROCESS INPUT/OUTPUT

19.1 INTRODUCTION

VORTEX supports a number of Sperry Univac MCO devices which are used in industrial applications for a wide range of monitor and control purposes. These devices are called 'Process Input/Output' devices and are listed below:

MCO Model	Description
70-8310 and -8311 (620-830A/B)	Digital Output Module User's Guide (98 A 9968 100)
70-8410 and -8411 (620-831A/B)	Digital Input Module User's Guide (98 A 9968 110)
70-800x and 70-801x (620-850/851)	Analog-to-Digital User's Guide (98 A 9968 060)
70-8020 and -8021 (620-860/860/A 70-8022 and -8023 (620-861/861A)	Converter/Multiplexor User's Guide (98 A 9968 070)
70-821x,8220,8221 (620-870/1/2/ 3/4/5, 620-870A/B, 620-871A/B, 620/872A/B)	Digital-to-Analog Module User's Guide (98 A 9968 050)
70-811x,812x (620-855xx)	Low Level Multiplexor User's Guide (98 A 9968 130)

VORTEX configurations which include Process Input/Output devices differ from others in that each is, to some degree, 'tailor-made', even though they are composed of the standard products listed above. This requires the VORTEX user to operate with VORTEX I/O features at a more fundamental level than with most other devices. For this reason, the operation of Process Input/Output devices under VORTEX will be presented in considerable detail in the following sections.

The VORTEX Support Library includes a number of subroutines (section 19.4) with FORTRAN calling sequences defined by the Instrument Society of America (ISA), which are useful for input, output, and manipulation of process data.

19.2 PROCESS OUTPUT

19.2.1 Hardware

VORTEX supports combinations of the 70-8310 (620-830A) Digital Output Module and the 70-8311 (620-830B) Digital Output Expansion Module. VORTEX also supports combinations of the following DAC (Digital-to-Analog Converter) modules and expansion modules: 70-8210 through 70-8221 (620-870, -870A,-870B,-871,-871A, -871B,-872,-872A,-872B,-873,-874,-875).

Eight device addresses (050-057) are available for these modules. Each address can hold up to four modules, each module containing two digital output registers or DAC's for a maximum of 64 registers or DACs.

For VORTEX operation, a device is defined as the collection of modules at a single device address, and the word 'device' will have this meaning for the remainder of this section. The word 'channel' will be used to mean either a digital output register or a DAC.

Software capabilities for referencing channels directly by number are provided. For this purpose, channels are assigned an (octal) number mn, where:

m = (device address-050)
n = hardware channel number (0-7) within device.

thus, for example, the channel selected by the command

```
EXC  0352
```

would be called channel number 023.

Process output is totally under control of software (no BICs, interrupts, or SENs are used). Therefore, no ready, complete, or error information is provided by the hardware.

19.2.2 SGEN Operations

The following SGEN operations must be performed to include Process Output capabilities in a VORTEX system:

a. Add EQP directives to SGEN directive input file.

b. Add ASN directives to SGEN directive input file.

Note: the SGL contains four input controller tables, four output controller tables, input and output drivers, and TDF records.

In the examples in the following discussions, the symbols 'm' and 'n' refer to register number mn.

The EQP Directive

Each device must have an EQP directive in the SGEN directive file, with the following format:

```
      EQP,COmA, 050+m, 1,0,0,ioa,ma
[ioa = I/O algorithm as decimal fraction]
[ ma = Multiplexor address]
```

For example, the device at address 053 with I/O algorithm of .33 and multiplexor address 062 will require the directive

```
EQP,CO3A,053,1,0,0,.33,062
```

The ASN Directive

Each device must be assigned to a logical unit number by any ASN directive of the following format:

```
ASN, lun = COm0
```

For example, assigning the device at address 053 to logical unit 24 will require the directive:

```
ASN, 24 = CO30
```

19.2.3 Output Calls

Output to a Process Output device is by use of the IOC 'WRITE' macro. FORTRAN source programs can request output by calling one of the ISA process control subroutines described in section 19.4, which will construct and execute such a macro.

The macro call has the format (see section 3.5.4):

```
WRITE    pcb,lun,wait,mode
```

where:

pcb	=	Name of Process Control Block (PCB)
lun	=	Logical Unit Number
wait	=	Wait Flag
mode	=	Data Mode (ignored)

Data is always output directly, without modification, so the Data Mode is effectively System Binary.

PCB format is:

Output Word Count C	Word 0
Output Buffer Address	Word 1
Address of Channel Number List	Word 2
Status Word Address (0 if none)	Word 3
Mask Word Address (0 if none)	Word 4
Pulse Width Word Address (0 if none)	Word 5

The Channel Number List is a sequential list of channel numbers m(i)n(i) (i = 1,C), where m(i) = m(1) for all i, and the device address to which the logical unit number is assigned is 050 + m(i). Thus, a single WRITE call can only reference those channels assigned to a single device address.

The Status Word is a word in the calling program in which status of the IOC call is maintained. This is required by the ISA subroutines of section 19.4.

The Mask Word is used by the ISA 'Latching' subroutines DOL and DOLW. 1-bits in this word flag bits that are to be updated. The device controller table will contain the previous setting of all bits in the output word and the output buffer will contain the new settings.

An error I003 is reported if the Channel Number List contains a channel mn where m is not in range 0-7, or if m does not correspond to the device address defined by the ASN directive at SGEN time.

The Pulse Width Word is used by the ISA 'Momentary' subroutines DOM and DOMW. It gives the time in VORTEX basic cycles (5-millisecond) that output points are to remain set.

Example 1:

A DASMR source program is to output the first 3 words from buffer OBUF to channels 023, 027, and 021 in a group of Digital Output Modules which are assigned to logical unit number 24.

Note that channels 023, 027, and 021 are all assigned to the module at device address 052 by the channel numbering convention.

```
          .
          WRITE    PCB1,24,0,0
          .
          .
PCB1      DATA     3
          DATA     OBUF
          DATA     PTLIST
          DATA     0,0,0
          .
          .
PTLIST    DATA     023,027,021
          .
          .
```

Example 2:

A FORTRAN program is to output the first 3 words of OBUF to analog channels 49, 50, and 53, which are assigned to logical unit 17. The octal equivalents of these channel numbers are 061, 062, and 065, so the device address of the output module is 056 (46 in decimal digits).

```
      .
      .
INTEGER STAT, PTLIST, OBUF
DIMENSION OBUF (3), PTLIST (3)
DATA PTLIST/49, 50, 53/
.
.
CALL V$OPIO (46, 17, 0, STAT)
.
.
CALL AO (3, PTLIST, OBUF, STAT)
.
.
```

19.3 PROCESS INPUT

19.3.1 Hardware

VORTEX supports combinations of the 70-8410 (620-831A) Digital Input Module and the 70-8411 (620-831B) Digital Input Expansion Module. VORTEX also supports combinations of the 70-8010 (620-850) and the 70-8011 (620-851) Analog Input System, the 70-8020 (620-860) and 70-8022 (620-861) High-Level Multiplexor Modules and the 70-8021 (620-860A) and the 70-8023 (620-861A) High-Level Multiplexor Expansion Modules, and the 70-811x (620-855x) Low-Level Analog Input System and the 70-812x Low-Level Multiplexor Expansion Modules. These provide from 1 to 2,048 digital or analog input channels.

Eight device addresses (060 to 067) are available for these modules. Each address can handle, through multiplexing, up to 256 digital channels. To each of these device addresses will correspond a multiplexor attached to a different device address in the range (040-077). All Process Input requires a Buffer Interlace Controller (BIC).

Software capabilities are provided for referencing channels directly by number. Each channel is assigned an (octal) number mn by the following rules:

m = (device address · 060)
n = hardware channel number (0-255) within device. n is a 3-digit octal number

Thus, for example, channel number 01003 would be selected by outputting a 3 as the select code to the multiplexor which is connected to the Analog-to-Digital converter whose address is 061.

A BIC will be used for all input and all input will end with a BIC complete interrupt. The BIC will operate with the programmable timer.

19.3.2 SGEN Operations

The following SGEN operations must be performed to include Process Input capabilities in a VORTEX system:

a. Add EQP directives to SGEN directive input file.

b. Add ASN directive to SGEN directive input file.

c. Add PIM directive to SGEN directive input file.

In the example in the following discussions, the symbols 'm' and 'n' refer to channel number mn.

The EQP Directive

Each device must have an EQP directive in the SGEN directive file, with the following format:

```
EQP,CImA, 060+m, 1,b,0, ioa,ma
 b = BIC device address
 ioa = I/O algorithm as decimal
fraction, see example
 ma = multiplexor address
```

For example, the device at address 063 using the BIC at address 020 with I/O algorithm value of .5 and multiplexor address 072 will require the directive:

```
EQP,CI3A,063,1,020,0,.5,072
```

The ASN Directive

Each device must be assigned to a logical unit number by an ASN directive of the following format:

```
ASN,lun=CIm0
```

For example, assigning the device at address 063 to logical unit number 21 will require the directive:

```
ASN,21=CI30
```

The PIM Directive

Linkage must be established between the BIC and its Priority Interrupt Module (PIM) by a PIM directive of the format:

```
PIM,pl,TBCImA,1,0
```

where: p = PIM number (single octal digit)
l = line number (single octal digit)

I/O Algorithm

The I/O algorithm value must be set for the highest transfer rate (smallest PCB Timer Count) that will be used in the system.

1.10 x (BIC RATE*/DEVICE RATE)

Rates are in microseconds.

* BIC rate represents the maximum trap-in, trap-out timing sequence on the E-bus.

19.3.3 Input Calls

Input to a Process Input device is by use of the IOC 'READ' macro. FORTRAN source programs can request input by calling one of the ISA process control subroutines described in section 19.4, which will construct and execute such a macro.

The macro call has the format (see section 3.5.3)

```
READ    pcb,lun,wait,mode
```

where:

pcb = Name of Process Control Block (PCB)
lun = Logical Unit Number
wait = Wait Flag
mode = Data Mode (ignored)

Data is always input directly, without modification, so the Data Mode is effectively System Binary.

PCB format is:

Input Word Count C	Word 0
Input Buffer Address	Word 1
Address of Channel Number	Word 2
Status Word Address (0 if none)	Word 3
Op Code	Word 4
Timer Count	Word 5

The Status Word is a word in the calling program in which status of the IOC call is maintained. This is required by the ISA subroutines of section 19.4.

The Op Code (OP) is defined thus:

OP = 0:

Sequential Mode. Let m00n be the channel number specified by word 2. Data is repeatedly input from channels m001-m00n, till the input word count C (Word 0) is satisfied.

OP = 1:

Random Mode. Channel mn is repeatedly input the number of times specified in word 0.

The Timer Count (Word 5) is the desired time, in microseconds, between inputs. This value is output to the programmable timer, which will control the BIC input rate.

An error (I003) is reported if m is not in range 0-7, if n (or C, if in sequential mode) is not in range 0-255, or if m does not correspond to the device address defined by the ASN directive at SGEN time.

Example 1:

A DAS MR program is to sample an input channel 100 times at a rate of 1 input/50 microsecond . The channel is number 5 on device address 062, which is assigned to logical unit number 22, and the data is to be input into buffer IBUF. Do not return till I/O complete.

```
                .
                .
                .
                READ    PCB1, 22, 0, 0
                .
                .
PCB1            DATA    100
                DATA    IBUF
                DATA    CHNO
                DATA    0
                DATA    1
                DATA    50
                .
                .
CHNO            DATA    02005
```

Example 2: (see section 19.4)

A FORTRAN program is to input sequentially from channels 04001, 04002, and 04003, which are assigned to logical unit number 35, storing the input values into IBUF. Do not return till I/O complete. Set the input rate to 1 word/20 microsecond. The device address to which the input module is assigned is seen to be 064 (52 in decimal digits, and the decimal equivalent of 04000 is 2048).

```
      .
      .
      INTEGER STAT, PTLIST
      DIMENSION IBUF(3)
      DATA PTLIST/2049/
      .
      .
      .
      CALL V$OPIO (52, 35, 20, STAT)
      .
      .
      CALL AISQW(3, PTLIST, IBUF, STAT)
      .
      .
```

19.3.4 Low-Level Multiplexor Gain Control

Control of the low-level multiplexor amplifier gains is accomplished through the use of the IOC FUNC macro. FORTRAN source programs can set amplifier gains by calling one of the subroutines described in section 19.4.1, which will construct and execute such a macro.

The macro call has the general form (see section 3.5.8).

FUNC **dcb,lun,***wait*

where:

dcb the address of the data control block.

lun the number of the logical unit (ADCM) being manipulated.

wait unused.

The DCB macro has the general form

DCB **rl,buff,fun**

where:

rl is the number of channels for which the gain will be set.

buff address of the channel table.

fun is the function code.

0 = Set gains on sequential channels to a fixed value, delay 5 milliseconds.
1 = Set gains on random channels through a table, delay 5 milliseconds.
2 = Set gains on sequential channels to a fixed value, immediate return.
3 = Set gains on random channels through a table, immediate return.

The format of the channel table when fun = 0 or 2 is:

STARTING CHANNEL ADDRESS	Word 0
GAIN OF CHANNELS	Word 1

The format of the channel tables when fun = 1 or 3 is:

Word

0 = ADDRESS OF CANNEL a
1 = GAIN CODE FOR CHANNEL a
2 = ADDRESS OF CHANNEL b
3 = GAIN CODE FOR CHANNEL b
4 = ADDRESS OF CHANNEL c
etc.

The gain is internally referenced by the following table

Gain parameter	Actual MUX Gain
0	8
1	16
2	32
3	64
4	128
5	256
6	512
7	1024

Therefore the gain parameter must be in the range of 0 through 7.

An error (IO03) is reported if the gain is not in the proper range.

Example: In a DAS MR program, set the gain to 256 (gain code 5) on 27 contiguous channel (starting from 04001), which are assigned to logical unit 36.

Delay 5 milliseconds after the gains have been set to give the amplifier time to settle.

```
          .
          .
          FUNC     LDCB,36,0
          .
          .
          .
LDCB      DCB      27,TABLE,0
          .
          .
          .
TABLE     DATA     04001,5
          .
          .
          .
```

Example 2: A DAS MR program is to set the gain of 3 random channels which are assigned to logical unit 37. Return after the gains have been set. The gain of channel 04001 will be set to 64 (gain code 3), the gain of channel 04031 will be set to 512, and the gain of 04007 to 8.

```
          .
          .
          .
          FUNC     LLDCB,37,0
          .
          .
          .
LLDCB     DCB      3,TABLE,3
          .
          .
          .
TABLE     DATA     04001,3,04031,6,04007,0
          .
          .
          .
```

19.4 ISA FORTRAN PROCESS CONTROL SUBROUTINES

The Instrument Society of America (ISA) has defined as standards a number of FORTRAN subprogram calls useful in process input/output applications. VORTEX includes the following subroutines of this group:

Input/Output Calls

AISQ(W):	Analog Input Sequential
AIRD(W):	Analog Input Random
AO(W):	Analog Output
DI(W):	Digital Input
DOM(W):	Digital Output-Momentary
DOL(W):	Digital Output-Latching

The (W) option with each of these subroutine names selects a 'wait' mode, that is, it specifies that return is not be made from the subroutine until the I/O is finished, either normally or erroneously.

Bit String Manipulation

IOR:	Inclusive OR (logical add)
IAND:	AND (logical multiply)
NOT:	NOT (logical invert)
IEOR:	Exclusive OR (logical subtract)
ISHFT:	Logical Shift

VORTEX also provides two FORTRAN subprogram calls to set the amplifier gains on the Low-Level Multiplexors. The gain control calls are not ISA standard calls.

Low Level Gain Calls

SGNF(D):	Set gain on sequential channels
SGNT(D):	Set gains through a table

The (D) option of each of these routines cause a 5 millisecond delay after the last gain control has been issued, to give the amplifiers time to settle.

19.4.1 Input/Output Calls

The parameter 'stat' appears in all the following I/O calls. Its contents give the status of the call, as follows:

stat =
- 1: I/O correctly completed
- 2: I/O in execution
- 3: Invalid channel number
- 4: BIC timeout error
- 5: Invalid parameter value

VORTEX provides a FORTRAN call which establishes execution-time association between channel numbers and logical unit numbers, and sets the timer for data input rate. The format is:

```
CALL V$OPIO (da, lun, time, stat)
```

where:

da	=	device address
lun	=	logical unit number
time	=	time, in microseconds, between input. This is loaded into device programmable timer, which controls BIC rate. It is ignored on output. Parameters may be redefined by successive calls to V$OPIO.

Read Analog Input Sequential

```
CALL AISQ (count, ptlist, ibuf, stat)
```

or

```
CALL AISQW (count, ptlist, ibuf, stat)
```

This call reads *count* analog inputs into buffer *ibuf*, starting with channel 0X001, where *ptlist* contains 0XYYY, and reading channels sequentially.

Read Analog Input Random

```
CALL AIRD (count, ptlist, ibuf, stat)
```

or

```
CALL AIRDW (count, ptlist, ibuf, stat)
```

This call reads *count* analog inputs into buffer *ibuf*, inputting from the list of random points *ptlist*.

Perform Analog Output

```
CALL AO (count, ptlist, obuf, stat)
```

or

```
CALL AOW (count, ptlist, obuf, stat)
```

This call outputs *count* analog values from buffer *obuf*, outputting to the list of random points *ptlist*.

Read Digital Input

```
CALL DI (count, ptlist, ibuf, stat)
```

or

```
CALL DIW (count, ptlist, ibuf, stat)
```

This call reads *count* words of digital input into buffer *ibuf*, inputting from the list of random digital channels *ptlist*.

Perform Digital Output - Momentary

```
CALL DOM (count, ptlist, obuf,
time, stat)
```

or

```
CALL DOMW (count, ptlist, obuf,
time, stat)
```

This call outputs *count* words of digital output from buffer *obuf*, outputting from the list of random digital channels *ptlist*. If *time* = 0 this completes the operation. Otherwise, after 5**time* in milliseconds a word of zeros will be output to every channel in *ptlist*, thus resetting all channels.

Perform Digital Output - Latching

```
CALL DOL (count, ptlist, obuf,
mask, stat)
```

or

```
CALL DOLW (count, ptlist, obuf,
mask, stat)
```

This call outputs *count* words of digital output from buffer *obuf*, outputting from the list of random digital channels *ptlist*. The device driver program will save the previous word output to each channel, and change only those bits specified by 1-bits in *mask*, which is an integer array parallel to *obuf* and *ptlist*.

Perform Gain Selection on Sequential Channels

```
CALL SGNF (chntbl,nochnl)
```

or

```
CALL SGNFD (chntbl,nochnl)
```

This call selects the gain on *nochnl* sequential low level input channels. *Chntbl is the name of a two word control table. The first word contains* the address of the first low level channel. The second word contains the gain parameter (0-7).

Perform Gain Selection on Channels through a Table

```
CALL SGNT (chntbl,nochnl)
```

or

```
CALL SGNTD (chntbl,nochnl)
```

This call selects gains on *nochnl* low level channels. *Chntbl* is the name of a table which contains a pair of words for control for each low level channel. The first word of each pair contains the address of the low level channel. The second word of each pair contains the gain parameter (0-7).

19.4.2 Bit String Operations

All these subprograms are defined as Integer Function Subprograms. In the following descriptions, m and n are integer mode expressions.

IOR(m, n) = m.OR.n	Inclusive OR (logical sum)
IAND(m, n) = m.AND.n	AND (logical product)
NOT(m) = NOT.m	NOT (logical invert)
IEOR(m, n) = n.XOR.n	Exclusive OR (logical difference)
ISHFT(m,n) = 0	If the absolute value of n ≥ 16
m*2**n	Otherwise
n < 0	right shift
n > 0	left shift

In line FORTRAN code can be generated with the use of OR, AND, and XOR. This results in possibly larger load modules, but faster execution.

19.5 ERRORS

Process Output

IO03	INVALID CHANNEL NUMBER

Process Input

IO03	INVALID CHANNEL NUMBER
IO2X	BIC TIMEOUT ERROR

19.6 EXTENSIONS

Other process control devices besides those in the table of section 19.1 may be brought into the VORTEX system at some future time. The procedure for entering a new process control device is as given for the currently supported devices: one codes a driver program and controller tables and enters them into the VORTEX Nucleus at SGEN time, remembering to increment the one-character suffix on all names (all names herein end in 'A'; the next type of DAC, say, would be tagged with 'B'). The controller table can be extended by as many words as desired, to store flags and fixed device parameters. For variable parameters, say a gain parameter on an analog input device, the PCB table can be extended to hold the new parameter. In the FORTRAN I/O calls, the array PTLIST can be made 2-dimensional if gain or other parameter information is to be transferred with each point or channel number.

19.7 IEEE STD 488-1975 DRIVER

19.7.1 Description

The IEEE STD 488-1975 driver is designed to provide a means for managing information interchange between a V77 minicomputer and devices connected to the IEEE Standard Bus within a VORTEX environment. This will enable various programmable instruments to tranfer digital data among themselves directly, and not necessitate intermediate processing by an intervening controller unit. The user directs the information management through the execution of various VORTEX I/O macros and a series of general interface management commands.

19.7.2 User Interface

19.7.2.1 General Capabilities

The IEEE - 488 VORTEX driver uses a BIC to pass a buffer to/from the interface bus. This buffer contains an ASCII string which represents command instructions as well as data input for programming a device. These instructions and data enable a device to be addressed then listen and transmit the buffer to the device under control; address a device to talk and transmit its measurement reading to the buffer; or command a device or devices to perform a certain function or to assume a specific state.

19.7.2.2 Program Interface

The IEEE - 488 interface driver is initiated by the user through the execution of VORTEX I/O control macros READ and WRITE. With these two macros, the user is able to send data to a device or receive measurement readings from a device. Also available to the user, is the FUNC macro which provides the ability to execute universal commands of the IEEE controller.

READ Macro:

This macro is used to receive data from a bus instrument. This involves addressing a device to talk, receiving the instrument's data, and un-addressing the device after receiving all its data. Only one device may be addressed to talk at any given time. The form of the I/O calling sequence is:

READ DCB, LUN, WAIT, MODE

where

DCB	is the address of the data control block (see section 2.2.1).

LUN is the number of the logical unit to which to IEEE controller has been assigned.

WAIT specifies the type of return, and should be coded 0 for a return suspended until I/O is complete.

MODE specifies the I/O data mode and should always be coded as 1 for ASCII.

WRITE Macro

This macro will transmit data from a user buffer area to a bus instrument. This includes addressing the device to listen, sending data or programming instructions, and un-addressing the device after it has accepted all data. More than one devioce may be addressed to listen at any given time. The form of the I/O calling sequence is:

WRITE DCB, LUN, WAIT, MODE

where the parameters have the same definitions and take on the same values as in the READ macro.

FUNC Macro

This macro allows the user to perform various universal command functions of the IEEE - 488 controller. The form of the FUNC macro is:

FUNC DCB, LUN, WAIT

Where the parameters have the same definitions and take on the same values as in the READ macro.

The particular action which is initiated by the FUNC call is dependent on the function code FUN in the data control block. Possible actions are:

Function Code	Universal Command	Operational Function
0	DCL	Device Clear. Initializes all devices to a pre-defined state. The particular state is device dependent and should be described in the operating manual.
1	LLO	Local Lockout. Disables the 'Return to Local' button on all bus instruments. While in remote mode this prevents a return to local mode via local controls.
2	TCT	Take Control. This allows a bus instrument other than the V77 to act as a controller device.
3	SPE	Serial Poll Enable. This allows a serial poll to be taken to determine the source and nature of a pending service request.

NOTE:
Function 2 is in an addressed command which requires a device be addressed to talk.

Data Control Block

The Data Control Block is required for all three macro requests READ, WRITE and FUNC. The general form of this macro is:

DCB RL, BUFF, FUN

where

RL is the record length, in words, of the record to be transmitted or received.

BUFF is the address of a buffer containing user parameters and a pointer to the data buffer to be transmitted (or in the case of a READ, the buffer into which data will be received).

FUN is the function code of the FUNC request, and is unused for other requests.

DCB Buffer Description for READ

The BUFF parameter of the READ DCB contains a pointer address to a buffer of user data. The structure of that user data buffer is:

Word 1 Mask Talk Address

Word 2 Pointer to Buffer to Receive Data

Word 1

The lower byte of the first parameter word provides the talk address of a selected device.

The upper byte is an eight bit mask which is applied to received data before it is stored in the user's buffer. A "1" in any mask position will cause the corresponding bit of a received data byte to be set to "1" before being sent to the user. The primary purpose of this mask is to force a set parity for the ASCII data received.

Word 2

The second parameter word is an address pointer to the user buffer which will receive the data returned from the talk device.

DCB Buffer Description for WRITE

The BUFF parameter of the WRITE DCB contains a pointer address to a buffer of user data. The contents of that user buffer may be a number of listen addresses, programming commands, universal or addressed commands, or device dependent data. A great deal of flexibility is provided for the user to set up a buffer designed for his own specific purposes. The contents of the buffer will control the transmission of data to listening devices and also handle certain system status lines (i.e., Remote Enable).

The universal commands issued via a FUNC request may be placed into the WRITE buffer if desired. There is no distinction between a FUNC O Device Clear and placing the code for a Universal Device Clear in the WRITE buffer. Their inclusion as FUNC requests are for user convenience only. The only exception is Function Code 3 which performs an entire serial polling routine to determine the source and nature of a service request. A Serial Poll Enable in the WRITE buffer will set the system in a mode ready to do a serial poll, but will not perform the actual polling sequence.

DCB Buffer Description for FUNC

The BUFF parameter of the data control block for a FUNC macro contains an address pointer to a buffer location of user data. This buffer is only used for Function Codes 2 and 3. The structure of the user data area is:

Word	# of Devices	Talk Address 1
Word 2		Talk Address 2
Word 3		Talk Address 3
.	.	.
.	.	.
.	.	.
Word n		Talk Address n
Word n + 1	Status Byte	Talk Address of SRQ

Word 1

The lower byte of the first parameter word for Function Code 3 is the TALK address of a device to be polled for a service request. For Function Code 2, it is the TALK address of the device which is to take control.

The upper byte of the first parameter word represents the number of devices to be serially polled for a pending service request. The upper byte is only used for Function Code 3.

Word 2 thru n

The lower byte of these words is used only for Function Code 3 and contain the TALK address of all devices which are to be polled for a service request.

The upper byte for Words 2 thru n are ignored for FUNC requests.

Word n +1

The IEEE - 48 interface driver will store in the lower byte of this word the TALK address of the device making a service request.

The driver will place the status byte of the device into the upper byte of Word n + 1. This word is only used for a FUNC 3 request.

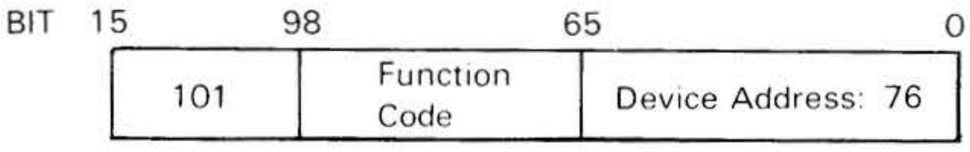
19.7.3 Data and Instruction Formats

The user has the capability to incorporate into his WRITE buffer a series of programming commands (EXC, EXC2). In order to accommodate the use of a BIC for the transference of data through the bus, it became necessary to change the format of the EXC and EXC2 instructions. The EXC format is:

BIT 15 98 65 0

5	Function Code	Device Address: 76

the EXC2 format is:



When Bits 9 and 11 are set, the word is interpreted as an EXC instruction. Bits 9 and 15 indicate an EXC2 instruction.

Programming commands, listen addresses and other device dependent messages should be placed in the buffer in the lower byte of each buffer word. Measurement readings returned to the application program will be stored in the lower byte of each buffer word.

Programming commands which are available to the user:

Command	Function
EXC 076	Program Identify True
EXC 176	Program Identify False
EXC 276	Progam Remote Enable True
EXC 376	Program Remote Enable False
EXC 576	Program Attention False
EXC 676	Program Attention True
EXC 776	Issue an Interface Clear
EXC2 076	Program Take Control Synchronously True

19.7.3.1 Identify

The Program Identify True or False is used strictly for a parallel polling operation. Polling occurs when both Attention and Identify are true and stops when either ATN and IDY is False.

19.7.3.2 Remote

Setting Remote Enable true will allow devices to go to the remote state when their LISTEN address is transmitted. Programming this line False places all bus instruments into local state.

19.7.3.3 Interface Clear

Issuing an Interface Clear will initialize the system by placing the system controller in charge and clearing the bus.

19.7.3.4 Take Control Synchronously

There are times when the controller may take control of the bus by a synchronous interruption of an action TALKER. To prevent the loss of data which is currently being transmitted, the Take Control Synchronously (TCS) interface function is executed. This does not have to be set for each transmission performed, but need only be executed once. It is reset by an Interface Clear or System Reset.

19.7.3.5 Attention

Messages which are sent through the BUS may be interpreted in one of two ways depending on the state of the Attention line. by placing an EXC 676 instruction in the WRITE buffer, the line is set true. This places the bus in command mode where all data in the buffer following the EXC command is read as universal or addressed commands.

In a similar manner, the Attention line is programmed false via an EXC 576 instruction. This will put the bus in the data mode in which the following data is interpreted as device dependent messages.

Once the controller has been programmed to the data or command mode, it retains that state until it is reprogrammed to the alternate mode.

19.7.4 System and User Requirements

19.7.4.1 System Generation Considerations

The environment for which the IEEE - 488 Interface Driver has been designed to perform in should have the following characteristics:

- System generated in conformance with the standard procedure for a VORTEX system generation
- The inclusion of the V75 extended instruction set is not necessary
- A dedicated BIC for the IEEE controller

19.7.4.2 User Program Considerations

There are times when an instrument on the IEEE bus will generate a service request interrupt. The driver will note the presence of the service request by placing a byte of all 1's (i.e., 0377) in event word TBEVNT of the TIDB. It is the responsibility of the application program to periodically check TBEVNT to see if a service request is pending, and, if so, to handle it accordingly.* The application program should respond to **all** pending service requests before issuing an I/O request.

To determine the source and nature of a service request, the user must perform a serial poll. This is done by issuing a FUNC 3 command. The result of this request will be the TALK address of the device with a pending service request and a status byte. Bits 0-6 of this byte will represent the specific nature of the request. The application program must interpret bits 0-6 (interpretation is device dependent) and perform whatever actions are warranted by the request. The event word TBEVNT should be cleared after a serial poll is performed.*

* **Note:** The RTE "TBEVNT" request should be used to examine and clear TBEVNT (Section 2.1.15).

SECTION 20
WRITABLE CONTROL STORE AND FLOATING-POINT PROCESSOR

The **Writable Control Store (WCS)** option extends the SPERRY UNIVAC 70 series processor's read-only control store to permit the addition of new instructions, development of microdiagnostics, and optimal tailoring of the computer system to its application. Unlike the read-only control store, which contains the 70 series standard instruction set and cannot be altered, the WCS can be loaded from main memory under control of certain I/O instructions. The capabilities of WCS give the user more complete access to the resources of the 70 series computer system.

20.1 MICROPROGRAMMING SOFTWARE

Supporting software for the WCS includes the following:

- Microprogram assembler MIDAS
- Microprogram simulator MICSIM microprogram
- Microprogram utility loader and diagnostic MIUTIL
- WCS reload task

All software for microprogram development operates under VORTEX. The capabilities and use of WCS and its supporting software are described in the SPERRY UNIVAC Microprogramming Guide.

20.1.1 Microprogram Assembler

The MIDAS program allows the user to prepare microprograms for SPERRY UNIVAC 70 series WCS, using operation mnemonics, symbolic addressing, address-field calculations, macro definitions, error detection and automatic program documentation.

Under VORTEX, MIDAS is scheduled from the background library at level 0 by

```
/LOAD,MIDAS
```

20.1.2 Microprogram Simulator

The SPERRY UNIVAC microprogram simulator (MICSIM) helps the programmer to verify and optimize microprograms. MICSIM runs the output from MIDAS within the system's main memory. At selected times, conditions and the contents of data locations can be examined and changed. MICSIM is scheduled from the background library at level 0 by

```
/LOAD,MICSIM
```

20.1.3 Microprogram Utility

Loading the control store with the assembled and tested microcode is performed by microprogram utility, MIUTIL.

In addition, on-line debugging directives are available through the utility on a special configuration. The MIUTIL program operates as a foreground program at priority level set by the user. The program is scheduled by operator input over the OC device. For example,

```
;SCHED,MIUTIL,3,FL,F
```

The microprogram utility is also responsible for maintaining an up-to-date image of the contents of the WCS on an RMD file, named WCSIMG on the OM library, see section 15.8. This image is then used by the WCS reload task, WCSRLD, to restore the WCS following a power failure/restart and VORTEX reload. The RMD file image is updated each time the R directive is used to exit from the utility.

If the update is completed successfully, the message:

```
WCS SAVED
```

is output on the OC and LO devices before the utility exits. If the RMD file for saving the WCS is not present on the OM library the OM library, the system outputs

```
IO10,MIUTIL
FILE WCSIMG NOT FOUND
WCS SAVE ABORTED
```

I/O errors which may occur during the save operation result in outputting messages

```
IOxx,MIUTIL
WCS SAVE ABORTED
```

If the restoration of WCS is completed successfully, the message WCS RELOADED will be output to the OC and LO devices before the reload task exits.

To exit from the microprogram utility without updating the RMD file, the operator may issue the directive.

```
;ABORT,MIUTIL
```

20.1.4 WCS Reload Task, WCSRLD

This task, WCSRLD, reinitializes the WCS to the contents specified by the RMD file image of WCS, WCSIMG on the OM library. It is automatically scheduled on power failure/ restart or upon the reloading of the VORTEX system. In this way, WCS contents are preserved through any periods without power.

Though usually scheduled automatically by the system, the reload task may also be scheduled manually by the operator. For example, the following directive schedules the reload task at priority level 15:

```
;SCHED,WCSRLD,15,FL,F
```

20.2 STANDARD FIRMWARE

Standard firmware is available on the 70 series computers to provide faster and more compact code. The executable code which uses the firmware, or microprograms, is automatically generated by the VORTEX FORTRAN IV compiler when the option F is specified (in the JCP directive /FORT, see section 4.2.15). The firmware also extends the capabilities of the user's assembly language programs and the support library (see section 13).

Standard firmware includes routines which are loaded into the system's WCS for the following categories of operations:

- Arithmetic for two-word fixed-point and integer numbers
- Arithmetic for real (floating-point) numbers
- Transfer of two-word values, such as a memory to memory move
- FORTRAN oriented routines
- Byte manipulation
- Stack manipulation

Executing a branch-to-control-store (BCS) instruction causes a transfer of control from the system's read-only memory to the WCS at the address specified in the BCS instruction. The MIUTIL program (see section 20.1.3) loads the standard firmware as well as any extensions to the instruction set the user may write. To execute firmware, the program must use a BCS instruction with the appropriate entry address and calling sequence for passing parameters.

A FORTRAN IV program specifies the option F on its request for compilation, and then BCS instructions are generated. The FORTRAN IV programs use this firmware without any changes to the FORTRAN IV statements.

Due to size constraints, some firmware is unavailable under certain hardware configurations. Table 20-1 shows these restrictions.

Table 20-1. Firmware Availability

Firmware Routine	Hardware Configurations without FPP	with FPP
XAD,XSB	YES	YES
XMU,XDV	YES	NO
IMU,IDV	NO	YES
FAD,FSB,FMU,FDV	YES	NO
FSQ	NO	YES
FLD,FST,FMV	YES	YES
FSE,FDO,FDO1	YES	YES
FTNE,FTEQ,...,FTGT	NO	YES
FJNE,FJEQ,...,FJGT	NO	YES
FAIF,FIOP	NO	YES
FRSC,FRSR,FJAG	NO	YES
Byte Firmware	YES	YES
Stack Firmware	YES	YES
FIMPY	NO	YES
NOX120	NO	YES

20.2.1 Fixed-Point Arithmetic Firmware

Two-word fixed-point and integer numbers use the following arithmetic firmware:

Mnemonic	Function	BCS Call
XAD	Fixed-point and integer add	0105334
XSB	Fixed-point and integer subtract	0105374
XMU	Fixed-point multiply	0105274
XDV	Fixed-point divide	0105234
IMU	Integer multiply	0105027
IDV	Integer divide	0105067

These operations are performed on the hardware A and B registers (AB), using the number specified by the second word of the respective BCS call. If overflow occurs, AB is set to the maximum number with the proper sign and the overflow flag (OVFL) is set.

For two-word fixed-point numbers, the decimal point is assumed to be to the left of bit 15 of the most significant word. For two-word integer numbers, the decimal point is assumed to be to the right of bit 0 of the least significant word. As a result, rounding and overflow conditions are different for multiply and divide. For example, multiplying two double-word numbers produces a logical four-word result. The fixed-point function returns the high order two-words and drops the lower two. The integer multiply returns the lower two-words of the logical result and sets overflow if either of the two higher words are non-zero.

20.2.1.1 Fixed-Point Multiply (FIMPY)

The following firmware is used for single word fixed-point and integer numbers.

FIMPY Fixed-point (one word) multiply

This operation is performed on an operand in the A register and a value located at an address which has been provided as a parameter, and returns its result in the A register. Overflow is not checked for. The parameter address may be indexed by the X register.

The BCS call is

0105015 if no indexing desired,
0105055 if indexing is desired.

20.2.2 Floating-Point Arithmetic Firmware

The addition, subtraction, multiplication, and division of single-precision real, or floating-point, numbers can be performed with the following firmware.

Mnemonic	Function	BCS Call
FAD	Floating-point add	0105134
FSB	Floating-point subtract	0105174
FMU	Floating-point multiply	0105074
FDV	Floating-point divide	0105034
FSQ	Floating-point square root	0105127

A floating-point arithmetic operation is performed on AB using the floating-point number specified by the second word of the BCS call. If underflow occurs, AB is set to zero. If overflow occurs, AB is set to the maximum floating-point number with a proper sign. Taking square root of a negative number results in the overflow being set and AB set to zero.

20.2.3 Data Transfer Firmware

The data transfer firmware routines load AB from memory, store AB in memory, and move the contents of two contiguous memory locations to another place in memory.

Mnemonic	Function	BCS Call
FLD	Load AB with two words from memory	0105032
FST	Store AB into memory	0105033
FMV	Memory-to-memory move of two words	0105037

20.2.4 FORTRAN-Oriented Firmware

These microprograms are oriented toward FORTRAN IV operations. However, they have a similar utility to assembly-language programs.

Mnemonic	Use	BCS Call
FTNE	Test for not equal	0105024
FTEQ	Test for equal	0105064
FTLT	Test for less than	0105124
FTGE	Test for greater than or equal	0105164
FTLE	Test for less than or equal	0105324
FTGT	Test for greater than	0105364
FJNE	Jump if not equal	0105026
FJEQ	Jump if equal	0105066
FJLT	Jump if less than	0105126
FJGE	Jump if greater than or equal	0105166
FJLE	Jump if less than or equal	0105326
FJGT	Jump if greater than	0105366
FAIF	Arithmetic IF processor	0105226
FIOP	Indexed operand processor	0105167
FRSC	Reentrant subroutine call	0105025
FRSR	Reentrant subroutine return	0105065
FJAG	Jump if A register greater	0105125
FSE	Pass parameters between subroutines	0105036
FDO	Terminate DO loop	0105035
FDO1	Terminate DO loop (1 increment)	0105027
NOX120	General indexed array processor	varies (see macro)

For FSE, the calling routine would use the following sequence:

```
CALL    SUB
DATA    P1      Address of first
                data to be moved
.
.
DATA    Pn      Address of last
                data to be moved
```

In the subroutine being called, the following sequence is necessary to receive the data or data address:

```
SUB     BSS     1
        DATA    0105036     BCS transfer for FSE
        DATA    n           Number of parameters
        BSS     m           Number of parameters
```

The second instruction, FDO to control a DO loop, uses the following calling sequence:

```
        DATA    0105035     BCS transfer to FDO
        DATA    P1          Address of DO
                            increment

        DATA    P2          Address of DO loop
                            counter

        DATA    P3          Address of DO loop
                            limit

        DATA    P4          Address for jump if
                            the counter is not
                            greater than the
                            limit
```

The third instruction, FDO1 to control a DO loop with increment of 1 uses the following calling sequence.

```
        DATA    0105027     BCS transfer to FDO1
        DATA    P1          Address of DO loop
                            counter
        DATA    P2          Address of DO loop
                            limit
        DATA    P3          Address for jump
                            if the counter is
                            not greater than the
                            limit
```

The DO loop is incremented and tested against the DO loop limit. If the loop counter is less than the limit, execution continues at the address specified by the BCS call word 5. If the value of the loop counter is equal to or greater than the value represented by the limit, execution continues at the instruction following this calling sequence.

The calling sequence for all the relational test (FT--) and jump (FJ--) instructions are as follows:

```
BCS
DATA        Address of first number
DATA        Address of second number
DATA        Jump address
```

These routines compare the two single precision floating-point numbers pointed to be the words following the BCS. The A register is set to minus one or zero, depending on the specified relation being met or not met, respectively. For the jump instructions, FJ--, the branch address is taken only when the condition is met, (i.e., when the A register equals minus one). Note that the specified relation is that of the first number to the second. For example, FTGT tests for the first number greater than the second.

The calling sequence for the arithmetic IF processor (FAIF), is as follows:

```
BCS
DATA        Address of first number
DATA        Address of second number
DATA        Branch address if less than
DATA        Branch address if equal
DATA        Branch address if greater than
```

This BCS also compares two single precision floating-point numbers. It determines if the first number is less than, equal to, or greater than the second number, and then takes the appropriate branch address.

The indexed operand processor is used to compute the effective address of an element in a FORTRAN real array. It has the following call sequence:

```
BCS
DATA        Address of index value
DATA        Base address
```

The effective address is computed by subtracting one from the index value, multiplying the result by two, and then adding in the base address. This allows for an array with two-word entries and induces from one to 'n'. The effective address is stored in the second word of the following instruction.

The reentrant subroutine call, FRSC, has the following call sequence:

```
BCS
DATA        Subroutine address
```

The B register points to a memory location which is used as a stack pointer. This memory location is decremented and the resulting value used as the address where the return address is stored.

Control is then transferred to the subroutine. Note that the subroutine address should be that of the first instruction of the subroutine.

The reentrant subroutine return, FRSR, has a calling sequence consisting of just the BCS without parameters. The return address is popped off the stack using the B register and the memory stack pointer as in the subroutine call. Note that no limit checks are made on the stack by either the call or the return. Also, the stack pointer format is not consistent with that of the general stack firmware.

The BCS calling sequence for FJAG (jump if A register greater than zero) is as follows:

```
BCS
DATA        Jump address
```

The jump address is taken only if the A register is strictly greater than (and not equal to) zero.

The General Indexed Array Processor is used to compute the effective address of an element in a one or two dimensional FORTRAN array, where an array element is one, two, or four words.

The calling sequences are:

For one-dimensional arrays A(I) dimensioned A(m)--

```
BCS word
address of index value (I)
address of array base address
(next instruction, word 1)
(next instruction, word 2)
```

For two-dimensional arrays A(I,J) dimensioned A(m,n)--

```
BCS word
address of index value (I)
address at dimension (m)
address of index value (J)
address of array base address
(next instruction, word 1)
(next instruction, word 2)
```

All operand addresses may be indirect. The array base address must not reflect the offset due to base zero, base one addressing. The actual (direct) address of the desired element of the array will be placed in the second word of the instruction following the BCS call.

The table below gives the BCS word for all combinations of 1, 2, and 4 words; one or two dimensional arrays.

BCS Word Contents (Octal)

	one dimension	**two dimensions**
one word/element	105216	105016
two words/element	105356	105156
four words/element	105316	105116

The effect address is computed by the algorithm

$$((((J - 1) * m) + m) + (I - 1)) * L) + B$$

where

I,J,m	are as defined above
L	is words/element
B	is the array base address (i.e., the address of element (1,) or (1))

For a one dimensional array, J is assumed to be one in the above formula.

20.2.5 Byte Manipulation Firmware

The byte instructions use a byte pointer address where bits 15-1 specify the word number and bit 0 is 0 for the left byte and 1 for the right byte. The byte-oriented instructions implemented in firmware are:

Mnemonic	**Function**	**BCS Call**
CBS	Compare byte strings	0105030
MBS	Move byte string	0105070

In the first microprogram sequence, the CBS instruction requires that the second word contain the address to which control is returned if the strings are not equal. The B register contains the byte starting address of the first string, the X register is the byte starting address of the second string, and the A register specifies the number of bytes to be compared.

The second byte-oriented microprogram sequence, the MBS instruction, moves the number of bytes specified in the A register from the location specified by the B register to the location specified by the X register.

Both share a common BCS entry point, and this may be extended for six more instructions.

20.2.6 Stack Firmware

A stack is kept in memory for use for return addresses, temporary storage or arithmetic operations. The base and limit of the stack (see figure 20-1) are defined by the user. The stack control block is indicated by a pointer in the second word of the calling sequence. Figure 20-2 is the format of the stack control block.

The following BCS instructions correspond with each of the stack operations:

Operation	BCS	Operation	BCS
Add	0105031	Push	0105231
Subtract	0105071	Pop	0105331
Multiply	0105131	Push double	0105271
Divide	0105171	Pop double	0105371

Eight stack instructions transfer to the same initial entry point in the WCS, where the decoder determines the specific instruction to be executed.

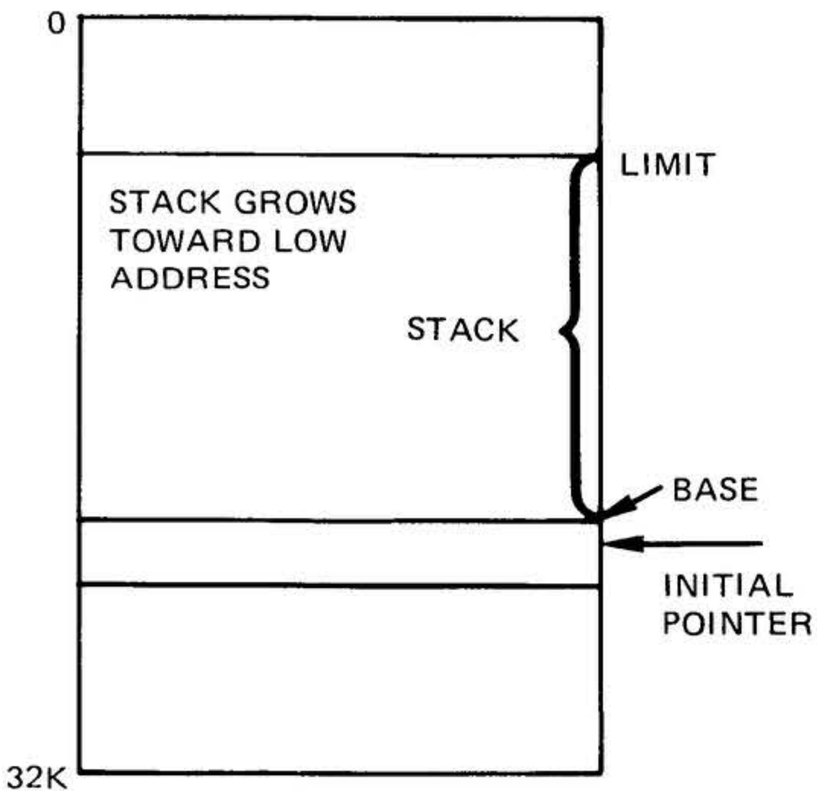


Figure 20-1. Base and Limit of Stack

On all stack operations, if the top-of-stack pointer (PTR) ever exceeds the boundaries of the stack (as the user defined them in the stack control block), no further processing takes place and a JMPM is made to the fourth word in the stack control block.

Single-Precision Integer Stack Arithmetic.

Add: adds the top two words of the stack, increments the pointer and replaces the new topmost word. If the result exceeds the maximum positive number (077777), the overflow indicator (OF) and the sign in bit 15 are set to one. For example, adding 000002 to 077777 sets OF to one and the result to 100001.

Subtract: subtracts the next stack word from the top of stack word (by adding the top word to the two's complement of the next stack word), increments the top-of-stack pointer, and stores the remainder in the new top-of-stack word. If the result exceeds the maximum negative number, it sets the overflow indicator and resets the sign.

Multiply: multiplies the two words at the top of the stack and replaces them by their 32-bit product (see figure 20-3). The most significant part of the product is placed in the top word, and the least significant portion will be placed in the next word. The sign bit of the top word gives the sign of the product, and the sign of the next word is set to zero. The overflow indicator (OF) is not set.

Word	
0	CURRENT STACK POINTER
1	LIMIT OF STACK
2	BASE OF STACK
3	ADDRESS OF INSTRUCTION WHICH CAUSED STACK OVERFLOW OR UNDERFLOW
4	ERROR ROUTINE FOR OVERFLOW OR UNDERFLOW

Figure 20-2. Stack Control Block

Divide: divides the top stack word into the following two words. The top-of-stack pointer (PTR) is incremented and the single-precision quotient with the sign of the dividend is stored in the new top-of-stack location. The remainder is stored in the next stack location (see figure 20.4).

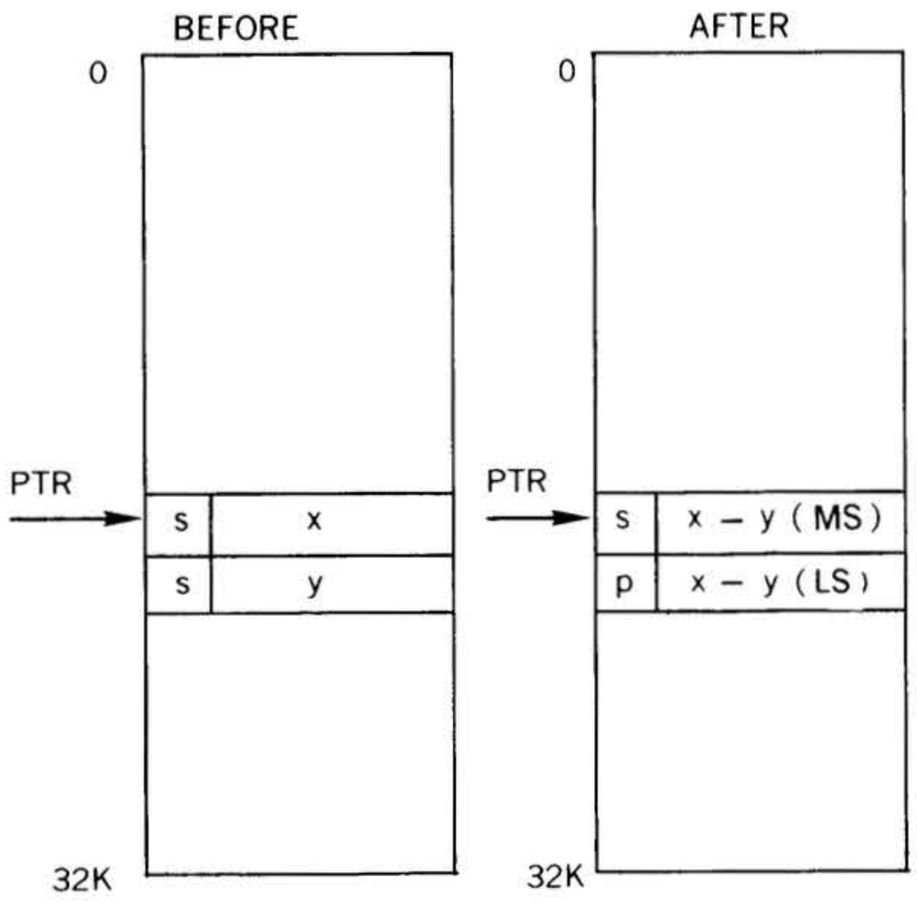


Figure 20-3. Stack Multiply

If the quotient overflows, the contents are unpredictable, and control is returned with the overflow indicator set (OF).

Figure 20-4. Stack Divide

Stack operators: these operators also require a stack control block as in figure 20-2.

Push (SPUSH): the A register (R0) is placed on the stack at the location addressed by the decremented top-of-stack pointer (see figure 20-5.)

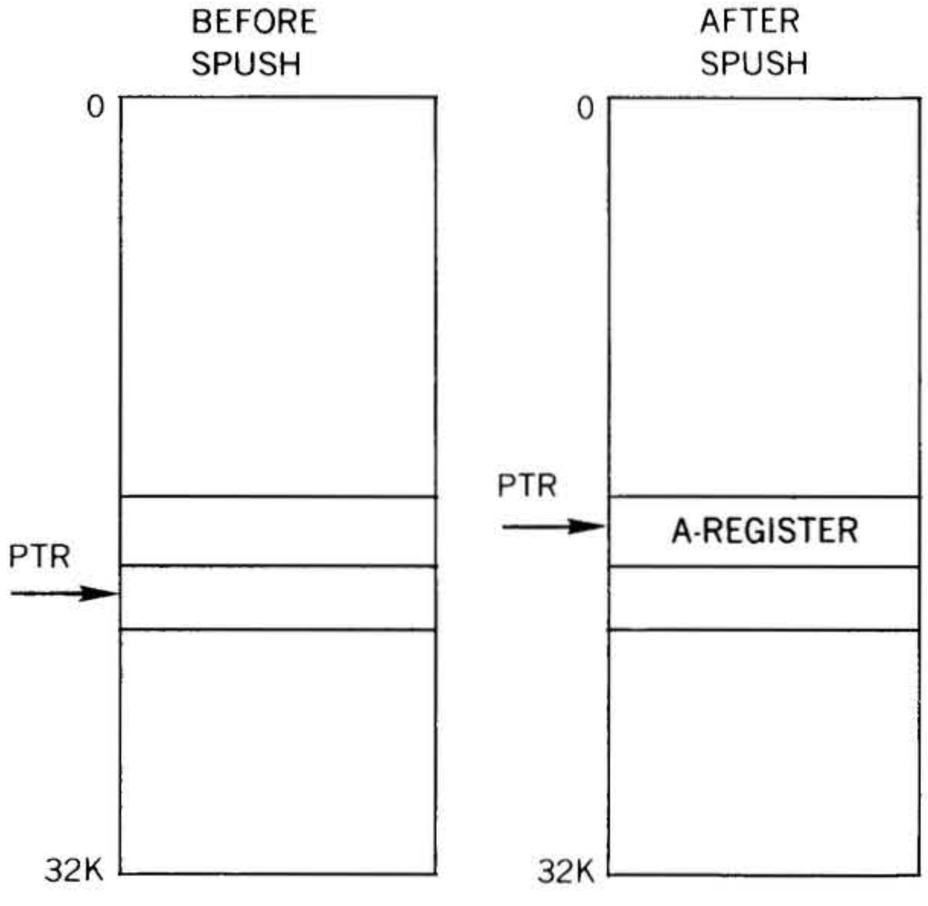


Figure 20-5. Stack Push

Pop (SPOP): the A-register (R0) is loaded from the top stack word and the stack pointer is incremented (see figure 20-6).

Figure 20-6. Stack Pop

Push Double (PUSHD): decrements the stack pointer and stores the B register (R1), and then decrements the pointer and stores the A register (R0) (see figure 20-7).

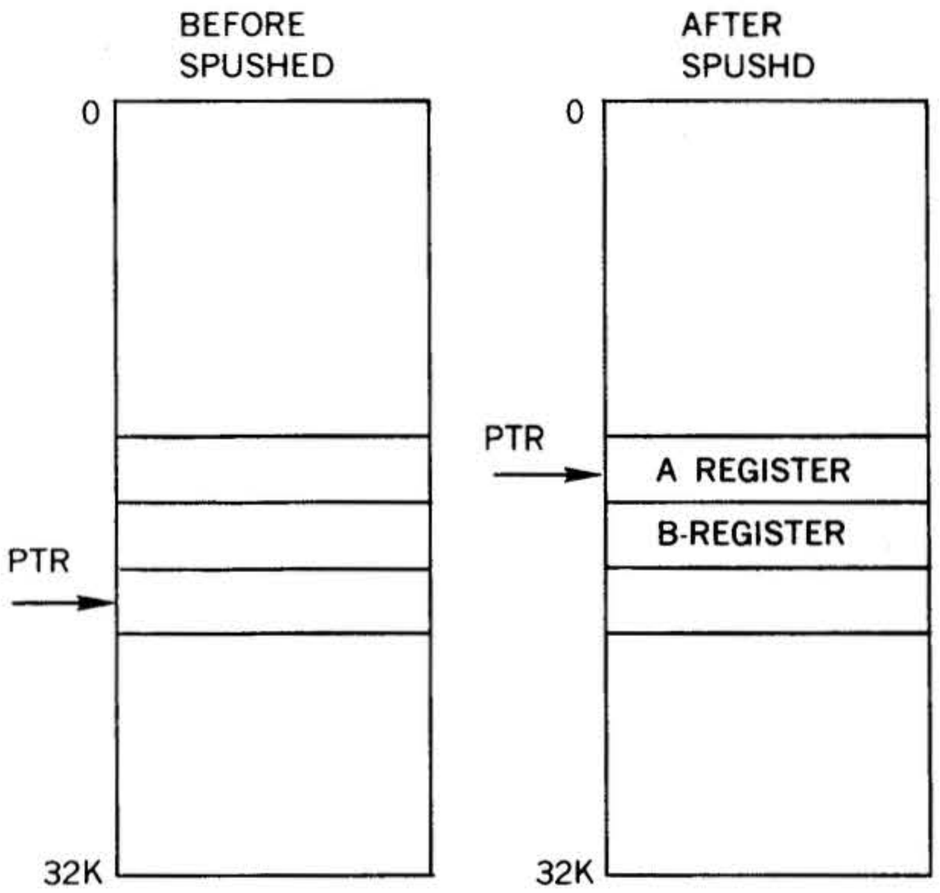


Figure 20-7. Stack Double Push

Pop Double (POPD): loads the A register (R0) with the word addressed by the top-of-stack pointer and then increments the top-of-stack pointer; loads the B register (R1) with the word addressed by the new value of the top-of-stack register and then increments the top-of-stack pointer again (see figure 20-8).

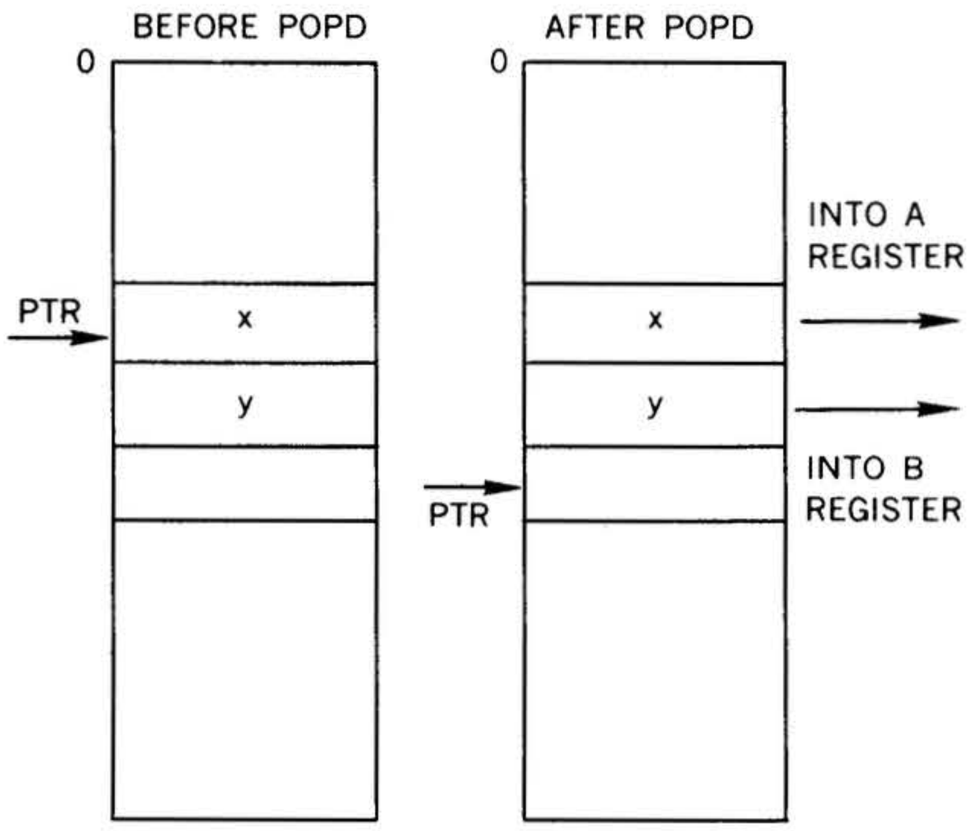


Figure 20-8. Stack Double Pop

20.2.7 Firmware Macros

The mnemonics given are not supported by the DAS MR assembler. The assembly-language programmer must supply his own macros in order to use any of these mnemonics. The following are examples and possible use of the required macros.

Macro **Use**

Fixed point add:

```
XAD     MAC                                     XAD     address
        DATA    0105334,P(1)
        EMAC
```

Fixed point subtract:

```
XSB     MAC                                     XSB     address
        DATA    0105374,P(1)
        EMAC
```

Fixed point multiply:

```
XMU     MAC                                     XMU     address
        DATA    0105274,P(1)
        EMAC
```

Fixed point divide:

```
XDV     MAC                                     XDV     address
        DATA    0105234,P(1)
        EMAC
```

Integer multiply:

```
IMU     MAC                                     IMU     address
        DATA    0105027,P(1)
        EMAC

FIMPY   MAC                                       FMPY  ,address
        DATA    0105015 + P(1)                          or
        DATA    P(2)                            FMPY 040,address
        EMAC
```

Integer divide:

```
IDV     MAC                                     IDV     address
        DATA    0105067,P(1)
        EMAC
```

and, immediately following the macros for floating point divide, add:

Floating square root:

```
FSQ     MAC                                     FSQ     address
        DATA    0105127,P(1)
        EMAC
```

Floating point add:

```
FAD     MAC                                     FAD     address
        DATA    0105134,P(1)
        EMAC
```

Floating point subtract:

```
FSB     MAC                                     FSB     address
        DATA    0105174,P(1)
        EMAC
```

Floating point multiply:

```
FMU     MAC                                     FMU     address
        DATA    0105074,P(1)
        EMAC
```

Floating point divide:

```
FDV     MAC                                     FDV     address
        DATA    0105034,P(1)
        EMAC
```

Load AB:

```
FLD     MAC                                     FLD     address
        DATA    0105032,P(1)
        EMAC
```

Store AB:

```
FST     MAC                                     FST     address
        DATA    0105033,P(1)
        EMAC
```

Memory to memory:

```
FMV     MAC                                     FMV     from address to address
        DATA    0105037,P(1),P(1)
        EMAC
```

Pass parameters:

```
FSE     MAC                                     FSE     #params
        DATA    0105036,P(1)
        BSS     P(1)
        EMAC
```

DO loop:

```
FDO     MAC                                     FDO     inc addr, count addr,
                                                        lim addr, loop addr
        DATA    0105035,P(1),P(2),
                P(3),P(4)
        EMAC
```

DO loop (one increment):

```
FDO1    MAC                                     FDO1    count addr, lim addr,
                                                        loop addr
        DATA    0105027,P(1),P(2),P(3)
        EMAC
```

Test for not equal:

```
FTNE    MAC                                    FTNE    OP address, OP address
        DATA    0105024,P(1),P(2)
        EMAC
```

(Typical relational test form).

Jump if not equal:

```
FJNE    DATA    0105026,P(1),P(2),P(3)  FJNE    OP address, OP address
                                                jump address
```

(Typical relational Jump form).

Arithmetic IF processor:

```
FAIF    MAC                                    FAIF    OP address, OP address,
        DATA    0105226,P(1),P(2),P(3),P(4),P(5)LT address, EQ address,
        EMAC                                            GT address
```

Index operand processor:

```
FIOP    MAC                                    FIOP    index address, base
        DATA    0105167,P(1),P(2)                      address
        EMAC
```

Reentrant subroutine call:

```
FRSC    MAC                                    FRSC    sub address
        DATA    0105025,P(1)
        EMAC
```

Reentrant subroutine return:

```
FRSR    MAC                                    FRSR
        DATA    0105065
        EMAC
```

Jump if A register greater:

```
FJAG    MAC                                    FJAG    jump address
        DATA    0105125,P(1)
        EMAC
```

General subscripting:

```
NOX120   MAC
         DATA    0105016 + ((2-P(1)) * 128)
                 + (((4 - P(2)/2)
                 - ((4 - P(2)/2)/4) * 4)
                 * 128)
         DATA    P(3)

         IFF     P(1), , 1
         GOTO    1
         DATA    P(4)
         DATA    P(5)
         DATA    P(6)
         GOTO    2
       1 DATA    P(4)
       2 CONT
```

EMAC

NOX120 should have the format

number dimensions, words/element, first subscript address, address of base

or

number dimensions, words/element, first subscript address, first dimension address, second subscript address, address of base

Compare string:

```
CBS     MAC                                     CBS     non compare addr
        DATA    0105030,P(1)
        EMAC
```

Move string:

```
MBS     MAC                                     MBS
        DATA    0105070
        EMAC
```

Stack add:

```
SADD    MAC                                     SADD    stack addr
        DATA    0105031,P(1)
        EMAC
```

Stack subtract:

```
SSUB    MAC                                     SSUB    stack addr
        DATA    0105071,P(1)
        EMAC
```

Stack multiply:

```
SMUL    MAC                                     SMUL    stack addr
        DATA    0105131,P(1)
        EMAC
```

Stack divide:

```
SDIV    MAC                                     SDIV    stack addr
        DATA    0105171,P(1)
        EMAC
```

Stack push:

```
SPUSH   MAC                                     SPUSH   stack addr
        DATA    0105231,P(1)
        EMAC
```

Stack pop:

```
SPOP    MAC                                     SPOP    stack addr
        DATA    0105331,P(1)
        EMAC
```

Stack push double:

```
SPUSHD   MAC                                        SPUSHD    stack addr
         DATA    0105271,P(1)
         EMAC
```

Stack pop double:

```
SPOPD    MAC                                        SPOPD     stack addr
         DATA    0105371,P(1)
         EMAC
```

The Floating Point Processor has the following OP codes.

Mnemonic	Opcode	Operation
FLD	0105420	Floating load single
FLDD	0105522	Floating load double
FAD	0105410	Floating add single
FADD	0105503	Floating add double
FSB	0105450	Floating subtract single
FSBD	0105543	Floating subtract double
FMU	0105416	Floating multiply single
FMUD	0105506	Floating multiply double
FDV	0105401	Floating divide single
FDVD	0105535	Floating divide double
FLT	0105425	Fix to float
FIX	0105621	Float to fix
FST	0105600	Floating store single
FSTD	0105710	Floating store double

Load or Float interrupts are locked out until a store or fix. EX34, -- as time out.

An interrupt after a store may change floating-point registers. User should restore their contents.

Mnemonics for floating-point operations are not supported by DAS MR. The following are possible macros which must be included by the user to define the mnemonics:

Macro			Use	
FLD	MAC		FLD	address
	DATA	0105420,P(1)		
	EMAC			
FLDD	MAC		FLDD	address
	DATA	0105522,P(1)		
	EMAC			
FAD	MAC		FAD	address
	DATA	0105410,P(1)		
	EMAC			
FADD	MAC		FADD	address
	DATA	0105503,P(1)		
	EMAC			

```
FSB     MAC                                     FSB     address
        DATA    0105450,P(1)
        EMAC

FSBD    MAC                                     FSBD    address
        DATA    0105543,P(1)
        EMAC

FMU     MAC                                     FMU     address
        DATA    0105416,P(1)
        EMAC

FMUD    MAC                                     FMUD    address
        DATA    0105506,P(1)
        EMAC

FDV     MAC                                     FDV     address
        DATA    0105401,P(1)
        EMAC

FDVD    MAC                                     FDVD    address
        DATA    0105535,P(1)
        EMAC

FLT     MAC                                     FLT     address
        DATA    0105425,P(1)
        EMAC

FIX     MAC                                     FIX     address
        DATA    0105621,P(1)
        EMAC

FST     MAC                                     FST     address
        DATA    0105600,P(1)
        EMAC

FSTD    MAC                                     FSTD    address
        DATA    0105710,P(1)
        EMAC
```

20.2.8 Commercial Firmware

Commercial firmware is available on the 70 series computers for supporting VORTEX, COBOL, and TOTAL. The firmware and assembly language routine V$DECM (see section 13), also extends the capabilities of the user's assembly language programs.

Commercial firmware includes the following operations:

- COBOL decode
- Load/Store multiple registers
- Main storage move or compare
- 32 bit unsigned math

Additionally, an assembly language routine V$DECM is provided in the support library for interface to the firmware decimal math routines.

The Commercial Firmware package is optionally available with the FORTRAN accelerator package requiring 1024 words of WCS on a V70 series computer.

COBOL Decode

COBOL decode uses the most significant 5 bits of the specified word of main storage to perform a 32 way branch. Register R2(X) points to the main storage word to be decoded. The BCS is followed by the 32 vector addresses. When the BCS is complete, R0(A) contains 0 and R1(B) contains the least significant eleven bits (left justified). R2 is not incremented. The calling routine uses the following sequence:

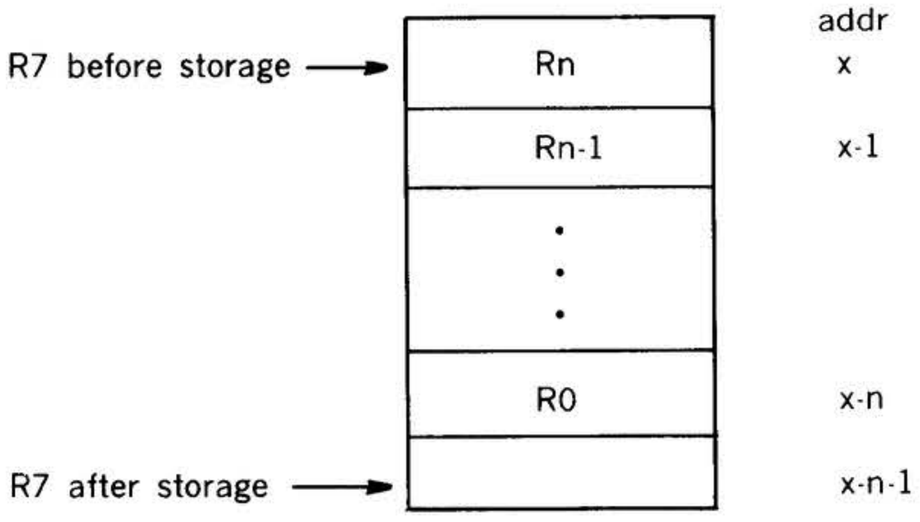
```
DATA            0105021                         BCS value
DATA            vector address zero
DATA            vector address one
                .
                .
                .
DATA            vector address thirty-one
```

Load/Store Registers

Multiple register loading or storing is performed by the following BCS instructions:

	Registers loaded/stored		
DATA	0105020	load	R0
	0105060		R0,R1
	0105120		R0,...,R2
	0105160		R0,...,R3
	0105220		R0,...,R4
	0105260		R0,...,R5
	0105320		R0,...,R6
	0105360	load	R0,...,R7
DATA	0105017	store	R0
	0105057		R0,R1
	0105117		R0,...,R2
	0105157		R0,...,R3
	0105217		R0,...,R4
	0105257		R0,...,R5
	0105317		R0,...,R6
	0105357	store	R0,...,R7

R7 contains the main storage address for loading or storing registers. Register contents are stored in main storage as follows:



R7 is decremented to the location following the contents of R0. For load registers, R7 initially points to the word following R0. After loading is complete, R7 will point to the last register loaded.

Main Storage Move or Compare

The Move routine moves a byte block of main storage from one area to another (overlap is allowed). The compare routine compares two byte blocks of main storage. The compare is logical and sets a user supplied condition word as follows:

0 = first block less than second block
1 = first block equal to second block
2 = first block greater than second block

At the end of each byte move or compare, byte pointers are incremented. Optionally, the user may specify non-incrementing of the first block byte pointer. This will result in storing a single byte value throughout a block of main storage or comparing a single byte value to a block of main storage.

Initially R0(A) points to the user's descriptive parameter block and R1(B) contains the address of the user's condition word. The parameter block appears as follows:

word	0	byte addr of first main storage block
	1	byte addr of second main storage block
	2	number of bytes for move or compare

The calling routine will issue one of the following BCS values:

0105223	Move without increment
0105263	Move with increment
0105323	Compare without increment
0105363	Compare with increment

When execution is complete, parameter block contents are as follows:

Move without increment

word 0 = single byte address
word 1 = last byte stored address +1
word 2 = 0

Move with increment

word 0 = last byte fetched address
word 1 = last byte stored address +1
word 2 = 0

Compare without increment

word 0 = single byte address
word 1 = last byte compared address +1
if equal
= last byte compared address
if unequal

word 2 = 0 if equal. Otherwise
decremented once for each
equal byte.

Compare with increment

word 0 = last byte compared address
word 1 = last byte compared address
+1 if equal.
= last byte compared address if
unequal.
word 2 = 0 if equal. Otherwise
decremented once for each
equal byte.

32 Bit Integer Math

These routines perform the operations add, subtract, multiply, and divide on 32 bit unsigned integer operands. Register R0(A) contains the four word parameter block address. The four word parameter block contains the two operands and received the results as follows:

add Operand two is replaced by the sum of the two operands.

subtract Operand two is replaced by operand one minus operand two.

multiply Both operands are replaced by the 4 word product of the two operands.

divide Operand one receives the quotient of operand one divided by operand two; operand two is replaced by the remainder.

The hardware overflow flag is set when any of the following occur:

- carry out of the most significant bit during an add.
- subtracting a larger number from a smaller one.
- dividing by zero.

The calling routine uses one of the following instructions:

Add	DATA 0105023
Subtract	DATA 0105063
Multiply	DATA 0105123
Divide	DATA 0105163

SECTION 21
FILE MAINTENANCE UTILITY

21.1 INTRODUCTION

The File Maintenance Utility program, (FMUTIL) is a background task which performs the following functions:

- Copies files, file directories, and/or partitions from one device to another
- Loads files, file directories, and/or partitions onto a device.
- Manipulates files and records
- Formats files and records which are to be printed or displayed.
- Manages filename directories
- Manages space allocation for files.

The following items should be noted when using FMUTIL.

- Only files assigned to disk devices can be referenced by name.
- Filespace allocated by FMUTIL is allocated contiguously within a partition, skipping bad tracks.

21.2 ORGANIZATION

FMUTIL is scheduled for execution by the JCP directive /FMUTIL. If the SI logical unit is a teletypewriter or a CRT device, the message FL** is output to indicate that the SI unit is waiting for FMUTIL input. Once activated, FMUTIL accepts directives from the SI unit until another JCP directive (first character is a slash) is input, or the exit directive, E is input.

In either case, FMUTIL terminates and JCP is scheduled.

If there is an error, one of the error messages given in Appendix A is output on logical unit SO, and a record is input from the SO unit to the JCP buffer. If the first character of this record is /, FMUTIL exits via the EXIT request. If the first character is C, FMUTIL continues. If the first character is neither / or C, the record is processed as a normal FMUTIL directive.

21.3 OUTPUT LISTINGS

FMUTIL outputs the following two types of listings to the LO logical unit:

- **Directive Listing** - lists, without modification, all FMUTIL directives entered from SI logical unit.
- **Directory Listing** - lists file names from a logical unit filename directory in response to the FMUTIL P, D, T and L directives.

All FMUTIL listings begin with the standard headings.

21.4 FMUTIL - OVERVIEW

The FMUTIL directives are described in Table 21-1.

Table 21-1. FMUTIL Directives

Directive	Function
D	Dump individual files or entire partitions to a magnetic tape.
L	Load individual files or entire partitions from a magnetic tape.
S	Search for specified partition on magnetic tape.
T	List contents of magnetic tape made by a dump.
P	Print contents of a partition in alphabetical order.
R	Rewind magnetic tape.
U	Release unused space in specified file.
X	Set expiration date for use in conjunction with LOAD.
E	Exit from FMUTIL or write end-of-file (EOF) to magnetic tape.

File maintenance utility directives consist of sequences of character strings having no embedded blanks. The characters strings are separated by commas (,) or equal signs (=). Although not required, a period (.) is a line terminator. Comments can be inserted after the period.

The general form of a file maintenance utility directive is:

directive,p(1),p(2),...,p(n)

where

directive Is one of the directive names given in Table 21-1.

p(n) Is a parameter.

Numerical data can be octal or decimal. Each octal number must have a leading zero.

For greater clarity in the descriptions of the directives, optional blank separators between character strings, and the optional replacement of commas (,) by equal signs (=) are omitted from the descriptions.

Error messages applicable to file maintenance utility directives are given in Appendix A.

21.5 D DIRECTIVE

The D directive dumps information contained in files, partitions, and/or directories onto magnetic tape. Once this information is on magnetic tape, it can be reloaded onto disk, or stored for later use. There are three types of D directives; dump file, dump partitions, and dump directories. Each D directive is described in the following paragraphs.

21.5.1 Dump File

The directive for dumping a file has the general form:

D,lun,key,**file,tapelun**

where

lun Is the number or name of the input logical unit.

key Is the partition protection code.

file Is the name of the file being dumped.

tapelun Is the number or name of the output logical unit (magnetic tape only). Note that **tapelun** cannot be equal to 50.

When individual files are dumped, the tape format consists of a file header, "EOF.", text record, file image (in 5760 word blocks, except for last block), and an "EOF." text record.

Note: Magnetic tapes created by pre-VORTEX G1 FMUTIL have EOF tape marks in place of the "EOF." text record.

File information is listed to the LO device as the file is dumped in the following format:

> file name, file type, extension, sectors used, sectors unused, total sectors, first sector number, last sector number, create date, access date.

All values are expressed in decimal.

Note: Dumping individual files only, does not terminate the output tape properly for all input functions (S and T). The E command must be used twice to properly terminate the output tape if the last operation to the tape was an individual file dump. No logical unit is kept in the individual file header when this directive is used. This means that the dumped file can be loaded to a different LUN than from which it was dumped.

Example: Dump the file DEBUG from the OM library with a protection code D to logical unit 18.

```
D,OM,D,DEBUG,18
```

A sample listing produced by this directive is shown in Figure 21-1.

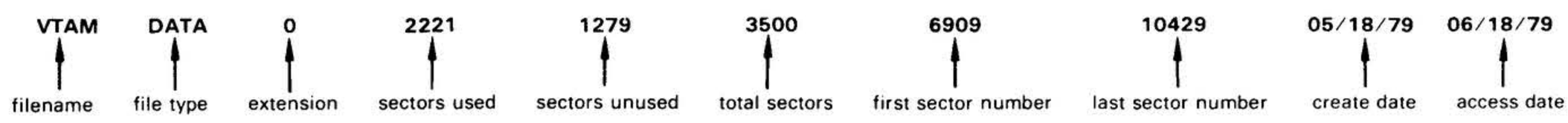


Figure 21-1. Sample Output Produced by Dump File Directive

21.5.2 Dump Partition

The directive for dumping a partition has the format

D,lun,key,**ALL,tapelun**

where

lun Is the number or name of the input logical unit.

key Is the protection code required to address lun.

ALL Is the keyword ALL specifying a partition dump.

tapelun Is the output logical unit (magnetic tape only). Note that **tapelun** cannot be equal to 50.

The tape format for a partition dump consists of a partition header, "EOF." text record, a file set (as per individual file dumping) for each file dumped, an "EOP." text record, and an "EOT." text record (which is skipped back over after being written).

Note: Magnetic tapes created by pre-VORTEX G1 FMUTIL has EOF tape marks in place of the "EOF.", "EOP.", and "EOT." text records. Alternate entry names are reflected by a ENTR file header that contains the alternate name and the root name.

File information is listed to the LO device as each file is dumped in the same manner as for an individual file dump. Alternate entry names are reflected by having the same extent/ location as the root file name. Dumping an entire partition does properly terminate the output tape, unlike individual file dumps, so the E directive is not required.

Example: Dump the entire OM partition to logical unit 18.

D,OM,D,ALL,18

21.5.3 Dump File-Name Directory

The directive for dumping a directory has the format

D,lun,key,**DIR,tapelun**

where

lun Is the number or name of the input logical unit.

key Is the protection code required to address lun.

tapelun Is the number or name of the output logical unit (magnetic tape only). Note that **tapelun** cannot be equal to 50.

DIR Is the keyword DIR specifying directory dump.

This form of the DUMP directive should only be used when the file directory information is to be maintained but the file data is not. File images are not dumped to the output magnetic tape when the DUMP directory directive is used.

The output tape produced by this directive contains a directory header, followed by a record containing pairs which consist of the directory sector address (1 word) and the contents of the directory sector (240 words). There may be up to 24 directory sectors per record. The last pair is followed by two "EOF." text records.

Note: Magnetic tapes created by pre-VORTEX G1 FMUTIL have EOF tape marks in place of the "EOF." text record.

Example: Dump directories for partition contained on logical unit OM, protection code D, onto magnetic tape unit 18.

D,OM,D,DIR,18

21.6 L Directive

This directive loads information from magnetic tape into RMD files, partitions, and/or directories.

There are three types of L directives, load files, load partitions, and load directories.

21.6.1 Load File

The directive for loading a file has the format

L,lun,key,**file,tapelun**

where

lun Is the number or name of the output logical unit.

key Is the partition protection code.

file Is the name of the file being loaded.

tapelun Is the number or name of the input magnetic tape unit. Note that **tapelun** cannot be equal to 50.

When a file is being loaded from magnetic tape, a search is made for that file. After the search, the tape is positioned in front of the file within the correct partition dump. The search stops if an "EOP." text record or a double end-of-file is encountered. An error message is output when the search stops. After the file is located, an attempt is made to create the file space. If the file already exists, the existing file is used. If the existing file is too small, an error message is output.

When creating a file for loading, the file size of the created file will include all of the original extent of the file, including the unused portion.

When a file already exits, the only check made is to see if there is enough space for the used portion of the file as on the tape, and the original extent of the file is ignored.

The load file directive produces a listing on the LO logical unit. The listing output format is similar to the listing ordered by the dump file directive. The only difference between the dump file directive listing and the load file directive listing is that the directive is shown on the second printed line of the listing.

Note: No search is made for the specified logical unit prior to the search for the specified file. If the magnetic tape has not been positioned to the partition from which the file was dumped, the user must position the tape using the FMUTIL "S" command prior to using the "L" command. If the "S" command is not used, the "FILE NOT FOUND" diagnostic will be output. Although the tape must be positioned to the portion that contains the partition dump containing the file, the file need not be loaded back onto the same partition or logical unit after the tape is positioned.

Example: Load the file COBINT, contained on magnetic tape unit 18, onto disk logical unit 22. Protection code is X.

```
L,22,X,COBINT,18
```

21.6.2 Load Partition

The directive for loading a partition has the format:

L,lun,key, { **ALL** | **ALLNEW** } , **tapelun**

where

lun Is the number or name of the output logical unit.

key Is the partition protection code.

ALL Keyword specifies partition load.

ALLNEW Keyword specifies new file only load.

tapelun Is the number or name of the input magnetic tape unit. Note that **tapelun** cannot be equal to 50.

When a partition is loaded, a search is made on the tape for the logical unit number specified prior to loading any files. This means that a partition load must be made to the same logical unit from which it was dumped, regardless of the actual partition or drive.

In order to move partition contents to a different partition, the target LUN must be assigned to the target partition, and the LUN must be the LUN from which the partition dump was made. The search for the LUN stops if an "EOT." test record or triple EOR is encountered. An error message is output if the search is stopped.

When the specified partition is found, the files are loaded in one of two manners depending upon the keyword used.

If the keyword ALL is used, FMUTIL ignores any current directory information on the target partition and loads all files in the order encountered. Directory entries are created by FMUTIL as the loading proceeds.

Note: Under this mode, FMUTIL reserves enough space at the front of the partition to hold all the necessary directory entries for the number of files on the partition dump. Hence all directories will appear together in front of the files (at least until a new directory sector is created by LMGEN, FMAIN, or VZFMA at a later date). For this reason, this reload mode should be avoided for FL and BL if a "nucleus only" system generation is to be performed at a later date. This reload mode does consolidate all file space and leave unused space at the end of the partition.

If the keyword ALLNEW is used, FMUTIL preserves all current directory information on the target partition and loads only those files which do not currently exist on the target partition. Directory and file creation is made by calling VZFMA. Since current directory information is preserved, this mode does not consolidate file space (unless the partition has been initiallized).

Note: A file is considered to exist if an entry exists under the file name regardless of the file size or the create/access date. If a more current version of the file is to be loaded under this mode, the old file must be deleted.

The following considerations should be made when using either the ALL or ALLNEW keywords.

- Speed of load - ALL is significantly faster.
- Existing files - ALLNEW must be used if existing files are to be preserved.

- Use of expiration date - ALLNEW must be used if the expiration date feature is desired.

- Space consolidation - Either ALL or ALLNEW may be used to consolidate space but the partition must be initialized when using ALLNEW.

- System generation considerations - ALL should not be used for FL and BL partitions.

The load partition directive outputs a listing to the LO device in the same basic format as the "D" command. If ALLNEW is used, existent files are flagged with the message:

FILE XXXXXX ALREADY EXISTS, NOT LOADED

If the expiration feature is used, expired files are flagged with the message:

FILEXXX EXPIRED, NOT LOADED

Example: Load OM partition from LUN 18 ignoring current files.

L,OM,D,ALL,18

Example: Load OM partition from lun 18 but load only those files not already on OM

L,OM,D,ALLNEW,18

21.6.3 Load Directory

The directive for loading filename directories has the following general form:

L,lun,key,**DIR,tapelun**

where

lun Is the number or name of the output logical unit.

key Is the protection code required to address **lun**.

tapelun Is the number or name of the input magnetic tape unit. Note that **tapelun** cannot be equal to 50.

DIR Specifies directory load.

When a directory is being loaded, a search is made for the directory on the input magnetic tape. The search starts after the search tape is positioned in front of the required partition directory.

If the directory is found its sectors are loaded onto their former recorded sectors. No reorganization takes place.

If the directory is not found or if an "EOT." text record or a triple end-of-file is encountered, an error message is output and the search stops.

Example: Load directory for partition contained on magnetic tape, on magnetic tape unit 18, onto RMD logical unit OM. The protection code is D.

L,OM,D,DIR,18

21.7 R DIRECTIVE

This directive rewinds a magnetic tape to the beginning of tape. The R directive has the format:

R,lun

where

lun Is the number or name of the input or output magnetic tape unit.

Example: Rewind magnetic tape located on logical unit 18.

R,18

21.8 E DIRECTIVE

The E directive has two functions:

- To write an EOF tape mark
- To exit from FMUTIL

The function performed by the E directive depends on the presence of the lun parameter. If lun is present, the EOF function is performed. If lun is not present, the exit function is performed.

The E directive has the format:

E,lun

where

,lun Is optional and when used specifies the lun to which an EOF is written.

At least one "E, lun" directive should be used at the end of a dump session in order to properly terminate an FMUTIL dump tape. If the last operation was an individual file dump, two "E, lun" directives should be used. If this is not done, subsequent use of commands that require searching (S, L for partitions or directories), displaying contents of the tape (T), or non FMUTIL use of the dump tape (such as copying it) may fail.

Note: The input of any "slash" command (/) to FMUTIL on the SI logical unit will also cause FMUTIL to exit.

Example: Write an EOF to logical unit 18.

E,18

Example: Exit from FMUTIL.

E

21.9 S DIRECTIVE

This directive searches for a specific logical unit (lun) dump image on a FMUTIL dump tape. The S directive has the format:

S,**lun**,key,**tapelun**

where

lun Is the number or name of the disk logical unit.

key Is the protection code required for addressing lun.

tapelun Is the number or name of the input magnetic tape unit.

After the search is completed, the tape will be positioned after the partition header record and ahead of any file header records for the specified partition. If the search fails to find the specified partition, the diagnostic message "END OF FILE?" is output. Search can be used across multiple reels.

Example: Search for the partition dump of logical unit OM, protection code D, on logical unit 18.

S,OM,D,18

Note: Search may only be used to locate a partition dump. It will not work if only individual files on a partition were dumped.

21.10 P DIRECTIVE

This directive prints out a listing of the file directory for each partition specified. The listing is printed on the LO logical unit. The P directive has the format:

P,lun,key

where

lun Is the number or name of the input logical unit.

key Is the protection code required for addressing lun.

Files are listed in alphabetical order. The output format used for the P command is the same as for the LOAD and DUMP commands.

Note: FMUTIL does a memory sort of the file names and has a limit to the number of file names that it can handle. If insufficient memory space is available, the message "CAPACITY EXCEEDED" is output to LO and all file names read up to that point are listed.

Example: Print a listing of OM, protection code D.

P,OM,D

21.11 U DIRECTIVE

This directive releases unused space from files after they have been written on disk. The U directive has the format:

U,lun,key,**file**

where

lun Is the number or name of the logical unit where space to be released.

key Is the protection code required for addressing lun.

file Is the name of the file where the unused space is located.

Example: Release unused space located in file COBINT, on partition 22, protection code X.

U,22,X,COBINT

21.12 T DIRECTIVE

This directive is used to print the contents of an FMUTIL dump tape. The T directive has the format:

T,lun

where

lun Is the number or name of the logical unit which contains the FMUTIL created dump tape.

The dump tape is read from its current position until an "EOT." text record or a triple EOF is encountered. Whenever a partition header record is encountered it is listed to LO in the format

PART: # ENTRIES = decimal integer , LUN = decimal integer

Whenever a file header is encountered it is listed to LO in the format

FILE: FCB = file name , file BOD , file EOD

Whenever an entry header is encountered it is listed to LO in the format:

ENTR: ENTRY NAME = entry name , ORG NAME = root name

Actual file contents and control records "EOF.", "EOP.", and "EOT." and not listed.

Example: Display the contents of the FMUTIL tape on logical unit number 18.

T,18

21.13 X DIRECTIVE

This directive is used to set the expiration date to be used in conjunction with the "LOAD ALLNEW" command. Files which have not been accessed (except load modules) since the specified date will not be reloaded onto a partition during a LOAD ALLNEW command. The expiration date is based on the last access date of the file and is ignored if the file is a load module.

The X directive has the format:

X,MM/DD/YY

where

MM Is a two digit month number.

DD Is a two digit day number.

YY Is a two digit year number.

The only way to revoke an expiration date is to utilize another "X" command providing a new date.

Example: Set an expiration date of January 1, 1979.

X,01/01/79

SECTION 22
COMPRESSION/EDIT SYSTEM (COMSY)

COMSY is a source record COMpression and edit SYstem. It is a background task that constructs files of programs in a compressed format for later updating and decompression. It has provision for maintaining these files as sequential files on magnetic tape and RMD or as random accessed files on RMD.

Figure 22-1 is a block diagram of the general data flow through COMSY.

22.1 ORGANIZATION

COMSY is scheduled by the job-control processor (JCP) directive/COMSY. Once activated, COMSY inputs and executes directives from the SI logical unit. COMSY directives specify both the action to be taken and the logical units and files to be used.

22.1.1 COMSY Compression

COMSY compresses 80 character ASCII records into modules called decks. A COMSY deck consists of an ASCII deck identification record and any number of 60-word binary records. The deck identification record is described in section 22.3.15.

COMSY binary records consist of a sequence count in word 0, a checksum in word 1, and compressed ASCII text in words 2 through 59. The last record of a deck contains its sequence number as a negative number. The checksum is a value which is obtained by summing the 116 8 bit bytes contained in words 2 through 59 in an unpacked array with each byte right justified in a word with the remainder of the word zeros.

COMSY compresses the ASCII text by reducing two or more imbedded blanks to a two character sequence the first of

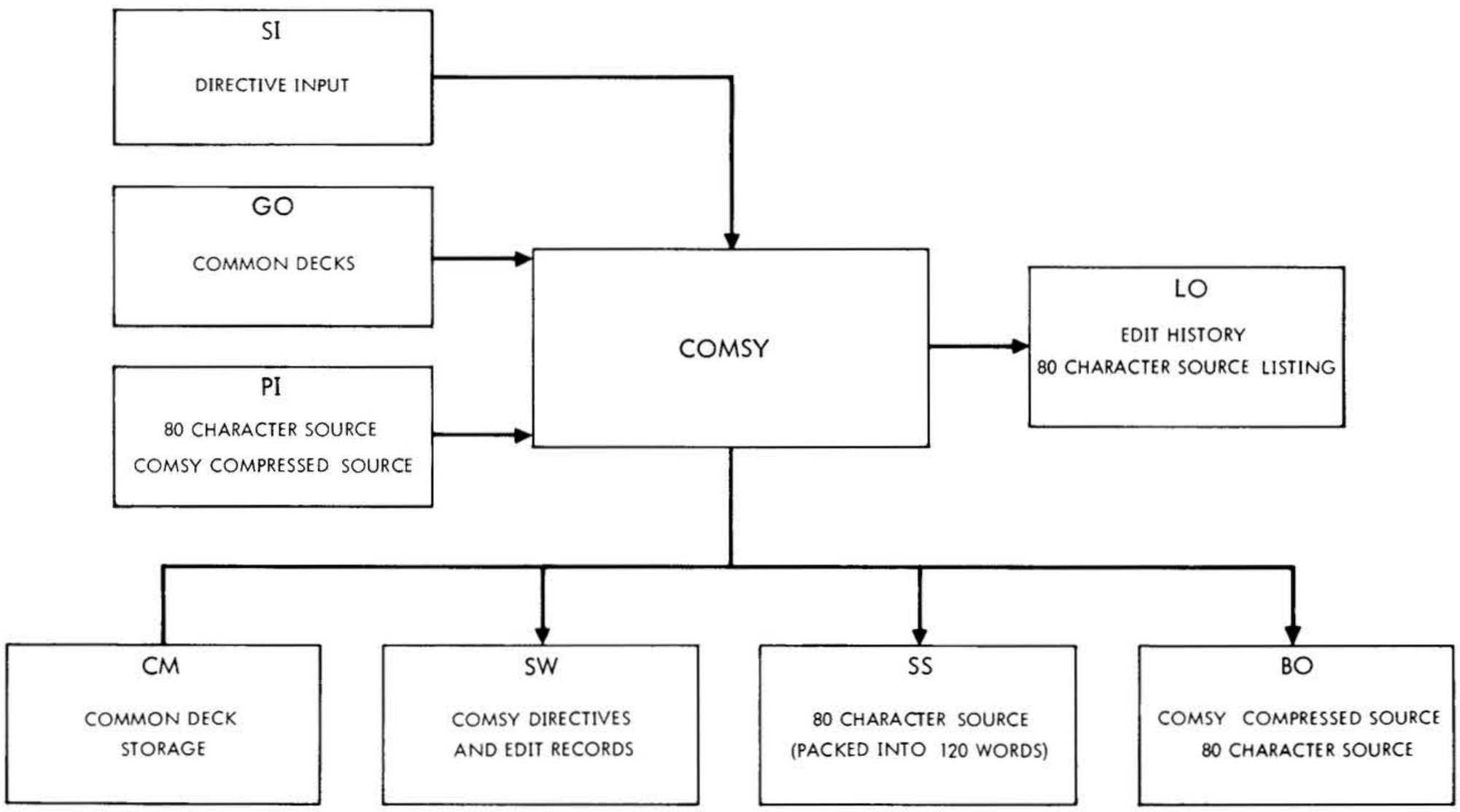


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Figure 22-1. COMSY Data Flow

which is an ASCII NUL character (200) and the second of which is the count of the number of blanks imbedded minus two. During compression, characters 73 through 80 are ignored and any trailing blanks are dropped and replaced by an end of record character represented by an ASCII rub-out (377). The last compressed record of a deck is followed by an ASCII EOT character (204).

22.1.2 Sequential Files

A sequential COMSY file is a file of COMSY decks which contain unpacked records. The last deck is followed by a .FILE directive and an end-of-file. Sequential files may be recorded on magnetic tape or RMD. Although COMSY will allow input of decks from a card reader, it is not programmed to consider the handling of files from cards.

22.1.3 Random Files

A random COMSY file is an RMD file which contains a deck directory and COMSY decks. COMSY decks are recorded in 120 word blocks of two 60 word records per block. This provides faster access to specific COMSY decks that can be obtained on a sequential file.

22.1.4 Common Files

A COMSY common file is a file containing up to nineteen decks which may be inserted into COMSY decks as updates. Each common file contains a directory which allows random accessing of the decks which it contains. Common decks may be entered into a common file by transferring an existing COMSY deck or by input of 80 character source records. Common decks are stored on an RMD in uncompressed form to allow for speedy insertion into other decks.

When initialized, COMSY assumes that the common file is assigned to unit CM with the default logical unit as lun 9 (GO File). A different common file may be utilized by assigning it to unit CM with a UNIT directive.

22.1.5 Sequence and Edition Numbers

During the compression of 80 character source records, COMSY truncates characters 73 through 80. Any identification or sequence numbers contained in these characters is lost. In order that different versions of the same deck may be identified, COMSY maintains a deck edition number. A decks edition number appears in its identification records.

Within a deck, COMSY identifies records by their relative positions in the deck. The first record has a sequence number of one, the second, two, etc. COMSY updating directives require the use of these sequence numbers to specify the location of insertions and deletions.

When 80 character source records are output, COMSY inserts the deck edition number in character positions 73 through 74 and the record sequence number in positions 75 through 80 of each record. When a new COMSY deck is not being output, the edition number used is the edition number of the input and the sequence numbers refer to each records position in the input deck. Inserted records are denoted by the insertion of asterisks in place of edition and sequence numbers. If a new COMSY deck is being output, the edition number used is the edition number of the new deck and the sequence numbers refer to each records position in the new deck. In this case, inserted records will have an edition and sequence number.

22.2 INPUT/OUTPUT

COMSY utilizes seven logical units, some of which are reassignable by use of the .ASSIGN and .UNIT directives. Table 22-1 contains the logical unit names, default assignments and usage.

Table 22-1. COMSY Logical Units

COMSY Name	LUN	Default Unit	Usage
SI	2	SI	Directive input. Source record input. COMSY deck input.
PI	4	PI	Source record input. COMSY deck input. COMSY file input.
BO	7	BO	Unblocked decompressed output. COMSY deck output. COMSY file output.
LO	5	LO	List output.
SS	8	SS	Block decompressed output.
SW	102	SW	Temporary update storage.
CM	9	GO	Common deck storage.

Note: SS, SW and CM must be on RMD.

22.3 COMSY DIRECTIVES

This section describes the COMSY directives:

a. I/O assignment and option selection directives

ASSIGN Assign non-RMD logical unit

UNIT Assign and open RMD file (with rewind)

SET Set COMSY options

GANG Select and specify out of identification field

These directives are used to replace the default logical units assigned by COMSY with user specified logical units and to select user options.

b. Deck creation, copying and checking directives

DECK Build COMSY deck from source input

COMDECK Build a common deck

COPY Copy decks or files

RANDOM Build a random file

APPEND Append to a random file

EDIT Edit a random file

LIST List decknames in a file

CHECK Check sequence and checksums

These directives are used to create, copy and check the validity of COMSY decks and files.

c. Updating directives

INSERT (**ADD**) Record insertion

REPLACE (**DELETE**) Record deletion and replacement

COMMON Common deck insertion

COMSY Deck decompression

These directives are used to update an existing COMSY deck and to cause decompression when required. The updating directives INSERT, ADD, REPLACE, DELETE and COMMON must directly precede as a group the COMSY directive which specifies the deck to be processed. All other directives required to produce a desired result must precede the updating directives. Sequence numbers must always be in ascending order (note: Equal is not considered ascending).

d. End-of-file and exit directives

FILE Logical end-of-file
END Exit COMSY

These directives are used to specify a logical end-of-file and to exit from COMSY.

COMSY directives must begin with a period as the first character of the record and must contain no imbedded blanks. Directives are terminated at the first blank with the exception of the .COMSY record which is the first record of a COMSY deck. Comments may appear after the terminating blank.

The general form of a COMSY directive is

.name,*p(1)*,*p(2)*...*p(n)*

where

name is one of the directives names given above

each p(n) is a parameter defined below under the descriptions of the individual directives.

22.3.1 ASSIGN Directive

This directive specifies a logical unit assignment for a COMSY reassignable unit. This directive cannot be used for an RMD logical unit. It has the form

.ASSIGN,unit,lun,*R*

where

unit is the name of a COMSY reassignable unit. Allowable unit may be SI, PI, BO, LO, and SS.

lun is the two character name or the logical unit number of the VORTEX logical unit to be assigned.

R is the character R which along with its preceding comma is optional. If present, it indicates the unit is to be rewound prior to use.

If the result of the assignment is a reassignment of unit BO or the logical unit, lun, currently assigned to BO, COMSY checks to see if any COMSY output had been written on BO since the last assignment of BO. If so, a .FILE directive and an end-of-file are output to BO prior to making the assignment. Additionally, if the current assignment of BO is to an RMD file (see section 22.3.2), the file is closed with update.

If the logical unit, lun, being assigned is currently assigned to unit PI and the current assignment is to an RMD file, the file is closed without update prior to making the assignment.

Reassignment of a lun to the same unit as is currently assigned is permitted and should be used to rewind units when necessary.

Example: Assign M0 as PI and logical unit 25 as BO specifying rewind of BO.

```
.ASSIGN,PI,M0
.ASSIGN,BO,25,R
```

22.3.2 UNIT Directive

This directive specifies a logical unit and file assignment for a COMSY reassignable unit on RMD. It has the form

.UNIT,unit,lun,file,*key*

where

unit is the name of a COMSY reassignable unit which may be assigned to RMD. Allowable units may be PI, BO or CM.

lun is the two character name or the logical unit number of the RMD partition containing the file to be assigned.

file is the name of the file to be assigned and opened.

key is the one character key for the assigned partition, lun. This parameter along with its preceding comma may be omitted when the partition does not require a key.

If the result of the assignment is a reassignment of unit BO or the logical unit, lun, currently assigned to BO, COMSY checks to see if any COMSY output had been written on BO since the last assignment of BO. IF so, a .FILE directive and an end-of-file are output to BO prior to making the assignment. Additionally, if the current assignment of BO is to an RMD file, the file is closed with update.

Since COMSY compares only the partition logical unit numbers and ignores file names, it is not possible to have two files referenced with the same logical unit number. If this is required, an alternate logical unit number should be assigned to the partition outside of COMSY. The normal logical unit number is then used for one file and the alternate may be used for the other.

Reassignment of a lun and file to the same unit as is currently assigned is permitted and should be used to reposition to beginning of file when necessary.

Example: Assign file OFILE on logical unit 25, key equal X, to PI.

```
.UNIT,PI,25,OFILE,X
```

Assign files OFILE to PI and NFILE to BO. Both files are on logical unit 20. The partition has no key.

```
/ASSIGN,25,20
/COMSY
.UNIT,PI,20,OFILE
.UNIT,BO,25,NFILE
```

22.3.3 SET Directive

This directive is used to turn on selected user options. It has the general form

.SET,*P(1),P(2)...P(n)*

where

each P(i) is one of the parameters listed in the table below.

The appearance of a parameter in the list turns the selected option on. All options whose parameters do not appear in the list are turned off. Any options which are previously set on and which are to remain on must appear in the list. The resulting option setting remains in effect until another SET directive is encountered.

If no parameters appear, the standard default options as indicated in the table below will be set. The standard default options are automatically set when COMSY is initialized. The acceptable parameters are:

Parameter	Default	Option
A	on	Addition/deletion listing
C	on	Compile file output
E	off	End-of-file insertion
I	off	Input source records from PI
L	off	List output
N	off	New decks to be output
S	off	Source record output
Vn	off	VORTEX option switch
Y	off	Copy option

Examples: Set the options to input source records from PI and output a new COMSY deck.

```
.SET,I,N
```

Set the standard default options which are to output to the compile file and list all additions/deletions.

```
.SET
```

The following describes the characteristics of the SET options:

Addition/Deletion List Option (A)

When this option is turned on, all records which are added or deleted are listed on the LO unit. Records which are deleted are preceded on the line by *D*. Records which are added or inserted are preceded by *A*. The update directive which caused deletions and/or additions is listed preceding the deleted or added records.

Compile File Option (C)

When this option is turned on, it indicates that 80 character source records which are decompressed are to be output to SS for submission to FORTRAN or DASMR. Records are packed three to a sector. The last sector will be blank filled when necessary. Records from successive decompression of different COMSY decks may be concatenated on the compile file, however, the last RMD sector occupied by records from a deck may contain up to two trailing blank records. If each deck is a separate subprogram, the last record is an END. FORTRAN and DASMR will ignore the trailing blank records and begin processing with the first record of the next sector. COMSY closes the file with update after each deck insertion.

Source Record Output Option (S)

When this option is turned on, it indicates that 80 character source records which are decompressed are to be output a record at a time to unit BO.

End-of-file Option (E)

When this option is turned on and the source record output option is also on (S), an end-of-file is output on BO after the last record of each deck is output.

New Deck Option (N)

When this option is turned on, it indicates that a new COMSY deck is to be output to BO for each COMSY deck or source deck input. Any updates which are applied to a COMSY deck input will be included in the deck output. The new deck retains the same name and date of origination, however, the edition number is incremented by one and the date of last update is set to the current date.

Copy Option (Y)

When this option is turned on, it has the same effect as the new deck option (N), with the following addition. In addition to outputting a new deck for each COMSY deck or source deck processed, any COMSY decks which are passed over during a search for a specific COMSY deck will be copied without modification to BO. Do not use the Y option with random created files.

Input Source from PI Option (I)

When a DECK directive is encountered, this option will cause COMSY to input source records from PI until a FILE directive or an end-of-file is encountered. When this option is turned off source records are input from SI.

List Output Option (L)

When this option is turned on, 80 character source records will be listed on unit LO.

VORTEX Switch Option (Vn)

This option is used to control the conditional assembly of programs. When the option is turned on, it causes COMSY to examine the first source record of each COMSY deck which is being decompressed. If the first record is a DASMR SET directive of the form:

1	8	16
VORTEX	SET	C

where

C is any character

The character in position 16 is replaced by character n. Character n may be omitted, in which case a 2 is placed in position 16.

Examples:

A DASMR SET directive of the following form appears as the first record of a deck.

```
VORTEX SET 1
```

A COMSY SET directive of the form:

```
.SET,V4,.....
```

would cause the above record to be changed to:

```
VORTEX SET 4
```

and a COMSY SET directive of the form:

```
.SET,V,....
```

would cause the above record to be changed to:

```
VORTEX SET 2
```

Note: If the first record of a deck does not contain a SET directive in the form indicated above, the option has no effect on that deck.

22.3.4 GANG Directive

This directive specifies a three character identification code which is to be inserted into the identification field, character positions 73 through 75, of all 80 character source records which are output as a result of the source record output option (S) is set. The identification code

replaces the deck edition number which is normally inserted in each record. The GANG directive has the general form

.GANG,xxx

where

xxx is any three ASCII characters, including blank.

If the parameter is omitted, the comma is absent, the normal edition number insertion made is reinstated. The GANG directive has no effect on other forms of COMSY output.

Example: Output a COMSY deck in 80 character source record mode, with the identification field set to COM.

```
.GANG,COM
.SET,S
```

22.3.5 DECK Directive

This directive is used to specify the name of a deck and to direct COMSY to input 80 character source records from unit SI or PI. The form of the directive is

.DECK,deckname

where

deckname is a one to eight ASCII character name to be assigned to the deck.

If the input from PI option is on (I), input is from unit, PI; otherwise, input is from unit SI. Records are input until a FILE directive or an end-of-file condition is encountered on the input unit. Output created as a result of this directive is controlled by the on or off conditions of the user options as specified by the last SET directive encountered.

Example: Input source records from SI and output a new COMSY deck with the deckname SOURCE, listing the records on the printer.

```
.SET,N,L
.DECK,SOURCE
  n 80 character source
  records
.FILE
```

Example: Input source records from logical unit M0 and output a new COMSY deck with the deckname ALPHA on logical unit 25.

```
.ASSIGN,PI,M0
.ASSIGN,BO,25
.SET,I,N
.DECK,ALPHA
```

22.3.6 COMDECK Directive

This directive is used to specify the name of a common deck and to cause COMSY to transfer the deck to the common file (see section 22.1.4). A special form of the directive is used to open an existing common file. The directive has the form:

.COMDECK,deckname,S

where

deckname is a one to eight ASCII character name to be assigned to the deck.

S is the optional character S, which when present, causes COMSY to input 80 character source records from PI until a .FILE or end-of-file is encountered.

If no parameter appears, COMSY will input a COMSY deck from SI using the name of the COMSY deck input as the common deck name. If parameter S and its preceding comma are absent, COMSY will search the COMSY file on PI for the named COMSY deck and transfer it to the common file.

Common decks are transferred to a common file as uncompressed records packed three records per RMD sector. Decks may be added to an existing common file up to a maximum of nineteen decks, after which an error will be indicated. Common decks which are to be used in any one update of a COMSY deck must reside in the same common file as there is no provision for changing common file once an update is started.

Upon initialization, the common file is defaulted to the VORTEX GO file. The UNIT directive may be utilized to assign CM to a different user file. A special COMDECK directive of the form:

```
.COMDECK,*
```

will cause COMSY to open the file currently assigned to CM, assuming that the file already contains a directory and existing common decks. If this directive does not appear, COMSY will assume that the file assigned to CM does not contain valid common information. It should be noted that a common file which resides in the VORTEX GO file will not be retained between COMSY executions within the same job.

Example: Assign an existing common file, CMFILE, on logical unit 25 as the common file and add COMSY deck COMMON from the file on PI into it.

```
.UNIT,CM,25,CMFILE
.COMDECK,*
.COMDECK,COMMON
```

Example: Input 80 character source records from PI and transfer them to the common file with a common deck named COMF.

```
.COMDECK,COMF,S
```

22.3.7 COPY Directive

This directive is used to copy COMSY decks on unit PI to a file on unit BO. It has the form

.COPY,*first*,*last*

where

first is the optional deckname of the first deck to be copied. COMSY will search the file on PI for the named deck. If the parameter is absent, COMSY will copy decks from the current position on PI.

last is the optional deckname of the last deck to be copied. If the parameter is absent, COMSY will copy decks until a FILE directive or end-of-file is encountered on PI.

Input to COPY is always in the form of COMSY decks. PI may be an existing random file in which case decks are copied in the order in which they were placed in the file. Output from COPY is controled by the settings of the user selectable output options. If the new deck (N) or copy (Y) options are set, output is in the form of COMSY decks. Otherwise, output is in the form selected by the remaining user options (S,E, C and L). The output file is always sequential. Random files may be copied by utilizing the RANDOM directive.

Example: Copy decks from the current position on PI until the deck named ADECK is copied. Output is to be COMSY decks.

```
.SET,N
.COPY,,ADECK
```

Copy decks starting from deck FIRST to end-of-file

```
.COPY,FIRST
```

Copy the deck named MYDECK only

```
.COPY,MYDECK,MYDECK
```

22.3.8 RANDOM Directive

This directive is used to copy COMSY decks from an existing sequential or random COMSY file into a new random file. It has the form

.RANDOM,*first*,*last*

where

first is the optional deckname of the first deck to be copied. COMSY will search the file on PI for the named deck. If the parameter is absent, COMSY will copy decks from the current position on PI.

last is the optional deckname of the last deck to be copied. If the parameter is absent, COMSY will copy decks until a FILE directive or end-of-file is encountered on PI.

During the process of copying, COMSY constructs a directory which will allow random accessing of the file. The input file may be an existing random file. If so, any deleted decks (decks which contain the deckname *DELETED) will be omitted from the output file.

At the completion of the copy, the output file is closed and must be reopened for subsequent use. Once a random file is created, additions to the file are made by use of the APPEND directive.

Example Build a random file called RFILE on logical unit 22, key X, from a COMSY file on tape unit M0.

```
.ASSIGN,PI,M0
.UNIT,BO,22,RFILE,X
.RANDOM
```

In the above example, include only those decks which are between and include DECKA and DECKZ.

```
.RANDOM,DECKA,DECKZ
```

22.3.9 APPEND Directive

This directive is used to copy COMSY decks from an existing sequential or random COMSY file into an existing random file. It has the form

.APPEND,*first*,*last*

where

first is the optional deckname of the first deck to be copied. COMSY will search the file on PI for the named deck. If the parameter is absent, COMSY will copy decks from the current position on PI.

last is the optional deckname of the last deck to be copied. If the parameter is absent, COMSY will copy decks until a FILE directive or end-of-file is encountered on PI.

Decks which are copied are appended to the end of the existing random file. At the completion of the copy, the output file is closed and must be reopened for subsequent use.

Example: Append decks FDECK to and including LDECK from a tape on logical unit 18 to an existing random file, RFILE, on logical unit 22, key X.

```
.ASSIGN,PI,18,R
.UNIT,BO,22,RFILE,X
.APPEND,FDECK,LDECK
```

Append decks from FDECK until the end of the input file.

```
.APPEND,FDECK
```

Append all decks from current position to the end-of-file

```
.APPEND
```

22.3.10 EDIT Directive

This directive used to edit existing random files. It may be used to delete a deck, rename a deck, or change a deck edition number. It has the form

.EDIT,op,deckname,*newname,newedition*

where

op is DEL to delete deckname or REN to rename deckname and / or change the edition number

deckname is the current name of the effected deck.

newname is the optional new deckname for the specified deck.

newedition is the optional new edition number for the specified deck.

COMSY does not remove the entry for a deleted deck from the directory or is the deck removed from the file. The deckname is replaced by the name *DELETED in both the directory and in the deck's COMSY record. Deleted decks may be dropped by copying a random file to a new file utilizing the RANDOM directive.

Examples: Delete deck named ALPHA

```
.EDIT,DEL,ALPHA
```

Rename deck currently named as BETA with new name GAMMA and edition 01

```
.EDIT,REN,BETA,GAMMA,01
```

22.3.11 LIST Directive

This directive is used to list the deck information from the COMSY records of all the decks contained in the file assigned to PI. It has the form

.LIST

Listing starts from the current position on PI, with no rewind, and continues until a FILE directive or end-of-file is detected. The listing contains deck position, deckname, edition, original COMSY date, last update date, deck size, and file accumulated size. Deck size is the number of records in the deck including the initial COMSY record.

22.3.12 CHECK Directive

This directive is used to verify the contents of a COMSY file on PI to list the deck information from the COMSY records of the decks contained in the file. It has the form

.CHECK

Verification starts from the current position on PI, with no rewind, and continues until a FILE directive or end-of-file is detected. A listing is produced with the same format as that produced by the LIST directive. All records contained within the decks are checked for checksum and sequence. When an error is detected, an error message is output prior to the deck information for the erroneous deck.

22.3.13 INSERT (ADD) Directive

This directive is used to insert new records after the record with the sequence number specified. It has the form

.INSERT,seqno

or

.ADD,seqno

where

seqno	is the sequence number (in the COMSY deck to be processed). of the record after which new records are to be inserted. Records directly following the INSERT directive are inserted until another directive is encountered. When an addition/ deletion listing is checked (see SET directive) added records are preceded by *A*.

Example: Insert new records after record number 8 and after record number 15.

```
.INSERT,8
  ABX=10
  ABY=ABX*25
.INSERT,15
  READ(5,100)IBUF
.COMSY,HTEST
```

22.3.14 REPLACE (DELETE) Directive

This directive is used to delete old records and to optionally replace the deleted records with new records. It has the form

.REPLACE,first,*last*

or

.DELETE,first,*last*

where

first	is the sequence number of the first record to be deleted.
last	is the optional sequence number of the last record to be deleted. If omitted, only the record specified by first is deleted.

REPLACE and DELETE both operate in the same manner and are interchangeable. Records are first deleted from output and then replaced by new records which directly follow the directive until another directive is encountered. New records may be omitted to cause deletion only. When an addition/deletion listing is created (see SET directive), deleted records are preceded by *D* and added records by *A*.

Example: Replace records 15 through 19 with new records and delete record 24.

```
.REPLACE 15,19
   LDA          TEMP
   STAE         ALPHA
.DELETE,24
.COMSY      (process next
             deck from PI)
```

22.3.15 COMMON Directive

This directive is used to insert a deck from the common file after a specified input record, or in place of specified input records. It has the form

.COMMON,name,action,first,*last*

where

name	is the name of the deck to be inserted from the common file currently open.
action	is the directive INSERT or the directive REPLACE to specify designed action. ADD or DELETE are not acceptable.
first	is the sequence number of the input record after which the common deck is to be inserted, or is the first record to be replaced.
last	is the optional sequence number of the last record to be replaced. If omitted, only the record specified by first is replaced.

This directive essentially operates in the same manner as INSERT and REPLACE, with the exception that the new records are in the common file rather than following the directive. The special directive **.COMDECK,*** must be used to open an existing COMMON file (22.3.6) before using the **.COMMON** directive.

Example: Place decks COM1 and COM2 in the common file and then insert COM1 at record 2 and replace records 25 through 32 with COM2.

```
.COMDECK,COM1
.COMDECK,COM2
.COMMON,COM1,INSERT,2
.REPLACE,16
   LDXI    5
.COMMON,COM2,REPLACE,25,32
   .
   .
.COMSY,PROGA
```

Example:

Assign the COMSY file "SRC" on lun 25 and the existing COMMON file "COMFIL" on lun 30. Open the COMMON file. Replace record 15 in "PRGB" with the contents of the COMMON deck "COMB".

```
.UNIT,PI,25,SRC
.UNIT,CM,30,COMFIL
.COMDECK,*
.COMMON,COMB,REPLACE,15
.COMSY,PRGB
.END
```

22.3.16 COMSY Directive

This directive specifies the COMSY deck which is to be processed. Updates directly preceding the COMSY directive will be applied during processing. It has the following two forms

form 1: **.COMSY**,*deckname,newname,newedition*

or

form 2: **.COMSY,deckname,edition,odate,udate**

where in form 1

deckname is the optional name of the deck to be processed

newname is the optional new name to be assigned to the deck if a new COMSY deck is to be output

newedition is the optional new edition number to be assigned to the deck if a new COMSY deck is to be output

where in form 2

deckname is the eight character deckname (including blanks)

edition is the two character edition number (00-99)

odate is the date the original COMSY edition was created

update is the date the deck was updated

When deckname is omitted in form (1), the deck to be processed is the next deck on unit PI. When deckname is present, it is the name of the deck to be searched for in the COMSY file assigned to PI. The input file may be in sequential or random format. During the search on a sequential file, decks passed over will be copied to BO if the copy option is selected (see SET directive).

The second form of the COMSY directive is the COMSY record which is output by COMSY as the first record of a COMSY deck. When a COMSY deck is to be processed from SI, form (1) must be omitted. Although COMSY originates form (2) it may be modified or replaced by the user; however, character positions within the record are fixed, therefore, field sizes must not be changed.

Example: Process deck ABLE changing its name to BAKER and edition to 09.

```
.COMSY,ABLE,BAKER,09
```

22.3.17 FILE Directive

This directive is used to specify a logical end-of-file. It may replace or be replaced by a physical end-of-file or a disc end-of-file. It has the form

.FILE

22.3.18 END Directive

This directive causes COMSY to exit. It may optionally specify that a series of JCP directives be executed. It has the form

.END,*NN,directive*

where

NN is an optional numeric parameter specifying the number of pages to be allocated by a JCP/MEM directive. If omitted, the preceding comma is omitted.

directive is optionally, any legal JCP directive without a slash (/).

Prior to exiting, a check is made to determine if any new COMSY decks have been output on BO. If so, a FILE directive and an end-of-file are output to BO. If BO is assigned to a file on RMD, the file is closed with update.

When the first parameter is present, COMSY performs the JCP/MEM function as if a /MEM,NN directive had been processed by JCP. If the second parameter is present, the parameter, preceded by a slash (/), is transferred into the JCP input buffer; and, if the compile file output option is on, the JCP functions

```
/ASSIGN,PI=SS,PO=DUM
/PFILE,PI,,SS
```

are preformed as if they had been input to JCP.

Example:

```
/COMSY
.SET,N,C
.DELETE,5
.COMSY,PROG1
.END,3,DASMR,B
```

The above directives will cause program PROG1 to be input from PI, record 5 will be deleted, a new COMSY deck will be

output to BO, assembler input will be blocked and output to SS, and COMSY will cause the following JCP functions to be performed:

```
/ASSIGN,PI=SS,PO=DUM
/PFILE,PI,,SS
/MEM,3
/DASMR,B
```

22.4 COMSY LOAD MODULE GENERATION

COMSY is normally executed as a priority 1 task from the VORTEX Background Library (BL). It may also be executed from an alternate library.

COMSY contains eighteen overlays. During load module generation, the error code LG16 will be output to SO for each overlay. This diagnostic is normal and should be ignored. COMSY requires 10K (20 pages) of memory for execution.

22.5 COMSY EXECUTION

COMSY is executed by input on the SI logical unit of a directive of the form

/COMSY

There are no parameters.

22.6 ERROR PROCESSING

When COMSY detects an error, a diagnostic message is printed on the LO logical unit and processing is terminated. COMSY exits by executing a FORTRAN STOP statement which contains the error number of the error detected. FORTRAN displays the STOP statement in the form

COMSY STOP n

where n is the error number

Upon completion of processing of a spool file status or spool file delete request, S$SPC writes a prompt message to the operator console and waits for the next operator request to be entered. After initiation of communication to a spool print task, S$SPC exits from the VORETX system.

23.4.1 EX (Spool Print Task Exit)

End of communication and exiting of either S$SPC or a spool print task may be requested by use of the EX command.

The format of the EX command is:

```
EX
```

23.4.2 SG (Spool Print Task Go)

End of communication with a spool print task may be requested by use of SG, the spool print task go command. A spool print task upon recognition of the SG command, resumes processing at the point of interruption to communicate with the operator console.

The format of the SG command is:

```
SG
```

where

nn	is a two-digit number in the range 01-14. This number specifies the spool print task with which communication is desired.

Example: Initiate communication with the spool print task S$SP01. The spool communication task S$SPC, is to be scheduled at priority level 9. The task resides on the foreground library whose protection code is F.

```
;SCHED,S$SPC,9,FL,F
S$SPC,SP**
SB,01
S$SPC,SP05,01
```

After S$SPC is scheduled, communication is initiated with the spool print task S$SP01. The communication initiated message (S$SPC, SP05,01) is written to the operator console and S$SPC exits from the system.

23.5 INITIATION OF COMMUNICATION WITH A SPOOL PRINT TASK

After scheduling S$SPC, the spool print break command SB is entered from the operator console to initiate communication to a spool print task. If communication is initiated to the spool print task specified in the spool print break command, S$SPC outputs a communication initiated message on the operator console and exits from the VORTEX system. If the spool break command is not valid or communication cannot be initiated to the spool print task specified in the break command, S$SPC outputs an error message on the operator console. In this case, if no further attempt to communicate with a spool print task is to be initiated, the spool communication exit command EX may be entered from the operator console to request S$SPC to exit from the VORTEX system.

The format of the SB command is:

```
SB,nn
```

23.6 SPOOL FILE STATUS DISPLAY

The status of spool files is obtained by use of the display status (DS) command. The status of the requested spool files is displayed on the operator console in the order of the spool files in the spool file directory. The format of the display status command is

```
DS { ,ALL       }
   { ,printclass }
   { ,jobname    }
```

where

ALL	constant 'ALL' specifies a display of the status of all spool files in the spool file directory
printclass	is a single alphabetic character (A through Z) used to relate individual spool files. This relationship or grouping together of individual spool files my be for any desired reason but most often is based on the similarity of information in the associated spool files.
jobname	one to eight-character jobname; applicable only to spool file output from background tasks.

Example: Obtain the status of all spool files within print class A

```
;SCHED,S$SPC,9FL,F
S$SPC,SP**
DS,A
```

JOB NAME	TASK NAME	SPOOL NAME	PRINT CLASS	LUN NO.	DST STATUS	
JOBONE	TASKA	S00036	A	5	43	S$SP01
JOBONE	TASKB	S00037	A	5	43	0
JOBONE	TASKC	S00038	A	5	43	S$SPO

S$SPC,SP05,04

After S$SPC is scheduled, operator console display of the three spool files associated to class A is initiated. The display is followed by the status display completion message (S$SPC,SP05,04)

A spool file may have one of four possible status settings

Status	Indication Status Display
open for write	S$SPO
available for print	0
open for print	S$SPnn
printed and held	nnnnn

where

S$SPO	is the name of the spool output task
0	indicates that the spool file is complete and has not been printed
S$SPnn	is the name of the spool print task and nn is a two digit number in the range 01-14
nnnnn	is the number of print lines of the held spool file and is a five digit number in the range 1-32767

23.7 DD (SPOOL FILE DELETE)

A Multitask Spool system command is available to delete spool file. The spool file delete command, DD, removes the requested spool file from the spool file directory and deletes the requested spool file from the RMD partition directories on which the spool file reside. To be deleted, a spool file must have a status of either closed or held.

The format of the DD command is:

$$DD,\left\{\begin{matrix}\text{print} \\ \text{class}\end{matrix}\right\},\text{jobname},\}\text{filename}$$

where

print class	one alphabetic character (A through Z)
jobname	one to eight character VORTEX II jobname
spool filename	a 6 character spool filename

Example: Delete the closed spool file named S00038.

```
;SCHED,S$SPC,9,FL,F
S$SPC,SP**
DD,,,S00038
S$SPC,SP05,05
```

After S$SPC is scheduled, the spool file S00038 is removed from the spool file directory, deleted from the RMD partition directory on which it resided and the delete complete message (S$SPC,SP05,05) is written to the operator console.

23.8 (Spool File Print)

Three Multitask Spool system commands are available to print spool files. The three commands are:

Command Code	Description
PA	**Spool File Print and Align** - If the first record of the specified spool file is a forms control record, it is displayed on the operator console then the number of records specified in the PA command are written to the line printer specified in the PA command. Specifying the line printer lun as a dummy lun allows a forms control record to be displayed with no printing.
PH	**Spool Print and Hold** - Executes the print request and does not delete the spool file after completion of print. If the first record of a spool file is a forms control record, it is displayed on the operator console. The spool records are then written to the line printer specified in the PH command. If the print is of spool files in a print class and all spool files in the print class are printed, then the print task waits for a time interval to lapse before searching the spool file directory for additional spool files to print.
PD	**Spool Print and Delete** - Executes the print request and deletes each spool file after completion of print. As with PA and PH, a forms control record, if present for a spool file, is displayed on the operator console.

The format of the PA, PH, and PD commands is

$$\left[\begin{matrix}PA\\PH\\\\PD\end{matrix}\right], \left\{\begin{matrix}\text{printer}\\\text{lun}\end{matrix}\right. , \begin{matrix}\text{print}\\\text{class}\end{matrix} , \begin{matrix}\text{spool}\\\text{filename}\end{matrix} , \left.\begin{matrix}\text{record}\\\text{number}\end{matrix}\right\}$$

where

printer lun — a 1-3 digit number

print class — one alphabetic character (A through Z)

spool filename — a 6 character spool filename

record number — 1-9 digit number; for PA specifies the number of records to be printed, for PH and PD specifies the record number within a spool file at which printing is to start.

Example 1: SPOOL FILE PRINT AND ALIGN - The spool print task S$SP01 is to print the first 10 records of the spool file S00037 from the print class A. Printing is on the line printer to which the logical unit number 15 is assigned.

```
;SCHED,S$SPC,9,FL,F
S$SPC,SP**
SB,01
S$SPC,SP05,01
S$SP02,SP**
PA,15,A,S00037,11
S$SP02,SP05,06
```

The first record of the spool file S00037, if it is a forms control record, is displayed on the operator console. The first 10 print records of the spool file are written to the line printer to which the lun 15 is assigned and the print and align complete message (S$SP01,SP05,06) is written to the operator console.

Example 2: SPOOL PRINT AND HOLD - The spool print task S$SP01 is to print all spool files generated for print class B. Printing is on the line printer to which the logical unit number 15 is assigned.

```
;SCHED,S$SPC,9,FL,F
S$SPC,SP**
SB,01
S$SPC,SP05,01
S$SP01,SP**
PH,15,B
```

After S$SPC is scheduled and communication is established with the spool point task S$SP01, each spool file in print class B that is available for printing (closed) is written to the line printer to which lun 15 is assigned. When printing of all spool files in print class B is complete, the spool print task S$SP01 waits for a time interval to elapse and then searches the spool file directory for additional print class B spool files to print.

23.9 SC (Spool Print Cancellation)

The SC command directs the system to cancel the spool print task currently in process. When the spool print task is cancelled, the spool file record number of the last printed line is displayed on the operator console.

The format of the SC command is

```
SC
```

Example: Cancel the spool print in progress of print class A by the spool print task S$SP01.

```
;SCHED,S$SPC,9,FL,F
S$SPC,SP**
SB,01
S$SPC,SP05,01
S$SP01,SP**
SC
S00118,0000000047
S$SP01,SP05,02
S$SP01,SP**
```

The spool print in progress by the spool print task S$SP01 of spool file S00118 within print class A is cancelled after the printing of record number 47. The spool print task S$SP01 is now waiting for a command to be entered by the console operator as indicated by the spool print prompt message (S$SP01,SP**).

23.10 ST (Spool Print Termination)

A spool print in progress is terminated by use of the ST command. When the ST command is entered, the spool file print continues to spool to file end. If no spool file print is in progress when the ST command is entered, the spool print task outputs a prompt message to the operator console. The format of the ST command is

```
ST
```

Example: Terminate the spool file print currently in progress by the print task S$SP01

```
;SCHED,S$SPC,9,FL,F
S$SPC,SP**
SB,01
S$SPC,SP05
S$SP01,SP**
ST
```

After S$SPC is scheduled and communication is established with print task S$SP01, the ST command is entered. The spool print task S$SP1 completes the spool file print in progress, then waits for initiation of communication via S$SPC.

23.11 SPOOL FILE ALLOCATION

Spool file records are 80 words in length. Word 1-66 of a spool file record contain forms control or print and words 67-80 contain spool file control information.

Spool files are created only on RMD partitions on the disk pack mounted on the drive to which the spool directory logical unit number 107 is assigned.

Spool files are created with a primary space allocation as specified in the SPOPN subroutine call or with the default space allocation of 100 sectors. When the primary space allocation of a spool file is exhausted, the spool file is extended by the secondary space allocation specified in the SPOPN subroutine call or by the default space allocation of 100 sectors.

The search for space to allocate a spool file begins on the disk partition on which the spool file directory resides. The search for space continues on each succeeding partition until the end of the disk or until either the required amount of space is located, or space allocation has been unsuccessfully attempted on each partition available. Note that partitions with a protection key are not used for allocation of spool files. If the space allocation search was not successful and the search was for an amount of requested space greater than the default space allocation, then a search to allocate the default space amount is performed in the same manner as the previous search for space.

23.12 COMPONENT DESCRIPTION

The VORTEX II Multitask Spool system consists of six components:

- VZSDA - spool dummy driver; nucleus, map 0, resident task
- SPOPN - spool file open subroutine. Resides in object module library
- SPCLS - spool file close subroutine. Resides in object module library
- S$SPO - spool output task. Foreground task with a resident TIDB
- S$SPC - spool print communication task. Foreground task with a non-resident TIDB
- S$SP01 - spool print task. Foreground task with a non-resident TIDB

VZSDA, the spool dummy driver, accepts open (spool file create), write, and close requests from either background or foreground tasks for logical units assigned to VZSDA. These requests are passed by VZSDA to S$SPO, the spool output task. VZSDA, upon indication by S$SPO of request processing completion, posts an I/O completion status to the initiating task.

A call to SPOPN, the spool file open subroutine, requests the creation of a spool file. In addition, SPOPN performs the following functions: specifies spool file disk space allocation, specifies the logical unit used in the requesting task's WRITE statement which directs output to a spool file, and specifies a print class to be associated with the spool file.

A print class is a single alphabetic character (A through Z) used to relate individual spool files. This relationship or grouping together of individual spool files may be for any desired reason but most often is based on the importance or similarity of information in the associated spool files. All spool files associated with a given print class may be printed by the computer operator by means of a print request that designates the print class to be printed and the line printer lun to which the print output is to be directed. This facility allows printing of spool files with no knowledge of either the names of tasks that generated the information in the spool files or names of the spool files associated to a print class.

A spool file may also be created without the use of the SPOPN call. Upon each WRITE from a background or foreground task to a logical unit assigned to VZSDA, the spool output task, S$SPO, checks to see if a spool file has been created (opened) for both the task issuing the WRITE and the logical unit number to which the WRITE is directed. If a spool file is not found to be open, then the spool output task creates a spool file with a default disk space allocation of 100 lines and a default print class of A for a background task and B for a foreground task.

A call to SPCLS, the spool file close subroutine, is a request to close a spool file for the task issuing the SPCLS call and for the logical unit number specified in the call. A spool file may also be closed without use of the SPCLS call. At least once every 500 milliseconds S$SPO, the spool output task, scans a table containing an entry for each open spool file to determine if the task that requested opening of the spool file remains active within the system. Open spool files for which the associated task is not active are closed and removed from the table of open spool files.

S$SPO, the spool output task, processes spool file created (open), write, and close requests from VZSDA, the spool dummy driver. S$SPO also performs spool file close processing based on a core table of open spool files as previously described in the discussion of the SPCLS subroutine. After processing an open, write or close request, S$SPO informs VZSDA of the result of request processing and waits for either another request to process from VZSDA or a time interval to lapse before resuming execution.

S$SPC, the spool print communication task, is scheduled by the computer operator for spool file status display, spool file deletion or to initiate communication with a spool print task.

The Multitask Spool system allows from 1 to 14 spool print tasks to be concurrently active within a system. Spool print tasks are named S$SP01 through S$SP14. One spool print task, S$SP01, is assigned at system generation time. Other spool print tasks may be created using the procedures described in this manual.

A spool print task is scheduled by entry of the SCHED directive from the operator console. Once a spool print task is scheduled, the task remains active until terminated by entry of the EX, spool print task exit command, from the operator console. Use of the ABORT directive to terminate a spool print task may result in unpredictable MSPOOL system operation.

The following Multitask Spool system actions are controlled by a spool print task and are available from each scheduled spool print task.

- Spool File Print
- Spool File Print Cancellation
- Spool file Print Termination
- Spool Print Task Exit

When a spool print task is scheduled or when a scheduled spool print task recognizes a communication request from S$SPC, the spool print communication task, it writes a prompt message to the operator console and waits for an operator entry. If the operator entry is a valid command for a spool print task then the action directed by the entered command is taken otherwise an error message and then the prompt message are written to the operator console and the spool print task again waits for an operator entry.

23.13 SYSTEM GENERATION

To incorporate the Multitask Spool sub-system into a VORTEX II system, include the following EQP directive at SYSGEN time:

```
EQP,SD0A,0,1,0,0
```

This will incorporate the dummy driver front-end to spool. Include from 1 to 15 ASN directives for each spool logical unit desired. For example, if it is desired to incorporate three spool channels using logical unit numbers 6, 40 and 41, include:

```
ASN,6=SD00
ASN,40=SD00
ASN,41=SD00
```

Include an ASN directive for logical unit number 107; it must be assigned to an **unprotected RMD partition**. For example,

```
ASN,107=D00J
```

Include an ASN directive for logical unit numbers 108 and 109; they must be assigned to a dummy device as follows:

```
ASN,108=DUM
ASN,109=DUM
```

Include an ASN directive for logical unit numbers 110 through 123 as needed. 110 is used by print task number one (S$SP01), 111 is used by print task number two (S$SP02), etc. They must be assigned to a dummy device. For example, for a system using spool print tasks S$SP01, S$SP02 and S$SP04, include:

```
ASN,110=DUM
ASN,111=DUM
ASN,112=DUM
```

Spool print tasks in addition to S$SP01 are obtained by use of the File Maintenance ENTER directive. For example, to reference also the spool print task S$SP01 as S$SP02 and S$SP04 from the foreground library with logical unit number 106 and protection code F, use the File Maintenance ENTER directive as follows:

```
ENTER,106,F,S$SP01,S$SP02
ENTER,106,F,S$SP01,S$SP04
```

23.14 CONSOLE MESSAGES

The general form of a Multitask Spool console message is:

```
st,ms,mm
```

where

st	is a 5 or 6 character Multitask Spool taskname
ms	is a 4 character message
mm	is a 2 digit message modifier

The Multitask Spool tasknames that appear in console messages are:

S$SPC	Spool Print Communication Task
S$SPnn	Spool Print Task

where

nn — is a two-digit number that identifies a particular print task

S$SPO — Spool Output Task

CONSOLE MESSAGES AND MODIFIERS

SP** prompt to console

SP01 command error

SP02 requested resource in use

- 01 communication with print task cannot be initiated. Communication request to another print task is outstanding
- 02 print task cannot be activated. Print task identical name is already active
- 03 print request cannot be honored. Print is in progress by print task
- 04 exit request cannot be honored. Print is in progress by print task

SP03 requested resource not available

- 01 communication to print task cannot be initiated. Specified print task is not active
- 02 spool input task bootstrap initilization not successful. No lun available for spool file directory and/or at least one spool print task
- 03 spool file directory full; directory pack initiated
- 04 spool file directory full; directory pack did not free directory entries
- 05 spool file name not found

SP04 input/output (I/O) error

- 01 spool file create error
- 02 spool file directory open error
- 03 spool file directory read/write error
- 04 spool file open error
- 05 spool file read/write error
- 06 printer write error

SP05 requested service complete

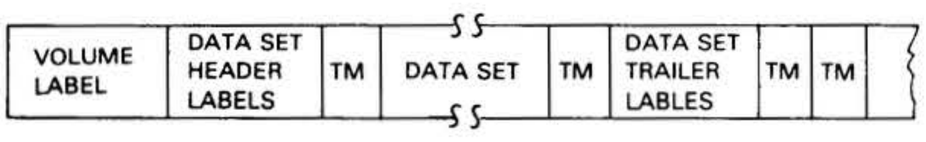
- 01 print task communication initiation
- 02 print cancel
- 03 print task terminate
- 04 spool file status display
- 05 spool file delete
- 06 spool file print align
- 07 spool file print
- 08 spool file directory pack

SECTION 24
TAPE LABELING

24.1 INTRODUCTION TO TAPE PROCESSING

Labels are used to identify magnetic tape reels and the files they contain. With the VORTEX II operating system, tapes can be processed with or without labels. However, the use of labels is recommended as a basis for efficient control of tape libraries.

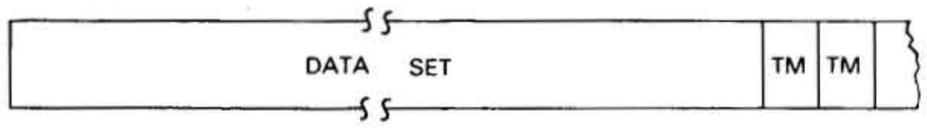
VORTEX II tape labels consist of volume labels and data set labels. The volume label is the first record on the tape. It identifies the volume (reel) and its owner. The labels preceding the data set (file) are called header labels, while the labels following the data set are called trailer labels. These labels identify and describe the data set. SUMMIT labeled tapes have the following basic layout:



where

TM identifies a tapemark (filemark)

Tapes without labels contain only data sets and tapemarks, as shown in the following layout:



24.2 LABEL DEFINITIONS

VORTEX II supports label processing for 9-track tapes at densities of 800 (bits per inch) and 1600 bpi. Labels are 40 word (80 byte) records encoded in EBCDIC and odd parity. The first two words (four bytes) identify the labels as follows:

VOL1 Volume label
HDR1 and/or HDR2 Header labels
EOV1 or EOV2 Trailer labels (end of volume)
EOF1 or EOF2 Trailer labels (end of data set)

The HDR2/EOV2/EOF2 labels use identical formats. Table 24-1 describes the format of the volume label (VOL1).

Table 24-1. Volume Label 1 (VOL1) Format

Bytes	Contents	Description
1-4	VOL1	Label Identifier
5-10	numeric	Volume Serial Number - A unique identification code assigned to the volume when it enters the system. This code may be from one to six digits but, if fewer than six digits, the code must be left justified with trailing blanks.
11	0	Reserved
12-41	b	Reserved
42-51	alphanumeric	Owner Code. A one to ten character code identifying the owner of the volume. If the code is less than ten characters long, it is left-justified with trailing blanks.
52-80	b	Reserved

Table 24-2 describes the format of he der label 1 (HDR1).
This format is also used for EOV1 and EOF1 labels.

Table 24-2. Header Label 1 (HDR1) Format

Bytes	Contents	Description
1-4	HDR1	Header Label (at beginning of a data set)
	EOV1	Trailer Label (at end of a tape volume)
	EOF1	Trailer Label (at end of a data set)
5-21	alphanumeric	Data Set Name - a one to seventeen character name for the data set. If the name is less than seventeen characters long, it is left justified with trailing blanks. The name may contain embedded blanks.
22-27	numeric	Data Set Serial Number - see volume serial number. Contains the volume serial number of the first or only tape volume.
28-31	numeric	Volume Sequence Number - a number (0001 to 9999) that indicates the order of the volume within a multivolume group.
32-35	numeric	Data Set Sequence Number - a number 0001 to 9999) that indicates the order of the data set within a multi-data-set group.
36-41	numeric	Reserved.
42-47	⌀yyddd	Creation Date - yy is the creation year (00 to 99) and ddd is the creation day (001 to 366).
48-53	⌀yyddd	Expiration Date - yy is the expiration year (00 to 99) and dd is the expiration day (001 to 366).
54	0	Reserved.
55-60	numeric	Block Count - this field is always zero (000000). In the header label; this field contains the number of physical records in the data set on the current volume (000000 to 999999) in the trailer labels.
61-80	⌀	Reserved.

Table 24-3 describes the format of header label 2 (HDR2).
This format is also used for the EOV2 and EOF2 labels.

Table 24-3. Header Label 2 (HDR2) Format

Bytes	Contents	Description
1-4	HDR2	Header Label (at beginning of a data set)
	EOV2	Trailer Label (at end of a tape volume)
	EOF2	Trailer Label (at the end of a data set)
5	alpha	Record Format - a single letter identifying the format of the records of the data set: F = Fixed length V = Variable length U = Undefined length
6-10	numeric	Block Length - a number (00000 to 32760) specifying the physical record length in bytes.
11-15	numeric	Record Length - a number (00000 to 32760) specifying the logical record length in bytes.
16	numeric	Tape Density - a single digit identifying the recording density of the tape: 2 = 800 bpi (NRZI) 3 = 1600 bpi (PE)
17	numeric	Data Set Position - a single digit indicating volume switch: 0 = No volume switch has occurred 1 = Volume switch has occurred
18-36	b	Reserved
37	alpha	Control Characters - a one letter code indicating whether a control character set was used to create the data set: A = ASCII control characters M = Machine control characters b = No control characters
38	b	Reserved
39	alpha	Block Attribute - a one letter code indicating the block attribute: B = Blocked records S = Spanned records R = Blocked and spanned records b = No blocked and no spanned records

24.3 LABEL ORGANIZATION

VORTEX II Labeled tapes may contain one or more data sets, and data sets may reside on one or more volumes. The following figures illustrate four typical organizations for standard label tapes.

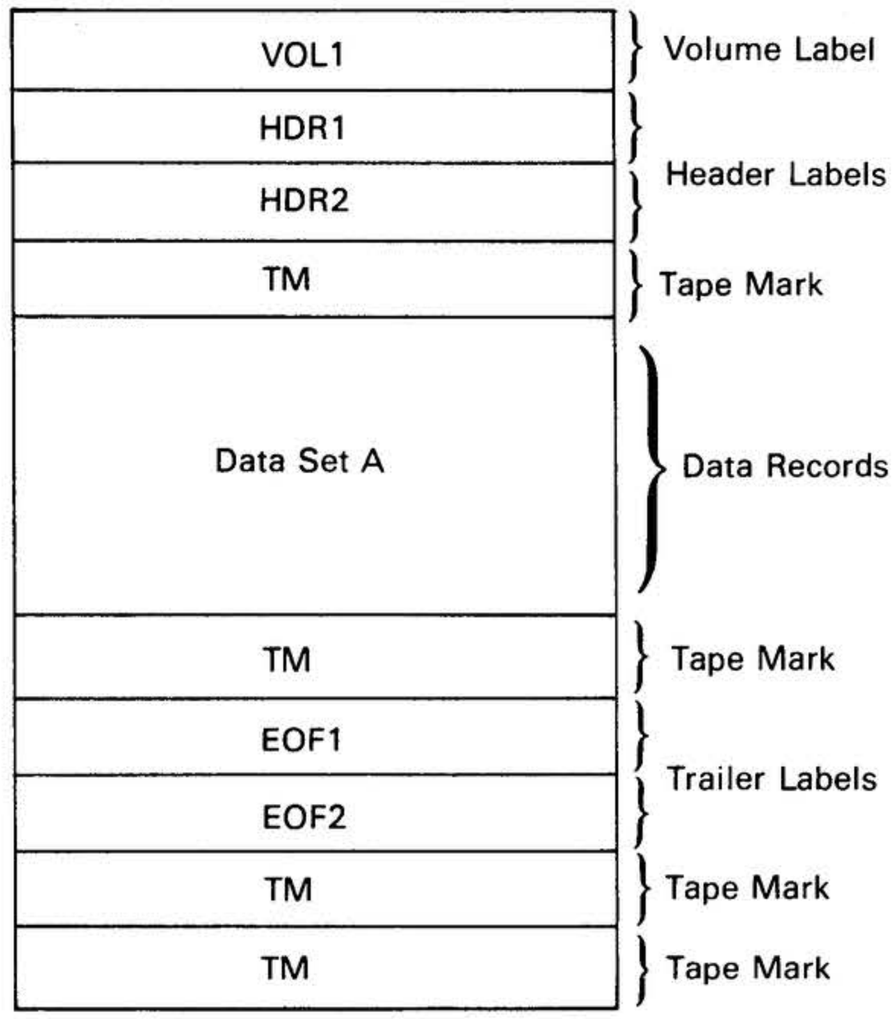


Figure 24-1. Layout of Single Data Set - Single Volume

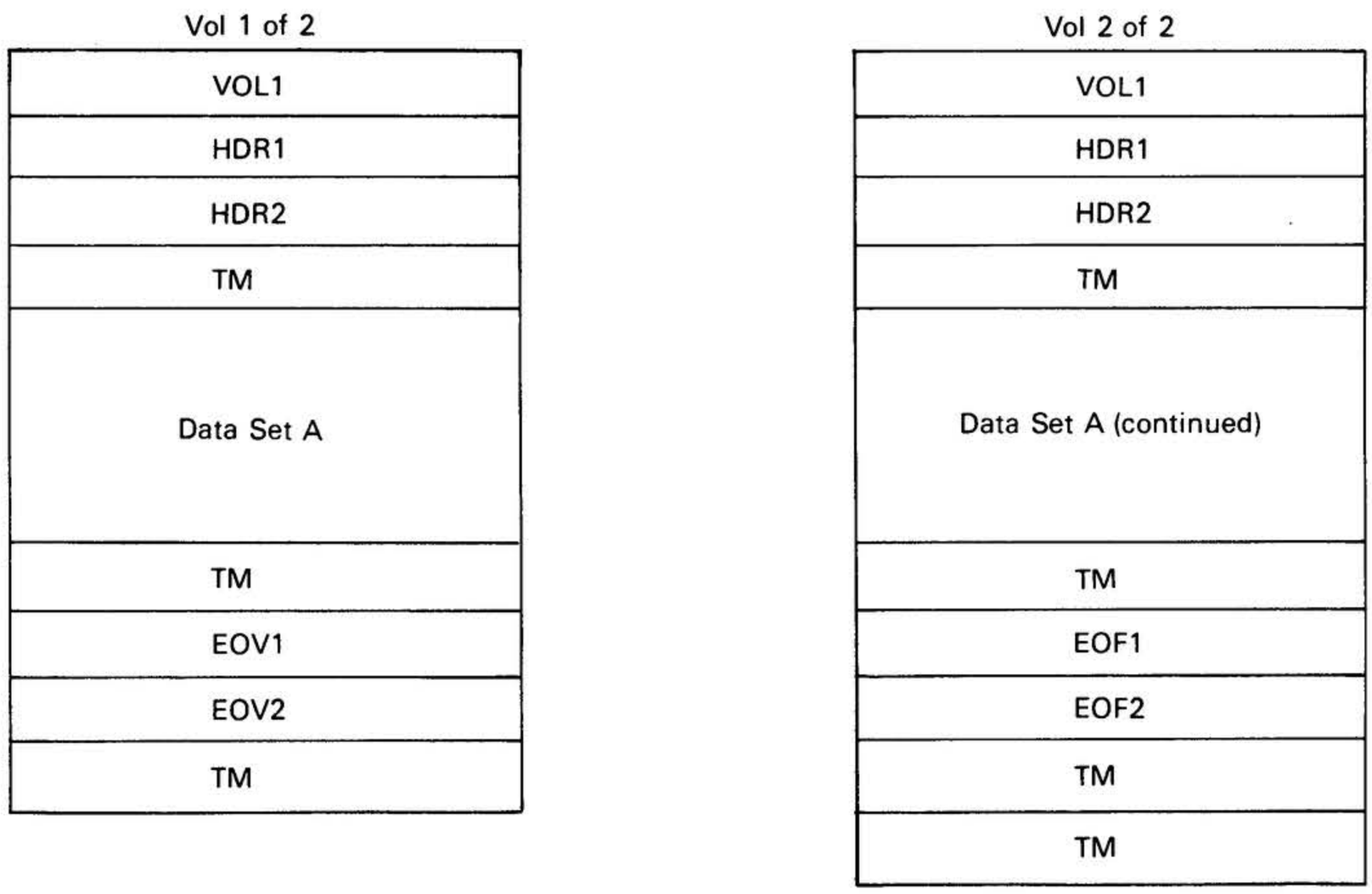


Figure 24-2. Layout of Single Data Set - Multiple Volumes

VOL1
HDR1
HDR2
TM
Data Set A
TM
EOF1
EOF2
TM
HDR1
HDR2
TM
Data Set B
TM
EOV1
EOF2
TM
TM

Figure 24-3. Layout of Multiple Data Sets - Single Volume

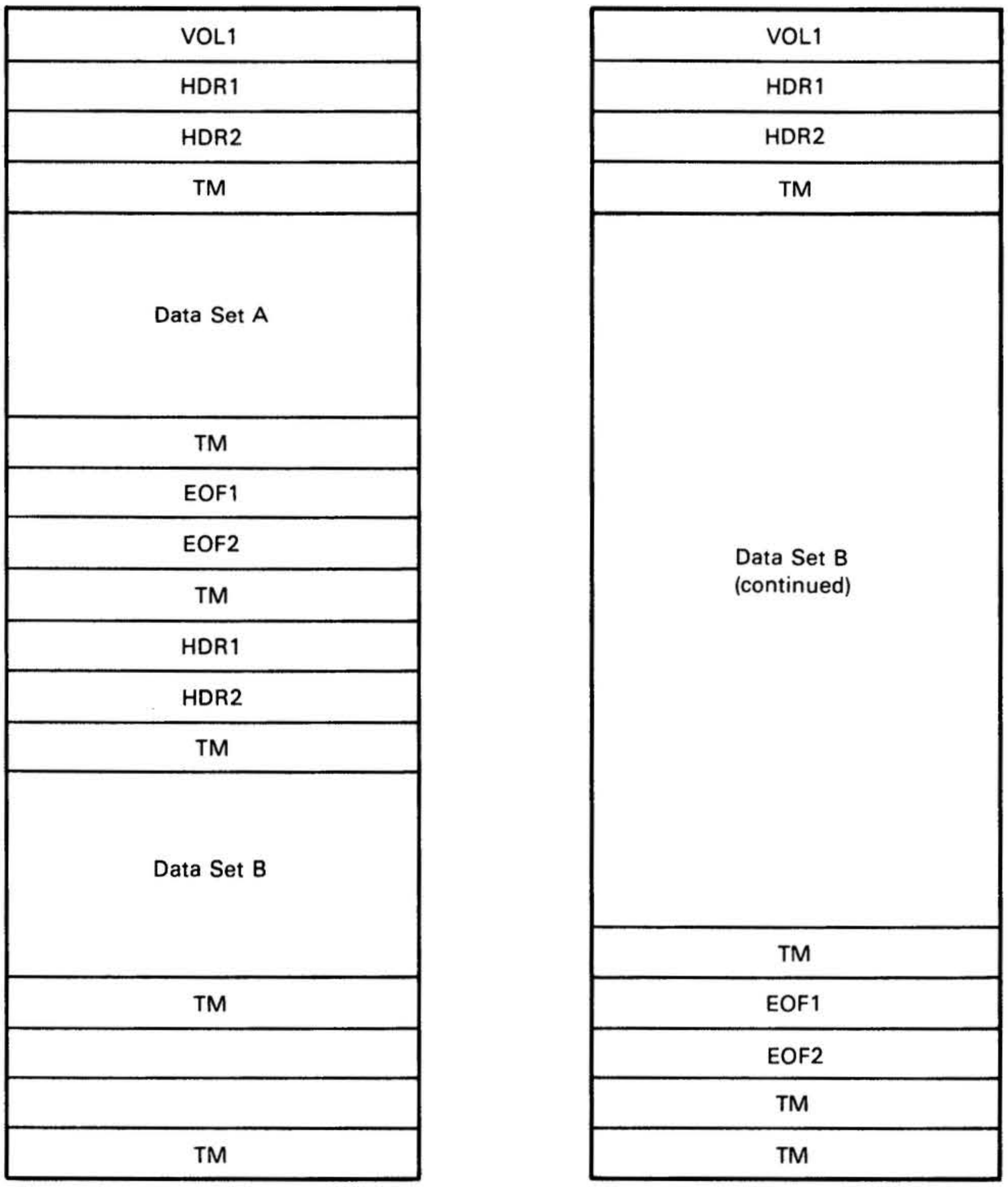


Figure 24-4. Layout of Multiple Data Sets - Multiple Volumes

24.4 DATA SET DEFINITION

Data sets are defined via TFILE commands to the Job Controller Processor (JCP) for background tasks, or to the Operator Communication Task (OPCOM) for foreground tasks. The format of this command is:

/TFILE,LUN,IO {,M,ID,L,T,SN,DSN,DN {,RF,BL,RL,TD,CC, BA,EXP }}

or

;TFILE,LUN,IO {,M,ID,L,T,SN,DSN,DN {,RF,BL,RL,TD,CC, BA,EXP }}

where:

Name	Description	Default
LUN	Logical unit name or number - must be assigned to magnetic tape.	-
IO	I/O Option: I = Input data set O = Output data set	-
M	Mount Option: I = Immediate mount D = Deferred mount (default)	D
ID	Identification - a one to six character alphanumeric identifier which serves as a reference to the data set definition.	JCP or OPCOM
L	Label option: B = Bypass labels S = Standard labels U = No labels (default)	U
T	Translate option: N = No translation (default) Y = Translate from EBCDIC to ASCII if IO = I Y = Translate from ASCII to EBCDIC if IO = O	N
SN	Serial number - a one to six character alphanumeric number specifying the first or only volume serial number. This field is required if IO = I and L = S or L = B. Default is blank.	∅
DSN	Data set name - a one to seventeen character name corresponding to the desired data set name - must be enclosed in apostrophes if the name contains embedded blanks or other special characters. Default is blank.	∅

DN	Data set number - a one to four digit number corresponding to the ordinal data number. Default is 1.	1
RF	Record format: F = Fixed length records V = Variable length records U = Undefined length records (default)	U
BL	Block length - a one to five digit number specifying the block length in bytes.	32760
RL	Record length - a one to five digit number specifying the record length in bytes.	0
TD	Tape density: 2 = 800 bpi 3 = 1600 bpi (default)	3
CC	Control characters: A = ASCII control characters M = Machine control characters	Ø
BA	Block attribute: B = Blocked records S = Spanned records R = Blocked and spanned records	Ø
EXP	Expiration date - a one to four digit number specifying the number of days until the data set expires.	30

Example: Define an unlabeled output data set which is to be written in ASCII.

```
/TFILE,22,O
```

Example: Define a labeled input data set residing on file two of tape reel 123456, in EBCDIC, named NEWMASTER.

```
/TFILE,22,I,,,S,Y,123456,NEWMASTER,2
```

Example: Access the same input data set, given that the data set name is **not** known.

```
/TFILE,22,I,,,B,Y,123456,,2
```

A special facility is provided for tape volumes which do not contain labels. The term data set is defined as the set of all data sets; that is to say, all data sets, even though separated by tapemarks, are considered to be a single data set. This facility is provided primarily to enable users who have implemented the tape labeling system to access tapes in a fashion similar to users who have not. Only a single TFILE command is required to access an unlabeled tape.

Data set definitions (TFILE commands) are queued to a particular physical magnetic tape drive at the time they enter the system. The definitions are activated to a particular tape drive when they are at the head of the queue. An open request is then made to that tape drive, the definitions are de-queued when they are active and an error close request occurs on the tape drive. The OPCOM command

```
;TLIST
```

results in the listing to the operator's console of all active and queued data set definitions in sequence by controller-subchannel number. The general format of this listing is:

```
MTmn IO ID LT SN DSN STATUS
```

where:

m	Is the controller number.
n	Is the subchannel number.

IO — Is RD for input data sets, or WT for output data sets.

ID — Is the ID parameter from the TFILE command.

LT — Is NL for no labels, or BL for bypass labels, or SL for standard labels.

SN — Is the SN parameter from the TFILE command.

DSN — Is the DSN parameter from the TFILE command.

STATUS — Is QUEUED if data set not yet accessed, or ACTIVE If data set being accessed.

Example: Given that the three TFILE command examples were entered and that logical unit number 22 is assigned to MT00, a TLIST command will give:

```
MT00    WT    JCP    NL                          QUEUED
MT00    RD    JCP    SL    123456    NEWMASTER   QUEUED
MT00    RD    JCP    BL    123456                QUEUED
```

If the first data set is opened, the TLIST command would give:

```
MT00    WT    JCP    NL                          ACTIVE
MT00    RD    JCP    SL    123456    NEWMASTER   QUEUED
MT00    RD    JCP    BL    123456                QUEUED
```

If the first data-set is closed, the TLIST command would give:

```
MT00    RD    JCP    SL    123456    NEWMASTER   QUEUED
MT00    JCP   BL     123456                      QUEUED
```

The OPCOM command

;TPURGE,**id**

where

id — Is the ID parameter from the TFILE command

deletes from the system all non-active data set definitions with a **matching id**. For example, assume a TLIST command results in the listing

```
MT00    RD    JCP       SL    107530    INVENTORY    QUEUED
MT00    RD    UPDATE    SL    106044    EXTRACT      QUEUED
MT10    RD    JCP       SL    108665    OLDMASTER    ACTIVE
MT10    WT    UPDATE    SL    106047    TEXTTAPE     QUEUED
```

The OPCOM command

;TPURGE,JCP

results in the data set definition for INVENTORY being deleted. EXTRACT and TESTTAPE would not be deleted since the IDs differ; OLDMASTER would not be deleted since it is already being accessed (i.e., it is active).

24.5 TAPE MOUNTING

When the operating system receives a request to open a data set (or when volume switching occurs), a mount message is issued to the operator (via OC). The general format of this message is

IO37, MTmnxx

where

m is the controller number

n is the subchannel number

xx is MU for Mount Unlabeled tape, or
ML for Mount Labeled tape, or
SU for mount Scratch Unlabeled tape, or
SL for mount Scratch Labeled tape, or
NU for mount Next volume of Unlabeled tape, or
NL for mount Next volume of Labeled tape.

The operator is then responsible for mounting the proper tape on the selected tape drive and enter:

;RESUME,MTmnxx

If the operating system is able to detect that the mounted tape does not meet the requirements of the data set definitions, the tape is rewound and the message repeated. The operator should mount the proper tape and restart the tape drive. If the operator does not know which specific tape is being requested, he should key in

;TLIST

to obtain a listing of the current data set definitions. The entry marked ACTIVE for the tape drive in question corresponds to the data set being requested by the operating system. If the operator is unable to mount the proper tape (i.e., if the data set definition is in error), he should key in

;DEVDN,MTmn
;RESUME,MTmnxx

This will clear the mount request freom the system and cause the open to complete with an error. The operator should then key in

;DEVUP,MTmn

in order to clear the status of the affected tape drive.

24.6 DATA SET ACCESS

User tasks accessing labeled tapes are responsible for performing physical I/O in such a fashion as to maintain consistency between the definitions of the data set labels and the actual contents of the data set: In other words, the operating system is responsible for processing the labels and the data set definitions (TFILE commands), while the user is responsible for processing the data set and creating the data set definitions. In all other respects access to magnetic tape is identical in operation to access to any other I/O device - the I/O macros are identical in format, the DCB macros are identical in usage, error status and data transfer length are returned in the I/O macro, etc.

24.7 INPUT DATA SETS

24.7.1 Opening an Input Data Set

An input data set can be opened by (1) specifying immediate mount in the TFILE request, (2) performing an OPEN from a user program, or (3) performing the first READ from a user program.

If standard label processing is specified, the first record on the tape is inspected to ensure that it is a VOL1 label. The serial number of the VOL1 label must match the serial number in the data set definition. The next record on the tape is inspected to ensure that it is a HDR1 label. The volume sequence number and the file sequence number of the HDR1 label must both be one (i.e., multi-volume groups must be accessed starting with the first volume). If necessary, successive data sets are skipped until positioning to the data set number specified in the TFILE request is achieved. The HDR1 label of the data set is inspected. The data set name of the HDR1 label must match the data set name of the TFILE request. The tape is positioned ready to input the first data record. If the data set is being opened via READ, the first data record is input to the user program.

If bypass label processing is specified, a similar procedure is performed except that the data set name is not validated.

If no label processing is specified, the first record on the tape is inspected to ensure that it is **not** a VOL1 label. The tape is then rewound. If the data set is being opened via READ, the first data record is input to the user program.

24.7.2 Accessing an Input Data Set

An input data set can be accessed only if properly opened. A READ request retrieves the next tape record and may perform volume switching. An **SREC forward** request spaces over the next tape record and may perform volume switching. An **SREC backward** request backspaces over the previous tape record unless the tape is positioned to the first record of the data set on a given volume; in which case, no tape movement occurs and end-of-file status is returned. WRITE and WEOF requests are invalid. FUNC requests perform no operation.

24.7.3 Closing an Input Data Set

If standard or bypass label processing is specified, an input data set can be closed in three ways. If a READ or an SREC forward request results in an end-of-file condition (as opposed to an end-of-volume condition), the data set is closed **automatically** and end-of-file status is returned. A CLOSE request skips successive records until an end-of-file condition occurs and closes the data set. An REW request closes the data set and rewinds the current volume.

If no label processing is specified, an input data set can be closed only by a REWIND request. Such a request closes the data set and rewinds the current volume. A READ or SREC forward request resulting in an end-of-file condition returns **end-of-file status** but does **not close the data set**.

24.8 OUTPUT DATA SETS

24.8.1 Opening an Output Data Set

An output data set can be opened by (1) specifying immediate mount in the TFILE request, (2) performing an OPEN from a user program, or (3) performing the first WRITE from a user program.

If standard label processing is specified, the first record on the tape is inspected to ensure that it is a VOL1 label. The serial number of the VOL1 label must match the serial number in the data set definition. If the data set number in the TFILE request is **not** 1 (i.e., if a data set is being appended to an existing data set), the next record on the tape is inspected to ensure that it is a HDR1 label. The volume sequence number and the file sequence number of the HDR1 label must both be one (i.e., multi-volume groups must be accessed starting with the first volume). If necessary, successive data sets are skipped until positioning to the data set number specified in the TFILE request is achieved. The next tape record is accessed to determine whether or not an attempt to over-write an existing data set is being made. If a HDR1 label is encountered, the data set must be expired as determined by the expiration date of the HDR1 label. The header labels are then written to the tape, and the tape is positioned ready to output the first data record. If the data set is being opened via WRITE, the first data record is output from the user program.

If bypass label processing is specified, the tape is considered to be positioned ready to output the first data record. **No protection** is afforded the user. This technique should only be used in order to initialize **new** tapes. If the data set is being opened via WRITE, the first data record is output from the user program.

If no label processing is specified, the first record on the tape is inspected to ensure that it is **not** a VOL1 label. The tape is then rewound. If the data set is being opened via WRITE, the first data record is output from the user program.

24.8.2 Accessing an Output Data Set

An output data set can be accessed only if properly opened. A WRITE request outputs the next tape record and may perform volume switching (including writing end-of-volume labels and header labels). READ and SREC requests are invalid. A request of the form FUNC 037 (31) forces volume switching; other FUNC requests perform no operation.

24.8.3 Closing an Output Data Set

If standard label processing is specified, an output data set can be closed in three ways. A WEOF request writes the end-of-file labels and closes the data set. A CLOSE request writes the end-of-file labels and closes the data set. An REW request writes the end-of-file labels, closes the data set, and rewinds the current volume.

If bypass or no label processing is specified, an output data set can be closed only by an REW request. Such a request writes a tape mark, closes the file, and rewinds the current volume. A CLOSE or WEOF request writes a tape mark, **but does not close the data set.**

24.9 TAPE INITIALIZATION

All magnetic tapes must be initialized prior to first usage. The tape labeling system accesses the first record of a tape volume during open processing. If the tape has not been initialized (i.e., nothing has ever been written on the tape), this access will result in an I/O error and the tape will spin off the end of the reel. A VOL1 label must be written onto standard label tapes (the serial number assigned to the tape must of course match the serial number of the VOL1 label), and anything **but** a VOL1 label (usually a tapemark) must be written onto unlabeled tapes. The following jobstream will initialize a standard label tape on a 800 bpi unit.

```
/JOB,INITIALIZE SL TAPE
/TFILE,xxO,I,INITAP,B,Y,,,,,,2
/IOUTIL
COPYR,1,ST,1,40,7,1,40
VOL1ssssss0bbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbnnnnnnn
nnn
/WEOF,xx
/REW,xx
/FINI
```

where

b — Is a space character.

xx — Is the logical name or number assigned to the mag tape driver.

sssss — Is the serial number (left justified).

nnnnnnnnnn — Is the owner name and address code.

The following jobstream will initialize a standard unlabeled tape.

```
/JOB,INITIALIZE NL TAPE
/TFILE,xx,O,I,INITAP,B,Y
/WEOF,xx
/REW,xx
/FINI
```

where

xx — Is the logical name or number assigned to the mag tape driver.

Note that tapes must be initialized at the tape density at which they will be used.

24.10 SYSTEM GENERATION

To incorporate label processing into a VORTEX II system, simply include an EQP directive at SYSGEN time specifying model code MTnB instead of MTnA for each magnetic tape controller. The magnetic tape driver (VZMTB) responsible for performing the standard label processing performs recovery from parity errors detected during WRITE operations by (1) backspacing over the record in error, (2) writing a tape mark, (3) backspacing over the tape mark, and (4) attempting the WRITE again. This forces a longer gap between data records thus, successive attempts to write the record are performed farther and farther along the tape and cause longer and longer gaps. Thus, the bad section of the tape is hopefully bypassed and left unused. For this reason, the retry count of the EQP directive should be set reasonably high. A retry count of ten, for example, allows for about five inches a bad tape, twenty allows for ten inches, etc.

24.11 ERROR MESSAGES

The following errors are recognized by the tape labeling system:

Error	Description
I000	Unit not ready
I007	Access error. READ attempted on output file, WRITE attempted on input file, etc.
I010	Data set not found or has expired.
I012	Data Set definition missing.
I014	Timeout error
I020	BIC error
I037	Volume mount request
I046	Unassigned memory error

All I/O errors cause the offending tape reel to be rewound; if a data set is open to the drive, it is closed.

24.12 EXAMPLES OF USAGE

The examples below assume the following configuration:

One 800 bpi tape drive (MT00)
One 1600 bpi tape drive (MT10)

and also assume that logical unit number 22=MT00 and logical unit number 26=MT10.

Example 1: Copy an unlabeled 800 bpi tape containing 3 files onto an unlabeled 1600 bpi tape.

```
/JOB,COPY
/TFILE,22,I,D,INPUT
/FTILE,26,O,D,OUTPUT
/IOUTIL
COPYF,3,22,0,0,26,0,0,
/REW,22
/REW,26
/FINI
```

At execution time this jobstream causes the message

I037,MT00MU

to be output to OC. The operator should then mount the tape to be copied onto the 800 bpi drive (if he has not already done so) and key in

;RESUME,MT00MU

Almost immediately the message

IO37,MT10SU

will be output to OC. The operator should then mount a 1600 bpi unlabeled scratch tape onto the 1600 bpi drive (if he has not already done so) and key in

;RESUME,MT10SU

The three files will then be copied and both drives rewound, at which point the tapes may be dismounted.

Example 2: Copy the input tape from Example 1 onto a 1600 bpi tape, but make each file a separate data set (i.e., the output tape will be labeled). Assume that the first file contains only 40 word records (in SEDIT format), the second file contains 60 word records (in object module format), and the third file contains 40 word records blocked six to one (i.e., 240 word blocks). In addition, data set 1 is to be called SOURCE, data set 2 is to be called RELOCATABLE, and data set 3 is to be called TEST-DATA. The files are to be placed onto reel 123456.

```
/JOB,SPLIT
/TFILE,22,I,D,INPUT
/TFILE,26,O,D,FONE,S,,123456,SOURCE,1,F,80,80
,3,,B,100
/TFILE,26,O,D,FTWO,S,,123456,RELOCATABLE,2,
F,120,120,3,,B,100
/TFILE,26,O,D,FTRE,S,,123456,TEST-DATA,3,F,
480,80,3,,B,100
/IOUTIL
COPYF,1,22,0,40,26,0,40
COPYF,1,22,0,240,26,0,240
/REW,22
/REW,26
/FINI
```

At the system operator's console the same procedure is followed for mounting the input tape. However, the mount request for the output tape will appear as

IO37,MT10ML

The system operator should then mount the 1600 bpi standard label tape 123456 on the 1600 bpi drive and key in

;RESUME,MT10ML

Since the magnetic tape driver retains information regarding the current tape volume mounted after a data set is closed, no mount requests are made for RELOCATABLE and TEST-DATA.

Example 3: Perform the same procedure as in Example 2, but copy the data sets onto a labeled scratch tape.

The only change required in the jobstream is the replacement of the TFILE commands for SOURCE, RELOCATABLE, and TEST-DATA. They should be

```
/TFILE,26,O,D,FONE,S,,,SOURCE,1,F,80,80,3,,B,
100
/TFILE,26,O,D,FTWO,S,,,RELOCATABLE,2,F,120,
120,3,,B,100
/TFILE,26,O,D,FTRE,S,,,TEST-DATA,3,F,480,80,3,,
B,100
```

The request for the 1600 bpi drive will appear as

IO37,MT10SL

The system operator should then mount a 1600 bpi standard label scratch tape and key in

;RESUME,MT10SL

Example 4: Assuming that Example 3 resulted in the three files being written onto reel 777777, add the object module RELOCATABLE from this tape to the object module library.

```
/JOB,ADD
/TFILE,26,I,,,S,,777777,RELOCATABLE,2
/FMAIN
INPUT,26
ADD,OM,D
/REW,26
/FINI
```

At the console, the mount request will appear as

IO37,MT10ML

The operator should mount reel 777777 on MT10 and key in

;RESUME,MT10ML

Example 5: List the first file of the Example 3 tape, assuming the name of the data set is not known.

```
/JOB,LIST
/TFILE,26,I,,,B,,777777,,1
/SEDIT
AS,IN,26
AS,OU,DUM
LI
FC
/REW,26
/FINI
```

Mounting procedure is the same as in Example 4.

Example 6: Backup the exceedingly large disk file LARGE on lun 8 (SS) onto magnetic tape. Assume that the file contains 120-word records which are not blocked, that the file will not fit on one reel of tape, and that a tape without labels is to be used.

```
/JOB,TWO TAPES
/TFILE,22,O
/IOUTIL
PFILE,8,,120,LARGE
COPYF,1,8,0,120,22,0,120
/REW,22
/FINI
```

At execute time, the mount request

```
IO37,MT00SU
```

appears on the system operator's console. The operator should mount an 800 bpi unlabeled scratch tape on MT00 and key in

```
;RESUME,MT00SU
```

When the first reel is filled, the drive rewinds and the message

```
IO37,MT00SU
```

appears. The system operator should dismount the first reel and label it reel 1 of 2, mount another 800 bpi unlabeled scratch tape, and key in

```
;RESUME,MT00SU
```

Upon job completion, the system operator should dismount the second reel and label it 2 of 2.

Example 7: Place the same disk file onto a labeled tape using data set name LARGE.

The only change required in the jobstream of Example 6 is the replacement of the TFILE command. It should be

```
/TFILE,22,O,,S,,,LARGE,1,F,240,2,,B
```

The mount requests will appear as

```
IO37,MT00SL
```

The system operator should mount an 800 bpi labeled scratch tape and key in

```
;RESUME,MT00SL
```

in response to each request.

Example 8: Assume that Example 7 resulted in reels 00127 and 001233 respectively being used. Copy the data set back to disk.

```
/JOB,RESTORE
/TFILE,22,I,,,S,,001276,LARGE
/IOUTIL
PFILE,8,,120,LARGE
COPYF,1,22,0,120,8,0,120
CFILE,8,,LARGE,1
/REW,22
/FINI
```

The mount requests will appear as

```
IO37,MT00ML
```

and

```
IO37,MT00NL
```

respectively. The system operator should mount 001276 and 001233 respectively and key in

```
;RESUME,MT00ML
```

and

```
;RESUME,MT00NL
```

respectively.

Example 9: Append the disk file SMALL On lun 8 (SS) to the output tape from Example 2. The file contains 40 word records blocked three to one.

```
/JOB,APPEND
/TFILE,26,O,,F4,S,,123456,SMALL,4,F,240,80,3,,B
/IOUTIL
PFILE,8,,120,SMALL
COPYF,1,SMALL,0,120,26,0,120
/REW,22
/FINI
```

At the console

```
IO37,MT10ML
```

appears. The system operator should mount reel 123456 and key in

```
;RESUME,MT10ML
```

The tape will be spaced past data set 3, the file will then be written to the tape, and the tape will be rewound.

Section 25
CONSOLE LOGGING PROGRAM

25.1 INTRODUCTION

The purpose of the Console Logging program is to save all messages, on disk file, that have been input or output from the operator comunication (OPCOM) device.

25.2 PROGRAM REQUIREMENTS

The console log (CONLOG) program requirements are as follows:

The console log consists of two disk files residing on FL (Log1 and Log2) operating in flip-flop mode. These files contain all messages that have been input/output from the system console. (Device address = 1.)

Note: The user must create these files prior to using console logging. The size of these files depend on console activity level and whether or not the "AUTO" mode is used. console records are logged two per 120 word disk sector. The two files need not be the same size.

25.3 PROGRAM DESCRIPTION

The CONLOG program is initialized by the OPCOM operator entering a SCHED call. The schedule foreground task key-in request immediately schedules the foreground library task CONLOG for execution. It has the general form:

;SCHED,CONLOG, level, lun, key

where

level	is the priority level (from 2 to 31) of the scheduled task
lun	is the number or name of the foreground library rotating memory logical unit where the scheduled task resides,
key	is the protection code, if any, required to address **lun**.

Once the CONLOG program has been activated by the SCHED command, it prints CL** on the OPCOM device and enters a conversational mode with the operator. The commands listed below are available to the operator.

ON { **,AUT** / **,MAN** } *,INI*

OFF { **,LOG1** / **,LOG2** / **,ALL** }

PRINT { **,LOG1** / **,LOG2** / **,ALL** } *,S*

SWITCH

HELP

EXIT

STATUS

The operator enters as many of these commands as he desires at this point, and leaves the conversational mode only after he enters the EXIT command. If no parameters are required, the first two characters of the command are sufficient.

25.4 COMMAND DESCRIPTIONS

25.4.1 ON Command

This command turns on the logging mode. It contains two optional parameters. The form of the ON command is:

ON { **,AUT** / **,MAN** } *,INI*

where

AUT	if present causes printing to be automatically started when a log file is filled.
MAN	causes a message, 'FILE N FULL', to be sent to the OPCOM device every 30 seconds when file N is filled. The message terminates when the operator enters a PRINT command. This is the default mode. If MAN is specified and both the LOG1 and LOG2 files become full and are not printed, console logging is terminated.
,INI	must be included the first time that CONLOG is called, in order to allow the program to initialize the output files.

25.4.2 OFF Command

The OFF command terminates console logging. By including one of the optional parameters, LOG1, LOG2, or ALL, the operator may also cause the specified file to the printed.Console logging may be activated at any subsequent time by rescheduling CONLOG, via the ;SCHED command, and entering the ON command. If the operator does not want any printout, he enters only the command OFF. The files may be printed at a later time by rescheduling CONLOG with the SCHED macro, and then entering the print command.

The general form of the OFF command is:

$$\mathbf{OFF}\ \left\{\begin{matrix}\mathbf{,LOG1}\\\mathbf{,LOG2}\\\mathbf{,ALL}\end{matrix}\right\}$$

Example: Terminate console logging and print both LOG1 and LOG2

```
OFF,ALL
```

25.4.3 PRINT Command

The PRINT command outputs the specified file to the list output (LO) device (lun = 5). LOG1, LOG2 or ALL may be specified. If the optional parameter is not included the default is ALL.

The log files printed with the PRINT command are initialized (rewound) after printing unless the optional parameter *,S* is included.

The PRINT command has the format

$$\mathbf{PRINT}\left\{\begin{matrix}\mathbf{,LOG1}\\\mathbf{,LOG2}\\\mathbf{,ALL}\end{matrix}\right\}\mathit{,S}$$

Example: Print file LOG1. Initialize LOG1 after printing.

```
PRINT,LOG1
```

25.4.4 SWITCH Command

The SWITCH command causes the CONLOG program to output information the alternate device. If console messages were being placed on LOG1 and a SWITCH command entered, the console logging would then commence output to LOG2 to LOG2 and vice versa.

The form of the SWITCH command is:

SWITCH

25.4.5 HELP Command

The HELP command is included as an aid to the operator in reminding him of the commands and their format. If the HELP command is entered after CONLOG has been scheduled and the operator is still in the conversational mode with CONLOG, each of the commands, along with its optional parameters, will be output to the OPCOM device.

The form of the HELP command is:

HELP

25.4.6 EXIT Command

The EXIT command causes CONLOG to leave the conversational mode. The operator enters an EXIT command at the point when all the required control commands have been issued. After this command is issued, CONLOG will still log or print messages as specified by the operator, but will no longer expect additional commands from the operator.

The form of the EXIT command is:

EXIT

25.4.7 STATUS Command

The STATUS command causes the CONLOG program to output a status list in the form:

```
CONSOLE LOGGING ON/OFF
PRINT MODE AUTO/MAN
CURRENT LOGFILE LOG1/LOG2
LOGFILE LOG1/LOG2 FULL
```

The form of the STATUS command is:

```
STATUS
```

25.5 STATUS WORD

A status word, CLSTAT, is maintained by both the teletypewriter devices and program CONLOG. The status of each bit is described in the table 25.1.

Table 25.1. Status Word (CLSTAT)

bit		
0	0 = 1=	console logging inactive; console logging acitve
1	0 = 1 =	printing must be requested; files automatically printed when full
2	0 = 1=	first half of buffer to be filled; second half of buffer to be filled
3	0 = 1 =	do not initialize file; initialize files
4	0 = 1 =	LOG1 is current logging file; LOG2 is current logging file
5	0 = 1 =	LOG1 not full; LOG1 is full
6	0 = 1 =	LOG2 not full; LOG2 is full
7	0 = 1 =	do not print LOG1; print LOG1
8	0 = 1 =	do not print LOG2; print LOG2
9		Error occured opening files or reading file
10		No memory available for allocating 123 word buffer
11		Logging terminated by buffers full or 'off' command (deallocate 123 word buffer)
12	1 =	Teletypewriter log has called CONLOG via the SCHED MACRO, cleared by CONLOG when LOG1 or LOG2 is printed
13	1 =	open file 1
14	1 =	open file 2
15		UNUSED

25.6 OUTPUT FORMAT

Each message will be preceded by the time of day in HH:MM:SS format. In additon, the date, logical unit number of the sending/receiving device, and the name of the corresponding task will be appended to the message. Output consist of 120 word blocks of data. Each block of data will thus contain two messages. At the time the output goes to the logging device, a three word block of all ones is added to the buffer and a 123 word WRITE command is issued. This results in a 120 word record being written to one sector and a three word record of all 1's being written on the succeeding sector. The three word record serves as an end of file indicator and as a current record locator. When coming back up after a system crash, the program can search for this last record written indication and continue output at that location in that file. Each time a new output occurs, the previous three word record is written over. This action is performed until the file becomes full. The buffer format is as follows:

Buffer

Word	Contents
1	HH
2	:M
3	M:
4	SS
5	blanks
6	message
.	...
.	...
.	...
45	...
46	blanks
47	mm
48	/d
49	d/
50	yy
51	blanks
52	lun
53	...
54	blanks
55	task
56	name
57	...
58	unused
59	...
60	...
61	HH
62	:M
63	M:
64	SS

65	message
.	...
.	...
.	...
105	...
106	blanks
107	mm
108	/d
109	d/
110	yy
111	blanks
112	lun
113	...
114	blanks
115	task
116	name
117	...
118	unused
119	...
120	...
121	-1
122	-1
123	-1

25.7 TELETYPEWRITER DRIVER (V$TYB) ADDITIONS

The teletypewriter driver, V$TYB, will handle the packing of the messages in the buffer and the output of the buffer contents to the specified logging device. The teletypewriter driver will also call the program CONLOG whenever a file becomes full. Before it calls CONLOG, V$TYB will store the contents of the status register in the A register and expect the A register to obtain the updated status register upon return.

The ;SCHED command sets the A register to 0143152 before the requested program is called, so CONLOG uses the A register as a key to indicate if it was referenced from V$TYB or by an operator request via the SCHED macro.

25.8 ERROR MESSAGES

PROGRAM	MESSAGE	DESCRIPTION
CONLOG	I/O error (CONLOG) while attempting to print file.	An error occured while printing either file 1 or file 2. An attempt will be made to reprint the file if the file has full.
CONLOG	No memory available for allocating buffer.	123 word buffer for use by TTYLOG was unavailable at the time of the request. Re schedule CONLOG to try again.
CONLOG	Error occured opening files.	Error occurred when initializing files. Reenter the ON message specifying initialization by including the INIT parameter.

Section 26
MODEL F2963 DATA ACQUISITION AND CONTROL SYSTEM

26.1 INTRODUCTION

This section contains a decription of the VORTEX I/O driver for the Model F2963 Data Acquisition and Control System (DA/CS). All I/O operations to the DA/CS are performed by the I/O driver, thus, eleminating the necessity for the user to be concerned with the details of performing input and output from the DA/CS.

26.1.1 I/O MACROS

I/O requests in assembly language programs are in the form of macro calls. The DASMR assembler provides a standard set of system macros which specify I/O operations. The macros provide uniformity and ease of coding I/O request. The following macros are available:

READ
WRITE

26.1.2 Required Hardware

Minimum hardware required for a Data Acquisition and Control System is one master chassis and controller, Sperry Univac model number F2963-xx (consisting of one Analogic AN5400 chassis and one MCO controller), plus applicable user selected printed circuit boards (PCBs) necessary for the user's unique application.

Figure 26-1 shows a typical system configuration the F2963-xx (DA/CS)

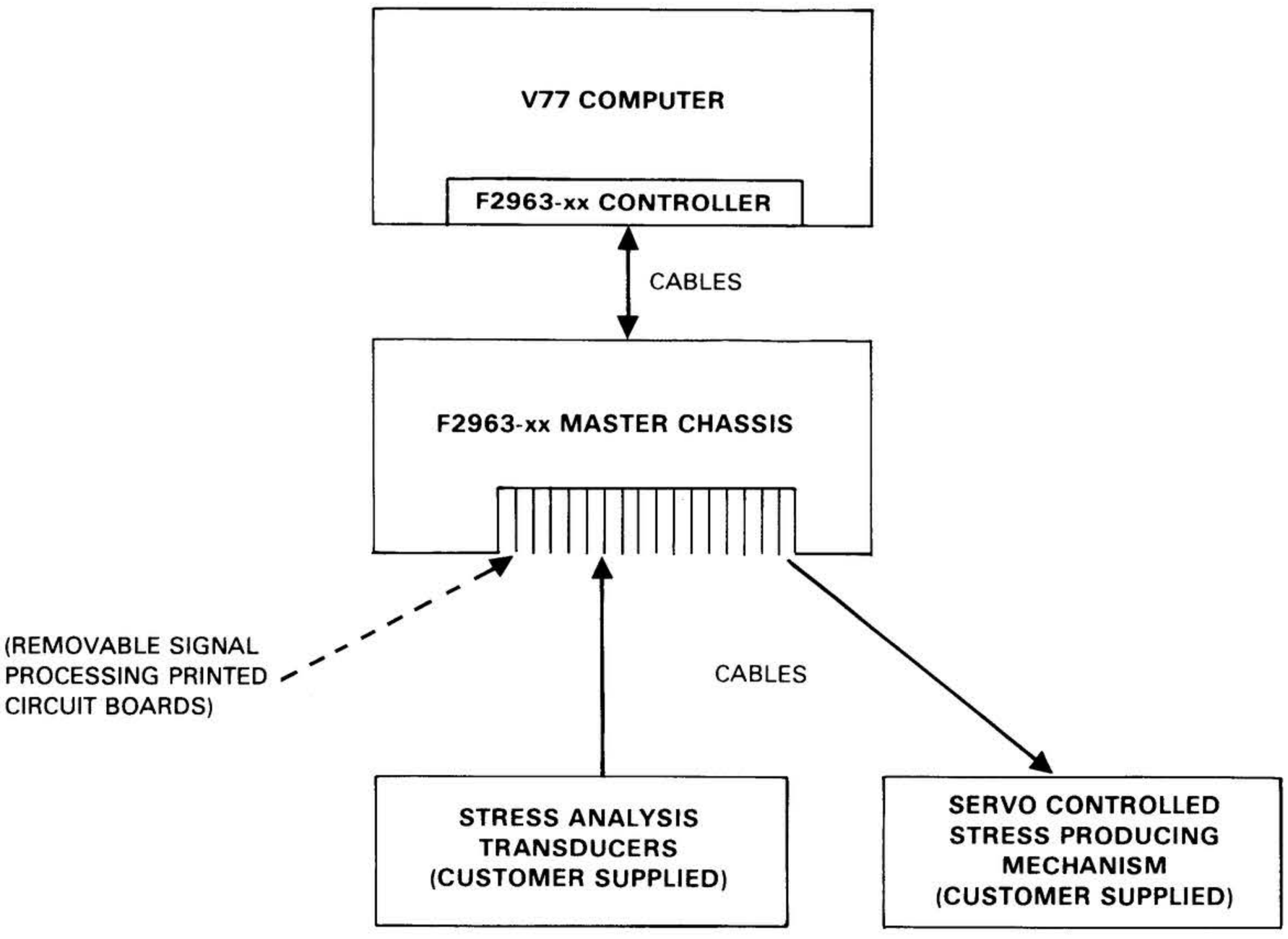


Figure 26-1. Typical System Configuration

26.2 HARDWARE DESCRIPTION

The F2963 Data Acquisition and Control System is a general purpose, computer oriented, analog-to-digital (A/D)/ digital-to-analog (D/A) data conversion system. Offering field add-on modular flexibility, and expandability, this system is designed for commercial, scientific, and industrial process monitoring and control and data-acquisition applications. The self-powered and self-contained F2963 can process and convert both multi-channel analog input signals and digital input and output signals within a single chassis. This feature, combined with a variety of plug-in signal-translation PCBs, offers the user freedom to configure inputs and outputs in any order or manner to meet his particular requirements.

Based on a single master chassis that holds up to 16 user-selected multiplexer/signal conditioning input PCBs, the F2963 system is expanded by adding up to seven expander chassis for a total of eight chassis. Consequently, up to 128 (16 x 8) user-selected PCBs can accommodate up to 4096 high-level single-ended, or 2048 high-level differential, multiplexer data channels. In any single chassis, differential multiplexing can be provided.

Standard multiplexer PCBs provide a variety of input formats, signal levels, isolation, transducer and thermocouple accomodations, and, when needed, cold-junction compensation. A single chassis can also contain up to 64 simultaneous sample and holds and up to 64 D/A converter outputs. Standard D/A converters provide 10- to 16-bit resolution, and various speeds, accuracies, and stabilities. Standard analog-to-digital converters provide from 8 to 16 bit resolution, moderate to very high speeds, moderate to very high stabilities and bipolar or unipolar input voltage ranges. There are also standard digital input/output PCBs to choose from.

26.3 SOFTWARE ADDRESSING

26.3.1 Device Address

Four device addresses are available for Sperry Univac DA/CS controllers. They are 050, 051, 052, and 053 (octal). An individual call to the VORTEX driver can read or write data from one controller only.

26.3.2 Unit Address

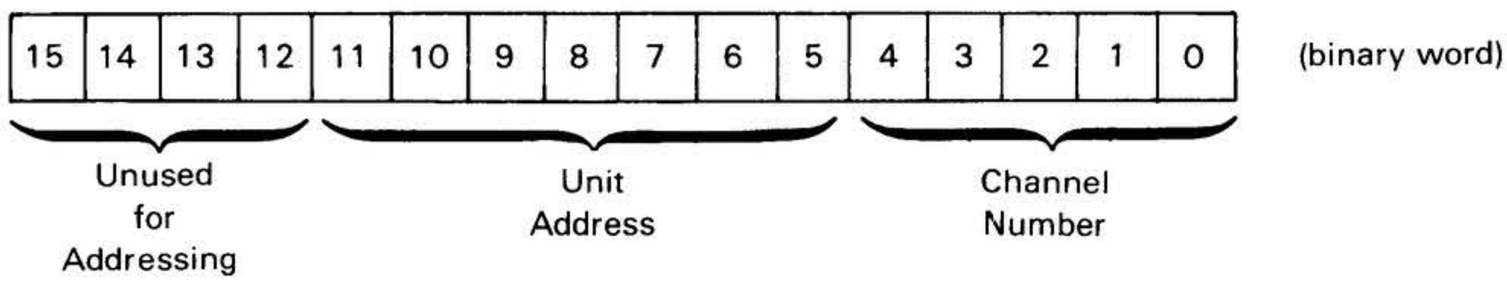
There are 16 slots for individual signal processing printed circuit boards on each chassis. One F2963-xx master chassis and one to seven F2963-03 expansion chassis can be connected to a Sperry Univac controller at an individual device address. Each individual slot within each chassis is referred to as a unit. Therefore, a controller with one chassis connected to it could have as valid unit addresses 0 through 15 (0 through 017). A controller with 8 chassis connected to it would have valid unit addresses 0 through 127 (0 through 0177).

26.3.3 Channel Address

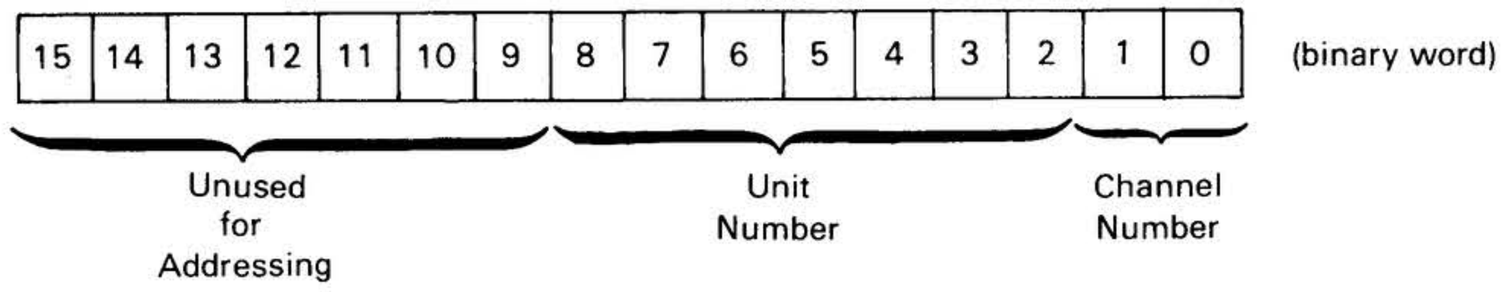
Each unit (individual signal processing printed circuit board) has 1, 2, 4, 16 or 32 individual sample points, depending upon the function of the individual unit. Each sample point is called a channel. A 4 sample point unit will have valid channel addresses 0, 010, 020, and 030. A 16 sample point unit will have valid channel addresses 0, 02, 04, 06, 010, 012, 014, 016, 020, 022, 024, 026, 030, 032, 034, and 036.

26.3.4 Addressing Format

The format for addressing input units is



The format for addressing output units is



Note: Only 2 bits are required for specifying output channel numbers, since output units can have a maximum of four channels per unit.

26.4 INPUT

26.4.1 Read Macro

Input to the DA/CS is by use of the IOC 'READ' macro. The macro call has the format

READ dcb,lun,wait,mode

where

dcb	is the name of data control block (DCB)
lun	is the logical unit number
wait	is the wait flag
mode	is the data mode (ignored)

Data is always input directly, without modification, so the data mode is effectively system binary.

26.4.2 Data Control Block

The READ macro Data control block (DCB) format is:

Input Buffer Count	Word 0
Input Buffer Address	Word 1
Opcode	Word 2
Status Word Address	Word 3
Unit/Channel List Address	Word 4
Trace Area Begin Address	Word 5
Trace Area End Address	Word 6

Opcode (Word 2)

0	0	0	0	0	0	0	0	0	0	0	V	W	X	Y	Z

Z = 1	Digital input data
Z = 0	Analog input data
Y = 1	Sequential Addresses
Y = 0	Random Addresses
X = 1	Place amplifiers in hold mode before input.
X = 0	This is not a sample and hold operation.
W = 1	Only one input address specified. Repeat same address until input buffer is full.
W = 0	Number of addresses specified is identical to number of words in input buffer.
V = 0	Reserved for special application. Must be zero.

Analog/Digital - If input data is digital, all other bits in the opcode should be set to 0.

Sample and Hold - If X=1 in the opcode, then the amplifiers in all sample and hold type units will be simultaneously placed in the 'hold' state. After this is performed, all channels listed in the unit/channel address list (word 4) will be input. When input is complete, all units will be reset to 'sample' state.

Random Addresses - In this mode, the unit/channel address list may specify one or several addresses. Upon completion of the sampling of the first address, the next address in the list will be sampled. The operation terminates when the count specified in the input buffer count (Word 0) is reached.

Sequential Addresses - In this mode, the unit/channel address list specifies only one address. After inputting data from the specified channel, the address is incremented to the address of the next input channel in sequence. This is normally valid only for analog input cards with 32 channels per card. The operation terminates when the count specified in word 0 is reached.

Input Buffer Count (Word 0) - This is the octal number of words in the input buffer. This must not be less than the number of words contained in the unit/channel address list (Word 4) or a loss of data will occur.

Input Buffer Address (Word 1) - This is the address of the input buffer area.

Status Word Address (Word 3) - The status word is a word in the calling program in which status of the IOC call is maintained. This parameter contains the address of that word. Status is an octal number returned in the Data Control Block. Its contents give the status of the call as follows:

1 I/O correctly completed

2 I/O in execution

3 Cable between V70 and DA/CS is not connected (hardware malfunction)

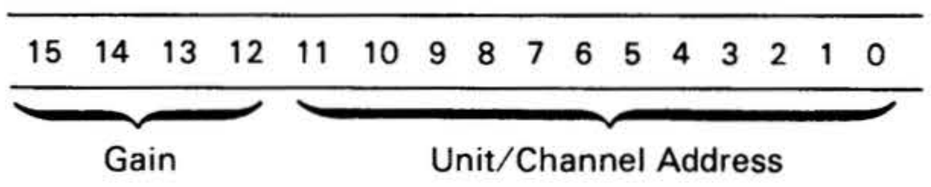
4 DA/CS is in local mode. Put in remote

5 "DONE" line from control is in incorrect state (hardware malfunction)

6 BIC transfer error (hardware malfunction)

7 Unsuccessful attempt to place amplifiers in hold state (hardware malfunction)

Unit/Channel List Address (Word 4) - This is the address of a list which contains the gain setting and the unit and channel numbers to be input. The format is as follows:



Gain Field Portion of Unit/Channel List

GAIN =
- 000 Unity Gain
- 0001 Gain of 2
- 0010 Gain of 4
- 0011 Gain of 8

} Single-Ended Amplifier

- 1000 Unity Gain
- 1001 Gain of 2
- 1010 Gain of 4
- 1011 Gain of 8

} Differential Amplifier

Any values not specified are invalid. For a signal processor card without programmable gain (i.e., F2963-07), the gain field is used only to determine whether the amplifier is single-ended or differential.

Unit/Channel Addresss Portion of Unit/Channel List - This is as specified in section 26.3.

TRACE Area Begin Address (Word 5) - This is the address of the beginning of a memory area in which a trace of all I/O instructions to and from the DA/CS can be stored. If tracing is not desired, then this field must be zero. Since tracing is performed only during debugging, this field will normally be zero.

TRACE Area end Address (Word 6) - This is the end address of the trace area. If more I/O operations are traced than can be contained within this area, tracing will "wrap around" and begin at the address specified in "Trace Area Begin Address". If tracing is not desired, this field must be zero.

26.4.3 Programming Examples

Example 1: A DASMR program is to sample single-ended analog input channels 0 through 31 on unit number 7 in sequential mode. Do not return until I/O complete. Do not set gain. Logical unit number is 22.

```
                .
                .
                .
                READ        DCB1,22,00,0
                .
                .
DCB1            DATA        32          (length of 32)
                DATA        INBUF       (input buffer is "INBUF")
                DATA        02          (OP code is sequential)
                DATA        STAT        (status is at address "STAT")
                DATA        CHLIST      (channel number list is at address
                                         "CHLIST")
                DATA        BEGTR       (TRACE area begins at address
                                         "BEGTR")
                DATA        ENDTR       (TRACE area ends at address "ENDTR")
```

```
                .
                .
                .
CHLIST          DATA        0340
                .
                .
                .
STAT            BSS         1
INBUF           BSS         32
BEGTR           BSS         1000
ENDTR           BSS         0
```

Example 2 A DASMR program is to sample differential amplifiers 3, 7 and 4 on unit 6; and 2 and 3 on unit 3. Do not set gain. Logical unit number is 26. Return immediately.

```
                .
                .
                .
                READ        DCB2,26,1,0
                .
                .
                .
DCB2            DATA        5           (length of 5)
                DATA        INBUF       (input buffer is "INBUF")
                DATA        0           (OP code is random)
                DATA        STAT        (status is at address "STAT")
                DATA        CHLIST      (channel number list is at address "CHLIST")
                DATA        BEGTR       (TRACE area begins at address "BEGTR")
                DATA        ENDTR       (TRACE area ends at address "ENDTR")
                .
                .
                .
CHLIST          DATA        0303        (binary equivalent = 0000000011000011)
                DATA        0307                             (0000000011000111)
                DATA        0304                             (0000000011000100)
                DATA        0142                             (0000000001100010)
                DATA        0143                             (0000000001100011)
                .
                .
                .
STAT            BSS         1
                .
                .
                .
INBUF           BSS         5
                .
                .
                .
BEGTR           BSS         1000
ENDTR           BSS         0
```

26.5 OUTPUT

26.5.1 Write Macro

Output to an AN5400 is by use of the IOC 'WRITE' macro. The macro call has the format:

```
WRITE    dcb,lun,wait,mode
```

where

dcb	is the name of Data Control Block (DCB)
lun	is the logical unit number
wait	is the wait flag
mode	is the data mode (ignored)

Data is always output directly, without modification, so the Data Mode is effectively System Binary.

Data Control Block

Output Buffer Count	Word 0
Output Buffer Address	Word 1
Opcode	Word 2
Status Word Address	Word 3
Unit/Channel List Address	Word 4
Trace Area Begin Address	Word 5
Trace Area End Address	Word 6
Mask Word List Address	Word 7
Pulse Width Word	Word 8

Output Word Count (Word 0) - This is the octal number of words of data to be output. This must be the number of words in both the output buffer and the unit/channel list, and, if specified, the Mask Word List.

Output Buffer Address (Word 1) - This is the address of the output data buffer. Data must be in a position in the buffer corresponding to the position of the desired channel in the unit/channel list.

Opcode (Word 2)

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Z

Z = 0 output data is analog

Z = 1 output data is digital

Status Word Address(Word 3) - The Status Word is a word in the calling program in which the status of the IOC call is maintained. This parameter contains the address of that word. See Paragraph 26.4.2 for format of this word.

Unit/Channel List Address (Word 4) - This is the address of a list that shows to which unit/channel addresses to output the data.

Mask Word List Address (Word 5) - The mask word is used to select specific bits within a digital output word which need to be changed. Bits set to one in the mask words flag bits that are to be updated. The list must contain the same number of entries as the output buffer and the unit/channel list. In order to use this function, all units referenced in the unit/channel list must be able to perform readback. The VORTEX driver will read back the previous setting of the channel, update only those bits selected by the mask word, then output to the channel the previous setting of any bits not selected in the mask word, plus the updated setting of any bits selected in the mask word. If the mask word list address is zero, the entire word in the output buffer is output and latched, with the mask function being ignored.

Pulse Width Word (Word 6) - The pulse width word gives the length of time in VORTEX basic cycles (5 milliseconds) that digital output points are to remain set. At the conclusion of this waiting period, the VORTEX driver will output a word of zeros to every channel in the unit/channel list.

26.5.2 Examples

Example 1: A DASMR source program is to output the first 3 words from buffer OBUF to channel 1 on unit number 3 and channels 0 and 1, on unit number 2. Data is analog. Logical unit number is 17. Do not wait for completion.

```
                .
                .
                .
WRITE           DCB1,17,0,0
                .
                .
                .
DCB1            DATA    3       (length of 3)
                DATA    OBUF    (output buffer is "OBUF")
                DATA    0       (OP code is analog output)
                DATA    STAT    (status is at address "STAT")
                DATA    CHLIST  (channel number list is at address "CHLIST")
                DATA    0       (do not TRACE)
                DATA    0       (do not TRACE)
                .
                .
                .
CHLIST          DATA    0141    (binary equivalent = 0000000001100001)
                DATA    0100    (binary equivalent = 0000000001000000)
                DATA    0101    (binary equivalent = 0000000001000001)
                .
                .
                .
STAT            BSS     1
                .
                .
                .
OBUF            DATA    01,02,03
```

Example 2: A DASMR source program is to output the first 3 words from buffer OBUF to channels 1 on unit number 3, and channels 0 and 1 on unit number 2, logical unit number is 22. Data is digital. The first word in the output buffer is to update only the low order 2 bits, the next two words will update the entire word. Leave output latched indefinitely. Do not wait for completion. Report Status in word STAT.

```
                .
                .
                .
                WRITE   DCB2,22,0,0
                .
                .
                .
DCB2            DATA    3       (length of 3)
                DATA    OBUF    (output buffer is "OBUF")
                DATA    01      (OP code is digital output)
                DATA    STAT    (status is at address "STAT")
                DATA    CHLIST  (channel number list is at address "CHLIST")
                DATA    BEGTR   (begin TRACE at address "BEGTR")
                DATA    ENDTR   (end TRACE at address "ENDTR")
                DATA    MASK    (mask is at address "mask")
                DATA    0       (leave output latched indefinately)
```

```
                .
                .
                .
CHLIST          DATA        0141
                DATA        0100
                DATA        0101
                .
                .
                .
MASK            DATA        03
                DATA        0177777
                DATA        0177777
                .
                .
                .
STAT            BSS         0
                .
                .
OBUF            DATA        01,02,03
                .
                .
BEGTR           BSS         500
ENDTR           BSS         0
```

26.6 THROUGHPUT CONSIDERATIONS

26.6.1 Sequential Input

In one range (gain) is applicable to all channels to be sampled and they are in sequential order in contiguous addresses (or the same channel is to be sampled repeatedly), the F2963-xx will be able to automatically sequence through the channels. The VORTEX driver will setup the operation, start the BIC, and will not be interrupted until all points have been sampled. The following table represents throughput rates for the different signal processors and A/D converters.

A/D THROUGHPUT MATRIX FOR SEQUENTIAL INPUT

A/D Converter Module	With F2963-07 (AC262) Signal Processor Module	With 2963-06 (AC260) Signal Processor Module
F2963-09 (AC2710)	50,000	50,000
F2963-10 (AC2712)	50,000	50,000
F2963-11 (AC2713)	50,000	27,000
F2963-12 (AC2714)	50,000	27,000
F2963-13 (AC8016)	50,000	15,000

Note: Figures represent number of Analog to Digital conversion per second. All timings were performed on V77/600 with 660 ns. semiconductor memory with no cache.

26.6.2 Random Input

Throughput for any operation which samples more than one channel and requires the range (gain) to be set and/or requires addresses to be specified in any given order will require VORTEX I/O driver setup and handling for each individual channel. The BIC will not be used. The I/O driver will operate in a programmed I/O mode. Timings may vary between adjacent channels and these figures are maximum under ideal conditions (no other tasks running concurrently).

26.6.2.1 A/D Throughput Matrix For Random Input

A/D Converter Module	With F2963-07 (AC262) Signal Processor Module	With F2963-06 (AC260) Signal Processor Module
F2963-09 (AC2710)	6,000	6,000
F2963-10 (AC2712)	6,000	6,000
F2963-11 (AC2713)	6,000	6,000
F2963-12 (AC2714)	6,000	6,000
F2963-13 (AC8016)	6,000	6,000

Note: Figures represent number of Analog to Digital conversions per second. All timings were performed on a V77/600 with 660 ns. semiconductor memory with no cache.

APPENDIX A
ERROR MESSAGES

This appendix comprises a directory of VORTEX operating system error messages, arranged by VORTEX component.

A.1 ERROR MESSAGE INDEX

Except for the language processors (section 5), VORTEX error messages each begin with two letters that indicate the corresponding component:

Messages beginning with:	Are from component:	Listed in subsections:
CM	Concordance program	A.5.3
DA	V$DEBUG	A.7
DG	Debugging program	A.7
DP	Dataplot II	A.12
EX	Real-time executive	A.2
FH	Disk Formatter	A.18.1
FM	File maintenance	A.9
IO	I/O control	A.3
IU	I/O utility	A.10
JC	Job-control processor	A.4
LG	Load-module generator	A.6
MS	Microprogram simulator	A.20.2
MU	Microprogram utility	A.20.3
NC	VTAM Network control	A.21
OC	Operator communication	A.17
RL	RELINK	
RP	RPG IV Compiler	A.3
RT	RPG IV Runtime/Loader	A.5.3
SE	Source editor	A.8
PT	Patch Program	A.15
SM	System maintenance	A.16
ST	VSORT	A.11
*	DAS MR assembler	A.5.1

Section A.25 gives explanations of error codes listed under "Possible User Action" in the last column of the following sections.

A.2 REAL-TIME EXECUTIVE

Message	Condition	Action	Possible User Action
EX01,xxxxxx	Invalid RTE service request by task xxxxxx	Abort task xxxxxx	D01,D02,P01
EX02,xxxxxx	Scheduled task xxxxxx name not in specified load-module library	Abort task xxxxxx	D01,D03
EX03,xxxxxx	Task xxxxxx made RESUME request but requested task not found	Continue scheduling task	D01,D03
EX04,xxxxxx	Task xxxxxx made ABORT request but requested task not found	Task xxxxxx continues	D01,D03
EX05,xxxxxx	Background task xxxxxx larger than allocatable	Task xxxxxx not loaded	M01,M02,M03 M04,P02
EX06,xxxxxx	Not enough allocatable space available for ALOC request	Abort task xxxxxx	M06
EX07,xxxxxx	OVLAY requests a segment not in library	Abort task xxxxxx	D01,D03

EX10,xxxxxx	Scheduled request has a library task priority conflict (task priority 0 from foreground library, task priority 2 from background library). Scheduled request specifies a foreground task to be executed at priority 0 or 1	Schedule request ignored, scheduling task continues	D04,D02,P01
EX11,xxxxxx,n	Memory protection violation at address n, math firmware generated (i.e., attempt to divide by zero)	Abort task xxxxxx	P03
EX12,xxxxxx	I/O link error (foreground task making request, or incorrect logical unit number)	Abort task xxxxxx	P01
EX13,xxxxxx	Attempted to load map registers and a sense-DMA-error stop condition occurred	Abort task xxxxxx	H05
EX14,xxxxxx	Lack allocable TIDB memory space for task xxxxxx attempted to be scheduled	If an OPCOM request, OPCOM is aborted. If the schedule is not an OPCOM, the request is reattempted	M02
EX15,xxxxxx	Foreground common specified by background task	Abort task xxxxxx	P01
EX16,xxxxxx	PASS macro specified zero or negative word count	Abort task xxxxxx	P01
EX17,xxxxxx	RMD I/O error detected when SAL attempted to load scheduled task, xxxxxx. Also pseudo TIDB data assumed bad, execution address less than 01000	Abort task xxxxxx	H06,P01
EX20,xxxxxx,n,p [1] [2]	Map memory-protection HALT violation at virtual address n in task xxxxxx	Abort task xxxxxx	P17

Note: **xxxxxx** is the name of a task.

EX21,xxxxxx,p[1] [2]	Map memory-protection I/O violation at virtual address n in task xxxxxx. User attempted to execute I/O command in a map other than map 0	Abort task xxxxxx	P17
EX22,xxxxxx,n,p[1] [2]	Map memory-protection WRITE violation at virtual address n in task xxxxxx. User attempted to write/ store into read-only or read-operand-only location	Abort task xxxxxx	P17
EX23,xxxxxx,n,m,p[1] [2]	Map memory-protection JUMP violation at virtual address n in task xxxxxx. User attempted to jump into read-operand-only location m + 2	Abort task xxxxxx	P17
EX24,xxxxxx,n,m,p[1] [2]	Map memory-protection UNASSIGNED violation at virtual address n in task xxxxxx. User attempted to read or write into unassigned location m	Abort task xxxxxx	P17
EX25,xxxxxx,n,p[1] [2]	Map memory-protection instruction-fetch violation at virtual address n in task xxxxxx. User attempted to fetch an instruction from read-operand-only location	Abort task xxxxxx	
EX26,xxxxxx,m[1]	Firmware floating point or stack over-flow or underflow occurred at logical address or in task xxxxxx.	Task is continued at location n+2	None
EX27,xxxxxx	ALOCPG request error. Parameter error or pages not available for allocation.	Program continues execution at specified reject address	P01

[1] The instruction which generated the memory-protection violation and the contents of the A, B, and X (and V75) registers are also posted. Note that on non-micro-VORTEX, if errors occur in two tasks almost simultaneously, the register values for the first task may incorrectly be the same as those for the second task.

[2] Where p is the physical page associated with the logical address of the instruction.

EX30,xxxxxx	DEALPG request error. Parameter error. Program continues execution at specified reject address	Program continues execution at specified reject address	P01
EX31,xxxxxx	MAPIN request error.	Program continues execution at specified reject address	P01
EX32,xxxxxx	Attempted to schedule a task from a non-RMD unit	Directive ignored	D02,P01
EX33,xxxxxx	Floating-point processor, FPP, error For V77-800: indicates arithmetic overflow	Program continues at the address following the FPP store instruction	None
EX34,xxxxxx	Floating-point processor, FPP, timeout	Program continues at interrupted instruction	None
EX35,xxxxxx,n,m	Memory parity error. n is the P register. m is the tracking register. For V77-800: indicates arithmetic underflow		
EX36,xxxxxx	REALPG request error.	Program continues execution at specified reject address	P01

Note: **xxxxxx** is the name of a task.

A.3 I/O CONTROL

Message	Condition	Action	Possible User Action
I000,xxxxxx	Unit not ready, or unit file protected	Repeats message until condition is corrected	H01,H03
I001,xxxxxx	Device declared down	Repeats message until condition is corrected	H04,D19
I002,xxxxxx	Invalid LUN specified	Abort task or request	D02,P01

I003,xxxxxx	FCB/DCB parameter error	Abort task or request	P04
I004,xxxxxx	Invalid protection code	Abort task or request	D01,D02,P01
I005,xxxxxx	Protected partition specified by unprotected task	Abort task or request	P01
I006,xxxxxx	I/O request error, e.g., I/O-complete bit not set, prior request may be queued	Abort task or request	P01
I007,xxxxxx	Attempt to read from a write-only device, or vice versa	Abort task or request	D02,P01
I010,xxxxxx	File name specified in OPEN or CLOSE not found	Abort task or request	D01,D03,P01, D29
I011,xxxxxx	Invalid file extent, record number, address or skip parameter, file already closed	Abort task or request	P04,P01
I012,xxxxxx	RMD OPEN/CLOSE error, or bad directory thread, seek or read error on OPEN request.	Abort task or request	H05,D03
I013,xxxxxx	Level 0 program read a JCP (/) directive	Task xxxxxx is aborted, directive passed to JCP buffer	None
I014,xxxxxx	Interrupt timed out or no cylinder-search-complete interrupt	Abort task or request	H05,D05
I015,xxxxxx	Disc cylinder-search or malfunction error	Abort task or request	H05
I016,xxxxxx	Disc read/write timing error	Abort task or request	H05
I017,xxxxxx	Disc end-of-track error	Abort task or request	H05
I020,xxxx	BIC: abnormal stop, not ready, or time out error on device xxxx	Abort task or request	D05,H05

I030,xxxxxx	Parity error	Abort task or request	H05,D02
I021,xxxxxxx	Memory parity error	Abort task or request	H05
I022,xxxxxxx	Map error	Abort task or request	H05
I023,xxxxxxx	Memory timeout error	Abort task or request	H05
I024,xxxxxxx	Rate error	Abort task or request	H05
I025,xxxxxxx	Memory/data bus verification error	Abort task or request	H05
I026,xxxxxxx	Memory access error	Abort task or request	H05
I027,xxxxxxx	Alternate sector partition full	Abort task or request	H05
I031,xxxxxx	Reader or tape error	Abort task or request	H05,P19
I032,xxxxxx	Odd-length record error	Abort task or request	H05,P12
I033,xxxxxx	Invalid terminal identifier or logical line number	Request ignored	D27
I034,xxxxxx	Line or terminal not opened	Request ignored	D28
I035,xxxxxx	Line or terminal down	Request ignored	D28
I036,xxxxxx	Line or terminal already open	Request ignored	D28
I037,xxxxxx	Request still pending	Request ignored	None
I040,xxxxxx	Action on terminal not opened	Request ignored	D28
I042,xxxxxx	Invalid physical line address	Request ignored	D27

I043,xxxxxx	Invalid TCM type	Request ignored	D27
I044,xxxxxx	No temporary storage available	Request ignored	None
I045,xxxxxx	RMD error. Format, end-of-file or head selection error	Abort task or request	H05,D13
I046,xxxxxx	Map memory protection I/O data transfer error	Abort task or request	H05
I047,xxxxxx	User write specified word count > 73	Record is `truncated`	P04
I05x,xxxxxx	RMD read error on spool stream X. Specified stream is last digit of error number	The data is used	H06
I060,xxxxxx	RMD file full	The program waits until space is available on the file. The message is repeated every 200 times the condition occurs	D08
I061,xxxxxx	User parameter error in request	Request is ignored	P01
I062,xxxxxx	RMD write error	The bad sector is skipped. This is likely to cause an I05x error later, but no data will be lost	H06
I063,xxxxxx	Buffer unavailable for spooler	Spooler waits until buffer is available	None
I065,xxxxxxx	Alternate sector directory record read error	Abort task or request	H05
I066,xxxxxx	Alternate sector directory record write error	Abort task or request	H05

Note: **xxxxxx** is the name of a task or device.

A.4 JOB-CONTROL PROCESSOR

Message	Condition	Action	Possible User Action
JC01	Invalid JCP directive	Ignore directive	D01,D02
JC02	Invalid or missing parameter in a JCP directive; or illegal separator or terminator	Ignore directive	D01,D02
JC03	Specified physical device cannot perform the functions of the assigned logical unit	Ignore directive	D07,H06
JC04	Invalid protection code or file name in a JCP directive	Ignore directive	D01,D02
JC05,nn	End of tape before the number of files specified by an /SFILE directive has been skipped; or end of tape, beginning of tape, or file mark before the number of records specfied by an /SREC directive has been skipped where **nn** is the number of files (or records) remaining to be skipped	SFILE, SREC terminates upon error condition	P07
JC06	An irrecoverable I/O error while compiling or assembling; or an error during a load/go operation; or insufficent symbol table memory (insufficient /MEM directive), or an EOF was encountered before an END statement	Job flushed to next /JOB directive	P07,M01,P06
JC07	Invalid or illegal logical/physical-unit referenced in JCP directive	Ignore directive	D01,D02,H06

A.5 LANGUAGE PROCESSORS

A.5.1 DAS MR Assembler

During assembly, the source statements are checked for syntax errors and usage. In addition, errors can occur where the program cannot determine the correct meaning of the source statement.

When an error is detected, the assembler outputs an error code following the source statement containing the error, on the LO unit, and continues to the next statement.

The assembler error messages are:

Message	Condition
***IL**	First nonblank character of the source statement invalid (statement is not processed)
***OP**	Instruction field undefined (two no-operation (NOP) instructions are generated in the object module)
***SY**	Expression contains undefined symbol
***EX**	Expression contains two consecutive arithmetic operators
***AD**	Address expression error
***FA**	Floating-point number format error
***DC**	An 8 or 9 in an octal constant
***DD**	Invalid redefinition of a symbol or the location counter
***VF**	Instruction contains variable subfields either missing or inconsistent with the instruction type
***MA**	Inconsistent use of indexing and indirect addressing three symbolic source statements to be assembled
***NS**	Nested DUP statements
***NR**	Symbol table full
***TF**	Tag error (undefined or illegal index register specifications)
***SZ**	Expression value too large for the size of the subfield, or a DUP statement specifying more than three statements to be duplicated (m parameter)
***UD**	Undefined digit in an arithmetic expression
***SE**	The symbol in the label field has, during pass 2, a value different than that in pass 1

*E	Syntax error (source statement incorrectly formed)
*R	Relocation error (relocatable item encountered where an absolute item was expected)
*MQ	Missing right quotation mark in character string
* =	Invalid use of literal
*II	Implicit indirect reference when I parameter is present on the /DASMR directive

A.5.2 FORTRAN IV Compiler and Runtime Compiler

During compilation, source statements are checked for such items as validity, syntax, and usage. When an error is detected, it is posted on the LO usually beneath the source statement. The errors marked T terminate binary output.

All error messages are of the form

ERR xx c(1)-c(16)

where xx is a number form 0 to 18 (notification error), or T followed by a number from 0 to 9 (terminating error); and c(1)-c(16) is the last character string (up to 16) encountered in the statement being processed. The right-most character indicates the point of error and the @ indicates the end of the statement. The possible error messages are:

Notification Error	Definition
0	Illegal character input
1	Construction error
2	Usage error
3	Mode error
4	Illegal DO termination
5	Improper statement number
6	Common base lowered
7	Illegal equivalence group
8	Reference to nonexecutable statement
9	No path to this statement
10	Multiply defined statement number
11	Invalid format construction
12	Spelling error
13	Format statement with no statement number
14	Function not used as variable
15	Truncated value
16	Statement out of order
17	More than 29 named common regions
18	Noncommon data
19	Illegal name
20	DO index not referenced
21	Name is dummy
22	Array name previously declared
23	Exponent underflow or overflow
24	Undefined statement number

Terminating Error	Definition
T0	I/O error
T1	Construction error
T2	Usage error
T3	Data pool overflow
T4	Illegal statement
T5	Improper use
T6	Improper statement number
T7	Mode error
T8	Constant too large
T9	Improper DO nesting
T10	DO not parenthesized
T11	Item not operand
T12	Item not function
T13	Invalid unary +,
T14	Invalid hierarchy
T15	Invalid =
T16	Illegal operator
T17	Function statement without parameters
T18	Logical If follows logical If
T19	Invalid dimensions
T20	Operand is not a name
T21	Too many numeric characters
T22	Non-numeric exponent
T23	Terminator not
T24	Illegal terminator
T25	Not statement end
T26	Invalid common type
T27	Target statement precedes DO
T28	Subscript variable not dummy
T29	Not first statement (Title statement)
T30	First two characters not DO
T31	Not in subprogram
T32	Subscript not integer constant

Note: due to optimization, the error message may appear on the next labeled statement and not on the actual statement error.

RUNTIME

When an error is detected during runtime execution of a program, a message is posted on the LO device of the form:

taskname message

Fatal errors cause the job to be aborted; execution continues for non-fatal errors. The messages and their definitions are:

Message	Cause
ARITH OVFL	Arithmetic overflow
GO TO RANGE	Computed GO TO out of range*
FUNC ARG	Invalid function argument (e.g., square root of negative number)
FORMAT	Error in FORMAT statement*
MODE	Mode error (e.g., outputting real array with I format)*
DATA	Invalid input data (e.g., inputting a real number from external medium with I format)*
I/O	I/O error (e.g., parity, EOF)*

* indicates fatal error; all others non-fatal

A.5.3 RPG IV Compiler and Runtime Compiler

During compilation, source statements are checked for such items as validity, syntax and usage. When an error is detected an arrow is printed pointing to the discrepancy in the source statement and an error message is output on the LO device. Detailed descriptions can be found in the RPG IV User's Manual (98 A 9947 03X). The possible error messages are:

Messages

Indicator	Name
Invalid	Relational
Label	Size
Literal	Syntax

If an I/O error occurs during compilation one of the following messages is posted on Logical Unit 15 and compilation is terminated:

Message	Condition	Action	Possible User Action
RP01,nnn	I/O error	Compilation terminated	H06
RP02,nnn	End of file error	Compilation terminated	P07
RP03,nnn	End of device error	Compilation terminated	P07
RP04	End card error (End card encountered before procedure card)	Compilation terminated	P07
RP05	Available memory exceeded	Compilation terminated	M01,M03,M04

where nnn is the logical unit number on which the error occurred.

RPG Runtime/loader during the loading or executing of an RPG IV object program in the background any of the following conditions will cause an error. The message is posted on Logical Unit 15 and the task aborted:

Message	Condition	Action	Possible User Action
RT01,nnn	I/O error	Task aborted	H06
RT02,nnn	End of file error	Task aborted	P07
RT03,nnn	End of device error	Task aborted	P07
RT04	Program too big	Task aborted	P07
RT05	Invalid object record	Task aborted	P08
RT06	Checksum error	Task aborted	P08
RT07	Sequence error	Task aborted	P08
RT08	Program not executable	Task aborted	P08
RT09	Work list overflow	Task aborted	M01,M02,M03 M04
RT10,xxxxxx	Invalid call to subroutine or missing subroutine where xxxxxx = subroutine name	Task aborted	P08

Concordance Program:

Message	Condition	Action	Possible User Action
CN01	Symbol table full	Partial concordance output, then next segment is processed	M01

A.6 LOAD-MODULE GENERATOR

Message	Condition	Action	Possible User Action
LG01	Invalid LMGEN directive	Ignore directive	D01,D02
LG02	Invalid or missing parameter in an LGMEN directive	Ignore directive	D01,D02
LG03	Check-sum error in object module	Abort loading	P08,D02
LG04	READ error in object module	Abort loading	P08,H06
LG05	WRITE error in load module loading	Abort loading	P08,H06
LG06	Cataloging error, name already in library, library full, or reference, subroutine without 'NAME' statement	Abort loading	D03,H06
LG07	Loader code error in object module	Abort loading	P08
LG08	Sequence error in object module	Abort loading	P08
LG09	Structure error in object module (i.e., non-binary record), or directory structure error.	Abort loading	P08
LG10	Literal pool overflow or use of literal or indirect by foreground program	Abort loading	P08,P09
LG11	Invalid redefinition of common-block size during load-module generation	Abort loading	P08

ERROR MESSAGES

LG12	Load-module size exceeds available memory or SW file size	Abort loading	P02,D34
LG13	LMGE internal tables exceed available memory	Abort loading	M01
LG14	Number of overlay segments input not equal to that specified in TIDB	Abort loading	D01,D02
LG15	Undefined externals	Loading continues	P10
LG16	No program execution address	Loading continues. Address defaults to the first location of the program	P17
LG17	Attempt to load protected task on background library or unprotected task on foreground library	Abort loading	D01,D02,D33
LG18	No load module to catalog	Abort cataloging	P08

A.6.1 RELINK

Message	Condition	Action	Possible User Action
RL01	Input error	Ignore input	correct syntax
RL02 xxxxxx	Load module xxxxxx in error	Ignore	Check validity of load module
RL03 xxxxxx	Invalid CRST item in module xxxxxx	Ignore module	Load module not relinkable, re-LMGEN
RL04 xxxxxx	Nucleus pointer name xxxxxxx not found in CL	Abort relinking	Load module not relinkable on this system
RL05 xxxxxx	Invalid displ. found in CRST	Abort relinking	CRST is invalid, Re-LMGEN

A.7 DEBUGGING AIDS

V$DBUG

DA01	Incorrect response to initial query	Enter correct response
DA02	Requested task has aborted	Reschedule task
DA03	Requested task has exited	Reschedule task
DA04	Illegal response to query or number too large for TIDB	enter correct response
DA05	Bad data in directive	Enter correct directive
DA06	Read error on DI logical unit	Repeat previous directive
DA07	Illegal command	Enter correct command
DA08	Add/subtract to undefined base symbol	Repeat after defining base symbol
DA09	Base/CL tag has more than 6 characters	Repeat with correct base/CL tag
DA10	Name not found on CL directory	Repeat with correct name
DA11	No room in base symbol table	Delete unwanted symbols and try again
DA12	Wrong area for command type	Command cannot be used for the area indicated
DA13	Illegal P Address for trap	Enter correct address and retry

DEBUG

Message	Condition	Action	Possible User Action
DG01	Invalid DEBUG directive	Ignore directive	D01,D02
DG02	Invalid or undefined parameter in DEBUG directive	Ignore directive	D01,D02
DG03	Attempt to set more than 5 traps from DEBUG	Ignore directive	D01,D02

DSYSTM/DSPMEM

DM01	Image file not available (not created) DSYSTM will not dump system	
DM02	RMD seek error VORTEX reactived, no dump file	
DM03	RMD BIC/BTC error	VORTEX reactivated no dump file
DM04	EOF/EOD encountered during dump	VORTEX reactivated, no dump file
DM05	RMD I/O error	VORTEX reactivated, no dump file
DM06	DSYSTM busy (next file not opened yet)	VORTEX reactivated, no dump file
DM07	File mismatch (information set up wrong)	VORTEX reactivated, no dump file

A.8 SOURCE EDITOR

Message	Condition	Action	Possible User Action
SE01	Invalid SEDIT directive	Directive ignored	D01,D02
SE02	Invalid or missing parameter in SEDIT directive	Directive ignored	D01,D02
SE03	Error reported by IOC call	Edit terminated	H06
SE04	Invalid end of file	Edit terminated	P07

A.9 FILE MAINTENANCE

Message	Condition	Action	Possible User Action
FM01	Invalid FMAIN directive	Ignore directive	D01,D02
FM02	Name already in directory	Module not added	D03,D01,D02, D07,D37
FM03	Name not in directory	Module not deleted	D03,D01,D02

FM04	Insufficient space for entry	Module not added	D07,D08,D09 D37
FM05	I/O error	FMAIN process terminated	H06
FM06	Directory structure error, including writing over the directory by direct addressing of an RMD partition	FMAIN process terminated	H06
FM07	Check-sum error in object module	FMAIN process terminated	P08
FM08	No entry name in object module	FMAIN process terminated	P08
FM09	Record-size error in object module	FMAIN process terminated	P12
FM10	Loader code error in object module	FMAIN process terminated	P08
FM11	Sequence error in object module	FMAIN process terminated	P08
FM12	Non-binary record in object module	FMAIN process terminated	P12
FM13	Number of input logical unit not specified by INPUT	FMAIN process terminated	D01,D02
FM14	Insufficient space in memory	FMAIN process terminated	M01
FM15	Released unused request made to an empty file.	Space not released	D36

* Messages **FM07** through **FM14** apply only to the processing of object modules. The occurrence of any of these errors requires that the processing of the object module be restarted after the error condition is removed.

A.10 I/O UTILITY

Message	Condition	Action	Possible User Action
IU01	Invalid IOUTIL directive	Directive ignored	D01,D02
IU02	Invalid or missing parameter in IOUTIL directive	Directive ignored	D01,D02
IU03	PFILE directive not used to open an RMD file	Directive ignored	D02
IU04	I/O error	IOUTIL process terminated	H06
IU05,nn	END-OF-FILE before the specified number or records skipped. When nn = the number of records remaining when the END-OF-FILE or END-OF-DEVICE (on RMD only) occurred. END-OF-TAPE outputs MSG where operator has option to ;RESUME or ABORT. Note: nn is module 0 to 100.	SFILE, SREC terminates upon error condition	P07

A.11 SORT ERROR MESSAGES

Message	Condition	Action	
ST01,xxxxxxxx	Invalid or missing parameter or control word for the SORT control word xxxxxxxx	Abort job	D01
ST02	Alternate input on RMD	Abort SORT	D01
ST03	SORT control field ending character position is less than start character position, or character position is past end of SORT record	Abort SORT	D01
ST04	Insufficient memory available for work space.	Abort SORT	M01
ST05,xxxxxx	OPEN error on file xxxxxx	Abort SORT	D01,H06
ST06,xxxxxx	I/O error on file xxxxxx	Abort SORT	H06
ST07,xxxxxx	Attempt to write past end-of-file xxxxxx. (Work file or output file too small.)	Abort SORT	D32
ST08	Last of tags (LOT) requested, but tag SORT cannot be performed.	Abort SORT	D01
ST09,XXXXXX	Syntax error on control word INCL, OMIT, or MOVE XXXXXX	Abort SORT	D01

A.12 DATAPLOT

Message	Condition	Action	Possible User Action
DP00,xxxxxx	Plot file overflow	Incomplete plot	D30
DP01,xxxxxx	Buffer overflow	Incomplete plot	M05
DP02,xxxxxx	Attempted to plot from unsorted plot file	Abort plot	P20
DP03,xxxxxx	End-of-file detected before end-of-plot indicator	Incomplete plot	P07

DP04,xxxxxx	Minimum/maximum x or y value exceeded	Line will follow plot boundary, origin will be shifted	P21
DP05,xxxxxx	PLOTS not called	Abort plot	P22
DP06,xxxxxx	Data Plot I/O error	Abort task xxxxxx	H06,H05
DP07,xxxxxx	Attempted to sort from a non-RMD media	Abort task	D31

where xxxxxx is the task name.

A.13 SUPPORT LIBRARY

There are no error messages unique to this section of the manual.

A.14 REAL-TIME PROGRAMMING

There are no error messages unique to this section of the manual.

A.15 PATCH ERROR MESSAGES

Message	Condition
PT01,ILLEGAL DIR	Directive not recognized.
PT02,PARAM ERROR	Directive parameter cannot be interpreted.
PT03,CL DIR ER--xxxxxx	Error while searching the CL directory for the name xxxxxx. Name xxxxxx not found.
PT04,IMAGE ERRROR	Error while creating the patch image file. File not found or extent violated. The entire patch image must be recreated.
PT05,STAT ERROR	Status error while performing I/O. End of device or file encountered.
PT06,ADDR EXTENT	Attempt to change the location of a load module file outside of its bounds.
PT07,OVERLAY ERROR	Error while searching for overlay segment. Segment not in overlay directory.
PT08,RELO DIR ERROR	Error while searching relocation file. No room in relocation file for new relocation bits.
PT09,	Base symbol table full. Five special symbols already defined.
PT10,LOG FILE ERROR	I/O error in file PDLOG.
PT11,LOG FILE FULL	Log file PDLOG is full.

A.16 SYSTEM MAINTENANCE

Message	Condition	Action	Possible User Action
SM01	Invalid SMAIN directive	Ignore directive	D01,D02
SM02	Record not recognized	Ignore directive	P19,D10
SM03	Check-sum error in object module	Waits for indicated corrective action	P08,D10
SM04	Incorrect size of object-module record (correct: 120 words for RMD input, otherwise 60 words)	Waits for indicated corrective action	P12,D10
SM05	Loader code error in object module	Waits for indicated corrective action	P08,D10
SM06	Sequence error in object module	Waits for indicated corrective action	P08,D10
SM07	Object module contains non-object-module text record	Waits for indicated corrective action	P12,D10
SM08	Error or end of device received after reading operation	Waits for indicated corrective action	P07,D10
SM09	Error or end of device received after writing operation	Waits for indicated corrective action	P07,D10
SM10	Stack area full	Waits for indicated corrective action	M01
SM11	Invalid control record	Waits for indicated corrective action	P19,D10

A.17 OPERATOR COMMUNICATION

Message	Condition	Action	Possible User Action
OC01	Request type error	Ignore directive	D01,D02
OC02	Parameter limits exceeded	Ignore directive	D01,D02
OC03	Missing parameter	Ignore directive	D01,D02
OC04	Unknown or undefined parameter	Ignore directive	D01,D02
OC05	Attempt to schedule or time schedule OPCOM task	Ignore directive	D01,D02
OC06	Attempt to declare OC device or system resident unit down	Ignore directive	D01,D02
OC07	Task specified in TSTAT key-in has no established TIDB, task currently not active	Ignore directive	D01,D02
OC10	Attempt to assign unit declared down or assign an unassignable logical unit/device	Ignore directive	D19,H04
OC11	Attempt to allocate TIDB unsuccessful for TSCHED request	Ignore directive	M02

A.18 RMD ANALYSIS AND INITIALIZATION

Message	Condition	Action	Possible User Action
RZ01	Invalid RAZI directive or illegal separator or terminator	Ignore directive	D01,D11
RZ02	Invalid parameter in a RAZI directive	Ignore directive	D01,D11
RZ03	Insufficient or conflicting directive information	Ignore directive	D01,D11
RZ04	New PST incompatible with the system	Ignore directive	D20,D21,D22, D11

RZ05	Named device cannot be replaced (system RMD or device busy)	Ignore directive	D01,D11
RZ06	Irrecoverable I/O error on designated RMD	Ignore directive	H06,D11
RZ07	First track of disc pack bad (pack unusable)	Ignore directive	D24
RZ08	Directive incompatible with specified RMD	Ignore directive	D25,D23
RZ09	Irrecoverable I/O error on system RMD (VORTEX nucleus)	Ignore directive	H06,D11
RZ10	I/O error on LO device	Ignore directive	D11,H06
RZ11	I/O error on SI device	Ignore directive	D11,H06
RZ12	No memory available to allocate for new bad-track table	RAZI aborted	M02
RZ13	Total number of tracks specified in PRT directive exceeds size of the device or is incompatible with the FRM directive	Ignore directive	D25,D11

A.18.1 Disk formatter Error Messages

Message	Description
FH01	Invalid directive name
FH02	Invalid parameters
FH03	Invalid controller
FH04	Invalid unit number
FH05	Invalid request error
FH06	Unrecoverable system error (controller)
FH07	Unrecoverable disk error
FJ01	Command syntax error
FJ02	Parameter error
FJ03	Hardware malfunction reported by controller
FJ04	Read/write I/O error
FJ05	Timeout while waiting for controller
FJ06	BIC busy or abnormal stop
FJ07	Write protect violation
FJ08	Data verification error (copy routine)

A.19 PROCESS INPUT/OUTPUT

There are no error messages unique to this section of the manual.

A.20 WRITABLE CONTROL STORE

A.20.1 Microprogram Assembler

During assembly the symbolic statements are checked for syntactic errors. In addition, a condition may occur where the assembler is unable to determine the correct meaning of the symbolic source statements.

Either case is indicated as an error and up to eight error codes will be output beneath the source statement incorrectly constructed.

NR, LC and IO errors terminate the assembly.

ERROR MESSAGES

Each error code with the exception of IO is followed by a space and two decimal digits indicating the character position the assembler was scanning when the error was detected.

The error codes and their meanings are listed below:

Error Code	Meaning
AD	Address expression or associated fields in error
CC	Continuation not expected
CE	Numeric conversion error
DD	Illegal redefinition of a symbol
ER	Syntax error
EX	An expression contained an illegal construction
FN	Field number inconsistent with format
IO	I/O error
LC	Program location counter setting exceeds the maximum WCS page size (512 words)
MF	Duplicate field reference
NR	No memory available for addition of an entry to assembler's tables
NS	No symbol in the label field where required
OP	Operation field undefined
SE	Symbol in label field has a value during pass 2 that is different from the value determined in pass 1
Sy	Undefined symbol. A value of zero is assumed
SZ	A value too large for the size of a field, or the fields defined in a format statement do not equal 64 bits

A.20.2 Microprogram Simulator

Message	Condition	Action	Possible User Action
MS01	Input could not be interpreted as a valid command	Directive ignored; input recovery*	D01,D02
MS02	A non-hex character was encountered when hex expected	Directive ignored; input recovery*	D02,D02
MS03	Insufficient common area to contain specified number of pages	Request for highest page repeated	M01,D26
MS04	The selected page number was not valid	Directive ignored; input recovery*	D26
MS05	An attempt was made to jump to an unavailable WCS page	Simulation halted	P13

MS06	A BCS instruction was encountered when WCS page 1 is unavailable	Simulation halted	D26,P13
MS07	Read error on BI device	Loading aborted	H06
MS08	EOF encountered before load complete	Loading aborted	P07
MS09	EOD/BEOD encountered before load complete	Loading aborted	P08
MS10	Sequence error on BI	Loading aborted	P08
MS11	Invalid loader code	Loading aborted	P08
MS12	Checksum error	Loading aborted	P08
MS13	Undefined macro opcode	Simulation continues	P15
MS14	Attempted to write to memory outside defined main memory	Simulation continues	P16
MS15	Attempted to load outside main memory	Loading aborted	P23
MS16	Invalid field name	Remainder of directive ignored	D01
MS17	Invalid field value	Remainder of directive ignored	D01

* Input recovery message or corrected directive from SO device.

A.20.3 Microprogram Utility

Message	Condition	Action	Possible User Action
MU01	Input could not be interpreted as a valid command	Directive ignored; input recovery*	D01,D02

MU02	A non-hex character was encountered when hex expected	Directive ignored; input recovery*	D01,D02
MU03	EOF detected on SI	Microprogram utility aborted	P07
MU04	The selected page number was not valid	Directive ignored; input recovery*	D01,D02
MU05	Unable to access WCS: WCS is busy	Directive ignored	H05
MU06	Unable to access WCS: BIC load in progress	Directive ignored	H05
MU07	Read error on BID device	Loading aborted	H06
MU08	EOF encountered before load complete	Loading aborted	P07
MU09	EOD/BOD encountered before load complete	Loading aborted	P08
MU10	Sequence error on BI	Loading aborted	P08
MU11	Invalid loader code	Loading aborted	P08
MU12	Checksum error	Loading aborted	P08

* Input recovery message or corrected directive from SO device.

A.21 VTAM NETWORK CONTROL MODULE

The VTAM network control module (NCM) generates the following error messages:

Message	Condition	Action	Possible User Action
NC01	Syntax error	Ignore directive	D01,D02
NC02	Undefined line	Ignore directive	D27,D02
NC03	Undefined TUID	Ignore directive	D27,D02
NC04	I/O error on file VT$DFL	Ignore directive	H06,D02

NC05	I/O error on file VT$DFT	Ignore directive	H06,D02
NC06	Undefined CCM number	Ignore directive	D27,D02

A.22 FILE MAINTENANCE UTILITY (FMUTIL) ERRORS

Message	Condition	Action	Possible User Action
END-OF-FILE	This is an ERROR MSG meaning an END-OF-FILE was encountered before the specified request could be completed.	FMUTIL Process Terminated	D01,P07
A DIRECTORY STRUCTURE ERROR-LUN lun SECTOR-sector num	A = blanks lun = 4 digits giving logical unit number sector num = 7 digits giving the sector number in error. This is an ERROR MSG. Meaning there is a structure error in the object module.	FMUTIL Process Terminated	H06
FILENAME ERROR	INVALID filename or filename not found	No action taken error output and ignored goes to next entry.	D01,D02, D03
- DIRECTORY ERROR ERROR - - - Beg. - - end - - eof - - current - - end - - eof.	Directory error shows writing over the directory by direct addressing of an RMD partition. - = blanks Beg = 2 digits showing beginning sector addr. end = 2 digits showing the ending sector addr. eof = 2 digits showing end-of-file addr. current = 7 digits showing current beg. addr. end = 7 digits showing ending addr. of current sector. eof = 7 digits showing current eof.	FMUTIL Process Terminated	P17
TAPE INPUT ERROR	READ ERROR (file Header not found)	Outputs error tries again.	D01,D07, D11
PARTITION OVERFLOW	Insufficient space for entry into partition.	Module not added, outputs last directory sector.	D07,D09, D01,D03

ERROR MESSAGES

Message	Condition	Action	Possible User Action
INSUFFICIENT SPACE IN PARTITION	Insufficient space for entry	File not added, FMUTIL process terminated	H06,M01
FMAIN ERROR·	4 blanks and 1 digit reference to FMAIN ERROR indicated required I/O error.	Outputs msg. FMUTIL process terminated, depending upon error mentioned.	H06
CAPACITY EXCEEDED	Insufficient space for entry to Directory.	Sorts entries in alphabetical order, and outputs listing.	M01
PARTITION SIZE sze SECTORS ····· num ARE UNASSIGNED	Partition size and sectors as stated in error message have not been assigned. · = blanks size = 7 digits showing size of partition. num = 5 digits showing number of sectors unassigned.	Returns to try again.	P17,H06

A.23 COMSY ERROR MESSAGES

The following are the COMSY error numbers and associated types of errors detected:

Error	Definition
1	Directive not understood.
2	Missing directive.
3	Input was not .COMSY or .FILE when searching for a named COMSY deck on PI.
4	Record sequence error on binary COMSY input.
5	Record checksum error on binary COMSY input.
6	Parameter list in error.
7	Missing .COMSY directive on PI.
8	Updates were not terminated by a .COMSY directive.
9	Sequence number greater than 99999 on an update directive.
10	Update sequence numbers not ascending.
11	.COMSY deck specified, not on COMSY file on PI.
12	Incorrect unit.
14	Common decks limited to 19.
15	Common deck not found.
16	Update directive not understood.
17	I/O error.
18	Erroneous end-of-file condition.
19	Directory error on a random file.

A.24 PARITY ERROR MESSAGES

Message	Description
DOUBLE BIT PARITY ERROR IN TASK XXXXXX BOARD NUMBER = XX, MODULE = XX, SYNDROME = XX	Start routine DUMPPR to print parity error log. If double bit error occurs in nucleus or is repeated, place the system in "HALT" mode and run hardware tests."

A.25 ERROR CODES

A.25.1 Errors Related to Directives

D01 Check spelling, delimiters, and parameters.

D02 Enter corrected request from OC or SO.

D03 Check specified library for module name (FMAIN list).

D04 Correct task priority.

D05 Check PIM directives used at system generation.

D06 Use a global logical unit in directive.

D07 Use an alternate library or unit.

D08 Increase library size with RAZI or during SGEN.

D09 Delete unused modules from library.

D10 Reposition record if PT or CR (for MT or RMD positioning is automatic and enter on SO:

R@ to reread the record or
P@ to reread the program or
/SMAIN@ to restart SMAIN

where @ is a carriage return

D11 Correct input record by entering it on SO or indicate that it is positioned for rereading by entering C on SO.

D12 Restart component by entering C on SO. (Repositioning is automatic for MT and RMD, for cards reload the entire deck and SGEN will find component.)

D13 SGEN requesting bad track analysis for unformatted RMDs or reformat formatted RMDs.

D14 Restart SGEN from beginning.

D15 Check spelling, delimiters, etc. of IO INTEROGATION.

D16 Correct appropriate SGEN directives as indicated.

D17 Correct indicated module for next SGEN or add corrected module with LMGEN after SGEN completes.

D18 Check that all RMDs are included in the SYS directive that are indicated by the EQUIP directives.

D19 Use OPCOM IOLIST for unit to check unit status (up or down) and unit's logical group.

D20 Check PRT directive.

D21 Check if maximum number of partitions specified in EDR directive has been exceeded.

D22 Check for conflicts in controller/unit relations.

D23 Check logical unit in directive, must be assigned to first partition of the subject RMD unit.

D24 The specified RMD pack cannot contain a bad track table due to the first track being bad, use another pack.

D25 Check FRM directive and total number of tracks specified in PRT directive. The following table gives the track capacity for the standard RMDs:

70-75XX	4060 tracks
70-76X0	203 tracks
70-76X3	406 tracks
70-7701	128 tracks
70-7702	256 tracks
70-7703	512 tracks

D26 Check response to the highest page number requested.

D27 Check NDM definition or use LIST directive of NCM.

D28 Use NCM module to check line/terminal status.

D29 Check that all subject logical units assigned to RMD have been positioned with a PFILE.

D30 Use a larger file for the plot file.

D31 Check for proper logical unit (i.e., IOLIST).

D32 Increase work file xxxxxx size.

D33 Check type parameter on TIDB directive

D34 Increase track allocation for the two largest RMD partitions in PRT directives

D35 (1) Specify task using VOL directive

(2) Remove taskname from TDF directive

(3) Ignore warning message and leave as non-VNO task

D36 Ignore or delete empty file from partition.

D37 Continue to process of adding object modules by entering "ADD,lun,key" from SO

A.25.2 Errors Related to Programs

P01 Correct request in requesting task and re-execute.

P02 Recode task using overlays.

P03 Check for privileged or illegal instruction at specified location. Check listings or check

P04 Check FCB or DCB entries.

P05 Check for proper read mode, packed or unpacked.

P06 Check for needed global files such as PO, SS, GO, SW. Note: the diagnostic gives the task name and not necessarily the missing file name.

P07 Check source for an erraneous EOF, END directive, etc.

P08 Check module for the indicated error;
sequence number--word 1, bits 0-7
checksum value--word 2
Note: binary records can be listed using the DUMP directive of IOUTIL.

P09 Check $LIT and $IAP values from the load module map.

P10 Examine map for missing externals and make necessary program changes.

P11 Check for an execution label on the END statement of the source. Note: this is a normal diagnostic for FORTRAN overlays.

P12 Check for a non-binary record or a short or long record in the module. The record length can be found in word 5 of the request block upon completion of I/O.

P13 Check code and continue after making corrections as indicated.

P14 Check requested page number.

P15 Check opcode for valid instruction.

P16 Check memory address, store request is ignored.

P17 Check for specified instruction or operation at location indicated in error message. Note: the address indicated refers to the instruction causing the error and not the violated address.

P18 Check the page status: read/write, read only, fetch operand only, or unassigned.

P19 Check for illegal data under current mode, i.e., binary in ASCII record, non-binary in binary record.

P20 Sort the plot file.

P21 This may be an intentional message. Plot continues.

P22 Call PLOTS.

P23 Check memory address, check ORG value and load range

P24 Recode into multi tasks or use fewer overlays

P25 Modify PRT directive(s) so bad track is not first one in partition.

A.25.3 Errors Related to Memory Size

M01 If background, adjust MEM directive as needed.

M02 Wait for foreground tasks to release memory or TIDB space.

M03 If MEM request OK or cannot be increased then cut back on foreground common, empty TIDBs, reentry stack size, peripheral drivers, etc. by re-SGEN.

M04 If sharing blank common and VTAM LCB area, check that a program has not used part of the LCB area.

M05 Increase buffer area with BSS or dimension commands.

M06 Increase reentry stack size in SGEN EDR directive.

A.25.4 Errors Related to Hardware

H01 Make indicated unit ready.

H02 Clear the protection of the unit. (Disc write protection or write ring in MT).

H03 ABORT task, reassign SI if necessary, and then declare device down through OPCOM, do not forget to declare it back up again.

H04 ABORT task and assign alternate device or declare device back up.

H05 Check hardware for indicated problem.

H06 Check the OC device for an IO error message, i.e., IOxx.

APPENDIX B
I/O DEVICE RELATIONSHIPS

Function	Allowable Functions by I/O Device Type						
	RMD	MT	PT	CR	CP	LP	TY or CRT
Read binary record	X	X	X	X			X[4]
Read alphanumeric record	X[1]	X	X	X			X
Read BCD record	X[1]	X	X[2]	X[2]			X[4]
Read unformatted record	X[1]	X[1]	X	X			X[4]
Write binary record	X	X	X		X	X[9]	X[4]
Write alphanumeric record	X[1]	X	X		X[3]	X	X
Write BCD record	X[1]	X	X[2]		X[2]	X[9]	X[4]
Write unformatted record	X[1]	X[1]	X		X	X[9,10]	X[4]
Write end of file		X	X		X		X[8]
Rewind unit	X	X	X[3]	X			
Skip one record forward	X	X					
Skip one record backward	X	X					
Perform function zero			X[3]		X[3]	X[5]	X[5]
Perform function one						X[6]	X[6]
Perform function two						X[7]	X[7]
Open a file with rewind option	X	X					
Open a file with leave option	X	X					
Close a file with leave option	X	X					
Close a file with update option	X	X					

NOTES

(1) All modes are read/written in binary mode.
(2) BCD mode is handled like unformatted mode.
(3) Punch 256 frames of leader on paper tape or eject one blank card on card punch.
(4) All modes are written in alphanumeric mode.
(5) Advances paper to top of form on line printer, or causes carriage return and feeds three lines on Teletype or CRT.
(6) Advances paper one line.
(7) Advances paper two lines.
(8) Rings bell on Teletype or beeps on CRT.
(9) 620-77 line printer -- All modes are treated as alphanumeric.
(10) 620-76 printer/plotter -- Unformatted records are transmitted without interpretation as plot data.

I/O Errors by I/O Device Type

Code	Description	I/O Device RMD	MT	PT	CR	CP	LP	TY or CRT
000	Unit not ready	X	X	X	X	X	X	X
001	Device down	O	O	O	O	O	O	X
002	Illegal LUN specified	O	O	O	O	O	O	O
003	FCB/DCB parameter error	O	O	O	O	O	O	O
004	Level 0 program references a protected partition	O	O	O	O	O	O	O
005	Level 0 program references protected memory	O	O	O	O	O	O	O
006	I/O request error	O	O	O	O	O	O	O
007	Read request to write-only device, or vise versa				O	O	O	
010	File name not found	X						
011	File extent error	X						
012	RMD directory error	X						
013	Level 0 program read a JCP (/) directive on SI	O	O	O	O			
014	Interrupt time out	X	X	X				
015	RMD cylinder-search or malfunction error	X						
016	RMD read/write timing error	X						
017	RMD address error	X						
02n	BICn error	X	X		X	X	X	
030	Parity error	X	X					
031	Reading error by card reader or paper tape device			X	X			
032	Odd-length record error		X					

X = Error reported by I/O drivers.

O = Error reported by I/O control processor.

APPENDIX C
DATA FORMATS

This appendix explains the formats and symbols used by VORTEX for storing information on paper tape, cards, and magnetic tape.

C.1 PAPER TAPE

Information stored on paper tape is binary, alphanumeric, or unformatted. It is separated into records (blocks of words) by three blank frames. The last frame of each record contains an end-of-record mark (1-3-4-8 punch).

C.1.1 Binary Mode

Binary information is stored with three frames per computer word (figure C-1). Note that channels 6 and 7 are always punched.

C.1.2 Alphanumeric Mode

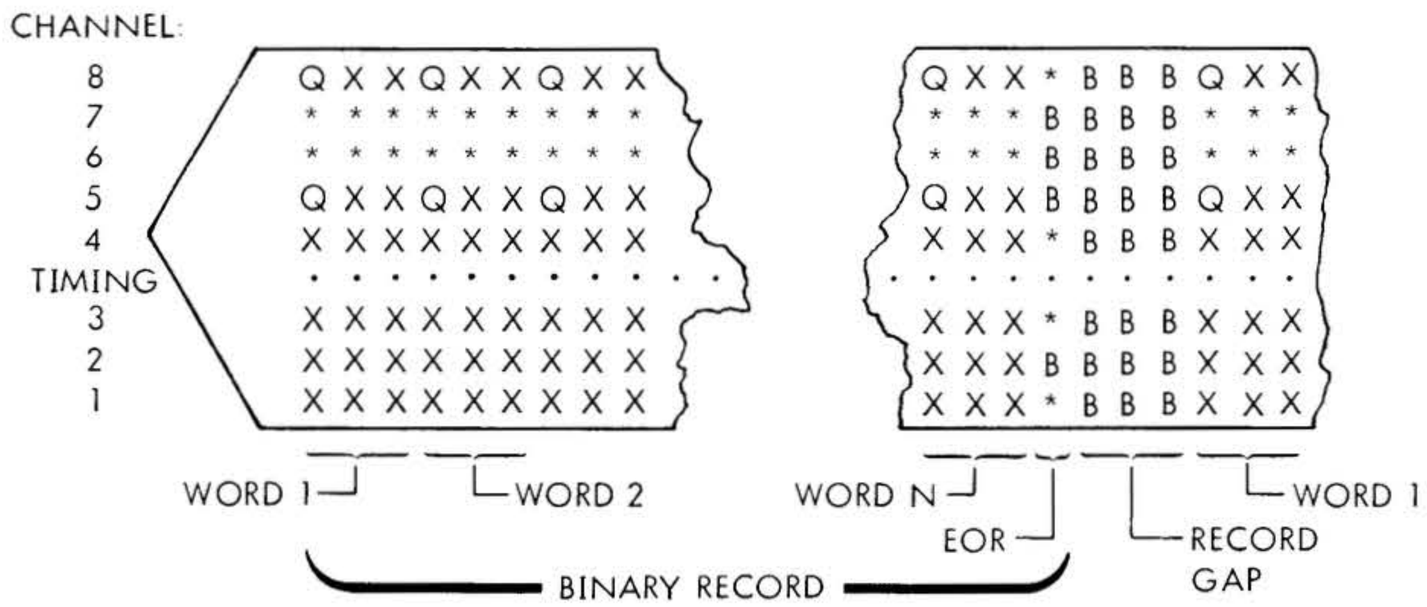
Alphanumeric information is stored with one frame per character (figure C-2). Standard ASCII-8 punch levels are used.

C.1.3 Unformatted Mode

The tape is handled as for alphanumeric mode, but without validity-checking.

C.1.4 Special Characters

An end of file is represented by the ASCII-8 BELL character (1-2-3-8 punch).



VTII-1374

Figure C-1. Paper Tape Binary Record Format

When paper tape is punched on a Teletype, the ASCII-8 ERROR character flags erroneous frames punched by the Teletype when it is turned on or off. This notifies the Teletype and paper-tape reader drivers to ignore the next frame.

When alphanumeric input tapes are punched off-line on a Teletype, there is no means of spacing the three blank frames after every record. The following procedure gives a tape that can be read by the paper-tape reader driver:

a. Punch the alphanumeric statement.

b. Punch an end of record (RETURN on the Teletype keyboard).

c. Punch three or more frames containing any of the following characters:

Press CONTROL and:	ASCII-8 Equivalent
@	DCO
LINE FEED	LINE FEED
WRU	WRU
EOT	EOT
RU	RU
VT	VTAB
TAB	HTAB
HERE IS (33 ASR only)	NULL

NOTE

Any of these characters can also be used for leader and trailer.

d. Punch the next alphanumeric statement. Return to step b.

C.2 CARDS

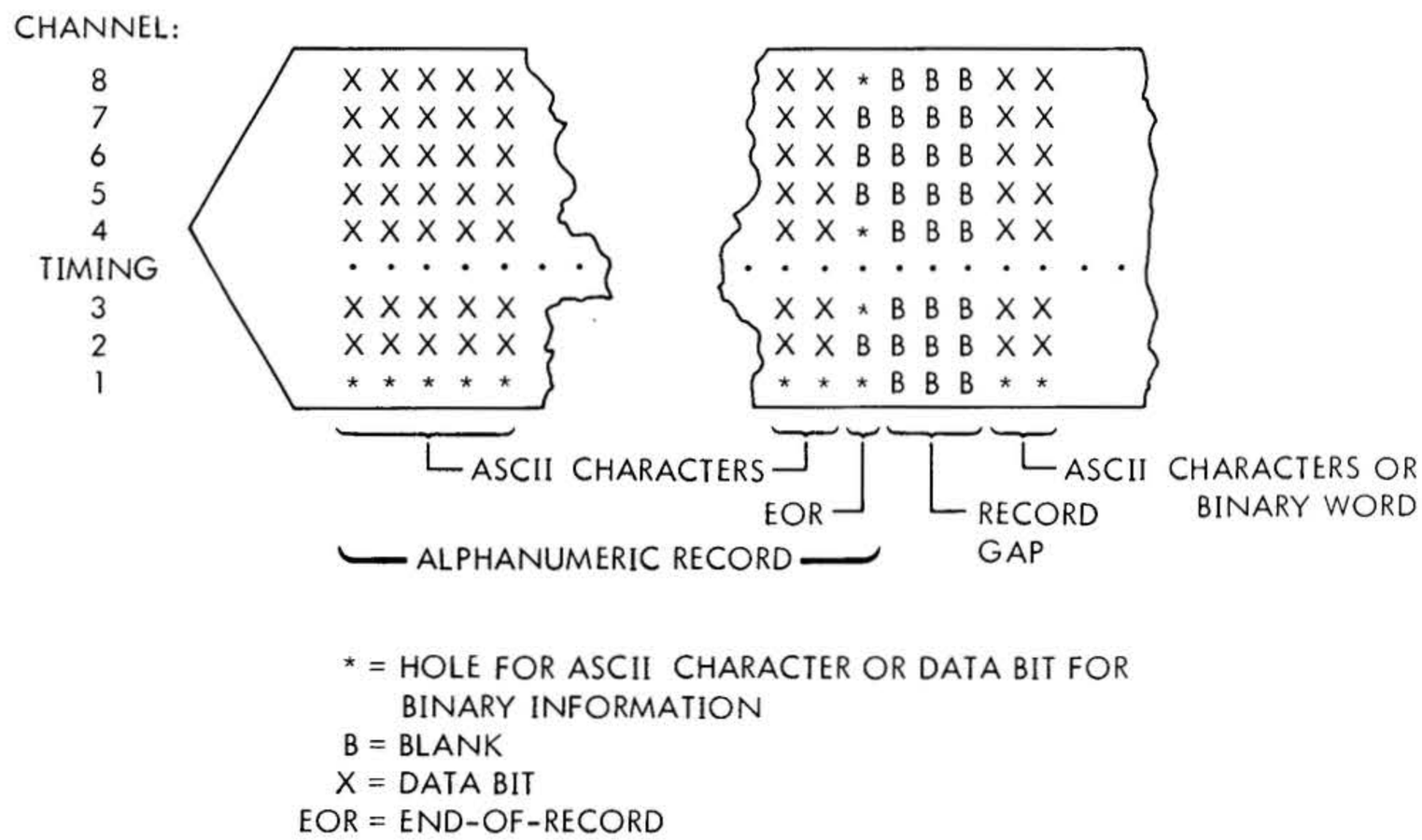
Information stored on cards in binary, alphanumeric, or unformatted. Each card holds one record of information. Hence, there is no end-of-record character for cards.

C.2.1 Binary Mode

Binary information is stored with sixty 16-bit words per card. The information is serial with bit 15 of the first word in row 12 of column 1, bit 14 in row 11, etc. (figure C-3). Any 11-0 punch in column 1 is treated as binary.

C.2.2 Alphanumeric Mode

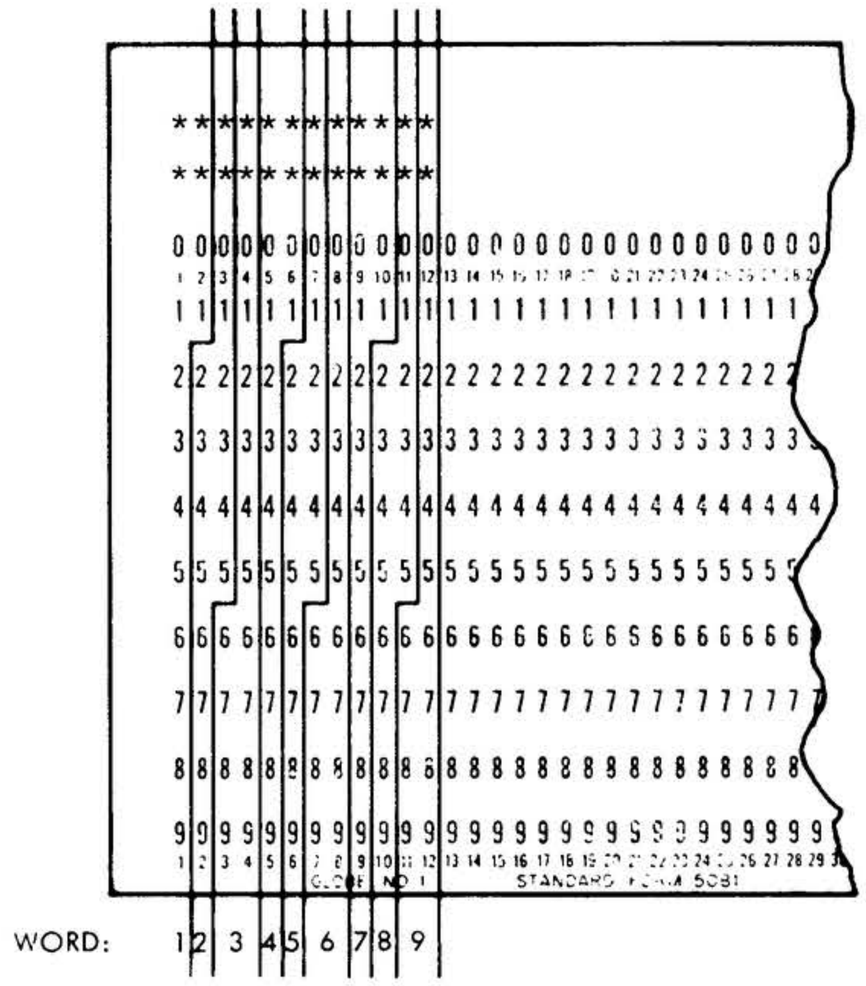
Alphanumeric information is stored one character per card column (figure C-4) using the standard punch patterns.



* = HOLE FOR ASCII CHARACTER OR DATA BIT FOR BINARY INFORMATION
B = BLANK
X = DATA BIT
EOR = END-OF-RECORD

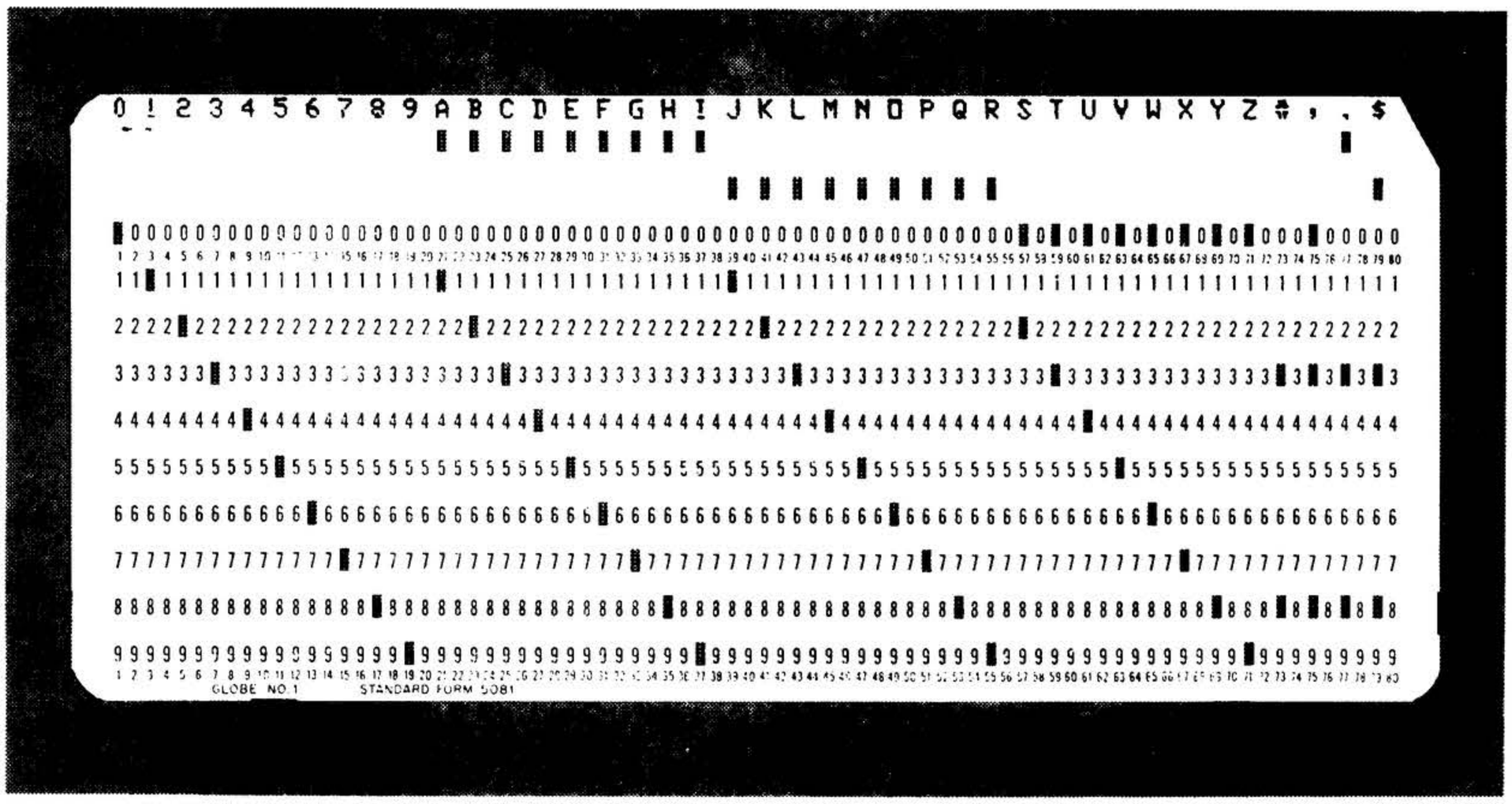
VTII-1375

Figure C-2. Paper Tape Alphanumeric Record Format



VTII-1376

Figure C-3. Card Binary Record Format



VTII-0957

Figure C-4. Card Alphanumeric Record Format (IBM 026)

C.2.3 Unformatted Mode

The data are handled, one column per computer word, right-justified, and without validity-checking.

C.2.4 Special Character

An end of file is represented on cards by a 2-7-8-9 punch in column 1 regardless of what is present on the rest of the card.

C.3 MAGNETIC TAPE

Information stored on seven-track magnetic tape is either binary or BCD. On nine-track tape, information is always binary.

C.3.1 Seven-Track

For system-binary, ASCII, and unformatted modes, the first frame is read into bits 15-12 of the word, the second frame into bits 11-6, and the third into bits 5-0. For BCD mode, the first frame is read into bits 11-6 and the second into bits 5-0.

C.3.2 Nine-Track

In all modes, the first frame is read into bits 15-8 of the word, and the second frame into bits 7-0.

C.4 STATOS PRINTER/PLOTTER

Information may be output to the Statos printer/plotter in alphanumeric and unformatted modes.

C.4.1 Alphanumeric Mode

Information output in alphanumeric mode is assumed to be ASCII characters packed two to a word. Each character is converted to a dot matrix and the print line is transmitted to the device. Characters may be printed in two sizes. The normal print size consists of a 7 by 11 dot matrix and allows 140 characters per line. The large size print consists of a 14 by 22 dot matrix and allows 70 characters per line. Excess characters will be truncated.

C.4.2 Unformatted Mode

Information output in unformatted mode is assumed to be plot data. The information is truncated after n words and transmitted to the device without conversion. Each 1 bit transmitted will cause a dot to be printed on the output line. The most significant bit of the first word is transmitted to represent the left-hand dot position on the line.

"n" depends on the bed width of the plotter. See section 20.3.3 for specific value.

APPENDIX D
STANDARD CHARACTER CODES

IBM 026 Punch Symbol	ASCII	Hollerith	IBM 029 Punch ASCII	Symbol
↑	336	7-8	242	"
>	276	6-8	275	=
:	272	5-8	247	'
'	247	4-8	300	@
=	275	3-8	243	#
←	337	2-8	272	:
9	271	9	271	9
8	270	8	270	8
7	267	7	267	7
6	266	6	266	6
5	265	5	265	5
4	264	4	264	4
3	263	3	263	3
2	262	2	262	2
1	261	1	261	1
(blank)	240	(blank)	240	(blank)
&	246	12-7-8	336	↑
<	274	12-6-8	253	+
[	333	12-5-8	250	(
)	251	12-4-8	274	<
.	256	12-3-8	256	.
?	277	12-2-8	333	[
I	311	12-9	311	I
H	310	12-8	310	H
G	307	12-7	307	G
F	306	12-6	306	F
E	305	12-5	305	E
D	304	12-4	304	D
C	303	12-3	303	C
B	302	12-2	302	B
A	301	12-1	301	A
+	253	12	246	&
%	245	11-7-8	334	\
;	273	11-6-8	273	;
]	335	11-5-8	251	)
*	252	11-4-8	252	*
$	244	11-3-8	244	$
!	241	11-2-8	241	!
R	322	11-9	322	R
Q	321	11-8	321	Q
P	320	11-7	320	P
O	317	11-6	317	O
N	316	11-5	316	N
M	315	11-4	315	M
L	314	11-3	314	L
K	313	11-2	313	K
J	312	11-1	312	J
-	255	11	255	-
#	243	0-7-8	277	?
\	334	0-6-8	276	>
"	242	0-5-8	337	←
(	250	0-4-8	245	%

STANDARD CHARACTER CODES

IBM 026 Punch Symbol	ASCII	Hollerith	IBM 029 Punch ASCII	Symbol
	254	0-3-8	254	,
@	300	0-2-8	335	]
Z	332	0-9	332	Z
Y	331	0-8	331	Y
X	330	0-7	330	X
W	327	0-6	327	W
V	326	0-5	326	V
U	325	0-4	325	U
T	324	0-3	324	T
S	323	0-2	323	S
/	257	0-1	257	/
0	260	0	260	0

APPENDIX E
ASCII CHARACTER CODES

Character	Internal ASCII	Character	Internal ASCII
0	260	R	322
1	261	S	323
2	262	T	324
3	263	U	325
4	264	V	326
5	265	W	327
6	266	X	330
7	267	Y	331
8	270	Z	332
9	271	(blank)	240
A	301		241
B	302	"	242
C	303	#	243
D	304	$	244
E	305		245
F	306	&	246
G	307	'	247
H	310	(	250
I	311	)	251
J	312	*	252
K	313	+	253
L	314	,	254
M	315	-	255
N	316	.	256
O	317	/	257
P	320	:	272
Q	321	;	273
<	274	FORM	214
=	275	RETURN	215
>	276	SO	216
	277	SI	217
@	300	DCO	220
....	333	X-ON	221
....	334	TAPE AUX	....
....	335	ON	222
↑	375	X-OFF	223
←	337	TAPE OFF	....
RUBOUT	377	AUX	224
NUL	200	ERROR	225
SOM	201	SYNC	226
EOA	202	LEM	227
EOM	203	S0	230
EOT	204	S1	231
WRU	205	S2	232
RU	206	S3	233
BEL	207	S4	234
FE	210	S5	235
H TAB	211	S6	236
LINE FEED	212	S7	237
V TAB	213		

APPENDIX F
VORTEX HARDWARE CONFIGURATIONS

Device	Device Address	Interrupt	Interrupt Address	BIC	Comments
73-3300 Memory Map	046	MP halt error	020	n/a	Wired as system priority 1
		MP I/O error	022	n/a	
		MP write error	024	n/a	
		MP jump error	026	n/a	
		MP unassigned error	030	n/a	
		MP instruction fetch error	032	n/a	
		MP write and overflow error	034	n/a	
		MP jump and overflow error	036	n/a	
Power Failure/ Restart	---	Power failure	040	n/a	Wired as system priority 2
		Power restart	042	n/a	
Real-Time Clock	047	RTC variable interval	044	n/a	Wired as system priority 4
		RTC overflow	046	n/a	Base timer interval rate is 100 microseconds; free-running clock rate is 100 microseconds
Priority Interrupt Module (PIM)	040-043		0100-0277	n/a	Wired as system priority 5; assignments should be from fastest to slowest Addresses 064-067 available for special use
Special PIM Instruction	044		n/a	n/a	PIMs modified to enable/disable with EXC 044
Buffer Interlace Controller (BIC) or Block Transfer Controller (BTC)	020-027 070-073	BIC complete	0100-0277	n/a	All wired as system priority 3 Addresses 070-073 available for BIC5 and BIC6 others created for special use

VORTEX HARDWARE CONFIGURATIONS

Device			Device Address	Interrupt	Interrupt Address	BIC	Comments
Disc Memory	70-7702 70-7703	620-47 -48,-49 Drum -43C, D Disc Memory	014	BIC complete	0100-0277	Yes	RMD assigned to Highest system BIC (no other devices can be so assigned)
Disc Memory	70-7600 70-7610	620-37, -36 Disc Memory	016-017	BIC complete Cylinder-search complete	0100-0277 0100-0277	Yes	RMD assigned to highest system BIC (no other devices can be so assigned)
	70-7603 70-7613	Model F Disc Memory	015-017	BIC complete Cylinder-search complete	0100-0277 0100-0277	Yes	RMD assigned to highest system BIC (no other devices can be so assigned)
	70-7500	620-35 Disc Memory	015	BIC complete Cylinder-search complete	0100-0277 0100-0277	Yes	RMD assigned to highest system BTC (no other devices can be so assigned)
	70-7510	620-34 Disc Memory	015-017	BIC complete Cylinder-search complete	0100-0277 0100-0277	Yes	RMD assigned to highest system BTC (no other devices can be so assigned)
	70-755x	70-755x direct memory disk	014	Status interrupt	0100-0277	No	Device address and device address plus one are required
	70-7560 70-7561 70-7562	Direct Memory Disk	014	Status Interrupt	0100-0277	No	Device address and device plus one required.
		F3064	016	Controller busy/not busy transition interrupt	0100-0277	Yes	
	Magnetic Tape	70-7100	620-30 -31A, -31B, or -31C, -32 Magnetic Tape Unit	Tape motion complete	0100-0277 0100-0277	Yes	
	Card Reader	70-6200	620-25 Card Reader	030	BIC complete	0100-0277	Yes

Device			Device Address	Interrupt	Interrupt Address	BIC	Comments
Printer/ Plotter	70-6602	620-75 Statos Printer/ plotter	035-036	BIC complete PC not busy	0100-0277	Yes	
		70-7702 70-660x Statos Printer/ Plotter	035-036	BIC complete PC not busy Statos not busy	0100-1077 0100-0277 0100-0277	Yes	Interrupt event words should be 01 for BIC, 02 for Statos, and 04 for PC
Line Printer		620-77 Line Printer	035-036	BIC complete	0100-0277	Yes	
Card Punch	70-6201	620-27 Card Punch	031	BIC complete	0100-0277	Yes	
Paper-tape System	70-6320	620-55, -55A Paper Tape System	037,034	Character ready	0100-0277	No	
Teletype	70-6100 70-6104	620-6, -7, -8 Teletype	001-007	Read buffer ready Write buffer ready	0100-0277 0100-0277	No	Event 1 = READ Event 2 = WRITE
	70-6400	CRT with E-2184 Controller	...	Read buffer ready Write buffer ready	0100-0277 0100-0277	No	Compatible with Teletype (Event 1 = READ, Event 2 = WRITE)
		Front Panel	...		00-01	No	Wired as system priority 6; not used by VORTEX
WCS	73-4000, -4001, -4002	070-074	n/a	n/a		No	Only one device is used in a given system. Multiple (512 word) WCS pages use the same device address.

NOTES

(1) The priority look-ahead option is required if there are more than eight priority devices in the system.

(2) PIM[2] assignments are arranged from the fastest devices to the slowest.

APPENDIX G
OBJECT MODULE FORMAT

Object modules generated by the VORTEX language processors result from assembly or compilation. The modules are input by the load-module generator and are bound together into a load module.

The first record of the module contains the size of the program, an eight-character identification, and an eight-character date. Entry name addresses, if any, appear as the first data field items of the object module.

G.1 RECORD STRUCTURE

Object-module records have a fixed length of sixty 16-bit words. Word 1 is the record control word. Word 2 contains the exclusive-OR check-sum of word 1 and words 3 to 60. Words 3 to 11 can contain a program identification block (optional). Words 12 to 60 (or 3 to 60 if there is no program identification block) contain data fields.

Table G-1 illustrates record control word formats.

G.2 PROGRAM IDENTIFICATION BLOCK

The program identification (ID) block appears in words 3 to 11 of the starting record of each module. Word 3 contains the program size, words 4 to 7 contain an ASCII eight-character program identification, from the TITLE statement, and words 8 to 11 contain an ASCII eight-character date.

G.3 DATA FIELD FORMATS

Data fields contain one-, two-, three-, or four-word entries. One-word entries consist of a control word; two-word entries consist of a control word and a data word; three-word entries consist of a control word and two data words; and four-word entries consist of a control word, two name words, and a data word. Data words can contain instructions, constants, chain addresses, entry addresses, and address offset values.

Table G-1. Record Control Word Format

Bit	Binary Value	Meaning
15	0	Verify check-sum
	1	Suppress check-sum
13-14	11	Binary record
	00-10	Nonbinary record
12	0	First record of module
	1	Not the first record
11	0	Last record of module
	1	Not the last record
10	0	
9	0	
8	0	Not a relocatable module (absolute)
	1	Relocatable module
0-7		Sequence number (modulo 256)

G.4 LOADER CODES

Loader codes, which have the following format, are among the data in an object module.

```
 15   14 13 12   11 10 9    8 7 6      5 4 3      2 1 0
---------- ---------- ------------ ----------
    Code       Subcode      Pointer        Name
```

Code Values	Meaning
00	Refer to subcode for specific action.
01	Undefined.
02	Add the value of the selected pointer to the data word before loading.
03	Add the value of the selected pointer to the first data word (literal value) and enter the sum in the direct literal pool if bit 11 of the second data word is zero. Otherwise, enter it in the indirect literal pool. Add the address of the literal to the second data word before loading.

Code Values	Meaning
04	Load the data word(s) absolute. Bits 12 through 0 indicate the number of words minus one (n-1) to load.
05-07	Undefined.

Subcode Values	Meaning
00	Ignore this entry (one word only).
01	Set the loading address counter to the sum of the specified pointer plus the data word.
02	Chain the current loading address counter value to the chain whose last address is given by the sum of the selected pointer plus the data word. Stop chaining when an absolute zero address is encountered.
03	Complete the postprogram references by adding to each address the sum of the selected pointer plus the data word.
04-06	Undefined.
07	Set the program execution address to the sum of the values of the selected pointer plus the data word.
010	Define the entry name with entry location as equal to the value of the selected pointer plus the data word. (Equal to the beginning of the programming region, if not already defined.)
011	Define a region for the pointer whose size is given in the data word. If the entry name is not blank, define the entry point as the base of the region.
012	Enter a load request for the external name. The chain address is given by the sum of the selected pointer plus the data word.
013	Enter the loading address of the external name in the indirect literal pool. Add the address of the literal plus the value of the selected pointer to the data word (command) before loading.
014-017	Undefined.

Pointer Values	Meaning
00	Program region.
01	Postprogram region.
02	Blank common region.
03-036	Labelled COMMON regions.
037	Absolute (no relocation).

Name Format

Names are one to six (six-bit) characters, starting in bit 3 of the control word and ending with bit 0 of the second name word. Only the right 16 bits of the two name words are used.

G.5 EXAMPLE

The following is a sample background program with the description of the object module format after the assembly and the core image after loading.

G.5.1 Source Module

```
                NAME    SUBR
                EXT     BBEN
SUBR            ENTR
                LDA*    SUBR
                CALL    BBEN
                STA     TIME
                JAN     DONG
                LDA     =2
                CALL    BBEN
DONG            INR     SUBR
                JMP*    SUBR
TIME            BSS     1
                END
```

G.5.2 Object Module

060400	Record control word (first and last record, verify check-sum sequence number 0)
157631	Check-sum word.
	(Begin program ID block)
000016	Program size (exclusive of FORTRAN COMMON, literals, and indirect address pointers).
142730 140715 150314 142640	Identification in ASCII (assume this program was labeled EXAMPLE).
131263 126661 130255 133271	Date of creation in ASCII (assume assembled 03-10-69)
	(End program ID block)
010000 000647 054262 000000	Define entry name SUBR at relative 0 (code 0, subcode 010, pointer 0, name SUBR, and data word 0).
100000 000000	Enter absolute data word 0 in memory at relative 0.
060000 100000 017000	Enter literal (indirectly addressed relative 0) in indirect pointer pool, add address of pointer to load 017000 and enter memory at relative 1.
100000 002000	Enter absolute data word 02000 in memory at relative 2.

100000 000000	Enter absolute data word 000000 in memory at relative 3.
100000 054010	Enter absolute data word 054010 in memory at relative 4.
100000 001004	Enter absolute data word 01004 in memory at relative 5.
040000 000012	Enter relative data word 012 in memory at relative 6.
060760 000002 010000	Enter literal (absolute 2) into literal pool, add address of literal to load command 010000, and enter in memory at relative 7.
100000 002000	Enter absolute data word 02000 in memory at relative 010.
040000 000003	Enter relative data word 03 in memory at relative 011.
060000 000000 047000	Enter literal (relative 0) into indirect pointer pool, add address of literal to increment command 047000, and enter in memory at relative 012.
100000 001000	Enter absolute data word 01000 in memory at relative 013.
040000 100000	Enter relative data word 0100000 in memory at relative 014.
001000	Set loading location for next command, if any, to relative 016.
012003 000212 024556 000011	Enter load request for external name BBEN and chain entry address to relative 011.
•	
•	
•	
•	

(The remaining words of this record contain zero).

G.5.3 Core Image

Assume the program originates at 01000, the literal pool limits are 0500-0777, and BBEN is loaded at 01016.

```
0500        101000      DATA        *01000
0501        001000      DATA        1000
 .
 .
 .
0777        000002      DATA        2
 .
 .
 .
01000       000000      ENTR        0
01001       017500      LDA*        0500
01002       002000      JMPM
01003       001016                  01016
01004       054010      STA         01015
01005       001004      JAN
01006       001012                  01012
01007       010777      LDA         0777
01010       002000      JMPM
01011       001016                  01016
01012       047501      INR*        0501
01013       001000      JMP
01014       101000            *     01000
01015                   BSS         1
01016                   BSS         1
```

The following six-bit codes are used by the load-module generator in building load modules. The codes define names created by NAME, TITLE, and EXT directives.

Character	Octal	Character	Octal	Character	Octal
@	40	V	66	+	13
A	41	W	67	,	14
B	42	X	70	-	15
C	43	Y	71	.	**16**
D	44	Z	72	/	17
E	45	[	73	0	20
F	46	\	74	1	21
G	47	]	75	2	22
H	50	↑	76	3	23
I	51	←	77	4	24
J	52	(blank)	00	5	25
K	53	!	01	6	26
L	54	"	02	7	27
M	55	#	03	8	30
N	56	$	04	9	31
O	57	%	05	:	32
P	60	&	06	;	33
Q	61	'	07	<	34
R	62	(	10	=	35
S	63	)	11	>	36
T	64	*	12	?	37
U	65				

G.6 END LOAD RECORD

An end-load-module record is used to terminate one or more object modules which comprise a root or sequent of a load module. This record is processed simularly to an end-of-file indication by LMGEN, however, more than one end-load-module record may be present on an RMD file.

The form of an end-load-module record is a binary record in which the first word has the value 077000 and all other words are zero.

Appendix H
RMD STATUS WORDS

H.1 70-76x0 RMD

Bit	Meaning if bit on
0	Unit 0 Seek Complete
1	Unit 1 Seek Complete
2	Unit 2 Seek Complete
3	Unit 3 Seek Complete
4	Selected Unit Illegal Sector
5	Selected Unit Illegal Address
6	Selected Unit Malfunction
7	Selected Unit Timing Error
8	Selected Unit Read Parity Error
9	Selected End of Track Error
10	Selected Write Protect

Bit	Description
11	Selected Unit - Unit Not Ready
12	Not Used
13	Not Used
14	Not Used
15	Not Used

H.2 70-7500 and 70-7510 RMD

Bit	Meaning if bit on
0	Timing error
1	Track stop (record not found)
2	Format error (record too long)

Bit	Meaning if bit on
3	Search error (bad cyclic check)
4	Data error (bad cyclic check)
5	End of file (data length = 0)
6	Unit not on line
7	Disk pack unsafe
8	Seek error (seek incomplete)
9	Write Protect
10	Unit not selected
11	Head select error
12	Bad track flag set
13	Not used
14	Not used
15	Not used

H.3 70-7520/7530 RMD

Bit	Meaning if bit on
0	Timing error
1	Track stop (record not found)
2	Format error (record too long)
3	Search error (bad cyclic check)
4	Data error (bad cyclic check)
5	End of cylinder (head no 19)
6	Unit not on line
7	Disk drive unsafe
8	Seek error (seek incomplete)
9	Read Only

Bit	Meaning if bit on
10	Unit not selected
11	Head select error
12	Bad track flag set
13	Disk reserved
14	Not used
15	Not used

H.4 70-7603/7613 RMD

Bit	Description
0	Unit 0 seek complete
1	Unit 1 seek complete
2	Unit 2 seek complete
3	Unit 3 seek complete
4	Selected unit illegal sector
5	Selected unit illegal address
6	Selected unit malfunction
7	Selected unit timing error
8	Selected unit CRC search error
9	Selected unit read CRC error
10	Selected end of track error
11	Selected write protect
12	Selected unit - unit not ready
12	Selected unit - header compare error
14	Format error
15	Sync byte not found

H.5 70-755x, 70-7560, 70-7561, and 70-7562 RMD

H.5.1 Primary Status

Bit	Explanation
15	Unit busy
14	Secondary status
13	End of unit
12	End of file
11-8	0 No error
	1 Memory error
	2 Map error
	3 Unit data error
	4 Attention
	5 Off line
	6 Chaining interrupt
	7 Memory timeout
	10 Command reject
	11 Rate error
	12-17 Not used
7-0	Address of unit supplying status

H.5.2 Secondary Status

Word	Bit	Field	Definition
0	15-0	C	Cylinder address of the last operation
1	15-8	T	Track address of the last operation
1	7-0	S	Sector address of the last operation
2	15-10	ZERO	All zeros
2	9-0	SF	Secondary status field

9 = Correctable ECC error detected
8 = Write protect error
7 = Sector flagged bad
6 = Data synchronization fail
5 = Header synchronization fail
4 = Sector search
3 = Track select error
2 = Cylinder seek error
1 = Data check error
0 = Header CRC error

H.6 F3064 FLEXIBLE DISKETTE

Bit	Meaning	Description
15-14	Undefined	
13	Track analysis recommended	Following a format operation, indicates that at least one track required rewriting. Otherwise, indicates that more than one retry was required to complete the last operation.
12	Selected unit not ready	Selected drive is not ready.
11	Write protect violation	WRITE operation attempted on protected diskette.
10	Track overflow	BIC buffer length exceeded number of sectors remaining on the track.
9	Data CRC error	Data field CRC error occurred.
8	Header CRC error	Header field CRC error occurred.
7	Transfer timing error	Data lost or data overwrite detected during transfer operation.
6	Seek error	Desired track cannot be found (verified).
5	Bad sector indicator	Bad sector flag detected during READ operation.
4	Illegal disk address	Range error for sector or track address was detected by firmware.
3	Record search error	Header for desired record cannot be found.
2-1	Undefined	
0	Context error	Firmware command is not preceded or followed by necessary supportive commands.

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