VORTEX

REFERENCE MANUAL

Specifications Subject to Change Without Notice

varian data machines/a varian subsidiary
2722 michelson drive, irvine, california 92664

98 A 9952 101

SEPTEMBER 1972

This manual explains the **Varian Omnitask Real-Time Executive (VORTEX)** and its use, but it is not intended for a beginning audience. Prerequisite to an understanding of this manual is a knowledge of general programming concepts, and preferably some 620 serie≗ or 73 computer system is desirable.

This manual discusses the following components of the VORTEX system:

- Real-time executive (RTE, section 2)
- Input/output control (IOC, section 3)
- Job-control processor (JCP, section 4)
- Language processors (section 5)
- Load-module generator (LMGEN, section 6)
- Debugging and snapshot dump programs (section 7)
- Source editor (SEDIT, section 8)
- File maintenance (FMAIN, section 9)
- Input/output utility program (IOUTIL, section 10)
- Support library (section 11)
- Real-time programming (section 12)
- System generation (SGEN, section 13)
- System maintenance (SMAIN, section 14)
- Operator communication (OPCOM, section 15)
- Operation of the VORTEX system (section 16)
- Error messages (section 17)

TABLE OF CONTENTS

SECTION 1
INTRODUCTION

SECTION 2
REAL-TIME EXECUTIVE SERVICES

SECTION 3
INPUT/OUTPUT CONTROL

SECTION 4
JOB-CONTROL PROCESSOR

SECTION 5
LANGUAGE PROCESSORS

SECTION 6
LOAD-MODULE GENERATOR

SECTION 7
DEBUGGING AIDS

SECTION 8
SOURCE EDITOR

SECTION 9
FILE MAINTENANCE

SECTION 10
INPUT/OUTPUT UTILITY PROGRAM

SECTION 11
SUPPORT LIBRARY

SECTION 12
REAL-TIME PROGRAMMING

SECTION 13
SYSTEM GENERATION

SECTION 14
SYSTEM MAINTENANCE

SECTION 15
OPERATOR COMMUNICATION

SECTION 16
OPERATION OF THE VORTEX SYSTEM

SECTION 17
ERROR MESSAGES

SECTION 18
VORTEX PROCESS INPUT/OUTPUT

APPENDIX A
OBJECT MODULE FORMAT

APPENDIX B
I/O DEVICE RELATIONSHIPS

APPENDIX C
DATA FORMATS

APPENDIX D
STANDARD CHARACTER CODES

APPENDIX E
TELETYPE AND CRT CHARACTER CODES

APPENDIX F
VORTEX HARDWARE CONFIGURATIONS

INDEX

LIST OF ILLUSTRATIONS

LIST OF TABLES

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 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

The **V**arian **O**mnitask **R**eal-Time **EX**ecutive (**VORTEX**) is a modular software operating system for controlling, scheduling, and monitoring tasks in real-time multiprogramming environment. VORTEX also provides for background operations such as compilation, assembly, debugging, or execution of tasks not associated with the real-time functions of the system. Thus, the basic features of VORTEX comprise:

- Real-time I/O processing
- Provision for directly connected interrupts
- Interrupt processing
- Multiprogramming of real-time and background
- Priority task scheduling (clock time or interrupt) tasks
- 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

1.1 SYSTEM REQUIREMENTS

VORTEX requires the following minimum hardware configuration:

a. Varian 620/f, 620/f-100 or 73 computers with 12K read/write memory (16K for foreground and background)

b. Direct memory access (DMA)

c. 33/35 ASR Teletype on a priority interrupt module

d. Real-time clock

e. Memory protection

f. Power failure/restart

g. Optional instruction set

h. Priority Interrupt Module (PIM)

i. Rotating memory on a PIM with either a buffer interlace controller (BIC) or priority memory access (PMA)

j. 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

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

a. Additional main memory (up to 32K) and/or rotating memory

b. Automatic bootstrap loader

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

d. Card punch with BIC and PIM

e. Line printer with BIC and PIM

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

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.

1.2.1 Computer Memory

The VORTEX operating system divides computer (main) memory into five areas (figure 1-2):

a. Real-time executive area

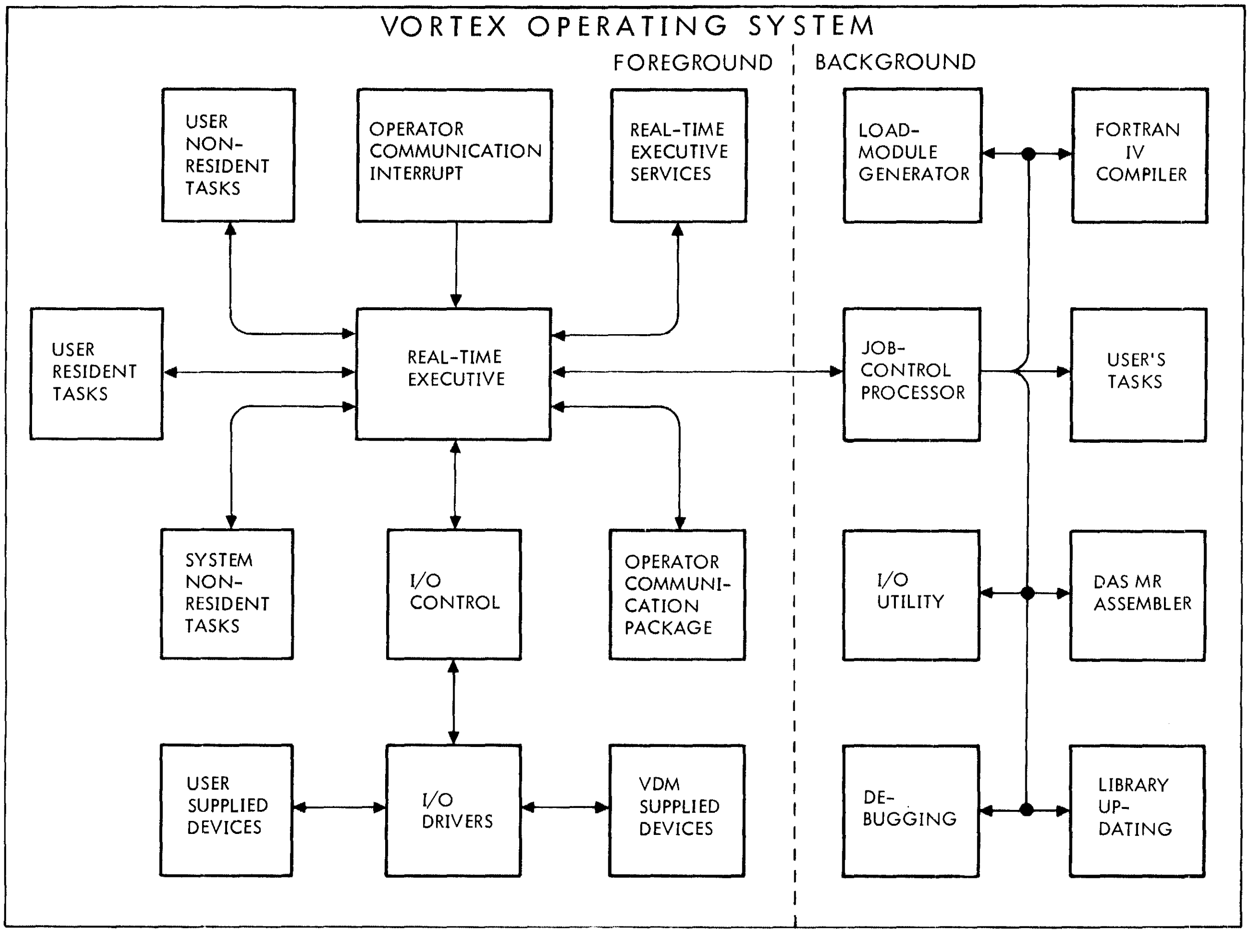
b. User's resident task and subroutine area

c. User's nonresident task allocation area

d. Background task area

e. ʟow-memory block area

The **real-time executive area** is the highest segment of memory. It contains the real-time executive, the I/O control component, I/O drivers, the load-module loader, interrupt processors, and the foreground blank common (section 6).



VTII-1314

Figure 1-1. VORTEX System Flow

All subroutines that reside in this area must be declared at system-generation time because no modification of the area is possible at run time. (Maintenance of the foreground blank common is a user responsibility. The VORTEX system provides blank-common pointers for use by the load-module generator.)

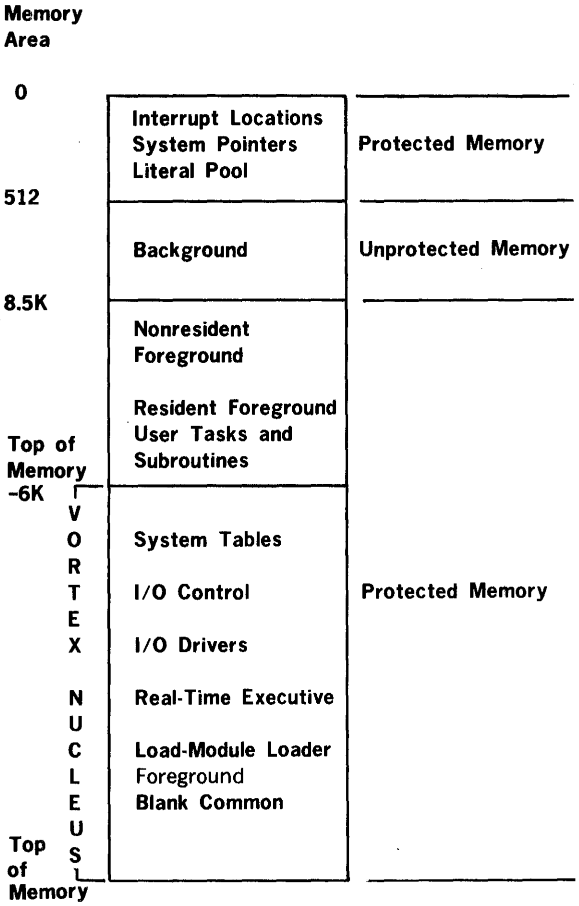


Figure 1-2. VORTEX Computer Memory Map

The **user's resident task and subroutine area** is adjacent to the real-time executive area. All resident foreground subroutines must be declared at system-generation time because no modification of the area is possible at run time.

The **user's nonresident task allocation area** is for the execution of tasks that reside on the RMD in the form of load modules, i.e., fully link-edited, but relocatable. When such a task is to be executed, it is loaded into this area and activated. If no nonresident foreground area is available for loading this task, background area is used, the background task being suspended and stored on the RMD. When the background area is again free, the background task is reloaded and resumed.

The **background task area** is for the execution of tasks that are less time-critical, such as compilers, assemblers, editors, and other general-purpose tasks. *Note that this area is the only unprotected area of memory.* Tasks executing in this area cannot modify the system, i.e., this area is suitable for the execution of undebugged tasks.

The **low-memory block area** contains system pointers and tables, interrupt addresses, and the background literal pool.

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 3).

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.

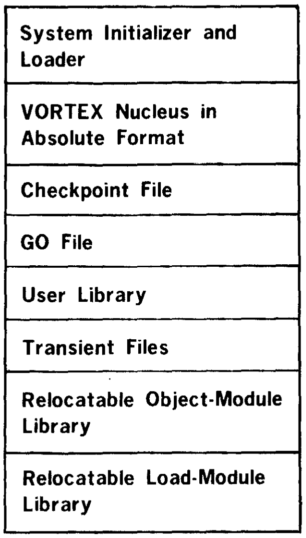

System Initializer and Loader
VORTEX Nucleus in Absolute Format
Checkpoint File
GO File
User Library
Transient Files
Relocatable Object-Module Library
Relocatable Load-Module Library

Figure 1-3. VORTEX RMD Storage Map

1.3 BIBLIOGRAPHY

The following gives the stock numbers of manuals pertinent to the use of VORTEX and the 73/620 computers:

Title	Document Number
73 Handbook	98 A 9906 010
620-100 Computer Handbook	98 A 9905 003
620 FORTRAN IV Reference	98 A 9902 037
620 Training Manual	98 A 9902 503
RPG IV Manual	98 A 9947 032

Maintenance information is in the following VORTEX Software Performance Specifications:

Document Number	Title
89A0156-000	System Overview
89A0203-000	External Specification
89A0231-000	Internal Specification, Vol. I
89A0232-000	Internal Specification, Vol. II
89A0233-000	Internal Specification, Vol. III
89A0225	DAS MR Assembler Internal Spec
89A0214	FORTRAN IV compiler Internal Spec
89A0211	FORTRAN IV Library Internal Spec
89A0234	RPG IV Runtime/Loader Internal Spec
89A0184	RPG IV Compiler Internal Spec

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.

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.

Background and foreground RTE service requests are similar. However, a level 0 background RTE request causes a memory-protection interrupt and the request is checked for validity. If there is an error, the system prints the error message **EX11** with the name of the task and the location of the violation of memory protection. The background task is aborted.

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
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

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

There are 12 RTE service request macros. Certain of them are illegal in unprotected background (level 0) tasks. Table 2-1 lists the RTE macros, indicates whether they are illegal in level 0 tasks, and indicates whether there is a FORTRAN library subroutine (section 11) provided.

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 below

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,'F','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 section 17.2.

2.1.1 SCHED (Schedule) Macro

This macro schedules the specified task to execute on its designated priority level. The scheduling task can pass the two values in the A and B registers to the scheduled task. The macro has the general form

label **SCHED** **level,*wait*,lun,*key*,'xx','yy','zz'**

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 tasks 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, **zero to schedule a resident foreground task**, or 106 to schedule a nonresident task from the foreground library

key is the protection code, if any, required to address **lun** (0306 or 'F' to schedule a nonresident task from the foreground library)

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 ',' '

The foreground library logical unit and its protection key are specified by the user at system-generation time.

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 containing the values 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 task, a foreground task, 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).

Bit	15 14 13	12	11 10 9 8 7 6 5	4 3 2 1 0
Word 0	J S R			
Word 1	V$EXEC address			
Word 2	☒	w	0 0 0 0 0 1 0	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 that 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(3),N2(3)
DATA N1(1)/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)
```

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 interrupt or a RESUME (section 2.1.4) macro. The macro has the general form

label **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 interrupt.

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															
Word 1	V$EXEC address															
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 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 immediately.

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															
Word 1	V$EXEC address															
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)
        •
        •
```

Co'trol 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 time-of-day 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

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 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 is equal to or greater than the resolution of the clock. The delay interval is stored in minute increments and real-time clock resolution increments. Time is kept on a 24-hour clock.

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															
Word 1	V$EXEC address															
Word 2					0	0	1	0	0	1					type	
Word 3	milli															
Word 4	min															

Examples: 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
        •
        •
        •
```

2.1.5 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 set 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.

Expansion: The *opt* flag is bit 0 of word 2 (o).

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R															
Word 1	V$EXEC address															
Word 2					0	0	1	0	0	0						o
Word 3	pim								mask							

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
             •
             •
             •
```

2.1.6 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 hours and minutes in 1-minute integer increments, and **milli** is the seconds in 5-millisecond integer increments.

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R															
Word 1	V$EXEC address															
Word 2	☒				0	0	1	0	1	0	☒					

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)
             •
```

2.1.7 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

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															
Word 1	V$EXEC address															
Word 2	☒				0	0	1	0	1	1	☒					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 a 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)
```

2.1.8 ALOC (Allocate) Macro

This macro allocates space in a push-down (LIFO) stack of variable length 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 ALOC(subr)

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

The first location of the LIFO stack is V$LOC, and that of the current position in the stack is V$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 2.1.7) is executed in the called subroutine. Between ALOC and DEALOC, (1) the 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		
Word 1	V$EXEC address		
Word 2	☒	0 0 0 1 1 0	☒
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	For reentrant subroutine use (temporary storage)	
•	•	
•	•	
Word n	•	

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 2.1.7), six words are deallocated from the reentrant stack.

2.1.9 DEALOC (Deallocate) Macro

This macro deallocates the current reentrant stack, restores the contents of the A and B 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 2.1.6). The 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
Word 1	V$EXEC address
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
```

2.1.10 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
Word 1	V$EXEC address
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)
```

2.1.11 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
Word 1	V$EXEC address
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   )
```

2.1.12 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 3.4.11) in the VORTEX system reserved for background use. System background and user programs can reference these global FCBs. JCP directive /PFILE (section 4.2.12) 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.

Expansion:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word 0	J S R															
Word 1	V$EXEC address															
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,PI,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.

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.

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 15) 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 15-1 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; Teletype or CRT only
4	PI	Processor input	For input of source statements from all operating system language processors

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

Number	Name	Description	Function
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 only
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

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				

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						

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		
Word 1	ppb	╳	Protection key
Word 2	Number of bad tracks in the partition		
Word 3	Ending partition address + 1		

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.

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 3.4.1 and 3.4.2). 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.

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 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:

		op-code
• OPEN	Open file	6
• CLOSE	Close file	7
• READ	Read one record	0
• WRITE	Write one record	1
• REW	Rewind	3
• WEOF	Write end of file	2
• SREC	Skip one record	4
• FUNC	Function	5
• STAT	Status	
• DCB	Generate data control block	
• FCB	Generate file control block	

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 3.4.11) or a data control block (DCB, section 3.4.10). 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 section 17.3.

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 3.4.1.

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:

<table>
<tr><th>Bit</th><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Word 0</td><td colspan="16">J S R</td></tr>
<tr><td>Word 1</td><td colspan="16">V$IOC address</td></tr>
<tr><td>Word 2</td><td>c</td><td colspan="6">Status</td><td>e</td><td colspan="3">cc</td><td colspan="5">Priority*</td></tr>
<tr><td>Word 3</td><td>w</td><td colspan="3">Mode</td><td colspan="4">Op-code</td><td colspan="8">Logical-unit number</td></tr>
<tr><td>Word 4</td><td colspan="16">FCB or DCB address</td></tr>
<tr><td>Word 5</td><td colspan="16">User task identification block address*</td></tr>
<tr><td>Word 6</td><td colspan="16">IOC thread address*</td></tr>
</table>

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 section 17.3.

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 5 initially points to the user's task identification block. Upon completion of a READ or WRITE macro (sections 3.4.3 and 3.4.4), the IOC sets word 5 to the actual number of words transmitted.

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 3.4.9.

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
Word 1	V$IOC address
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 tape and bbb is the address of the end of the tape or end of device.

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

rl

```
label       DCB       fl,buff,fun
```

where the symbols have the definitions given in section 3.4.10.

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 rl
Word 1	Address of user data area buff
Word 2	Function code func

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 3.4.11.

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	Access method	Protection key
Word 3	Current record number	
Word 4	Current ~~position~~ 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 15 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.

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. + but OPEN sets it to one ...

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.

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.

3.4.1 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 initializing 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 3.4.11).

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 file FILE10 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','LE','10'
```

3.4.2 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 3.4.11).

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    ,,SEQR,,'MA','TR','IX'
```

3.4.3 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

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
```

3.4.4 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 3.4.3).

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

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 mag-
                          netic-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)
```

3.4.5 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        fcb,lun,wait
```

or

```
      label   REW        dcb,lun,wait
```

where

fcb is the address of the FCB

dcb is the address of the DCB

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 3.4.1).

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

Rotating-memory devices: REW places the start-RMD-partition and end-RMD-partition addresses in words 5 and 6, respectively, of the FCB (section 3.4.11). Not for use with named file

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 3.4.11).

```
DISC   EQU    10   (LUN assigned to RMD partition)
RECL   EQU    120
       •
       •
       •
REWD   REW    FCB,DISC
       •
       •
       •
FCB    FCB    RECL,BUFF,,,'SY','ST','EM'
              (section 3.4.11)
BUFF   BSS    120
```

3.4.6 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        ,TAPE
            •
            •
            •
```

3.4.7 SREC (Skip Record) Macro

This macro, which applies only to magnetic-tape 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

If applied to an RMD, SREC adds or subtracts from the value of word 3 of the FCB (section 3.4.11).

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 ,MT,IM,REV
      •
      •
```

3.4.8 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 3.4.10):

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 x
	1	Advance paper one line
	2	Advance paper two lines

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 printer)
CNT     EQU     2     (Paper-tape channel 2)
        •
        •
        •
UPSP    FUNC    DCB,LP
        •
        •
        •
DCB     DCB     ,,CNT
```

3.4.9 STAT (Status) Macro

This macro examines 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

eof eot

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

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

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   ,MT,IM (DCB can be omitted for REW)
      •
      •
      •
BUSY  STAT  REW,ERR,BOT,EQT,BUSY
      •
      •
      •
BOT   •
ERR   •
EQT   •
```

3.4.10 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 3.4.8)

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)
```

3.4.11 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*

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 sequentia access by logical record, 2 for direct access using the relative sector number (beginning with 1) within the file, or 3 for sequential access using the relative sector number within the file

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 increment record >EOF	Adds or subtracts one	Set to position of file on directory by mode chosen	Current record set to one or beginning address of logical unit
4	Set to current position of file as noted on directory	Checks end of file	No action	Checks end of file	No action	Set to ending address of logical unit
5	Set to beginning of file address put in this word	No action	No action	No action	No action	Set to beginning address of logical unit
6	Set to end of file address	No action	(check end) No action	No action	No action	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
			Direct-Access Method			
3	Set to position of current record by mode chosen	No action	No action	No action	Set to position of file on directory by mode chosen	Current record set to one or beginning address of logical unit
4	Set to current position of file as noted on directory	No action	No action	No action	No action	Set to ending address of logical unit
5	Set to beginning of file address	No action	No action	No action	No action	Set to beginning address of logical unit
6	Set to end of file address	No action	No action	No action	No action	Set to ending address of logical unit

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 (section 15.2) 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.

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
/MEM	Allocate extra memory for background task

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

/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

c. Language-processor directives:

/DASMR	Schedule DAS MR assembler
/FORT	Schedule FORTRAN 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

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

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 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 JCP directives are given in section 17.4.

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.

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

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 2.1.10). It has the form

/FINI

To reschedule JCP after a FINI, input any JCP directive from the OC unit (section 15).

Example: Terminate JCP operations.

```
/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 15-1)

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 15.2.10), 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, 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 unit, causes the specified logical unit to move the tape the designated number of records in the required direction. 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

If a file mark, end of tape, or beginning of tape is encountered 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.

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.

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, 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, 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 3.4.11) 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 2.1.12). 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 (default value) 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	Outputs binary object
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

The /DASMR directive can contain up to four such 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 paragraph 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
B	Suppresses binary object	Outputs 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
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

The /FORT directive can contain up to seven 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

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,SS=MT00
/REW,SS
/DASMR
/PFILE,SS,,SS
/CONC
```

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*

where *M*, if present, suppresses the output of a memory map.

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 14) 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 background [illegible] upon completion of execution.

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
```

4.2.23 /LOAD Directive

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

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

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
```

4.3 SAMPLE DECK SETUPS

The batch-processing facilities of VORTEX are envoked 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. 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)
     .
     .
     .
/EXEL
/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.

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.

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.

Details of the DAS MR assembly language are given in the Varian 620/f Computer Handbook (document 98 A 9908 001), 620-100 Computer Handbook (98 A 9905 030), and 73 System Handbook (98 A 9906 010). These references include descriptions of the directives recognized by the assembler (table 5-1), except for the new directive TITLE, which is discussed below.

Table 5-1. Directives Recognized by the DAS MR Assembler

BES	IFF
BSS	IFT
CALL	LOC
COMN	MAC
CONT	MZE
DATA	NAME
DETL	NULL
DUP	OPSY
EJEC	ORG
END	PZE
EMAC	RETU*
ENTR	SET
EQU	SPAC
EXT	SMRY
FORM	TITLE
GOTO	

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 3.4) macros. Figure 5-1 illustrates these definitions.

```
*
M1        MAC
          EXT       V$IOC
          JSR       V$IOC,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$IOST
          JSR       V$IOST, 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
*
*         VORTEX FILE CONTROL BLOCK MACRO DEFINITION
*         FCB       RL,BUF,AC,KEY,'N1','N2','N3'
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*                        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$EXEC
          JSR       V$EXEC,1
          EMAC
*
*         VORTEX SCHEDULE MACRO DEFINITION
*         SCHED     PL,W,LUN,KEY,'N1','N2','N3'
*                        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
SCHED     MAC
          M2
F         FORM      3,1,6,1,5
          F         0,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 INCREMENT
*                              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
*
*         VORTEX TIME REQUEST MACRO DEFINITION
*         TIME
```

Figure 5-1. VORTEX Macro Definitions for DAS MR *(continued)*

```
*
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
```

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

5.2 CONCORDANCE PROGRAM

The background **concordance program** (**CONC**) provides an indexed listing of all source statement symbols, 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.

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 100 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.

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
	RESUME	

Excepting the STOP and PAUSE statement, compilation and execution with the VORTEX operating system is the same as with the MOS system described in Varian 620 FORTRAN IV Reference Manual (document 98 A 9902 037). STOP and PAUSE statements output the message

```
taskname STOP (or PAUSE) n
```

With VORTEX, the PAUSE statement generates a SUSPND call to the VORTEX executive.

To resume the suspended task, input operator-communication key-in request; RESUME (section 15.2.4).

FORTRAN-compiled programs can execute either in foreground or background.

Details of the FORTRAN IV compiler language are given in the Varian 620 FORTRAN IV Reference Manual, except for the new statement TITLE, which is discussed below.

5.3.1 TITLE Statement

This FORTRAN 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

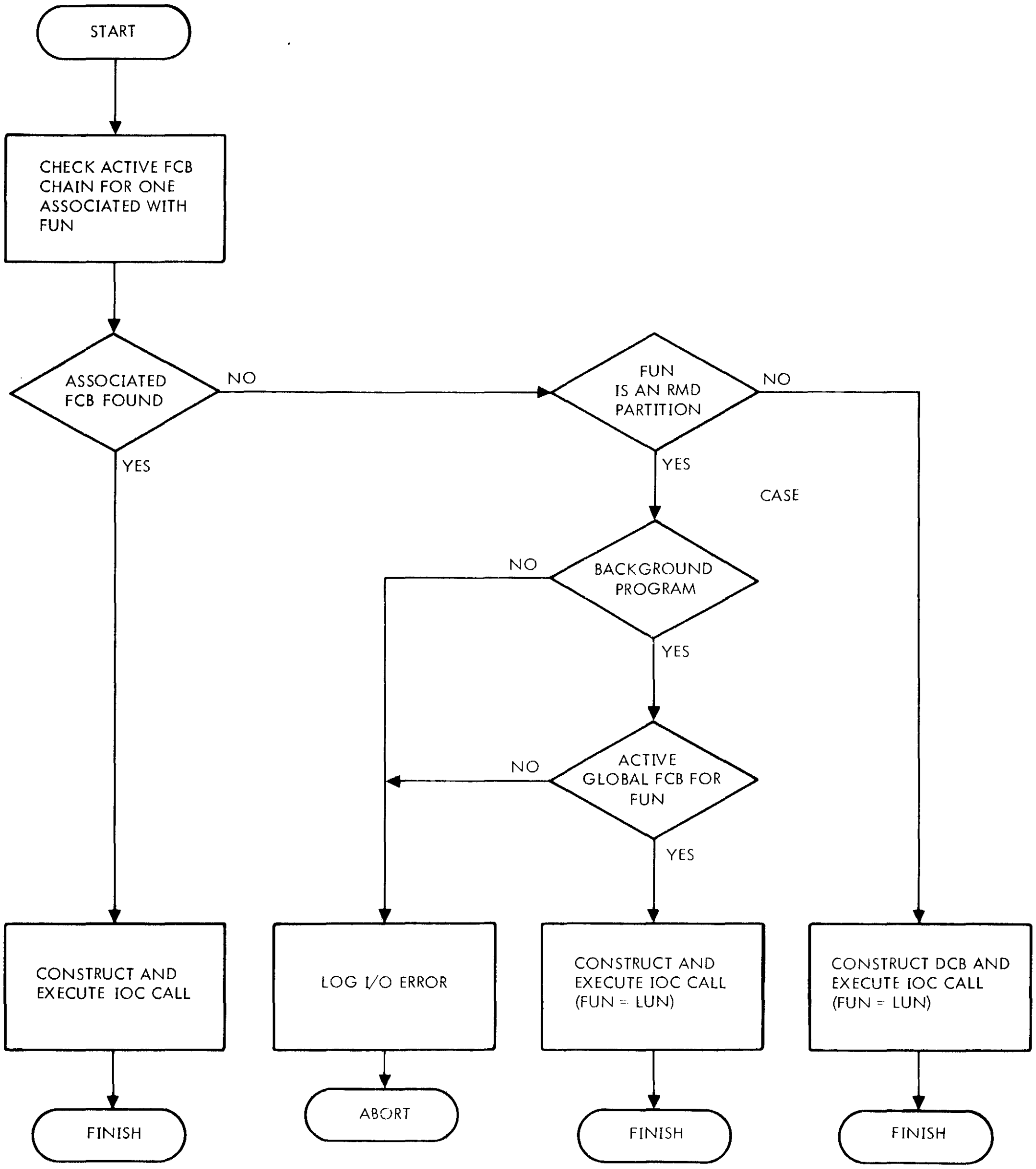
where **name** is the title to be output. The title contains up to eight characters, and is output in the object text as the name by which the program is to be referenced by SMAIN.

If a TITLE statement is used, it must be the first source statement. A TITLE statement forces a page eject on the LO listing.

5.3.2 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). ~~Three~~ Four differenct 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 SYSGEN (section 13) 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


START
CHECK ACTIVE FCB CHAIN FOR ONE ASSOCIATED WITH FUN
ASSOCIATED FCB FOUND
NO
YES
FUN IS AN RMD PARTITION
NO
YES
CASE
BACKGROUND PROGRAM
NO
YES
ACTIVE GLOBAL FCB FOR FUN
NO
YES
CONSTRUCT AND EXECUTE IOC CALL
LOG I/O ERROR
CONSTRUCT AND EXECUTE IOC CALL (FUN = LUN)
CONSTRUCT DCB AND EXECUTE IOC CALL (FUN = LUN)
FINISH
ABORT
FINISH
FINISH

NOTE: THE FORTRAN LOGICAL UNIT (FUN) IS NOT NECESSARILY IDENTICAL WITH THE FILE LOGICAL UNIT (LUN) UNLESS SO INDICATED.
VSOPEN OVERRIDES A /PFILE ASSIGNMENT.

VT11-1445

Figure 5-4. FORTRAN I/O Execution Sequences

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:

```
•
•
•
/ASSIGN,PI=50
/PFILE,4,X,FILE1
/FORT
•
•
•
READ (4,...
•
•
•
```

Case 3, Manual 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

lun is the name or number of the file logical unit

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 3.4.1)

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 3.4.2)

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 instead of REWIND
IFCB(4) = IFCB(4) -1 instead of BACKSPACE
CALL V$CLOS(fun, 1) instead of ENDFILE
```

5.4 VORTEX RPG IV SYSTEM

5.4.1 Introduction

The VORTEX RPG IV System is a 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 particularly effective in the 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 language, and its compilation and execution under VORTEX is described in the Varian 620 RPG IV User's Manual (98 A 9947 031).

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. This I/O capbility is enhanced by providing seven CALL 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.

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.

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 section 17.6. 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.

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 section 17.6.

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:

Print position	2 3 4 5 6 7 8	9	10	11	12 13 14 15 16
	item	*b*	*x*	*y*	*location*

where

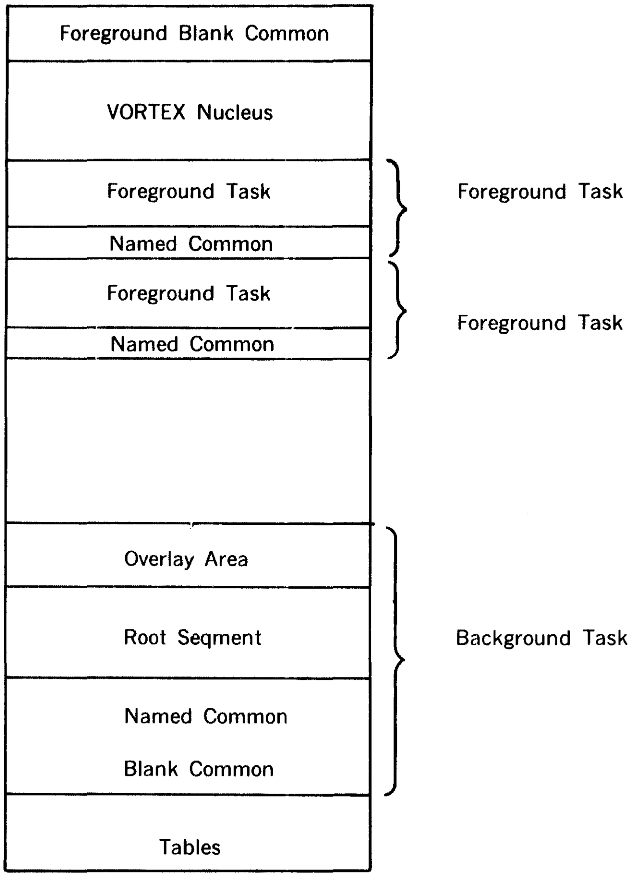
item is a left-justified entry or external name or labeled data block

b is a blank

x is A for an absolute or R for a relocatable item

Y is blank for an entry definition or slash (/) for an unsatisfied external reference

location is the left-justified relative location of the item



All foreground tasks share the foreground blank common area but may have their own named common area.

Figure 6-1. Load-Module Overlay Structure

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 2.1.7.

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 037, or the DAS MR COMN directive description in the handbook or 620-100 Computer Handbook, document number 98 A 9905 003 or 73 System Handbook (document number 98 A 9906 010).

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 givเn load module must be in the first object module loaded to generate that load module.

6.2 LOAD-MODULE GENERATOR DIRECTIVES

This section describes the load-module generator directives:

• TIDB	Create task-identification block
• LD	Load relocatable object modules
• OV	Overlay
• LIB	Library search
• 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 section 17.6.

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*

where

name	is the name (1 to 6 ASCII characters) of the task
type	is 1 for an unprotected background task, or 2 for a protected foreground task
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

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).

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 is encountered.

Successive LD directives permit the loading of object modules that reside on different logical units.

Examples: Load the relocatable object modules from logical unit 6 (BI) until an end-of-file mark is encountered.

```
LD,6
```

Open ε 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 115, 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.) Input

```
LIB,115,M,103,C,104,D
```

or, more briefly,

```
LIB,115,M
```

To change the order of search to logical units 104, 115, and 103, input

```
LIB,104,D,115,M,103,C
```

or, more briefly,

```
LIB,104,D,115,M
```

To search only the CL and OM libraries to satisfy undefined externals, input

```
LIB
```

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 requires 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 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 catalogued 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
```

6.3 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)
```

continued

```
LIB
OV,SGM1
(Object Module(s))
  (End of File)
LIB
OV,SGM2
(Object Module(s))
  (End of File)
LIB
OV,SGM3
(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
```

SECTION 7
DEBUGGING AIDS

The VORTEX system contains two debugging aids: the *debugging program (DEBUG)* and the *snapshot dump program (SNAP)*.

7.1 DEBUGGING PROGRAM

The 816-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 if the root segment of the task is an overlay load module. The load-module generator sets the load-module execution address equal to that of DEBUG.

If the load module has been cataloged, DEBUG executes when the module is scheduled. Otherwise, JCP directive /EXEC (section 4.2.22) is used to schedule the module and DEBUG.

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.

When debugging is complete, the input of any job-control directive (section 6.2) 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 if 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.

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.

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 psuedoregister
B	Display and change the contents of the B pseudoregister
Bx	Change, but do not display, the contents of the B pseudoregister
Cx	Display and change the contents of memory address 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
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
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 yyyyy

Numerical data are always interpreted as octal by DEBUG. Negative numbers are accepted, but they are converted to their two's complements by DEBUG.

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.

Examples of DEBUG directive usage: Note that, in the following examples, operator inputs are in **bold** type and the carriage return is represented by the at sign (@). Other entries, in *italics*, are program responses to the directives.

Display the contents of a pseudoregister:

```
A@
(001200)@
```

Display and change the contents of a pseudoregister:

```
B@
(001200) 010406@
```

Change, but do not display, the contents of a pseudoregister:

```
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@
(102401) 001234,@
(000067)@
```

Display, but do not change, the contents of memory address 002050, then display the contents of the next location:

```
C002050@
(102401) ,@
(000067)@
```

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:

```
I00020,000210,077777@
```

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  000001@
```

Display the contents of memory address 001234:

```
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 229-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

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 registers and the setting of the overflow indicator are displayed.

Output examples: with the snap request at 01234, display th contents of the A (017770), B (001244), and X (03/576) registers, and the overflow indicator (on).

```
SN** TASK01
001234 017770 001244 037576 000001
```

Using the same data, display, in addition, the contents of memory addresses 001241 through 001255, inclusive.

```
SN** TASK01
001234 017770 001244 037576 000001
001240 005000 005000 005000 005000 005000 005000 005000 005000
001250 001000 001244 000000 000000 000000 000000 000000 000000
```

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. (Note that 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 s urce 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 section 17.8. 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 LIST directive (section 3.2.1).

Error messages applicable to SEDIT are output on the SO and LO logical units. The individual messages and errors are given in section 17.8.

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.

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 directive 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 directive 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 device.

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,recnol,*recno2*

where

recnol 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 **recnol**, 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 **recnol**. Then, records are read from IN, but not copied onto OUT, up to and including the record specified by *recno2*. Thus, the records **recnol** 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

nl 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 **nl** and **n3** in record number **recno** after shifting out the characters in positions **nl** 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 **nl,n3** is then shifted to the left and filled with blanks until the field **nl,n2** is shifted out. Then, the character string **string** shifts into the left end of the field **nl,n3**. There is no check on the length of **string** and shifting continues until it is left-justified in the field **nl,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 **nl,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,recnol,*recno2*

where

recnol 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 **recnol**, 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 **recnol** 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 now 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 and 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, OUT, or ALT. These can be coded in any order.

Example: Rewind all SEDIT logical units.

```
REWI,IN,ALT,OUT
```

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
```

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 section 17.9 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	Number of 120-word logical records/track		
Word 1	Address of bad tracks table (0 if none)		
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 left to right 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.)

9.1.2 File-Name Directory

Each RMD partition contains a **file-name directory** of the files contained in that partition. The beginning of the directory is in the first sector of the 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. 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, 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.

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 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, section 3.2) 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 3.4.1) 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 13) 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 section 17.9.

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

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 if 120 words each where n is the smallest integer such that **words**/120 ≤ n. The file size is n***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)

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 the CURRENT column; word 4, in the START column; and word 5, in the END column. After the last file name, there is an e 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

Example: On logical unit 113, whose protection code is K, make the file X1 accessible by using either the name X1 or the name Y1.

```
ENTER,113,K,X1,Y1
```

9.2.5 LIST Directive

This directive outputs on the LO logical unit the file-name directory of the specified logical unit. The output comprises the file names, file extents, current end-of-file positions, logical unit name or number, and the extent of unassigned space in the partition. All number are in octal. 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 address **lun**

The output format has a two-line heading

```
FILE DIRECTORY FOR LUN lun
FILE NAME       START     END        CURRENT
```

where lun is the number or name of the logical unit whose contents are being listed. This heading is followed by a blank line and a listing of all file names from the directory, one name per line. Words 0-2 of the file-name directory entry (section 9.1.2) are placed in the FILE NAME column; word 4, in the START column; word 3, in the CURRENT column; and word 5, in the END column. 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 (word 2 of the PST entry), and both the CURRENT and END columns contains the last address + 1 (word 3 of the PST entry).

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.

Examples: Specify logical unit 6 as the device from which object modules are to be input.

```
INPUT,6
```

Open and rewind the file ARCTAN on logical unit 104, which has protection code D.

```
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 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
```

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 input, at which time IOUTIL terminates and the JCP is again scheduled.

Error messages applicable to IOUTIL are given in section 17.10. 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
•	WEOF	Write end of file
•	REW	Rewind
•	PFILE	Position file
•	CFILE	Close file

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.

Error messages applicable to IOUTIL directives are given in section 17.10.

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

iu is the name or number of the input logical unit **im**

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

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 files.

orl is the number of words in each record of the output files

Any RMD involved with copying files, whether as input or output medium, must have been previously positioned with a PFILE directive (section 10.2.8).

If a difference in record lengths **irl** and **orl** causes a part-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).

Example: Copy three files containing 120-word records from the SW logical unit onto logical units LO, 50, and 51 in 40-word records.

```
COPYF,3,SW,1,120,LO,1,40,50,51
```

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

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

Any RMD involved with copying records, whether as input or output medium, must have been previously positioned with a PFILE directive (section 10.2.8).

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 10.2.8), 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).

Example: Copy the first ten records from file EDIT1 to record 11 through 20 of file EDIT2. Both files are on RMD partition DOOK, 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 task.

```
/ASSIGN,BI=DOOK
/ASSIGN,BO=DOOK
/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, 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.

```
SFILE,PI,3
```

10.2.4 SREC (Skip Record) Directive

This directive, which applies only to magnetic-tape units 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 10.2.8).

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 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 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.

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 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
```

10.2.7 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
```

10.2.8 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.

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
```

10.2.9 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 of 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 10.2.8) 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
```

SECTION 11
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.

11.1 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 of all containing p(1).

11.2 NUMBER TYPES AND FORMATS

Integers uses one 16-bit word. A negative number is in two's complement form. An integer in the range − 32,767 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^{38} 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 of 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 $10^{\pm38}$ 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------------------
```

11.3 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 subroutine V$8G)
d	A double-precision number
f	Two-word, fixed-point number
i	An integer
r	A real number
S	A six-character ASCII string
X	Hardware X register
z	A complex number
**	Exponentiation

The external references in table 11-2 refer to items in tables 11-1 and 11-2. A subroutine with more than one name is indicated by multiple calls under Calling Sequence.

Table 11-1. DAS Coded Subroutines

Name			
$HE	Given: A contains i1, in A compute i1**i2.	CALL $HE,i2	$SE, $HM
$PE	Given: AB contains r, in AB, compute r**i.	CALL $PE,i	$SE, $QM, $QN
$QE	Given: AB contains r1, in AB, compute r1**r2.	CALL $QE,r2	ALOG, $QM, EXP, $SE
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, $QM, XDMU, XDAD, $NML, XDDI, XDSU, $SE, $PC, $QL, $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, $NML, $EE, $QM, $QN, $SE
ATAN	In AB, compute arctan r	CALL ATAN,r	$QM, $QL, $QN, $QK, $SE
SINCOS	In AB, compute cos r with COS, or sin r with SIN	CALL COS,r CALL SIN,r	$QK, $QL, $QM, $QN, $SE
SQRT	In AB, compute square root of r	CALL SQRT,r	XDDI, $FSM, $SE
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, $EE, $NML

Table 11-1. DAS Coded Subroutines *(continued)*

Name			
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, $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
$IFIX	In A, convert the r in AB to i and, for $HS, store result in i	CALL $IC CALL $HS,i	$SE, $EE
IABS	In A, compute absolute i	CALL IABS,i	$SE
ABS	In AB, compute absolute r	CALL ABS,r	$SE
ISIGN	Set the sign of i1, in A, equal to that of i2	CALL ISIGN,i2	$SE
SIGN	Set the sign of r1, in AB, equal to that of r2	CALL SIGN,r2	$SE
$HN	Given: A holds i1, in A, compute i1/i2	CALL $HN,i2	$SE, $EE
$HM	Given: A holds i1, in A, compute i1*i2	CALL $HM,i2	$SE, $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, $ZM, $ZN, AC $DLO
DATAN	In AC, compute arctan d	CALL $DAN CALL DATAN,d	$DLO, $STO, $DAD, $DSU, IF, $SE, AC, $DMP, $DDI, POLY

Table 11-1. **DAS Coded Subroutines** *(continued)*

Name			
DEXP	In AC, compute exponential d	CALL $DEX CALL DEXP,d	$DLO, $STO, $SE, AC, $DNO, $EE, $ZC, $ZK, $ZL, $ZM, $ZN
DLOG	In AC, compute ln d	CALL DLOG,d CALL $DLN	$DLO, $STO, $DNO, $EE $SE, $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	CAL_ 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, AC
$DFR	In AC, compute fractional part of d	CALL $DFR,d	$DLO, $DNO, $DSU, $DIT, AC, $SE
IDINT	In AC, compute integral part of d	CALL $DIT,d CALL IDIN,d	$DNO, $SE
DMULT	In AC, compute d1*d2	CALL $DMP,d2 CALL $ZM,d2	$DLO, $STO, $DNO, $DAD, AC, $SE
DDIVIDE	In AC, compute d1/d2	CALL $DDI,d2 CALL $ZN,d2	$DLO, $STO, $DNO, $DSU, AC, $SE
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, $EE
DNORMAL	In AC, normalize d	CALL $DNO	$SE
DLOADAC	Load AC with d	CALL $DLO,d CALL $ZF,d	AC, $SE
DSTOREAC	Store AC in d	CALL $STO,d CALL $ZS,d	AC, $SE
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

Table 11-1. DAS Coded Subroutines *(continued)*

Name			
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	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	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
TIME	Formats and executes an RTE TIME macro with the minute count in i1 and delay mode in i2.	CALL TIME(i1,i2)	V$EXEC
OVLAY	Formats and executes an RTE OVLAY macro with i1 = 0 to execute, i2 = 0 to load, and s is the overlay name.	CALL OVLAY(i1, i2,s)	V$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

Table 11-2. **FORTRAN IV Coded Subroutines**

Name	Function	Calling Sequence	External References
$9E	Compute ACCZ**i	CALL $9E(i)	$SE, IABS, $8F, $8M, $8N, $8S
CCOS	In ACCZ, compute cos z	CALL CCOS(z)	$SE, CSIN, $8F, $8K, $8S
CSIN	In ACCZ, compute sin z	CALL CSIN(z)	$SE, EXP, $QN, SIN, $QK, $QM, COS, $QL, $8F
CLOG	In ACCZ, compute ln z	CALL CLOG(z)	$SE, ALOG, $QM, $QK, $QN, ATAN2, $8F
CEXP	In ACCZ, compute exponential z	CALL CEXP(z)	$SE, EXP, COS, $QM, SIN, $8F
CSQRT	In ACCZ, compute square root of z	CALL CSQRT(z)	$SE, SQRT, CABS, $QK, $QN, $8F
CABS	In AB, compute absolute z	CALL CABS(z)	$SE, SQRT, $QM, $QK
CONJG	In ACCZ, compute conjugate of z	CALL CONJG(z)	$SE, $8F
$AK	Add r to real part of ACCZ	CALL $AK(r)	$SE, $8S, $QK, $8F
$AL	Subtract r from the real part of ACCZ	CALL $AL(r)	$SE, $8S, $QL, $8F
$AM	Multiply ACCZ by r	CALL $AM(r)	$SE, $8S, $QM, $8F
$AN	Divide ACCZ by r	CALL $AN(r)	$SE, $8S, $QM, $8F
$AC	Convert AC 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, $8F
$8K	Add z to ACCZ	CALL $8K(z)	$SE, $8S, $QK, $8F
$8L	Subtract z from ACCZ	CALL $8L(z)	$SE, $8S, $QL, $8F
$8M	Multiply ACCZ by z	CALL $8M(z)	$SE, $8S, $QM, $QL, $QK, $8F
$8N	Divide ACCZ by z	CALL $8N(z)	$SE, $8S, $QM, $QK, $QN, $QL, $8F
$ZD	Compute negative of z	CALL $ZD	$8S, $8F
AIMAG	Load AB with the imaginary part of z	CALL AIMAG(z)	$SE

Table 11-2. **FORTRAN IV Coded Subroutines** *(continued)*

Name	Function	Calling Sequence	External References
$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
$8F	Load ACCZ with z	CALL $8F(z)	$SE
$8S	Store ACCZ in z	CALL $8S(z)	$SE, $3S
$XE	Compute d**i where d is in AC	CALL $XE(i)	$SE, $ZF, MOD, $ZM, $HN, $ZN, $ZS
$YE	Compute d**r where d is in AC	CALL $YE(r)	$SE, $ZS, DBLE, $ZE, $ZF
$ZE	Compute d1**d2 where d1 is in AC	CALL $ZE(d2)	$SE, $ZS, DEXP, DLOG, $ZM
DATAN2	In AC, compute arctan (d1/d2)	CALL DATAN2(d1,d2)	$SE, $ZF, $ZS, $ZI, $ER, $ZN, $ZL, $ZK, DATAN
DLOG10	In AC, compute log d	CALL DLOG10(d)	$SE, DLOG, $ZM
DMOD	In AC, compute d1 modulo d2	CALL DMOD(d1,d2)	$SE, DINT, $ZF, $ZN, $ZS, $ZM, $ZL, $ZC
DINT	In AC, compute integer portion of d	CALL DINT(d)	$SE, $ZF, $JC $XC
DABS	In AC, compute absolute d	CALL DABS(d)	$SE, $ZF, $ZI, $ZC
DMAX1	In AC, select the maximum value in the set d1, d2,...,dn	CALL DMAX1(d1,d2, ...,dn,0)	$SE, $ZF, $ZS I$FA, $ZL, $ZI
DMIN1	In AC, select the minimum value in the set d1, d2,...,dn	CALL DMIN1(d1,d2, ...,dn,0)	$SE, $ZF, ZS, IFA, $ZL, $ZI
DSIGN	Set the sign of d1 equal to that of d2	CALL DSIGN(d1,d2)	$SE, $ZF, $ZI, $ZN
$YK	Add r to AC	CALL $YK(r)	$SE, $ZS, DBLE, $ZK
$YL	Subtract r from AC	CALL $YL(r)	$SE, $ZS, DBLE, $ZL, $ZC
$YM	Multiply AC by r	CALL $YM(r)	$SE, $ZS, DBLE, $ZM
$YN	Divide AC by r	CALL $YN(r)	$SE, $ZS, DBLE, $ZF, $ZN
DBLE	In AC, convert r to d	CALL DBLE(r)	$SE, $YC
$XC	In AC, convert i to d where i is in A	CALL $XC	$PC, $YC

Table 11-2. FORTRAN IV Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References
TANH	In AB, compute tanh r	CALL TANH(r)	$SE, $QK, EXP, $QL, $QN
ATAN2	In AB, compute arctan (r1/r2)	CALL ATAN2(r1,r2)	$SE, $ER, ATAN, $QK, $QL, $QN
ALOG10	In AB, compute log r	CAL. ALOG10(r)	$SE, ALOG, $QM
AMOD	In AB, compute r1 modulo r2	CALL AMOD(r1,r2)	$SE, AINT, $QN, $QM, $QL
AINT	In AB, truncate r	CALL AINT(r)	$SE, $IC, $PC
AMAX1	In AB, select the maximum value in the set r1,r2,...,rn	CALL AMAX1(r1,r2 ...,rn,0)	SE, IFA, $QL
AMIN1	In AB, select the minimum value in the set r1, r2,...,rn	CALL AMIN1(r1,r2 ...,rn,0)	SE, IFA, $QL
AMAX0	In AB, select the maximum value in the set i1,i2,...,in and convert to r	CALL AMAX0(i1,i2, ...,in,0)	SE, IFA, 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, IFA, FLOAT
DIM	In AB, compute the positive difference between r1 and r2	CALL DIM(r1,r2)	$SE, $QL
FLOAT	In AB, convert i to r	CALL FLOAT(i)	$SE, $PC
SNGL	In AB, convert d to r	CALL SNGL(d)	$SE, $ZF, $RC
MAX0	In A, select the maximum value in the set i1,i2,...,in	CALL MAX0(i1,i2, ...,in,0)	SE, IFA
MIN0	In A, select the minimum value in the set i1,i2,...,in	CALL MIN0(i1,i2, ...,in,0)	SE, IFA
MAX1	In A, select the maximum value in the set r1,r2,...,rn and convert to i	CALL MAX1(r1,r2, ...,rn,0)	SE, IFA, $QL, 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, IFA, $QL, IFIX
MOD	In A, compute i1 modulo i2	CALL MOD(i1,i2)	$SE, $HN, $HM
INT	In A, truncate r and convert to i	CALL INT(r)	$SE, $IC
IDIM	In A, compute the positive difference between i1 and i2	CALL IDIM(i1,i2)	$SE

Table 11-2. FORTRAN IV Coded Subroutines *(continued)*

Name	Function	Calling Sequence	External References
IFIX	In A, convert r to i	CALL IFIX(r)	$SE, $IC
$JC	In AC, convert d to i and store result in A	CALL $JC	$RC, $IC

SECTION 12
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

12.1 INTERRUPTS

12.1.1 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-clearing 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 RTC service request PMSK (section 2.1.5).

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 12-1).

Directly connected routines preempt VORTEX and are thus used only when response time demands it. The rules for the use of directly connected routines are:

a. All volatile registers used by the routine are restored before returning to the interrupted task.

b. Interrupts remain disabled during processing.

c. IOC and RTE calls are not allowed.

d. Execution time is minimal.

e. Interrupts are enabled before returning to the interrupted task through word 0 of the line handler.

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 tasks 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 and the interrupt-expected status bit to lock out further interrupts until processing is complete. The event word distinguishes different interrupt lines that could activate the same task.

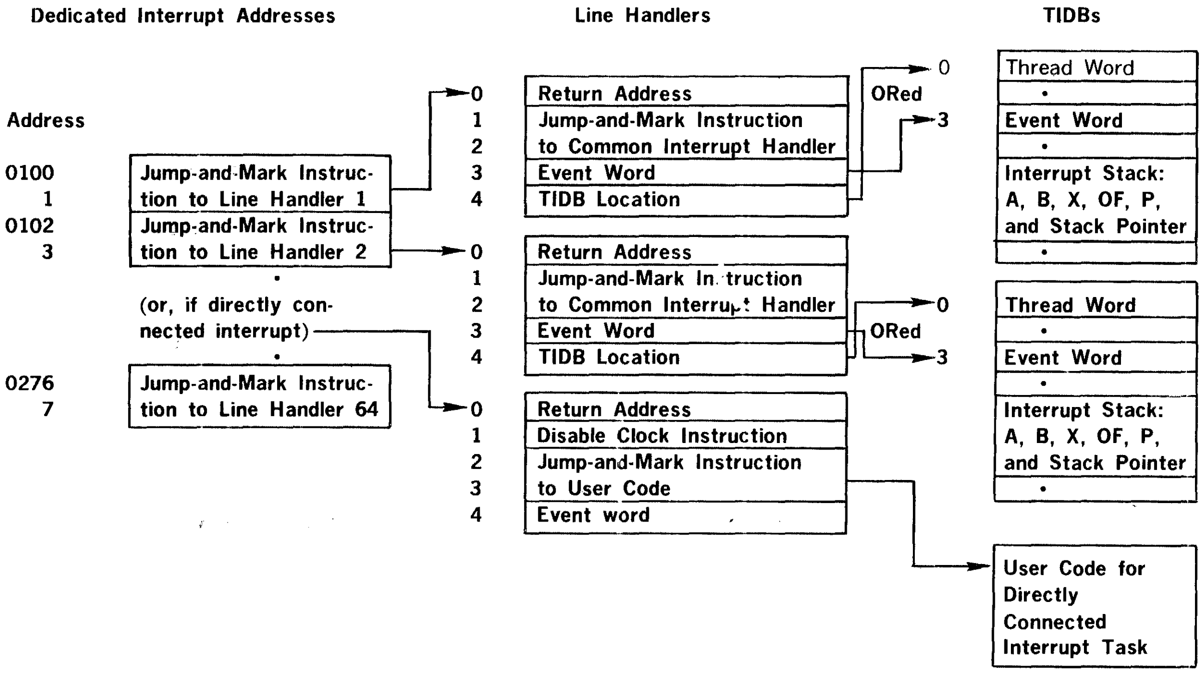

Dedicated Interrupt Addresses
Line Handlers
TIDBs
Address
0100
1
0102
3
0276
7
Jump-and-Mark Instruction to Line Handler 1
Jump-and-Mark Instruction to Line Handler 2
(or, if directly connected interrupt)
Jump-and-Mark Instruction to Line Handler 64
0
1
2
3
4
Return Address
Jump-and-Mark Instruction to Common Interrupt Handler
Event Word
TIDB Location
Disable Clock Instruction
Jump-and-Mark Instruction to User Code
Event word
ORed
3
Thread Word
Event Word
Interrupt Stack: A, B, X, OF, P, and Stack Pointer
User Code for Directly Connected Interrupt Task

Figure 12-1. Interrupt Line Handlers

An interrupt-processing task can exit with one of the following options:

a. Issue a suspend RTE (type 1) service call that suspends the task and sets the interrupt-expected status bit. Upon receiving the interrupt, the task continues execution following the request.

b. Issue a delay RTE (type 2) service call that suspends the task and sets the interrupt-expected status bit and time delay. Either one activates the task following the delay call. (Upon entry, the event word not-zero indicates an interrupt activation. The user also clears the time-delay status bit upon reactivation.)

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 12.3) to start the higher-priority interrupt-processing task (if all its conditions are met). The posting time is 66 cycles, approximately.

12.2.3

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 processor interrupts the interrupt handler, the common interrupt handler posts the interrupt and returns to the clock processor in approximately 40 cycles.

12.1.2 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: When the background area is active, it is run as an unprotected area of memory with the rest of the system protected. In such a situation, memory protection interrupts are generated when the background task attempts to execute a "privileged" instruction such as external control or halt, or attempts to jump into, write into, or perform I/O on protected memory. The memory protection routine processes all protection violation interrupts and is the highest-priority interrupt in the system.

Power failure/restart interrupt: When computer power goes down or comes up, the power failure/restart routines are executed. On power-down, VORTEX saves the contents of volatile storage and masks. On power-up, these data are restored and control returns to the point of interrupt. During a power failure, I/O devices typically reset due to loss of interrupts. IOC attempts retrials and resumes normal operation upon resumption of normal power. Data losses on the RMD due to power failure could cause VORTEX to malfunction, but other nonsystem-resident devices are recoverable. The power failure/restart routines operate just below memory protection as the second-highest priority interrupts in the system.

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, one 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.

12.1.3 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 13.5.11) with **r(n)** and **s(n)** both zero and a TDF directive (section 13.6.2) 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.

12.2 SCHEDULING

12.2.1 System Flow

VORTEX is designed around the TIDB (figure 12-2). 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 12.3) 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.

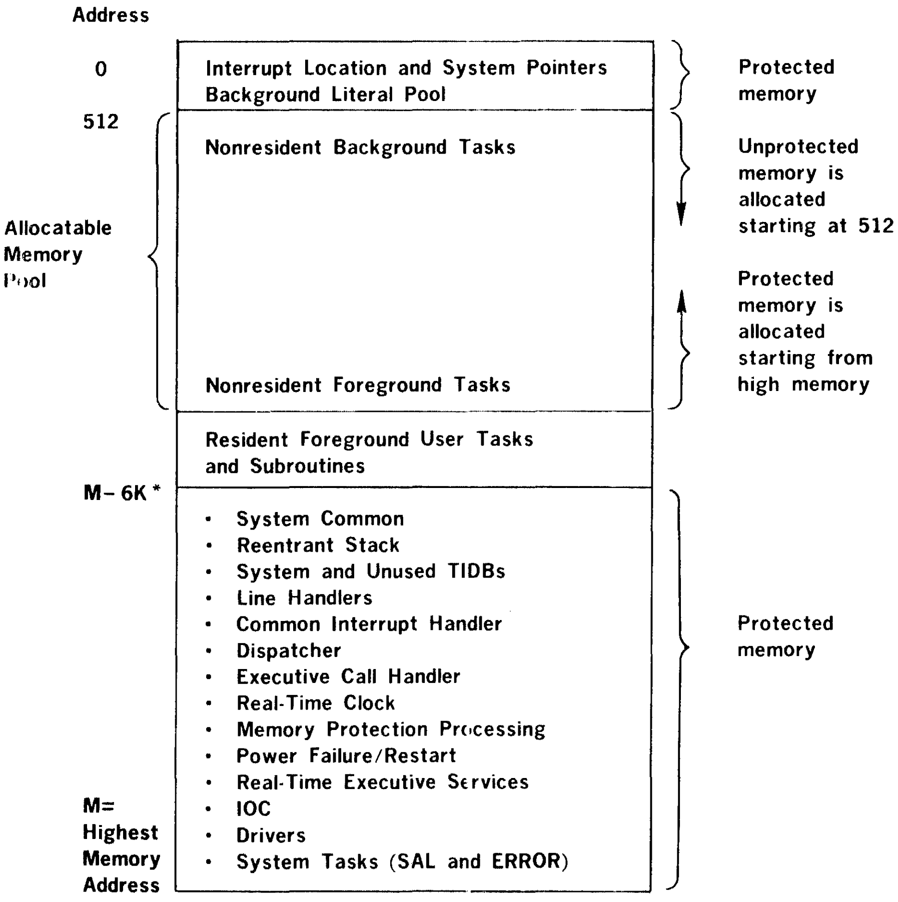
The status word of each TIDB, starting with the highest-priority task, is scanned. Depending upon the setting of status bits, the task is activated, passed over, or made to activate a related system task.

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 allocates memory in 512-word blocks starting with location 512 for background, or the first 512-word block below the resident task directory for foreground tasks. A foreground task is allocated into the first such available area. 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.

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 12-2 is a VORTEX memory map, figure 12-3 shows the priority structure, figure 12-4 is a description of a TIDB, and table 12-1 is a detailed description of lower memory.


Address
0
512
Allocatable Memory Pool
M- 6K *
M= Highest Memory Address
Interrupt Location and System Pointers
Background Literal Pool
Nonresident Background Tasks
Nonresident Foreground Tasks
Resident Foreground User Tasks and Subroutines
• System Common
• Reentrant Stack
• System and Unused TIDBs
• Line Handlers
• Common Interrupt Handler
• Dispatcher
• Executive Call Handler
• Real-Time Clock
• Memory Protection Processing
• Power Failure/Restart
• Real-Time Executive Services
• IOC
• Drivers
• System Tasks (SAL and ERROR)
Protected memory
Unprotected memory is allocated starting at 512
Protected memory is allocated starting from high memory
Protected memory

If a configuration increases memory, the allocatable memory pool would increase and resident routines would reside in a higher position in memory.

* 5.5-6K is enough room for all VORTEX nucleus components, plus four empty TIDB's and three I/O drivers. Users with more I/O devices or a greater number of TIDB's will need more than 6K.

Figure 12-2. VORTEX Memory Map

12.2.2 Priorities

Thirty-two priority levels (0 through 31) are provided in the VORTEX system. Levels 2 to 31 are reserved for protected foreground usage. 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 system 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 is reserved for unprotected background tasks, e.g., an undebugged user task. Level 0 tasks cannot modify or destroy the system (figure 12-3).

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

	Priority Level	
Foreground Priority Levels	31 • • • 26	
	25	VORTEX System Tasks SAL and ERROR
	24	Driver Tasks (Low-Speed Devices)
	23	Driver Tasks (High-Speed Devices)
	22 • • • • • 11	
	10	Operator Communication Task
	9 • • • 2	
Background Priority Levels	1	VORTEX System Protected Tasks
	0	User Unprotected Tasks

Figure 12-3. VORTEX Priority Structure

Symbol	Word	Bits		
		15	5	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 Blocks Allocated	No. of I/O Req. Threaded	No. of I/O Req. 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		

Figure 12-4. TIDB Description

KEY:

Symbol	**Word**	**Bits**	**Set =**	**Description**
TBTRD	0	15-0	Task thread	Points to next TIDB in chain. Two queues are maintained in the system: active and inactive. V$TB points to the highest-priority active task. V$UTB points to next available inactive TIDB space. Last TIDB on queue has zero in TBTRD.
TBST	1	15-0	Task status	See table 13-5.
TBPL	2	15	Task opened	Bit set when SAL has opened task but not loaded it (memory not available).
		14	Unused	
		13	Load overlay	RTE overlay request made by task with overlay name in user request.
		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.
TBPL *(continued)*	2	11	Allocation override flag	Overrides bits 9 and 12 of TBPL and bit 5 of TBST. When FNIS 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 scheduler, a TIDB
		10	Background being checkpointed	Background task being written on checkpoint file.
		9	TIDB not available	Schedule request made but no TIDBs available for allocation.
		8	Unused	
		7	Unused	

Figure 12-4. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
		6	Unused	
		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
TBEVNT *(continued)*				TIDB word 3 when processed by line handler; if a bit sets while status bits 3 and 14 are set, dispatcher activates task. Clears 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	R 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.
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.)

Figure 12-4. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
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	3	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	15-10	Block allocation size	Number of 512-word blocks for execution of task.
		9-5	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.)
		4-0	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.
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.

Figure 12-4. TIDB Description *(continued)*

Symbol	Word	Bits	Set =	Description
TBTLC	21	15-0	First address in allocatable memory	Points to first address allocated for use by task.
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.

Figure 12-4. TIDB Description *(continued)*

Table 12-1. Map of Lowest Memory Sector

Address	Symbolic Name	Description
00-01		CPU interrupt code (preset to NOP)
02-017		Unassigned: available to the user
020,021		Memory protection interrupt: halt (jump-and-mark to V$MPER)
022,023		Memory protection interrupt: I/O (jump-and-mark to V$MPER)
024,025		Memory protection interrupt: write (jump-and-mark to V$MPER)
026,027		Memory protection interrupt: jump (jump-and-mark to V$MPJP)
030,031		Memory protection interrupt: overflow (jump-and-mark to V$MPER)
032,033		Memory protection interrupt: I/O overflow (jump-and-mark to V$MPER)
034,035		Memory protection interrupt: write overflow (jump-and-mark to V$MPER)

Table 12-1. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
036,037		Memory protection interrupt: jump overflow (jump-and-mark to V$MPER)
040,041		Power-down interrupt (jump-and-mark to V$PFDN)
042,043		Power-up interrupt (jump-and-mark to V$PFUP)
044,045		Variable-interval interrupt address (jump-and-mark to V$CLOK)
046,047		Reserved for future VORTEX use
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$JCFG	JCP flags: Bits 15-10 Number of extra memory blocks to be allocated with background task (cleared after loading) Bits 9-5 Unused. Bit 4 Dump flag if load and go Bit 3 Dump flag (if set, the background dumps after a normal EXIT or abortion) Bits 2-0 Load-and-go flags
056-067	V$BIC1	BIC in sequence (maximum 10)
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$BGLB	Protection code and logical unit number of the BL unit
076	V$CRDM	Keypunch (0 = 026, 1 = 029): Bit 0 SGEN nominal keypunch Bit 9 Current keypunch specified by JCP /KPMODE directive (/JOB, /FINI, or /ENDJOB resets current value to nominal value)

Table 12-1. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
077	V$JCTM	JCP temporary storage
0100-0117		PIM 1 jump-and-mark to individual line handlers
0120-0137		PIM 2* jump-and-mark to individual line handlers
0140-0157		PIM 3* jump-and-mark to individual line handlers
0160-0177		PIM 4* jump-and-mark to individual line handlers
0200-0217		PIM 5* jump-and-mark to individual line handlers
0220-0237		PIM 6* jump-and-mark to individual line handlers
0240-0257		PIM 7* jump-and-mark to individual line handlers
0260-0277		PIM 8* jump-and-mark to individual line handlers
0300	V$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)
0303	V$TB	Address of highest-priority TIDB in the active stack
0304	V$UTB	Address of unused TIDB stack (zero if no TIDB are available to be allocated)
0305	V$PTVB	Address of next entry in reentrant stack
0306	V$FLRS	Address of first location of reentrant stack
0307	V$LRSK	Address of last location of reentrant stack + 1
0310	V$CKPT	Checkpoint flag (set if background checkpointed)
0311	V$OPCL	Address of TIDB for OPCOM task

Table 12-1. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0312	V$LSAL	Address of TIDB for system SAL task
0313	V$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$LUP	Address of first unprotected word (memory address 01000)
0317	V$LLUP	Address of last unprotected word (depends upon size of background executing task)
0320	V$IM	Interrupt mask for PIM 1 (0 = enable, 1 = disable)
0321		Interrupt mask for PIM 2
0322		Interrupt mask for PIM 3
0323		Interrupt mask for PIM 4
0324		Interrupt mask for PIM 5
0325		Interrupt mask for PIM 6
0326		Interrupt mask for PIM 7
0327		Interrupt mask for PIM 8
0330-0333	V$MPM	Memory protection mask (4 words), 0 = unprotected, 1 = protected (words initially set to 0177777)
0334-0337	V$CAM	Core allocation mask (4 words), 0 = 512-word block available for allocation, 1 = 512-word block in use and not available for allocation (SGEN generates initial mask)
0340		Reserved for future VORTEX use
0341	V$CRDR	Address of resident directory
0342	V$TBGT	Top of thread of background tasks waiting for allocation
0343	V$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)

Table 12-1. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
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)
0345	V$LUNT	Address of logical-unit name table
0346	V$OPCF	OPCOM lockout flag
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$CKB])
0353	V$CKB	Basic clock interrupt rate in milliseconds
0354	V$CRM	Clock resolution increments for fractions of a minute in 5-millisecond increments
0355	V$DSTB	Address of DST block
0356	V$LIT	Last address in background literal pool
0357		Reserved for future VORTEX use
0360	V$CTAD	Base address for controller address table
0361	V$SCTL	Current controller in scan
0362	V$NCTR	Number of controllers
0363-0372	V$PIMN	External device address table for PIMs
0373-0374		Reserved for future VORTEX use
0375	V$SLFG	System SAL task busy flag (1 = busy)
0376	V$ERFG	Error task busy flag (1 = busy)
0377	V$JOP	JCP operating flag (1 = busy)
0400	V$LUT1	Starting address of logical-unit table for JCP/OPCOM-assignable logical units

Table 12-1. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
0401	V$LUT2	Starting address of logical-unit table for unreassignable logical units
0402	V$LUT3	Starting address of logical-unit table for OPCOM-assignable logical units
0403	V$1MIN	Clock constant set up by SGEN where V$1MIN = 32767 − (60000/(5*V$CTMS)) + 1
0404-0407		Reserved for future VORTEX use
0410	V$IOA	I/O algorithm
0411	V$CKIT	Clock interrupted PIM before it could be locked out (common interrupt handler and clock-processor flag)
0412	V$JCB	Address of 41-word JCP buffer (all system background programs and JCP input directives into this system buffer)
0413	V$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
0415	V$BFC	Top of foreground area, bottom of foreground blank common
0416	V$TFC	Top of foreground blank common, top of VORTEX nucleus core
0417	V$PST	Maximum RMD partitions 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

Table 12-1. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
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
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)

Table 12-1. Map of Lowest Memory Sector *(continued)*

Address	Symbolic Name	Description
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

* If PIM is not present, the space is available to the user.

12.2.3 Timing Considerations (Approximate)

Real-time clock interrupt processor: At each incrementation of the real-time clock, there is a TIDB service scan requiring

$$x + 8y + 5z \text{ cycles}$$

where

x is 60 when the scan interrupts the dispatcher, or 73 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 18 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

$$t + 14u + 17v + 12w + 18x + 25y + z \text{ cycles}$$

where

t is 9 or 11, 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 value:

48 to activate the ERROR task
56 to activate the SAL task on aborting or exiting
60 to activate a loaded task that is not suspended, or to activate the SAL task to load the requested
61 to activate an interrupted, suspended task
65 to activate a task when the event word is set and the interrupt suspended

Search, allocate, and load:

Open processing requires

$$x + y + z \text{ cycles}$$

where

x is 180 for a foreground task, or 187 for a background task

y is the time required for an I/O open request (variable)

z is the time required to read one RMD I/O record (variable)

Load processing requires, for a foreground task,

$$747 + w + x + ny + 214z \text{ cycles}$$

where

w is the memory allocation time (average 1,334 cycles)

x is the time required to read one RMD I/O record (variable)

n is the number of RMD records read

y is the time required to read one RMD record (variable)

z is the number of 16-bit relocation words

For a background task, load processing requires

$$346 + x \text{ cycles}$$

where x is the time required to read one RMD I/O record.

Resident-task load processing requires

$$70 + 16x \text{ cycles}$$

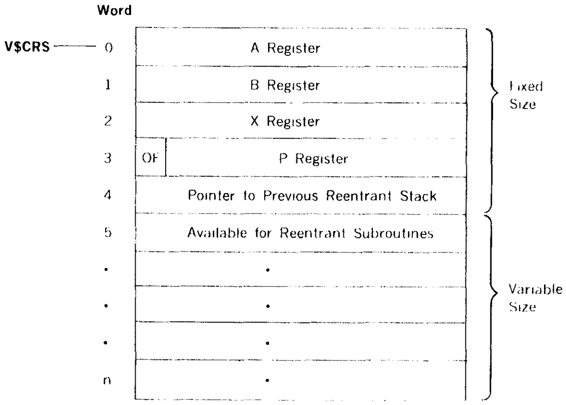
where x is the number of entries searched before the required task name is found.

12.3 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 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 temp-
         •                   orary location)
         •
         •
         STA       6,1       Save A in temp-
         •                   orary storage
         •
         •
         LDA       6,1       Get   temporary
         •                   storage value
         •
         •
         •
         STA       0,1       Modify return in
         •                   A register
         •
         •
         •
         DEALOC              Return to location
         •                   following ALOC
         •                   call
         •
         END
```

12.4 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 V$IOC,X instruction with V$IOC containing the IOC entry address. 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.

12.4.1 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 diiver 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. TBRST (word 7 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

12.4.2 I/O Driver System Functions

Each I/O driver under IOC performs certain system pre- and post processing functons.

Pre-interrupt processing: If the I/O driver uses a BIC, the driver calls V$BIC to build and execute the initial BIC transfer instruction. If the BIC is shared, the interrupt line handler is modified to the proper interrupt event word setting (TBEVNT) and TIDB address. V$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 DELAY call.

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 RSTPE (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.

12.4.3 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 13):

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).
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 controller TIDB. It specifies the name of the driver, status word (TBST) setting, and priority level of the driver.

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., CTTYOA, CTMT01, and CTDOB.

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 items in the controller table are treated as being constants for a controller.

(1) CTADNC (word 1) = end of table + 1

(2) CTOPM (word 2) = operation-code mask

(3) CTDST (word 3) = 0 (set by IOC)

(4) CTRQBK (word 4) = 0 (set by IOC)

(5) CTIOA (word 7) = I/O algorithm

(6) CTSTAT (word 8) = 0 (driver use)

(7) CTFCB (word 10) = 0 (set by IOC)

(8) CTWDS (word 11) = 0 (driver use)

(9) CTFRCT (word 12) = I/O algorithm frequency count

(10) CTSTSZ (word 13) = number of words in an RMD sector

(11) CTTKSZ (word 14) = number of sectors in an RMD track

The variable parameters are inserted into the controller table by SGEN during directive processing. These are assembled, referencing the external names.

(1) CTIDB (word 0) = name of the related controller TIDB (TB followed by the same three- or four-character name used in the controller table, e.g., TBTY0A)

(2) CTRTRY (word 5) = error retry count (#T followed by the name of the controller, e.g., #TTY0A)

(3) CTDVAD (word 6) = controller device address (#A followed by the name of the controller, e.g., #ATY0A)

(4) CTBICB (word 9) = address of BIC flag table (B followed by the name of the controller, e.g., BTY0A)

(5) CTPST0 (word 15) = base address of the PST for RMD unit 0 (P followed by the four-character device name, e.g., PD00A)

(6) CTPST1 (word 16) = base address of the PST for RMD unit 1 (e.g., PD01A)

(7) CTPST2 (word 17) = base address of the PST for RMD unit 2 (e.g., PD02A)

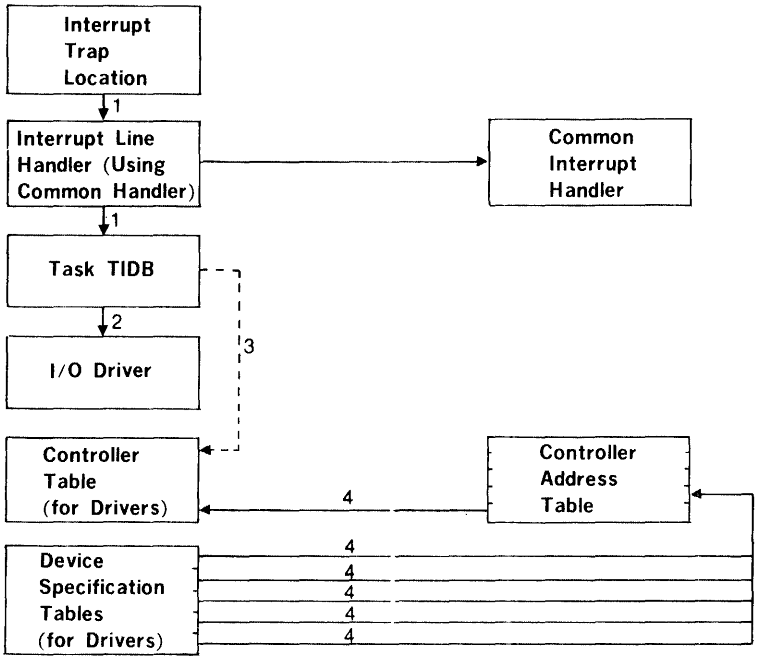
(8) CTPST3 (word 18) = base address of the PST for RMD unit 3 (e.g., PD03A)

12.4.4 Enabling and Disabling PIM Interrupts

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 12-5 shows the stand and VORTEX driver interface.


Interrupt Trap Location
1
Interrupt Line Handler (Using Common Handler)
Common Interrupt Handler
1
Task TIDB
2
I/O Driver
3
Controller Table (for Drivers)
4
Controller Address Table
Device Specification Tables (for Drivers)
4
4
4
4
4

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 12-5. Driver Interface

SECTION 13
SYSTEM GENERATION

The VORTEX **system-generation component (SGEN)** tailors the VORTEX operating system to specific user requirements. SGEN is a collection of programs on magnetic tape, punched cards, or disc pack. It includes all programs (except the key-in loader, section 13.3) for generating an operating VORTEX system on an RMD.

Figure 13-1 is a block diagram of the data flow through SGEN.

13.1 ORGANIZATION

SGEN is a four-phase component comprising:

- I/O interrogation (section 13.4)
- SGEN directive processing (section 13.5)
- Building the VORTEX nucleus (section 13.6)
- Building the library and the resident-task configurator (section 13.7)

I/O interrogation specifies the peripherals to:

a. Input VORTEX system routines (LIB unit)

b. Input user routines (ALT unit)

c. Input SGEN directives (DIR unit)

d. Output the VORTEX system generation (SYS unit)

e. List special information and input user messages (LIS unit)

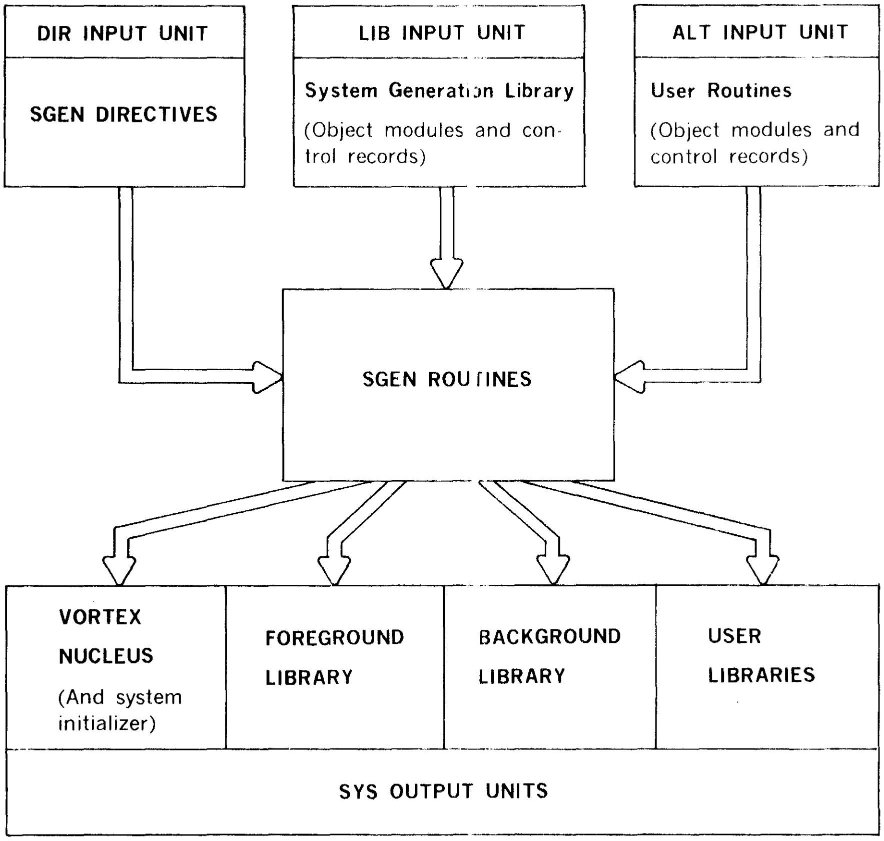


Figure 13-1. SGEN Data Flow

I/O interrogation also specifies that the Teletype on hardware address 01 is the OC unit. After these peripherals are assigned, appropriate drivers and I/O controls are loaded into memory.

Note: SGEN does not build an object-module library. To construct the VORTEX object-module library (OM) or any user object-module library, use the file-maintenance component (FMAIN, section 9).

SGEN directive processing specifies the architecture of the VORTEX system based on user-supplied information that is compiled and stored for later use in building the system. SGEN directives permit the design of systems covering the entire range of VORTEX applications.

Building the VORTEX nucleus consists of gathering object modules and control records from the system-generation library (SGL, section 13.2) and from user input, and constructing the VORTEX nucleus from these data. SGL items are input through the LIB input unit, and user items through the ALT unit according to rules set up by the SGEN directives.

Building the library and the resident-task configurator consists of generating load modules from the object modules and control records input from the SGL and user data. These load modules are then cataloged and entered into the foreground, background, and user libraries. During library building, load modules can be added, deleted, or replaced as required to tailor the library to any of a wide variety of formats. After the libraries are completed, designated load modules are copied into the VORTEX nucleus to become *resident tasks*. The resident-task configuration of SGEN can also be generated without regeneration of the VORTEX nucleus or libraries (section 13.7).

SGEN directive format requires that, unless otherwise indicated (e.g., section 13.5), the 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, i.e., before and after commas (or equal signs). Although not required, a period (.) is a line terminator. Comments can be inserted after the period. 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.

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

Error messages applicable to SGEN are given in section 17.13.

SGEN errors are divided into five categories according to type. The category of each error, as well as the specific error, is given by the error code. Recovery is automatic where manual intervention is not required. When manual intervention is necessary, the OC device expects a response after the error message is posted. The response can be either a corrected input statement (where the statement in error was an ASCII record) or the letter " C". In the latter case, the corrected input is expected on the input device where the error occurred, immediately after the " C" is input. If the input media is magnetic tape or disc pack, positioning to reread an input statement is also automatic.

13.2 SYSTEM-GENERATION LIBRARY

The **System-generation library (SGL)** is a collection of system programs (in object-module form) and control records (in alphanumeric form) from which a VORTEX system is constructed.

In the case of punched cards or of magnetic tape, the SGL occupies contiguous records, beginning with the first record of the medium.

In the case of disc pack, the SGL occupies contiguous records beginning with the second track. Track 0 contains the partition-specification table (PST, section 3.2) that specifies one partition extending from the second track (track 1) to the end of device.

The SGL and the VORTEX system cannot be on the same disc pack during system generation.

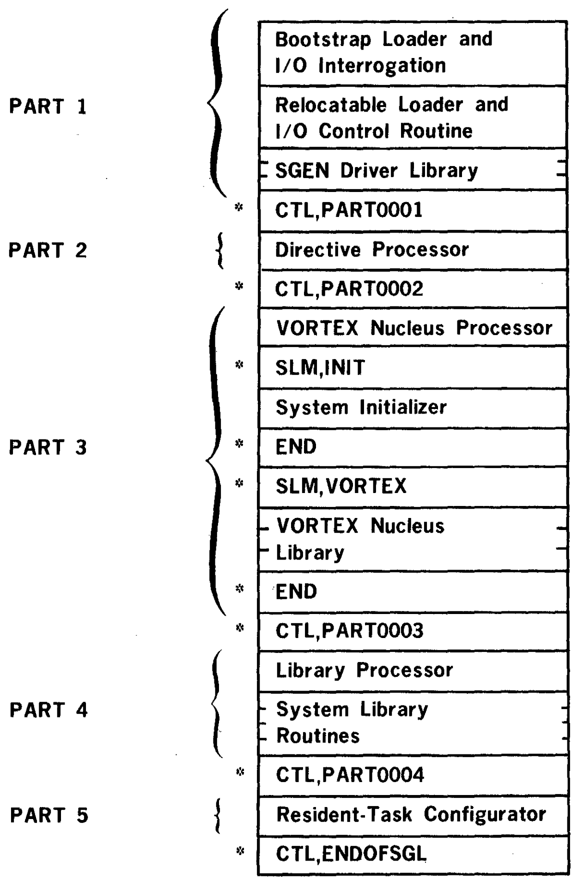
The SGL is divided into five functional parts, each separated by CTL control records (figure 13-2).

Part 1 of the SGL comprises a *VORTEX bootstrap loader* and an *I/O interrogation routine*. It also comprises the *SGEN relocatable loader*, the *basic I/O control routine*, and *library of peripheral drivers* for the use of SGEN. Part 1 consists entirely of object modules. It is loaded with device-sensitive key-in loader (section 13.3) that also serves the bootstrap loader as a read-next-record routine. The bootstrap-loader/interrogator is a core-image sequence of records generated by a VORTEX service routine. Because it calls the key-in loader to read records, the bootstrap-loader/interrogator is itself device-insensitive.

Control record CTL,PART0001 terminates part 1 of the SGL.

Part 2 of the SGL contains the *directive processor*. After being itself input, the directive processor obtains all input from the DIR and OC input devices. The system generation directives are to be placed between the directive processor and the CTL,PART0002 control record if the CIB and DIR input units are the same.

Control record CTL,PART0002 terminates part 2 of the SGL.



NOTE:

* = Alphanumeric control record

Figure 13-2. System-Generation Library

Part 3 of the SGL comprises all system routines and control records required to build the VORTEX nucleus (figure 13-3):

- *VORTEX nucleus processor* -- the SGEN-processing portion

- *SLM control record* -- indicates the beginning of the system initializer portion

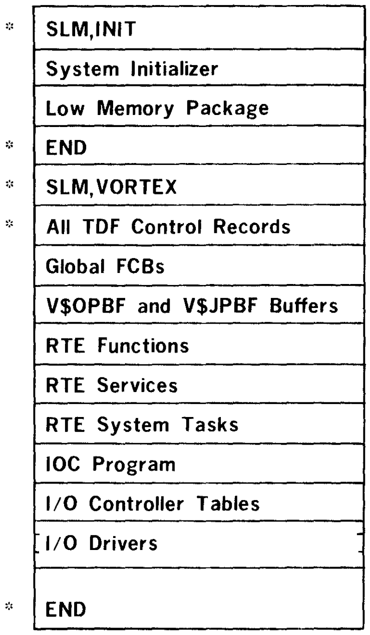
- *System-initializer routines* -- object modules to be converted into the system initializer

- *END control record* -- indicates the end of the system-initializer portion

- *SLM control record* -- indicates the beginning of the VORTEX nucleus portion

- *VORTEX nucleus routines* -- control records and object modules to be converted into the VORTEX nucleus

- *END control record* -- indicates the end of the VORTEX nucleus portion



NOTE:

* = Alphanumeric control record

Figure 13-3. VORTEX Nucleus

Control record CTL,PART0003 terminates part 3 of the SGL.

Part 4 of the SGL comprises all system routines and control records required to build load-module libraries (figure 13-4) on the RMD. The *library processor* converts these inputs into load modules, catalogs them, and enters them into the foreground, background, and user libraries. The library processor is followed by groups of control records and object modules, with each group forming a *load-module package (LMP).*

Control record CTL,PART0004 terminates part 4 of the SGL.

Part 5 of the SGL contains the *resident-task configurator* portion of SGEN. The configurator copies specified load modules from the foreground library into the VORTEX nucleus, i.e., makes them resident tasks.

Control record CTL,ENDOFSGL terminates the SGL.

REQUIRED (FOREGROUND) SYSTEM TASKS

*	SLM,FGTSK1
*	TID,V$OPCM,2,8,106
	V$OPCM Program
*	ESB
*	END
*	SLM,FGTSK2
*	TID,JCDUMP,2,0,106
	JCDUMP Program
*	ESB
*	END
*	SLM,FGTSK3
*	TID,RAZI,2,0,106
	RAZI Program
*	ESB
*	END

REQUIRED (BACKGROUND) SYSTEM TASKS

*	SLM,BGTSK1
*	TID,JCP,1,0,105
	Job-Control Processor
*	ESB
*	END
*	SLM,BGTSK2
*	TID,LMGEN,1,0,105
	Load-Module Generator
*	ESB
*	END
*	SLM,BGTSK3
*	TID,FMAIN,1,0,105
	File Maintenance
*	ESB
*	END
*	SLM,BGTSK4
*	TID,SMAIN,1,0,105
	System Maintenance
*	ESB
*	END

*	SLM,BGTSK5
*	TID,FORT,1,0,105
	FORTRAN Compiler
*	ESB
*	END
*	SLM,BGTSK6
*	TID,CONC,1,0,105
	Concordance Program
*	ESB
*	END
*	SLM,BGTSK7
*	TID,IOUTIL,1,0,105
	I/O Utility Program
*	ESB
*	END

*	SLM,BGTSK8
*	TID,SEDIT,1,0,105
	Source Editor
*	ESB
*	END
*	SLM,BGTSK9
*	TID,DASMR,1,0,105
	DAS MR Assembler
*	ESB
*	END

NOTE:

* = Alphanumeric control record

Figure 13-4. Load-Module Library

13.3 KEY-IN LOADER

SGEN is initiated on a new or initialized system by inputting the key-in loader through the CPU. The key-in loader loads the VORTEX bootstrap loader (part 1 of the SGL). Key-in loaders are available for loading from magnetic tape, punched cards, or disc pack. The required key-in loader is input to memory through the CPU console and then executed to load the VORTEX bootstrap loader.

Automatic bootstrap loader (ABL) In systems equipped with an ABL, load the key-in loader from the input medium into memory starting with address 000000. To execute the key-in loader, clear the A, B, X, I, and P registers; then press RESET, set STEP/RUN to RUN, and press START.

Manual loading through the CPU front panel: The key-in loader can be entered manually as follows using the appropriate loader given in table 13-1.

a. Press REPEAT.

b. Enter a STA instruction (054000) in the I register.

c. Clear the P register.

d. Enter a key-in loader instruction in the A register.

e. Press STEP.

f. Clear the A register.

g. Repeat steps (d), (e), and (f) for each key-in loader instruction.

To execute the key-in loader, clear the A, B, X, I, and P registers; then press RESET, set STEP/RUN to RUN, and press START.

Table 13-1. SGEN Key-In Loaders

Address	Magnetic Tape	Card Reader	RMD
000000	010030	010054	010064
000001	001010	001010	140066
000002	001106	001106	001010
000003	040030	040054	001106
000004	001000	001000	001000
000005	000012	000012	000012
000006	000000	000000	000000
000007	006010	006010	006010
000010	000300	000300	000300
000011	050027	050053	050065
000012	1041zz	1002zz	1004zz
000013	1000zz	002000	1002zz
000014	001000	000046	010063
000015	000021	1025zz	110072
000016	1025zz	002000	1031zz
000017	057027	000046	101uzz
000020	040027	1026zz	000023
000021	1011zz	004044	001000
000022	000016	004444	000017
000023	1012zz	057053	1025zz
000024	100006	005001	150071
000025	001000	040053	001016
000026	000021	004450	000012
000027	000500	002000	1000yy
000030	177742	000046	1003zz
000031		1026zz	010064
000032		004044	110072
000033		004450	1031zz
000034		002000	010065
000035		000046	1031xx
000036		1022zz	120070
000037		057053	005012
000040		040053	1031yy
000041		067053	1000xx
000042		040053	1000zz
000043		001000	1014zz
000044		000013	000043
000045		1011zz	1025zz
000046		000000	150071
000047		1016zz	001016
000050		100006	000012
000051		001000	060065
000052		000045	040064
000053		000500	010064
000054		177742	140067
000055			001016
000056			100006
000057			050064
000060			040063
000061			001000
000062			100006
000063			000001
000064			000001
000065			000500
000065			000037
000067			000060
000070			000074
000071			007760
000072			0v0000

where

xx = even BIC address
yy = odd BIC address
zz = device address
u = RMD unit number in Sense Instruction
  u = 0 for unit 0
  u = 1 for unit 1

v = RMD unit number in unit Select Instruction
  v = 0 for unit 0
  v = 4 for unit 1

13.4 SGEN I/O INTERROGATION

Upon successful loading of the bootstrap loader and I/O interrogation, the OC unit outputs the message

```
IO INTERROGATION
```

after which the SGEN peripherals are specified by inputting on the OC unit the five I/O directives:

- DIR Specify SGEN directive input unit
- LIB Specify SGL input unit
- ALT Specify SGL modification input unit
- SYS Specify VORTEX system generation output unit
- LIS Specify user communication and list output unit

These directives can be input in any order. SGEN will continue to request I/O device assignments until valid ones have been made for all five functions.

SGEN drivers are loaded from the SGEN driver library according to the specifications of the SGEN I/O directives. Errors or problems with reading the drivers will cause the applicable error messages (section 17.13) to be output.

The general form of a SGEN I/O directive is

function = driver,device,*bic*

where

function is one of the directive names given above

driver is one of the driver names given below

device is the hardware device address

bic is the BIC address

Name*	Type of Device	Model Numbers
MTcuA	Magnetic-tape unit	620-30,-31A,-31B, -31C,-32,-32A
LPcuA	Line printer	620-77
LPcuD	Statos-31	620-75
CRcuA	Card reader	620-22,-25
PTcuA	Paper-tape reader/punch	620-55A
TYcuA	Teletype or CRT	620-06,-08, E2250
DcuA1	Rotating-memory	620-47,-43C
DcuA2	Rotating-memory	620-48,-43D
DcuA5	Rotating-memory	620-49
DcuB	Rotating memory	620-36,-37
DcuC	Rotating memory	620-35**

* where c stands for the controller number (0, 1, 2 or 3), and u for the unit number (0, 1, 2, or).

** this disc must be formatted first (see section 16.4).

13.4.1 DIR (Directive-Input Unit) Directive

This directive specifies the unit from which all SGEN directives (section 13.5) will be input (DIR unit). The directive has the general form

DIR = driver,device,*bic*

where

driver is one of the driver names MTcum, TYcum, or CRcum (m is a model code, as given in 13.4)

device is the hardware device address

bic is the BIC address (used only, and then optionally, for magnetic-tape units)

Example: Specify Teletype unit 0 having model code A and hardware device address 01 as the DIR unit.

```
DIR=TY00A,01
```

13.4.2 LIB (Library-Input Unit) Directive

This directive specifies the unit from which the SGL will be input (LIB unit). The directive has the general form

LIB = driver,device,*bic*

where

driver is one of the driver names MTcum, CRcum, or Dcum

device is the hardware device address

bic is the BIC address (used only, and then optionally, for magnetic-tape units)

Example: Specify magnetic-tape unit 0 having model code A and hardware device address 010 (no BIC) as the LIB unit.

```
LIB=MT00A,010
```

13.4.3 ALT (Library-Modification Input Unit) Directive

This directive specifies the unit from which object modules that modify the SGL will be input (ALT unit). The directive has the general form

ALT = driver,device,*bic*

where

driver is one of the driver names MTcum or CRcum

device is the hardware device address

bic is the BIC address (used only, and then optionally, for magnetic-tape units)

Example: Specify card reader unit 0 having model code A and hardware device address 030 as the ALT unit.

```
ALT=CR00A,030
```

13.4.4 SYS (System-Generation Output Unit) Directive

This directive specifies the RMD(s) onto which the VORTEX system will be generated, with the VORTEX nucleus on the first such device specified. Up to 16 RMDs can be specified. The directive has the general form

SYS = driver1,device1,bic1;*driver2,device2, bic2;...;drivern,devicen,bicn*

where each

driver is an RMD driver name Dcum

device is the hardware device address of the corresponding **driver**

bic is the **mandatory** address of the applicable BIC

Examples: Specify RMD 0 having model code B, hardware device address 016, and BIC address 020 as the SYS unit.

```
SYS=D00B,016,020
```

Specify two SYS units: RMD 0 with model code A2, hardware device address 014, and BIC address 020; and RMD 0 with model code B, hardware device address 015, and BIC address 022.

```
SYS=D00A2,014,020;D00B,015,022
```

A system with 620-35 disc requires a special formatting program, described in section 16.4. This program formats disc packs and performs bad-track analysis.

13.4.5 LIS Directive

This LIS (User-Communication and List Output Unit) directive specifies the unit that will be used for user communication and list output (LIS unit). The directive has the general form

LIS = driver,device

where

driver is one of the driver names TYcum or LPcum

device is the hardware device address

The following information appears on the LIS unit:

a. Error messages

b. Load map of each load module

c. Directives input through the DIR unit (section 13.4.1)

d. Partition table for each system RMD

To suppress listing during system generation set " map" to zero in EDR directive.

Example: Specify line printer 0 having model code A and hardware device address 035 as the LIS unit.

```
LIS=LP00A,035
```

13.5 SGEN DIRECTIVE PROCESSING

Upon successful loading of the SGEN directive processor, the OC and LIS (section 13.4.2) units output the message

```
INPUT DIRECTIVES
```

to indicate that SGEN is ready to accept SGEN directives from the DIR unit (section 13.4.1).

The SGEN directives described in this section can be input in any order, except for the EDR directive (section 13.5.14), which is input last to terminate SGEN directive input.

In cases of conflicting data, SGEN treats the last information input as the correct data.

Errors cause the output of the applicable error messages (section 17.13).

The general form of an SGEN directive is

aaa,p(1)*xp(2)x...xp(n)*

where

aaa is a three-character SGEN directive name

each **p(n)** is a parameter as indicated in the specifications for the individual directives

each *x* is a punctuation mark as indicated in the specifications for the individual directives

In contrast to most VORTEX system directives, **the punctuation in SGEN directives is exactly as defined in the specifications for the individual directives**, although blanks are allowed between parameters, i.e., before or after punctuation marks. SGEN directives begin in column 1 and can contain up to 80 characters.

SGEN directives are listed on the OC and LIS units.

13.5.1 MRY (Memory) Directive

This directive specifies the memory-related parameters of SGEN. It has the general form

MRY,memory,common

where

memory is the extent of the memory area available to VORTEX (minimum 12K = 027777)

common is the extent (0 or positive value) of the foreground blank-common area

Examples: Specify a 16K memory for VORTEX with a foreground blank-common area from 037600 to 037777.

```
MRY,037777,0200
```

Specify an 18,000-word memory for VORTEX with no foreground blank-common area.

```
MRY,18000,0
```

13.5.2 EQP (Equipment) Directive

This directive defines the peripheral architecture of the system. It has the general form

EQP,name,address,number,bic,retry

where

name is the mnemonic for a peripheral controller

address is the controller device address (01 through 077 inclusive)

number is the number (1 through 4, inclusive) of peripheral units attached to the controller

bic is the BIC address (0 if no BIC applies)

retry is the number (0 to 99, inclusive) of retries to be attempted by the I/O driver when an error is encountered

Acceptable mnemonics for **name** are:

• MTnm	Magnetic-tape unit
• LPnm	Line printer
• CRnm	Card reader
• PTnm	Paper-tape reader/punch
• TYnm	Teletype
• CTnm	CRT device
• CPnm	Card Punch
• Dnm	RMD
• ETnA	Editor Terminal

where n is the controller number (0, 1, 2, or 3), and m is the model code (table 13-2).

Controller tables are arranged according to the priority levels of their task-identification blocks (TIDBs). On any given level, the tables are arranged in the input sequence of the corresponding EQP directives. Device-specification table (DST) entries are unsorted.

The following order is suggested for peripheral controllers:

a. RMDs

b. Operator-communication (OC) device (section 15)

c. Magnetic-tape units

d. Other units

Table 13-2. Model Codes for VORTEX Peripherals

Code	Model Number	Description
TYnA	620-06	ASR Teletype Model 33
	620-08	ASR Teletype Model 35
ETnA	E2250E,F	Editor Terminal
CTnA	E2250	CRT keyboard/display
CRnA	620-22,620-25	Card reader: 300 or 600 cards/minute
CPnA	620-27	Card punch: 35 cards/minute
MTnA	620-30	Magnetic-tape: 9-track,800 bpi, 25ips
	620-31A	Magnetic-tape: 7- track, 200-556 bpi
	620-31B	Magnetic-tape: 7-track, 200-800 bpi
	620-31C	Magnetic-tape: 7-track, 556-800 bpi
	620-32	Magnetic-tape: 9-track,800bpi, 37 ips
	620-32A	Slave unit with 620-32
DnA	620-47,-48,049	Rotating memory
	620-43C, -43D	Rotating memory
DnB	620-37, -36	Rotating memory
DnC	620-35	Rotating memory
PTnA	620-55A	Paper tape reader/punch
LPnA	620-77	Line Printer
LPnD	620-75	Statos-31 Printer/Plotter
CIma		Process I/O
COma		

Note: Other peripheral devices can be added to the system by creating an EQP directive with a unique physical- unit name for the device. A controller table with the same name is then added to the VORTEX nucleus by an ADD directive (section 13.5.5).

Example: Define a system containing one model B RMD, one model A magnetic-tape unit, one model A card reader, one model A line printer, and one model A Teletype.

```
EQP,D0B,016,1,020,3
EQP,MT0A,010,1,022,5
EQP,CR0A,030,1,024,0
EQP,LP0A,035,1,024,0
EQP,TY0A,01,1,0,0
EQP,PT0A,037,1,0,0
EQP,CP0A,031,1,022,0
```

13.5.3 PRT (Partition) Directive

This directive specifies the size of each partition on each RMD. It has the general form

PRT,Dcup(1),s(1),k(1);*Dcup(2),s(2), k(2);...;Dcup(n),s(n),k(n)*

where each

Dcup(n) is the name of the RMD partition with **c** being the number (0, 1, 2, or 3) of the controller, **u** the unit number (0, 1, 2, or 3), and **p** the partition letter (A through T, inclusive)

s(n) is the number (octal or decimal) of tracks in the partition. The maximum partition size on a 620-35 rotating memory is 1365 tracks.

k(n) is the protection code (single alphanumeric character including $) for the partition, or * if the partition is unprotected

At least seven partitions are required for the system rotating memory. PRT directives are required for every partition on every RMD in the system. 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 D00A, D00C, D00D, D00B is valid, but the sequence D00A, D00C, D00D, D00E constitutes an error.

Logical units 101 through 106 inclusive have preassigned protection codes (~~101 = C, 102~~ = S, 103 ~~= B~~; 104 = D, 105 = E, and 106 = F). (Any attempt to change these codes is ignored.)?

lun	101	102	103	104	105	106
pk	S	B	C	D	E	F

Total number of tracks of all partitions and the capacity of VORTEX nucleus (usually 4-5 tracks) must not exceed rotating-memory track capacity (e.g. for 620-37 disc it is 203 tracks).

Example: Specify the following partitions on two RMDs.

RMD No.	Partition	Tracks	Protection Code
0	A	2	C
0	B	20	F
0	C	25	E
0	D	40	D
0	E	8	S
0	F	18	B
0	G	18	None
0	H	66	None
1	A	40	None
1	B	60	R
1	C	50	None
1	D	53	X

```
PRT,D00A,2,C;D00B,20,F
PRT,D00C,25,E;D00D,40,D;D00E,8,S
PRT,D00F,18B;D00G,18,*;D00H,66,*
PRT,D01D,53,X;D01C,50,*
PRT,D01A,40,*;D018,60,R
```

13.5.4 ASN (Assign) Directive

This directive assigns logical units to physical devices. It has the general form

ASN,lun(1) = dev(1),*lun(2) = dev(2),...,lun(n) = dev(n)*

where each

lun(n) is a logical unit number (1 through 100 or 107 through 255, inclusive) that can be followed optionally by a two-character logical unit name e.g., 107:Y7

dev(n) is a four-character physical-device name, e.g., TY00, D00G

If a new assignment specifies the same logical unit as a previous assignment, the old one is replaced and is no longer valid. All logical units for which physical device assignments are not explicitly made are considered *dummy units*.

Restrictions: Any attempt to change one of the preset logical unit name:number or name:number:partition relationships given in table 13-3 will cause an error to be flagged. Table 13-4 indicates the permissible physical unit assignments for the first 12 logical units (with PO automatically set equal to SS).

Example: Specify physical device assignments for logical units 1-12, inclusive, 107 and 108, and 180 and 181, where the last two units have, in addition to their numbers, two-character names.

```
ASN,1=TY00,2=CR00,3=TY01,4=CR00
ASN,5=LP00,6=MT00,7=D00I,8=D00A
ASN,9=D00H,10=D00A,11=TY00,12=LP00
ASN,107=LP00,108=CR00
ASN,180:S6=MT00,181:S8=MT01
```

Table 13-3. Preset Logical-Unit Assignments

Preset logical-unit name/number relationships:

OC = 1	LO = 5	GO = 9
SI = 2	BI = 6	PO = 10
SO = 3	BO = 7	DI = 11
PI = 4	SS = 8	DO = 12

Preset logical-unit/RMD-partition relationships:

Logical-Unit Name	Logical-Unit Number	Partition Name	Protection Key	Minimum VORTEX Sector Allocation
CL	103	D00~~F~~ A	~~B~~ C	025
FL	106	D00~~B~~ B	F	0106
BL	105	D00~~C~~ C	E	01135
OM	104	D00~~D~~ D	D	0417
CU	101	D00~~A~~ E	~~E~~ S	0310[1]
SW	102	D00~~E~~ F	~~S~~ B	0310[2]
GO	9	D00G	None	0310[3]
SS	8	D00H	None	Varies
PO	10	D00H	None	0515[4]
BI	6	D00I	None	Varies
BO	7	D00I	None	Varies

[1] CU file must be as large as background task's largest part in core at on time (24K assumed above).

[2] SW file must be as large as the largest single task including overlays (24K assumed above).

[3] GO file must be somewhat larger than the largest task run in load-and-go mode. If system is foreground only or all tasks will be entered in libraries before execution, this partition may be eliminated.

[4] PO file must be large enough for source images of the largest task to be assembled or compiled. Source images are stored 3 card images per sector (1000 cards assumed above). If this function is assigned to magnetic tape, this partition may be eliminated.

Table 13-4. Permissible Logical-Unit Assignments

		Permissible Physical Units				
Logical Units		Teletype or CRT	RMD or MT	Line Printer	Other Output (CP,PT)	Other Input (PT,CR)
1	(OC)	X				
2	(SI)	X	X			X
3	(SO)	X				
4	(PI)	X	X			X
5	(LO)	X	X	X	X	
6	(BI)		X			X
7	(BO)		X		X	
8	(SS)		X			
9	(GO)		X			
10	(PO)		X			
11	(DI)	X				X
12	(DO)	X		X		

13.5.5 ADD (SGL Addition) Directive

This directive specifies the SGL control records and object modules *after which* new control records and/or object modules are to be added during nucleus generation. It has the general form

ADD,p(1),*p(2),...,p(n)*

where each **p(n)** is the name of a control record or an object module *after which* new items are to be added.

When the name of a specified item is read from the SGL, the program is processed and the message

```
ADD AFTER p(n)
READY
```

appears on the OC unit. User response on the OC unit is either

```
ALT
```

if an item is to be added from the SGEN ALT input unit (section 13.4.3), or

```
LIB
```

if processing from the SGL is to continue. If the former response is used, SGEN reads a load module from the ALT unit and adds it to the SGL, then prints on the OC unit the message

```
READY
```

to which the user again responds with either ALT or LIB on the OC unit.

Example: Specify that items are to be added during nucleus generation after control records or object modules named PROG1, PROG2, and PROG3.

```
ADD,PROG1,PROG2,PROG3
```

13.5.6 REP (SGL Replacement) Directive

This directive specifies the SGL control records and object modules to be replaced with new control records and/or object modules during nucleus generation. It has the general form

REP,p(1),*p(2),...,p(n)*

where each **p(n)** is the name of a control record or an object module to be replaced.

When the name of the specified item is read from the SGL, the program is skipped and the message

```
REPLACE p(n)
READY
```

appears on the OC unit. User response on the OC unit is either

```
ALT
```

if an item is to be replaced by one on the SGEN ALT input unit (section 13.4.3), or

```
LIB
```

if processing from the SGL is to continue. If the former response is used, SGEN reads a load module from the ALT unit and replaces p(n) with it in the SGL, then prints on the OC unit the message

```
READY
```

to which the user again responds with either ALT or LIB on the OC unit.

Example: Specify that control records or object modules named PROGA and PROGB are to be replaced during nucleus generation.

```
REP,PROGA,PROGB
```

13.5.7 DEL (SGL Deletion) Directive

This directive specifies the SGL control records and object modules that are to be deleted during nucleus generation.It has the general form

DEL,p(1),*p(2),...,p(n)*

where each **p(n)** is the name of a control record or an object module to be deleted.

When the name of a specified item is read from the SGL, the item is skipped and processing continues with the following control record or object module.

Example: Delete, during nucleus generation, all control records and object modules named PROG1 and PROG2.

```
DEL,PROG1,PROG2
```

13.5.8 LAD (Library Addition) Directive

This directive specifies the SGL load-module package *after which* new load-module packages are to be added during library generation. It has the general form

LAD,p(1),*p(2),...,p(n)*

where each **p(n)** is the name of a load-module package from an SLM control directive *after which* new items are to be added.

When the name of a specified load-module package is read from the SGL, the program is processed and the message

```
ADD AFTER p(n)
READY
```

appears on the OC unit. User response on the OC unit is either

```
ALT
```

if a load-module package is to be added from the SGEN ALT input unit (section 13.4.3), or

```
LIB
```

if processing from the SGL is to continue. If the former response is used, SGEN reads a module from the ALT unit and adds it to the library, then prints on the OC unit the message

```
READY
```

to which the user again responds with either ALT or LIB on the OC unit.

Example: Specify that items are to be added, during library generation, after load-module packages named PROG1, PROG2, and PROG3.

```
LAD,PROG1,PROG2,PROG3
```

13.5.9 LRE (Library Replacement) Directive

This directive specifies the SGL load-module package to be replaced with new load-module package during library generation. It has the general form

LRE,p(1),*p(2),...,p(n)*

where each **p(n)** is the name of a load-module package from an SLM control directive to be replaced.

When the name of the specified load-module package is read from the SGL, the program is skipped and the message

```
REPLACE p(n)
READY
```

appears on the OC unit. User response on the OC unit is either

```
ALT
```

if module is to be replaced by one on the SGEN ALT input unit (section 13.4.3), or

```
LIB
```

if processing from the SGL is to continue. If the former response is used, SGEN reads a module from the ALT unit and replaces p(n) with it in the SGL, then prints on the OC unit the message

```
READY
```

to which the user again responds with either ALT or LIB on the OC unit.

Example: Specify that load-module packages named PROGA or PROGB are to be replaced during library generation.

```
LRE,PROGA,PROGB
```

13.5.10 LDE (Library Deletion) Directive

This directive specifies the SGL load-module packages that are to be deleted during library generation. It has the general form

LDE,p(1),*p(2),...,p(n)*

where each **p(n)** is the name of a load-module package from an SLM control directive to be deleted.

When the name of a specified load-module package is read from the SGL, the load-module package is skipped and processing continues with the following load module.

Example: Delete, during library generation, all load-module packages named PROG1 and PROG2.

```
LDE,PROG1,PROG2
```

13.5.11 PIM (Priority Interrupt) Directive

This directive defines the interrupt-system architecture by specifying the number of priority interrupt modules (PIMs) in the system, the interrupt levels to be enabled at system-initialization time, and the interrupts to be manipulated by user-coded interrupt handlers. The PIM directive has the general form

PIM,p(1),q(1),r(1),s(1);*p(2),q(2),r(2),s(2);...;p(n),q(n),r(n),s(n)*

where each

p(n) is an interrupt line number comprising two *octal* digits with the first being the PIM number and the second the line number within the PIM. The two digits must be preceded by a zero, e.g., 0A2,011

q(n) is the name (1 to 6 characters) of the task handling the interrupt (could be taken from TDT deck or SMAP listing

r(n) is the content of the interrupt event word in octal notation

s(n) is 0 for an interrupt using the common interrupt-handler, or 1 for a directly connected interrupt

If an interrupt line is to use the common interrupt handler, a TIDB is generated for the related interrupt-processing routine, which can be in the VORTEX nucleus or in the foreground library.

If an interrupt line is to have a direct connection, the interrupt-processing routine must be added to the VORTEX nucleus. Failure to do so results in an error message.

Example: Specify two interrupt lines, one handled by the common interrupt handler, the other directly connected.

```
PIM002,TBMT0A,00001,0;003,TBLP0B,01,1
```

Note: The only interrupt used by the magnetic-tape I/O driver is the motion complete.

13.5.12 CLK (Clock) Directive

This directive specifies the values of all parameters related to the operation of the real-time clock. It has the general form

CLK,clock,counter,interrupt

where

clock is the number of microseconds in the basic clock interval

counter is the number of microseconds in the free-running counter increment period

interrupt is the number of milliseconds in the user interrupt interval

The value of **interval**, when not a multiple of 5 milliseconds, is increased to the next multiple of 5 milliseconds; e.g., if **interval** is 151, the interrupt interval is 155 milliseconds.

Example: Specify a basic clock interval of 100 microseconds, a free-running counter rate of 100 microseconds, and a user interrupt interval of 20 milliseconds.

```
CLK,100,100,20
```

13.5.13 TSK (Foreground Task) Directive

This directive specifies the tasks in the foreground library that are to be made resident tasks. It has the general form

TSK,task(1),*task(2),...,task(n)*

where each **task(n)** is the name of an RMD foreground-library task that is to be made a resident task.

If this directive is input as part of a full system generation, the names are those of tasks that will be built on the foreground library during the library-building phase (section 13.7).

Resident TIDBs are not created for the tasks defined on the TSK directives to be resident tasks. A TIDB is created each time a resident task is specified on a SCHED call. A resident TIDB is created at system generation for each task specified on a TDF directive (paragraph 13.6.2.).

Example: Specify that foreground-library tasks RTA, RTB, and RTC be made resident tasks.

```
TSK,RTA,RTB,RTC
```

13.5.14 EDR (End Redefinition) Directive

This directive, **which must be the last SGEN directive**, specifies all special system-parameters, or terminates SGEN directive input. If only a redefinition of resident tasks is required, the EDR directive is of the form

EDR,R

but if a full SGEN is necessary, the EDR directive has the general form

EDR,S,tidb,stack,part,list,kpun,map[,analysis]

where

tidb is the number (01 through 0777, inclusive) of 25-word empty TIDBs allocated

stack is the size (0 through 037777, inclusive) of the storage and reentry stack allocation, which is equal to the number of words per reentrant subroutine multiplied by the number of levels calling the subroutine

part is the maximum number (1 through 20, inclusive) of partitions on an RDM in the system

list is the number of lines per page for the list output, with typical values of 44 for the line printer and 61 for the Teletype

kpun is 26 for 026 keypunch Hollerith code, or 29 for 029 code

map is L if map information is to be listed, or 0 if it is to be suppressed

analysis is 0 or blank if a complete bad track analysis is desired on all RMD's, or 1 if the bad track tables from the last SGEN are to be reused. If this parameter is omitted, a full analysis is performed. A value of 1 may be entered only when an analysis has been made on a previous SGEN effort

Bad-track or RMD partitioning analysis is performed following input of the EDR directive. When that process is complete, the VORTEX nucleus or resident-task processor is loaded into main memory.

Examples: Specify redefinition of resident tasks only.

```
EDR,R
```

Specify full system generation with no empty TIDBs, no stack area, a maximum of five partitions per RMD, 44 lines per page on the list output, 026 keypunch mode, and a list map, and no bad track analysis is wanted.

```
EDR,S,0,0,5,44,26,L
```

Specify full system generation with 100 empty TIDBs, 0500 addresses in the stack area, a maximum of 20 partitions per RMD, 30 lines per page on the list output, 029 keypunch mode, and suppression of the list map. Assume bad track tables from the last SGEN are still good, and reuse them.

```
EDR,S,100,0500,20,30,29,0,1
```

13.6 BUILDING THE VORTEX NUCLEUS

If a full system generation has been requested by the S form of an EDR directive (section 13.5.14), the nucleus processor is loaded upon completion of directive processing. Once loaded, the nucleus processor reads the SGL routines and builds the VORTEX nucleus as specified by the routines and the SGEN control records.

There are three SGEN control records used in building the nucleus:

• **SLM**	**Start load module**
• **TDF**	**Build task-identification block**
• **END**	**End of nucleus library**

Normally these control records are used only to replace existing SGL control records.

VORTEX nucleus processing consists of the automatic reading of control records and object modules from the SGL, and, according to the specifications made by SGEN directives, either ignoring the item or incorporating it into the VORTEX nucleus. The only manual operations are the addition and replacement of object modules during system generation. In these cases, follow the procedures given in sections 13.5.5 and 13.5.6, respectively.

13.6.1 SLM (Start Load Module) Directive

This directive specifies the beginning of a load module. Its presence indicates the beginning of the system initializer or VORTEX nucleus. The directive has the general form

SLM,name

where **name** is the name of the load module that follows the directive.

Example: Indicate the beginning of the VORTEX nucleus.

```
SLM,VORTEX
```

13.6.2 TDF (Build Task-Identification Block) Directive

This directive specifies all parameters necessary to build a task-identification block in the VORTEX nucleus. It has the general form

TDF,name,exec,ctrl,stat,levl

where

name is the name (1 to 6 alphanumeric characters) given to the TIDB for linking purposes

exec is the name (1 to 6 alphanumeric characters) associated with the execution address of the task

ctrl is the name (1 to 6 alphanumeric characters) of the controller table required for Teletype and CRT processing tasks, or is 0 for any other task

stat is the 16-bit TIDB status word where the settings of the individual bits have the significance shown in table 13-5

levl is the priority level of the related tasks

Example: Define a foreground resident task PROG1 on priority level 10.

```
TDF,TIDPR1,PROG1,0,07401,10
```

The TDF directive causes a resident TIDB to be created for the specified task. The task itself may or may not be a resident task, as defined by the status word (stat). See paragraph 13.5.13 for generation of resident tasks without resident TIDB.

13.6.3 END Directive

This directive indicates the end of the system initializer or the VORTEX nucleus. It has the form

END

Example: Indicate the end of the system initializer.

```
END
```

Table 13-5. 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	The task is not activated. All stacked I/O is aborted, but currently active I/O is completed.
12	Task exited	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 in protected foreground. A background task is protected only if bit 8 is set.
8	Protected task	The task is protected.
7	Task scheduled by time increment	The task becomes nonsuspended when a specified time interval is reached. Prerequisite: Resident TIDB (bit 11).
6	Time delay active	The clock decrements the time counter that, upon reaching zero, clears bit 14.
5	Task checkpointed	The background task is checkpointed 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, allocated and loaded	The task is loaded in memory and is ready for execution.

13.7 BUILDING THE LIBRARY AND CONFIGURATOR

If a full system generation has been requested by the S form of an EDR directive (section 13.5.14), the library generator is loaded upon completion of nucleus processing. If only reconfiguration of resident tasks has been requested (R form of the EDR directive), the library generator is loaded immediately after directive processing.

A **load module** is a logically complete task or operation that can be executed by the VORTEX system in foreground or background. It resides in the foreground or background library, or in the user library. Load modules are constructed from sets of binary object modules interspersed with alphanumeric control records. The control records indicate the beginning and end of data for incorporation into each load module, and specify certain parameters to the load module. The group of object modules and control records used to construct a load module is called a **load-module package (LMP)**. Figure 13-5 shows an LMP for a load module without overlays, and figure 13-6 shows an LMP for a load module with overlays. Each LMP runs from a SLM control record to an END control record, and includes all modules and records between.

*	**SLM,name1**
*	**TID,name2,. . .**
	Object Modules Comprising the Root Segement
*	**ESB**
*	**END**

NOTE:

* = Alphanumeric control record

Figure 13-5. Load Module Package for Module Without Overlays

There are five SGEN control records used in building the library:

• SLM	Start load module
• TID	Task-identification block specification
• OVL	Overlay
• ESB	End of segment
• END	

Library processing consists of the automatic reading of control records and object modules from the SGL, and construction of the library from these inputs. The only manual operations are the addition and replacement of load modules. In these cases, follow the procedures given in sections 13.5.5 and 13.5.6, respectively.

Resident-task configuration takes place upon completion of library processing. All tasks specified by TSK directives (section 13.5.13) are copied from the foreground library into the VORTEX nucleus, thus becoming *resident tasks*. To change the resident-task configuration of a previously generated system, input the TSK directives followed by the R form of the EDR directive (section 13.5.14), thus bypassing nucleus and library processing and allowing the resident-task configurator to alter the existing system. **Note:** If a specified program is not found in the foreground library, configuration continues, but an appropriate message is output.

13.7.1 SLM (Start LMP) Directive

This directive indicates the start of an LMP. It has the general form

SLM,name

where **name** is the name of the LMP that begins with this directive.

Example: Indicate the start of the LMP named ABC.

```
SLM,ABC
```

13.7.2 TID (TIDB Specification) Directive

This directive contains the parameters necessary for the generation of the task-identification block required for each generated load module. The TID directive has the general form

TID,name,mode,ovly,lun

where

name is the name (one to six alphanumeric characters) of the task

mode is 1 if the task is a background task, or 2 if it is a foreground task

ovly is the number of overlay segments, or 0 if the task has no overlay segments, (note that the value 1 is invalid)

lun is the number of the logical unit onto which the task is to be cataloged

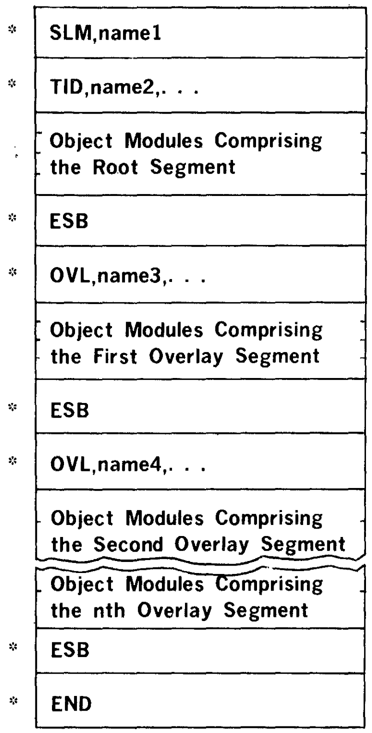
Once a TID directive is input and processed, object modules are input, processed, and output to the specified logical unit until the ESB directive (section 13.7.4) is found.

Examples: Specify a TIDB for a task PROG1 without overlays for cataloging on the BL unit (105).

```
TID,PROG1,1,0,105
```

Specify a TIDB for the task PROG2 with four overlay segments for cataloging on an FL unit (106).

```
TID,PROG2,1,4,106
```



* SLM,name1

* TID,name2,. . .

Object Modules Comprising the Root Segment

* ESB

* OVL,name3,. . .

Object Modules Comprising the First Overlay Segment

* ESB

* OVL,name4,. . .

Object Modules Comprising the Second Overlay Segment

Object Modules Comprising the nth Overlay Segment

* ESB

* END

NOTE:

* = Alphanumeric control record

Figure 13-6. Load Module Package for Module With Overlays

13.7.3 OVL (Overlay) Directive

This directive indicates the beginning of an overlay segment. The OVL directive has the general form

OVL,segname

where **segname** is the name (one to six alphanumeric characters) of the overlay segment.

Example: Indicate the beginning of the overlay segment SINE.

```
OVL,SINE
```

13.7.4 ESB (End Segment) Directive

This directive indicates the end of a segment, i.e., that all object modules have been loaded and processed. The directive has the form

ESB

The ESB directive causes the searching of the CL library, which was generated during nucleus processing, to satisfy undefined externals.

The ESB directive concludes both root segments (following TID, section 13.7.2) and overlay segments (following OVL, section 13.7.3) of a load module.

Example: Indicate the end of a segment.

```
ESB
```

13.7.5 END (End Library) Directive

This directive indicates the end of load-module generation. It has the form

END

Example: Specify the end of load-module generation.

```
END
```

13.8 SYSTEM INITIALIZATION AND OUTPUT LISTINGS

Upon completion of load-module processing, SGEN outputs on the OC and LIS units the message

```
VORTEX SYSTEM READY
```

The system initializer and VORTEX nucleus are then loaded into memory, the initializer is executed to initialize the system, and the nucleus is executed to begin system operation. At this time, the OM library should be loaded and built on the RMD using FMAIN.

The VORTEX system is now operating with the peripherals in the status specified by TID control records.

If the EDR directive specified a listing, linking information is listed on the LIS unit during nucleus processing and library generation. Regardless of the EDR directive, RMD and resident-task information is listed during nucleus processing or resident-task configuration, respectively. Figures 13-7 through 13-10 show the listing formats of load maps for the VORTEX nucleus, the library processor, the RMD partitions, and the resident tasks.

```
CORE RESIDENT LIBRARY

NAME           LOCATION

AAA            017285
BBB            000100
 .                .
 .                .
 .                .
ZZZ            025863

NONSCHEDULED TASKS

NAME           LOCATION

ABC            022620
DEF            014640
 .                .
 .                .
 .                .
XYZ            011400
```

Figure 13-7. VORTEX Nucleus Load Map

```
LOAD MODULE:     ABC

CATALOGED ON:    D00H

NAME             LOCATION

MOP        A     032556
QRS        R     000200
 .         .        .
 .         .        .
 .         .        .
TUV        A     032501


LOAD MODULE:     CDE

CATALOGED ON:    D10A

NAME             LOCATION

GHI        R     000010
JKL        R     000012
 .         .        .
 .         .        .
 .         .        .
MNO        R     000077
```

Figure 13-8. Library Processor Load Map

```
RMD PARTITIONING


NAME     FIRST      LAST       BAD
         TRACK      TRACK      TRACKS

D00A     0007       0008       0000
D00B     0009       0028       0000
D00C     0029       0053       0000
D00D     0054       0093       0000
D00E     0094       0101       0000
D00F     0102       0119       0000
D00G     0120       0137       0000
D00H     0138       0203       0000

D01A     0001       0039       0000
D01B     0040       0099       0000
D01C     0100       0149       0000
D01D     0150       0203       0000
```

Figure 13-9. RMD Partition Listing

```
CORE RESIDENT TASKS

NAME           LOCATIONS

PROG1          014630
PROG2          014630
PROG3          NOT FOUND
PROG4          014500
```

Figure 13-10. Resident-Task Load Map

13.9 SYSTEM GENERATION EXAMPLES

EXAMPLE 1

Problem: Generate a VORTEX system using the following hardware:

a. Computer with 16K main memory

b. A model 620-37 disc unit with device address 016

c. Teletype keyboard/printer

d. Card reader

e. Two buffer interlace controllers (BICs) with device addresses 020 and 022

f. One priority interrupt module (PIM) with device address 040

and having the characteristics listed below:

a. Foreground common size = 0200

b. Storage/reentry stack area size = 0200

c. Number of empty TIDBs = 20

d. Number of disc partitions = 9

e. All eight interrupt lines connected through a common interrupt handler

f. One user-coded program added to the resident module (PROG1)

g. JCP replaced with a new version

h. One user-coded load module added to the foreground library (after LMGEN)

i. The system file listed after system generation

Procedure:

Step	User Action	SGEN Response
1	Load and execute the card reader loader (table 13-1)	Loads the I/O interrogation routine punched cards from the card reader, and outputs on the OC unit **I/O INTERROGATION**
2	On the OC unit, input **DIR = TY00A,01** **LIB = CR00A,030** **ALT = CR00A,030** **LIS = TY00A,01** **SYS = D00B,016,020**	Loads the SGEN drivers and directive processor, and outputs **INPUT DIRECTIVES**
3	On the Teletype (DIR unit), type **CLK,100,100,20** **MRY,037777,0200** **EQP,D0B,016,1,020,3** **EQP,TY0A,01,1,0,0** **EQP,CR0A,030,1,0,0** **PRT,D00A,2,C;D00B,20,F** **PRT,D00C,25,E;D00D,40,D** **PRT,D00E,8,S;D00F,18,B** **PRT,D00G,18,*;D00H,52,*** **PRT,D00I,14,*** **ASN,1 = TY00,2 = TY00,3 = TY00** **ASN,4 = CR00,5 = TY00, = CR00** **ASN,7 = D00I,8 = D00H,9 = D00G** **ASN,10 = D00H,11 = TY00,12 = TY00** **ASN,180 = D00H,181 = D00I** **PIM,00,TBD0B,01,0;02,TBCR0A,01,0** **PIM,03,TBD0B,01,0;04,TBTY0A,01,0** **PIM,05,TBTY0A,02,0** **TSK,PROG1** **LRE,BGTSK1** **LAD,BGTSK2** **EDR,S,20,0200,9,44,26,L**	Processes the directives, partitions the disc, loads the nucleus processor and builds the nucleus, loads the library processor and builds the library until load module JCP is encountered, and outputs **REPLACE JCP** **READY**
4	Load revised version of BGTSK1 load module in the card reader, and on DIR type: **ALT**	Reads and processes the new load module, and outputs: **READY**
5	Load the remainder of the load module library in the card reader, and on DIR type **LIB**	Processes the load module library until the completion of LMGEN, and outputs **ADD AFTER BGTSK2** **READY**

Step	User Action	SGEN Response
6	Load the PROG1 load module in the card reader, and on DIR type **ALT**	Reads and processes PROG1, and outputs **READY**
7	Load the PROG2 load module in the card reader, and on DIR type **ALT**	Reads and processes PROG2, and outputs **READY**
8	Load the remainder of the load module library in the card reader, and on DIR type **LIB**	Processes the remainder of the load module library, copies PROG1 from the FL unit to the VORTEX nucleus, lists the resident task information, and outputs on OC and LIS **VORTEX SYSTEM READY**
9	None	Loads and initializes the VORTEX nucleus

EXAMPLE 2

Problem: Replace the current resident tasks in the foreground library with the tasks listed below in an operational VORTEX system.

PROG1
ABC
TEST
EFG

Procedure:

Step	User Action	SGEN Response
1	Load and execute the magnetic tape loader (table 13-1)	Loads the I/O interrogation routine from magnetic tape, and outputs from the OC unit **IO INTERROGATION**
2	On the OC unit, input **DIR = TY00A,01** **LIB = MT00A,010** **ALT = MT01A,010** **LIS = LP00A,035** **SYS = D00A2,014,020**	Loads the SGEN drivers and directive processor, and outputs **INPUT DIRECTIVES**
3	On the Teletype (DIR unit), type **TSK,PROG1,ABC** **TSK,TEST,EFG** **EDR,R**	Processes the directives, loads the resident-task processor, enters the PROG1, ABC, TEST, and EFG load modules from FL, lists resident information, and outputs on OC and LIS **VORTEX SYSTEM READY**
4	None	Loads and initializes the VORTEX nucleus

SECTION 14
SYSTEM MAINTENANCE

The VORTEX **system-maintenance component (SMAIN)** is a background task that maintains the **system-generation library (SGL)**. The SGL (figure 14-1) comprises all object modules and their related control records required to generate a generalized VORTEX operating system.

14.1 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.

INPUTS to the SMAIN comprise:

a. *System-maintenance directives* (section 14.2) input through the SI logical unit.

b. *The old SGL* input through the logical unit specified by the IN directive (section 14.2.1).

c. *New or replacement object modules and/or control records* input through the logical unit specified by the ALT directive (section 14.2.3).

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 record: 1) control records and comments (ASCII), 2) the system-generation relocatable loader (the only SGL absolute core-image record), 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 in section 17.14. 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

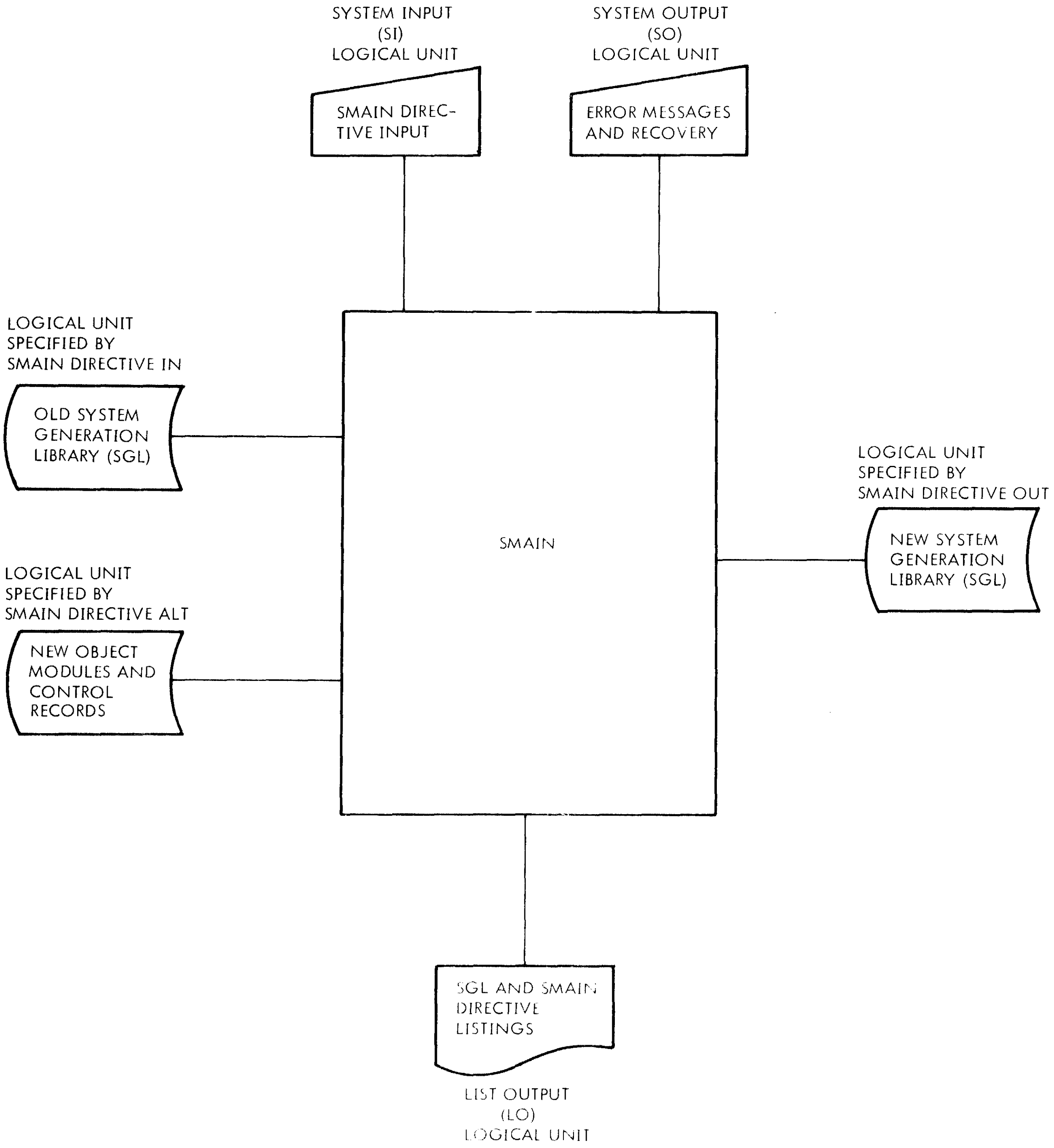
d. *Directive images*

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 section 17.14.

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



VTII-1364

Figure 14-1. SMAIN Block Diagram

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.

14.1.1 Control Records

In SMAIN there are two types of control record:

a. *SGL delimiters*

b. *Object-module delimiters*

SGL delimiters divide the SGL into six 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 13).

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.

14.1.2 Object Modules

Relocatable object-module outputs from the DAS MR assembler and the FORTRAN compiler are described in appendix A.

14.1.3 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 13.

14.2 SYSTEM-MAINTENANCE DIRECTIVES

This section describes the SMAIN directives:

•	IN	Specify input logical unit
•	OUT	Specify output logical unit
•	ALT	Specify alternate 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 section 17.14.

14.2.1 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 when **lun** is an RMD partition

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, the RMD is rewound to the first sector following the partition specification table (PST, section 3.2) before any processing takes place. The PST comprises one entry defining the entire RMD.

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.

```
IN,107,G
```

14.2.2 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, 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
```

14.2.3 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
```

14.2.4 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.

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)
```

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 14.2.3), 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
```

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

```
ADD AFTER PART0001
```

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
```

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.**

14.2.5 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.

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

```
REP p(n)
```

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 14.2.4), 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 14.2.3). Input

```
REP,IOCTL
```

then, when the message

```
REP IOCTL
```

appears, continue as for an ADD directive (section 14.2.4).

14.2.6 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.

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 14.2.7) or by the L parameter of an END directive (14.2.8), 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
```

14.2.7 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 14.2.1). The LIST directive has the form

LIST

Example: List the old SGL.

```
LIST
```

14.2.8 END Directive

This directive indicates that all ADD (section 14.2.4), REP (section 14.2.5), and DEL (section 14.2.6) 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
```

14.3 SYSTEM-MAINTENANCE OPERATION

The normal SMAIN operation consists of copying an existing SGL from the logical unit specified by the IN directive (section 14.2.1) to the logical unit specified by the OUT directive (section 14.2.2), making the modifications specified by the ADD (section 14.2.4), REP (section 14.2.5), and DEL (section 14.2.6) directives, and thus creating a new SGL.

Input of the END directive (section 14.2.8) 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 14.2.3). 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.

14.4 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
```

SECTION 15
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*.

15.1 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 15.2.9).

15.2 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 15-1 shows the system names of physical I/O devices as used in operator key-in requests.

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 section 17.15.

Table 15-1. 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-31
MTcu	Magnetic tape unit
PTcu	High-speed paper tape reader/punch
TYcu	Teletype printer/keyboard
CIma COma	Process I/O

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).

cu can be omitted to specify unit 0 controller 0, e.g., CR00 or CR.

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.

15.2.1 ;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*

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**

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,9,0,0
```

15.2.2 ;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.

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,9,0,0,0830
```

15.2.3 ;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 (1-8) 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 12) 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 1, 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 1, line 3).

```
;ATTACH,INTRPT,13,020
```

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.

15.2.4 ;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
```

15.2.5 ;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
```

15.2.6 ;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 (00 to 12)
dd is the day (00 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.

Operator key-in example: Set the system date to 25 December 1971.

```
;DATE,12/25/71
```

15.2.7 ;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
```

15.2.8 ;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.

The status-output for a ;TSTAT key-in request is of the form

task Plevel Sstatus *TMmin TSmilli*

where

task is the name of the task whose status is being output

level is the priority level (from 2 to 31) of the task

status is the status of the task as found in words 1 and 2 of the TIDB (table 15-2)

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 0 and/or 7 of TIDB word 1 (table 15-2) is set.

Table 15-2. 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
1	4	Task error
1	3	Task interrupt expected
1	2	Overlay task
1	1	Schedule task upon termination of active task
1	0	Task search-allocated-loaded
2	15	Task opened
2	14	Task loaded in background (checkpoint) area
2	13	Load overlay
2	12-0	Unused

Operator key-in examples: Request the output of the status of the task BIGJOB.

```
;TSTAT,BIGJOB
```

The output will be

```
BIGJOB P02 S000100, 000000 TM077777 TS077430
```

if the status of 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 10 and 11) of 077777 and 077430, respectively. The latter two octal complement counters show zero minutes and 0340 5-millisecond increments.

Request the output of the status of all foreground tasks inputs.

```
;TSTAT
```

and receive as a typical response

```
VZDB      P24 S047401, 000000 TM077311 TS071000
V$TYA     P23 S047411, 000000 TM077005 TS071011
V$TYA     P23 S047411, 000000 TM077200 TS076000
VZLPA     P22 S047401, 000000 TM077002 TS022000
VZCRA     P22 S047401, 000000 TM077000 TS070221
VZMTA     P22 S047401, 000000 TM077200 TS071000
VZMTA     P22 S047401, 000000 TM077200 TS071000
V$OPCM    P10 S005405, 020000 TM077020 TS077033
JCP       P01 S044400, 000000 TM077000 TS070005
```

15.2.9 ;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 15-1)

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 15.2.10), 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
```

15.2.10 ;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 15-1)

Operator key-in example; Declare TY01 inoperable for system use.

```
;DEVDN,TY01
```

15.2.11 ;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 15-1)

Operator key-in example: Declare TY02 operational for system use.

```
;DEVUP,TY02
```

15.2.12 ;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. 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, and the repeated number where no name is assigned to the logical unit. 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
```

SECTION 16
OPERATION OF THE VORTEX SYSTEM

This section explains the operation of devices in the VORTEX system, the loading of the system bootstrap and procedures for changing and initializing the disc pack during VORTEX operation.

16.1 DEVICE INITIALIZATION

16.1.1 Card Reader *(Model 620-25)*

a. Turn on the card reader.

b. Place the input deck in the card hopper.

c. Press READY/ALERT.

16.1.2 Card Punch *(Model 620-27)*

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.

16.1.3 Line Printer *(Model 620-77)*

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.

16.1.4 33/35 ASR Teletype *(Models 620-06, -08)*

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.

16.1.5 High-Speed Paper-Tape Reader
(Model 620-55)

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.

16.1.6 Magnetic-Tape Unit *(Models 620-30, -31, -32)*

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.

16.1.7 Magnetic-Drum and Fixed-Head Disc Units
(Models 620-47 through 620-49 and 620-43C or D)

a. Turn on the drum unit.

b. Wait for the drum unit to reach operating speed.

16.1.8 Moving-Head Disc Units
(Models 620-36 and -37)

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.

16.1.9 Moving-Head Disc Units (Model 620-35)

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.

16.2 SYSTEM BOOTSTRAP LOADER

System key-in loaders initiate loading of the VORTEX system from a drum (Models 620-47 through -49) or disc (Models 620-36 and -37) 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 16-1 contains the key-in loader programs.

Table 16-1. Key-In Loader Programs

Address	**Drum** -48,-49 -43C, D	**Disc** -36/37	**Disc** -35
001130	1000yy	1004zz	005302
001131	006020	1040zz	006030
001132	000002	1002zz	177773
001133	005001	005001	005001
001134	1031xx	1031zz	100015
001135	006120	1010zz	103115
001136	001127	001141	100515
001137	1031yy	001000	101015
001140	1000xx	001135	001143
001141	1000zz	1025zz	001000
001142	1032zz	151167	001137
001143	1010xx	001016	102515
001144	000600	001130	001016
001145	001000	1000yy	001130
001146	001143	1003zz	005122
001147		005102	005021
001150		1032zz	006120
001151		1031xx	000167
001152		006010	004460
001153		001130	100015
001154		1031yy	~~100071~~ 100021
001155		1000xx	~~103170~~ 103120
001156		1000zz	~~103271~~ 103221
001157		1014zz	~~100070~~ 100020
001160		001157	005041
001161		1025zz	006150
001162		151167	000007
001163		001016	103115
001164		001130	100415
001165		001000	101415
001166		000600	001171
001167		007760	001000
001170			001165
001171			102515
001172			001016
001173			001130
001174			005144
001175			001040
001176			000600
[illegible]			001000
[illegible]			001146

where xx = even BIC address, yy = odd BIC address, and zz = device address.

16.2.1 Automatic Bootstrap Loader (Model 620-15)

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 001130ff.

To initiate the loader: (1) clear the A, B, X, I, and P registers; (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.

16.2.2 Control Panel Loading

The appropriate key-in loader is entered through the computer control panel as follows:

a. Press REPEAT.

b. Load an STA instruction (054000) into the I register.

c. Load 001130 into the P register.

d. Load a key-in loader instruction into the A register.

e. Lift the STEP/RUN switch to STEP.

f. Clear the A register.

g. Repeat steps (d), (e), and (f) for each bootstrap instruction.

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.

NOTE: To facilitate reloading, the key-in loader may be dumped out on paper tape and then loaded by the binary loader (BLD II).

16.3 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 and LO devices. 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 and LO units*

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 section 17.16.

The listing of the RAZI directives is made as the directives are read. The VORTEX standard heading appears at the top of each page of the listing, and the directives are listed without modification.

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	

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). Although not required, a period (.) is a line terminator. Comments can be inserted after a period.

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)* if any	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.

Note: The disc pack containing the VORTEX nucleus cannot be replaced.

16.3.1 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 (A through T, inclusive)

s(**n**) is the number (octal or decimal) of tracks in the partition (must be > Ø)

k(n) is the protection code, if any, required to address **p**, or * if the partition is unprotected

While the parition 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, but the sequence A, C, D, E constitutes an error.

Example: Define three partitions on an RMD. The first occupies ten tracks and uses protection code Q, the second two tracks (11 and 12) and code S, and the third 48 tracks (13 through 50, inclusive) without protection.

```
PRT,A,10,Q,B,2,S,C,060,*
```

16.3.2 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. The directive has the general form

FRM,lu,size,flag

where

lu is the logical-unit name or number to which the subject RMD is assigned

size is the number (octal or decimal) of tracks on the RMD

flag is 1 to perform a complete bad-track analysis and clear the RMD, or 0 to merely clear the RMD and verify that it is cleared

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 disc in a system require the formatting program (described in section 16.4) to format disc and analyze bad tracks.

16.3.3 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 16.3.2).

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
```

16.3.4 EXIT Directive

This directive terminates RAZI. It has the general form

EXIT

Example: Terminate RAZI.

```
EXIT
```

16.4 620-35 DISC PACK FORMATTING PROGRAM

Each 620-35 disc pack requires formatting before any input or output operation can be performed on it. Before VORTEX can be prepared on a 620-35 disc pack or any 620-35 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 II or BLD. Execution begins at location 0500. 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 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 correpsonding 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. Head crashes generally indicate formatting should be done again.

SECTION 17
ERROR MESSAGES

This section comprises a directory of VORTEX operating system error messages, arranged by VORTEX component. For easy reference, the number of the subsection containing the error messages for a component ends with a number corresponding to that of the section that covers the component itself, e.g., the file-maintenance error messages are listed in subsection 17.9 because the file-maintenance component itself is discussed in section 9.

17.1 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 subsection:
CM	Concordance program	17.5
DG	Debugging program	17.7
EX	Real-time executive	17.2
FM	File maintenance	17.9
IO	I/O control	17.3
IU	I/O utility	17.10
JC	Job-control processor	17.4
LG	Load-module generator	17.6
OC	Operator communication	17.15
SE	Source editor	17.8
SG	System generator	17.13
SM	System maintenance	17.14
*	DAS MR assembler	17.5

17.2 REAL-TIME EXECUTIVE

Message	Condition	Action
EX01,xxxxxx	Invalid RTE service request by task xxxxxx	Abort task xxxxxx
EX02,xxxxxx	Scheduled task xxxxxx name not in specified load-module library	Abort task xxxxxx
EX03,xxxxxx	Task xxxxxx made RESUME request but requested task not found	Continue scheduling task
EX04,xxxxxx	Task xxxxxx made ABORT request but requested task not found	Continue scheduling task
EX05,xxxxxx	Background task xxxxxx larger than allocatable area	Abort task xxxxxx
EX06,xxxxxx	Not enough allocatable space available for ALOC request	Abort task xxxxxx
EX07,xxxxxx	OVLAY requests a segment not in library	Abort task xxxxxx
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 task at** correct priority
EX11,xxxxxx,n	Memory protection violation at address n	Abort task xxxxxx
EX12,xxxxxx	I/O link error (foreground task making request, or incorrect logical unit number)	Abort task xxxxxx

Note: xxxxxx is the name of a task.

17.3 I/O CONTROL

Message	Condition
IO00,xxxxxx	Unit not ready, or unit file protected
IO01,xxxxxx	Device declared down
IO02,xxxxxx	Invalid LUN specified
IO03,xxxxxx	FCB/DCB parameter error
IO04,xxxxxx	Invalid protection code, or priority ~~0 task~~ ~~requested~~ protected partition
IO05,xxxxxx	Protected partition specified by unprotected task
IO06,xxxxxx	I/O request error, e.g., I/O-complete bit not set, prior request may be queued
IO07,xxxxxx	Attempt to read from a write-only device, or vice versa
IO10,xxxxxx	File name specified in OPEN or CLOSE not found

Message	Condition
1011,xxxxxx	Invalid file extent, record number, address, or skip parameter
1012,xxxxxx	RMD OPEN/CLOSE error, or bad directory thread
1013,xxxxxx	Level 0 program read a JCP (/) directive
1014,xxxxxx	Interrupt timed out or no cylinder-search-complete interrupt

Note: 1000 error message, the user can take the following action; (a) Make unit ready or (b) ABORT task and then declare device down through OPCOM directives.

1015,xxxxxx	Disc cylinder-search or malfunction error
1016,xxxxxx	Disc read/write timing error
1017,xxxxxx	Disc end-of-track error
1020,xxxxxx	BIC1: abnormal stop, not ready, or time out error
1021,xxxxxx	BIC2: abnormal stop, not ready, or time out error
1022,xxxxxx	BIC3: abnormal stop, not ready, or time out error
1023,xxxxxx	BIC4: abnormal stop, not ready, or time out error
1024,xxxxxx	BIC5: abnormal stop, not ready, or time out error
1025,xxxxxx	BIC6: abnormal stop, not ready, or time out error
1026,xxxxxx	BIC7: abnormal stop, not ready, or time out error
1027,xxxxxx	BIC8: abnormal stop, not ready, or time out error
1030,xxxxxx	Parity error
1031,xxxxxx	Reader or tape error
1032,xxxxxx	Odd-length record error

Note: xxxxxx is the name of a task or device.

17.4 JOB-CONTROL PROCESSOR

Message	Condition	Action
JC01	Invalid JCP directive	Ignore directive
JC02	Invalid or missing parameter in a JCP directive; or illegal separator or terminator	Ignore directive
JC03	Specified physical device cannot perform the functions of the assigned logical unit	Ignore directive
JC04	Invalid protection code or file name in a JCP directive	Ignore directive
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 specified by an /SREC directive has been skipped where **nn** is the number of files (or records) remaining to be skipped	Ignore directive
JC06	An irrecoverable I/O error while compiling or assembling; or an error during a load/go operation or [illegible] overflow or no END stmt.	Job flushed to next /JOB directive
JC07	Invalid or illegal logical/ physical-unit referenced in JCP directive	Ignore directive

17.5 LANGUAGE PROCESSORS

17.5.1 DAS MR Assembler

During assembly, the source statements a‹e 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 sta ement.

The assembler error messages are:

Message	Condition
***IL**	First nonblank character of the so irce statement invalid (statement is not processed)
***OP**	Instruction field undefined (two nc operation (NOP) instructions are generated in the object module)
***SY**	Expression contains undefined symbol

Message	Condition
*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
*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 symbolic source statements to be assembled
*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

17.5.2 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 beneath the source statement. The erros marked T terminate binary output.

All error messages are of the form

ERR xx c(1)-c(16)

where xx is a number from 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

Terminating Error	Definition
T0	I/O error
T1	Constrution error
T2	Usage error
T3	Data pool overflow
T4	Illegal statement
T5	Improper use
T6	Improper satement number
T7	Mode error
T8	Constant too large
T9	Improper DO nesting

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	Computer GO TO out of range*

continued

Message	Cause
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

17.5.3 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 descripency 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 031). The possible error messages are:

Message	
Indicator	Name
Invalid	Relational
Label	Size
Literal	Syntax

If an I/O error occures during compilation one of the following messages is posted on Logical Unit 15 and compilation is terminated:

Error	Cause
RP01, NNN	I/O error
RP02, NNN	End of file error
RP03, NNN	End of device error
RP04	End card error (End card encountered before procedure card)
RP05	Available memory exceeded

where NNN is the logical unit number on which the error occurred.

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:

Error	Cause
RP01, NNN	I/O error
RP02, NNN	End of file error
RP03, NNN	End of device error
RP04	Program too big
RP05	Invalid object record
RP06	Checksum error
RP07	Sequence error
RP08	Program not executable
RP09	Work list overflow
RP10, xxxxxx	Invalid call to subroutine or missing subroutine where xxxxxx = subroutine name

CONCORDANCE PROGRAM:

Message	Condition
CN01	Symbol table full

17.6 LOAD-MODULE GENERATOR

Message	Condition	Action
LG01	Invalid LMGEN directive	Ignore directive
LG02	Invalid or missing parameter in an LMGEN directive	Ignore directive
LG03	Check-sum error in object module	Abort loading
LG04	READ error in object module	Abort loading
LG05	WRITE error in load module	Abort loading
LG06	Cataloging error	Abort loading
LG07	Loader code error in object module	Abort loading
LG08	Sequence error in object module	Abort loading
LG09	Structure error in object module	Abort loading
LG10	**Literal pool overflow or use of** literal by foreground program	**Abort loading**
LG11	Invalid redefinition of common-block size during load-module generation	Abort loading
LG12	Load-module size exceeds available memory	Abort loading
LG13	LMGEN internal tables exceed available memory	Abort loading

continued

Message	Condition	Action
LG14	Number of overlay segments input not equal to that specified in TIDB	Abort loading
LG15	Undefined externals	Load module generated but cannot be loaded (i.e., can reside on the SW logical unit only)
LG16	No program execution address	Abort loading
LG17	Attempt to load protected task on background library or unprotected task on foreground library	Abort loading

17.7 DEBUGGING PROGRAM

Message	Condition
DG01	Invalid DEBUG directive
DG02	Invalid or undefined parameter in DEBUG directive

17.8 SOURCE EDITOR

Message	Condition	Action
SE01	Invalid SEDIT directive	Abort SEDIT
SE02	Invalid or missing parameter in SEDIT directive	Input recovery message
SE03	Error reported by IOC call	Input recovery message
SE04	Invalid end of file	Input recovery message

17.9 FILE MAINTENANCE

Message	Condition	Directory Status
FM01	Invalid FMAIN directive	Unaffected
FM02	Name already in directory	Unaffected
FM03	Name not in directory	Unaffected
FM04	Insufficient space for entry	Unaffected
FM05	I/O error	Indeterminate
FM06	Directory structure error, including writing over the directory by direct addressing of an RMD partition	Indeterminate
FM07	Check-sum error in object module	*
FM08	No entry name in object module	*
FM09	Record-size error in object module	*
FM10	Loader code error in object module	*
FM11	Sequence error in object module	*
FM12	Nonbinary record in object module	*
FM13	Number of input logical unit not specified by INPUT	*
FM14	Insufficient space im memory	*

* 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.

17.10 I/O UTILITY

Message	Condition
IU01	Invalid IOUTIL directive
IU02	Invalid or missing parameter in IOUTIL directive
IU03	PFILE directive not used to open an RMD file
IU04	I/O error
IU05 gnnnn	End of file or end of tape before the specified number of records skipped, or end of tape before specified number of files skipped ([illegible])

17.11 SUPPORT LIBRARY

There are no error messages unique to this section of the manual.

17.12 REAL-TIME PROGRAMMING

There are no error messages unique to this section of the manual.

17.13 SYSTEM GENERATION

RECORD-INPUT ERRORS: Errors in input record found before processing.

Message	Condition	Action
SG00	Read error (I/O)	Correct input record, or indicate that the record is positioned for rereading
SG01	Syntax error in SYSGEN directive	Correct input record, or indicate that the record is positioned for rereading
SG02	Invalid or missing parameter in SYSGEN directive	Correct input record, or indicate that the record is positioned for rereading
SG03	Syntax error in control record	Correct input record, or indicate that the record is positioned for rereading
SG04	Invalid or missing parameter in control record	Correct input record, or indicate that the record is positioned for rereading
SG05	Binary-object check-sum error	Correct input record, or indicate that the record is positioned for rereading
SG06	Binary-object sequence error	Correct input record, or indicate that the record is positioned for rereading
SG07	Binary-object record code error	Correct input record, or indicate that the record is positioned for rereading
SG08	Unexpected end of file, end of device, or beginning of device	Correct input record, or indicate that the record is positioned for rereading
SG09	Improper ordering of load module-package control records	Correct order of records and continue processing

OUTPUT ERRORS: Errors in the attempt to perform I/O on an RMD or listing unit.

Message	Condition	Action
SG10	RMD I/O error in directive processor	Restart directive processor
SG11	RMD I/O error in nucleus processor	Restart nucleus processor
SG12	RMD I/O error during library generation	Reload directive processor
SG13	RMD I/O error during resident-task generation	Reload directive processor
SG14	First track on RMD bad (unable to write PST/bad-track table)	Restart directive processor
SG15	Write error on listing device	Retry operation

SYSTEM-GENERATOR PROCESSING ERRORS: Errors preventing the correct functioning of the system generator.

Message	Condition	Action
SG20	Requested SYSGEN driver not available	Restart I/O interrogation
SG21	Loading error in directive processor	Reload directive processor
SG22	Loading error in nucleus processor	Reload nucleus processor
SG23	Loading error in library processor/resident-task configurator	Reload library processor/ resident-task configurator
SG24	Stacks exceed available memory	Reload directive processor
SG25	Incomplete system definition (missing directives)	Restart directive processor
SG26	RMD error (too many sectors allocated, or nonsequential partition assignments)	Restart directive processor
SG27	Error while loading SYSGEN loader, I/O control, or drivers. Driver not found in SGL	Restart SYSGEN
SG28	Error while loading SGEN component	Reload component

MEMORY ERRORS: Errors of compatibility between allocated memory and a portion of the VORTEX system.

Message	Condition	Action
SG30	Size of nucleus larger than that of defined foreground area	Reload directive processor
SG31	Load-module literal pool overflow	Abort current load module and initiate generation of next load module
SG32	Size of load module larger than defined memory area	Abort current load module and initiate generation of next load module
SG33	Invalid definition of common during load-module generation	Abort current load module and initiate generation of next load module
SG34	Number of overlays input not the same as specified by OVL control record	Abort current load module and initiate generation of next load module

SYSTEM LOADING AND LINKING ERRORS: Errors that prevent normal loading or linking of system components.

Message	Condition	Action
SG40	Loader code error in library processor	Abort current load module and initiate generation of next load module
SG41	Loaded program contains no entry name	Abort current load module and initiate generation of next load module
SG42	Unsatisfied external in library processor	Abort current load module and initiate generation of next load module
SG43	No execution address found in root segment or overlay	Continue processing of current load module
SG44	Loader code error in nucleus processor	Restart directive processor
SG45	Unsatisfied external in nucleus processor	Restart directive processor
SG46	System peripheral assigned to to more than one logical-unit class	Restart directive processor

17.14 SYSTEM MAINTENANCE

Message	Condition
SM01	Invalid SMAIN directive
SM02	Record not recognized
SM03	Check-sum error in object module
SM04	Incorrect size of object-module record (correct: 120 words for RMD input, otherwise 60 words)
SM05	Loader code error in object module
SM06	Sequence error in object module
SM07	Object module contains nonobject-module text record
SM08	Error or end of device received after reading operation
SM09	Error or end of device received after writing operation
SM10	Stack area full
SM11	Invalid control record

17.15 OPERATOR COMMUNICATION

Message	Description
OC01	Request type error.
OC02	Parameter limits exceeded.
OC03	Missing parameter.
OC04	Unknown or undefined parameter.
OC05	Attempt to schedule or time schedule OPCOM task.
OC06	Attempt to declare OC device or system resident unit down.
OC07	Task specified in TSTAT key-in has no established TIDB.
OC10	Attempt to assign unit declared down or assign an unassignable logical unit/device.
OC11	Attempt to allocate TIDB unsuccessful for TSCHED request.

17.16 RMD ANALYSIS AND INITIALIZATION

Message	Condition	Action
RZ01	Invalid RAZI directive or illegal separator or terminator	Input corrected directive on SO, or input C to continue processing

ERROR MESSAGES

Message	Condition	Action
RZ02	Invalid parameter in a RAZI directive	Input corrected directive on SO, or input C to continue processing
RZ03	Insufficient or conflicting directive information	Input corrected directive on SO, or input C to continue processing
RZ04	New PST incompatible with the system	Restart RAZI by inputting the next directive on SO, or input C to continue processing
RZ05	Named device cannot be replaced (system RMD or device busy)	Restart RAZI by inputting the next directive on SO, or input C to continue processing
RZ06	Irrecoverable I/O error on designated RMD	Restart RAZI by inputting the next directive on SO, or input C to continue processing
RZ07	First track of disc pack bad (pack unusable)	Restart RAZI by inputting the next directive on SO, or input C to continue processing
RZ08	Directive incompatible with specified RMD	Restart RAZI by inputting the next directive on SO, or input C to continue processing
RZ09	Irrecoverable I/O error on system RMD (VORTEX nucleus)	Restart RAZI by inputting the next directive on SO, or input C to continue processing
RZ10	I/O error on LO device	Restart RAZI by inputting the next directive on SO, or input C to continue processing
RZ11	I/O error on SI device	Restart RAZI by inputting the next directive on SO, or input C to continue processing
RZ12	No core for new bad track table	Reschedule RAZI when more core is [illegible]
RZ13	PST specifies more tracks [illegible] with FRA	Input correct PST [illegible] or input C to continue

SECTION 18
VORTEX PROCESS INPUT/OUTPUT

18.1 INTRODUCTION

VORTEX supports a number of VDM 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:

VDM Model	Description
620-830A/B	Digital Output Module User's Guide - VDM 03-996810
620-831A/B	Digital Input Module User's Guide - VDM 03-996811
620-850/851	Analog to Digital Converter User's Guide - VDM 03-996806
620-860/860A 620-861/861A	Multiplexor Module User's Guide - VDM 03-996807
620-870/1/2/ 3/4/5 620-870A/B 620-871A/B 620-872A/B	Digital to Analog Module User's Guide - VDM 03-996805

DATASPEC brochures are also available for all these devices.

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 18.4) with FORTRAN calling sequences defined by the Instrument Society of America (ISA), which are useful for input, output, and manipulation of process data.

18.2 PROCESS OUTPUT

18.2.1 Hardware

VORTEX supports combinations of the 620-830A Digital Output Module and the 620-830B Digital Output Expansion Module. VORTEX also supports combinations of the following DAC (Digital to Analog Converter) modules and expansion modules: 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 DAC's.

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

```
EXC2 0352
```

would be called channel number 023.

Process output is totally under control of software - no BIC's, interrupts, or SEN's are used. Therefore, no ready, complete, or error information is provided by the hardware.

18.2.2 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.

c. Add Controller Table object modules to VORTEX Nucleus.

d. Add Process Output driver object module to VORTEX Nucleus.

e. Add TDF directives to VORTEX Nucleus.

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
```

For example, the device at address 053 will require the directive:

```
EQP, CO3A, 053, 1, 0, 0
```

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
```

Controller Table

Each device must have a controller table of the following format:

```
        NAME   CTCOmA
        EXT    TBCOmA
CTCOmA  DATA   TBCOmA
        DATA   CTEND
        DATA   2
        DATA   0
        DATA   0
        DATA   0
        EXT    #ACOmA
        DATA   #ACOmA
        DATA   0
        DATA   0
        DATA   0
        DATA   0
        DATA   0
        DATA   0
        DATA   0,0,0,0,0 TEMP STORE
        DATA   0,0,0,0,0,0,0,0, PREVIOUS OUTPUTS
CTEND   EQU    *
        END
```

Process Output Driver Program

This is the program named VZCOA.

TDF Directive

This has the format:

```
TDF, TBCOmA, VZCOA, 0, 047401, [priority level]
```

18.2.3 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 18.4, which will construct and execute such a macro.

The macro call has the format (see section 3.4.4):

```
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 18.4.

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 IOO3 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)
•
•
```

18.3 PROCESS INPUT

18.3.1 Hardware

VORTEX supports combinations of the 620-831A Digital Input Module and the 620-831B Digital Input Expansion Module. VORTEX also supports combinations of the 620-850 and the 620-851 Analog Input Systems, the 620-860 and 620-861 Multiplexor Modules and the 620-860A and the 620-861A 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 = 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 device address 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.

18.3.2 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.

d. Add Controller Table object modules to VORTEX Nucleus.

e. Add Process Input driver object module to VORTEX Nucleus.

f. Add TDF directives to VORTEX Nucleus.

In the example 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, CImA, 060+m, 1, b, 0
  [b = BIC device address]
```

For example, the device at address 063 using the BIC at address 020 will require the directive:

```
EQP, CI3A, 063, 1, 020, 0
```

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)

Controller Tables

Each device must have a controller table, whose format is shown below:

```
        NAME    CTCImA
        EXT     TBCImA
CTCImA  DATA    TBCImA
        DATA    CTEND
        DATA    1
        DATA    0
        DATA    0
        DATA    0
        EXT     #ACImA
        DATA    #ACImA
        DATA    [I/O algorithm value - see Internal
                  Spec., section 3]
        DATA    0
        EXT     !BCImA
        DATA    !BCImA
        DATA    0
        DATA    0
        DATA    0
        DATA    [multiplexor device address]
        DATA    0, 0          TEMP STORE
CTEND   EQU     *
        END
```

The I/O algorithm value must be set for the highest transfer rate (smallest PCB Timer Count) that will be used in the system.

Digital Input Driver Program

This is the program named VZCIA.

TDF Directive

This has the format:

```
TDF,TBCImA,VZCIA, 0, 047401, [priority level]
```

18.3.3 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 18.4, which will construct and execute such a macro.

The macro call has the format (see section 3.4.3)

```
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 required by the ISA subroutines of section 18.4.

The Op Code (OP) is defined thus:

OP = 0:

Sequential Mode. Data is input from channels, beginning with channel number m001, till the input word count C (Word 0) is satisfied. m is taken from the channel number mn specified by word 2.

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 (IO03) 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:

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)
        .
        .
```

18.4 ISA FORTRAN PROCESS CONTROL SUBROUTINES

The Instrument Society of America (ISA) has under consideration, for acceptance as an ISA standard, 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

18.4.1 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 inputs. 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, ibux, 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*.

18.4.2 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 m ≥ 16
m*2**n	Otherwise

18.5 ERRORS

Process Output

```
IO03 Invalid channel number
```

Process Input

```
IO03 Invalid channel number
IO2X BIC timeout error on BIC number X
```

18.6 FUTURE EXTENSIONS

Other process control devices besides those in the table of section 18.1 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.

APPENDIX A
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.

A.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 A-1 illustrates record control word formats.

Table A-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)

A.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.

A.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.

A.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.
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.

Code Values	Meaning
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.
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.

Subcode Values	Meaning
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 seconcd name word. Only the right 16 bits of the two name words are used.

A.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.

A.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
```

A.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 Identification in ASCII (assume this program was labeled
140715 EXAMPLE).
150314
142640

131263 Date of creation in ASCII (assume assembled 03-10-69)
126661
130255
133271

(End program ID block)

010000 Define entry name SUBR at relative 0 (code 0, subcode 010,
000647 pointer 0, name SUBR, and data word 0).

```
054262
000000

100000     Enter absolute data word 0 in memory at relative 0.
000000

060000     Enter literal (indirectly addressed relative 0) in indirect
100000     pointer pool, add address of pointer to load 017000 and en-
017000     ter memory at relative 1.

100000     Enter absolute data word 02000 in memory at relative 2.
002000

100000     Enter absolute data word 000000 in memory at relative 3.
000000

100000     Enter absolute data word 054010 in memory at relative 4.
054010

100000     Enter absolute data word 01004 in memory at relative 5.
001004

040000     Enter relative data word 012 in memory at relative 6.
000012

060760     Enter literal (absolute 2) into literal pool, add address of
000002     literal to load command 010000, and enter in memory at relative
010000     7.

100000     Enter absolute data word 02000 in memory at relative 010.
002000

040000     Enter relative data word 03 in memory at relative 011.
000003

060000     Enter literal (relative 0) into indirect pointer pool, add
000000     address of literal to increment command 047000, and enter in
047000     memory at relative 012.

100000     Enter absolute data word 01000 in memory at relative 013.
001000

040000     Enter relative data word 0100000 in memory at relative 014.
100000

001000     Set loading location for next command, if any, to relative
           016.
```

```
012003      Enter load request for external name BBEN and chain entry ad-
000212      dress to relative 011.
024556      000011
  •
  •
  •
  •
  •

            (The remaining words of this record contain zero).
```

A.5.3 Core Image

Assume the program originates at 01000, the literal pool limits are 0500-0777, and BBEN is loaded at 01016.

```
0500     100500    DATA      0500
0501     000500    DATA      0500
•
•
•
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        *     0500
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				

APPENDIX B
I/O DEVICE RELATIONSHIPS

Allowable Functions by I/O Device Type

	I/O Device						
Function	**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^{4}	X^{4}
Write alphanumeric record	X^{1}	X	X		X	X	X
Write BCD record	X^{1}	X	X^{2}		X^{2}	X^{4}	X^{4}
Write unformatted record	X^{1}	X^{1}	X		X	X^{4+9}	X^{4}
Write end of file		X	X		X		X^{8}
Rewind unit	X	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					

I/O DEVICE RELATIONSHIPS

Allowable Functions by I/O Device Type *(continued)*

Function	I/O Device RMD	 MT	 PT	 CR	 CP	 LP	 TY or CRT
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) [illegible] n 1, p.5.

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

I/O Errors by I/O Device Type *(continued)*

		I/O Device						
Code	**Description**	**RMD**	**MT**	**PT**	**CR**	**CP**	**LP**	**TY or CRT**
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				
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

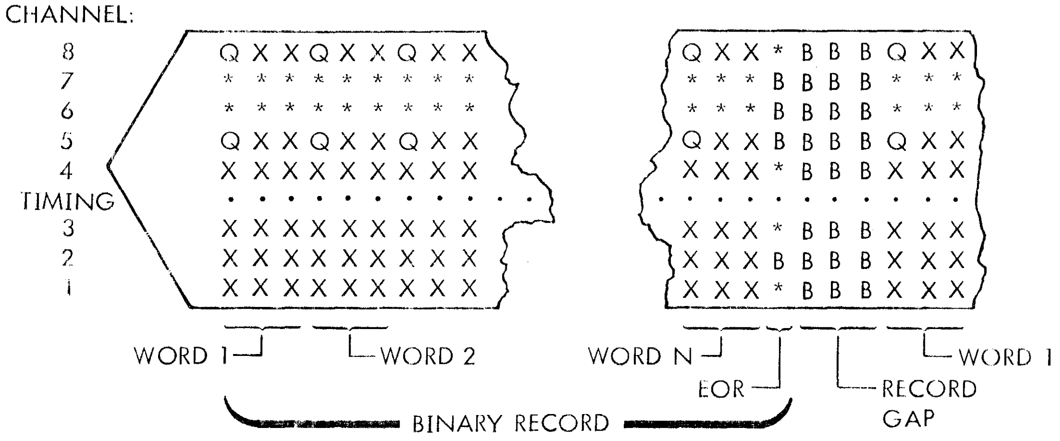
Binary information is stored with three frames per computer word (figure C-1). Note that channels 6 and 7 are always punched.

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

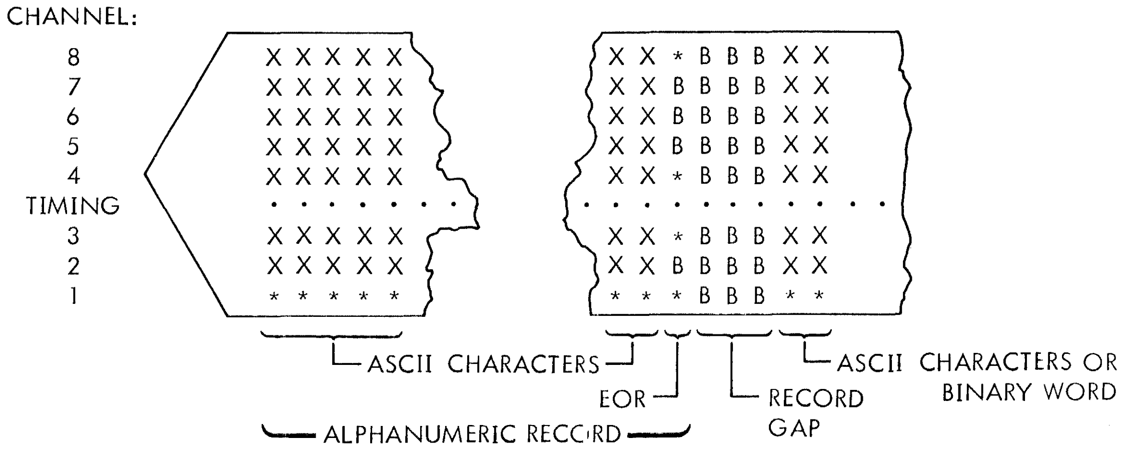
The tape is handled as for alphanumeric mode, but without validity-checking.



* = HOLE
B = BLANK
X = DATA BIT
EOR = END - OF - RECORD
Q = BLANK

VTII-1374

Figure C-1. Paper Tape Binary Record Format



* = HOLE FOR ASCII CHARACTER OR DATA BIT FOR BINARY INFORMATION
B = BLANK
X = DATA BIT
EOR = END-OF-RECORD

VT11-1375

Figure C-2. Paper Tape Alphanumeric Record Format

C.1.4 Special Characters

An end of file is represented by the ASCII-8 BELL character (1-2-3-8 punch).

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 is binary, alphaumeric, or unformatted. Each card holds one record of information. Hence, there is no end-of-record character for cards.

C.2.1 Binary Mode

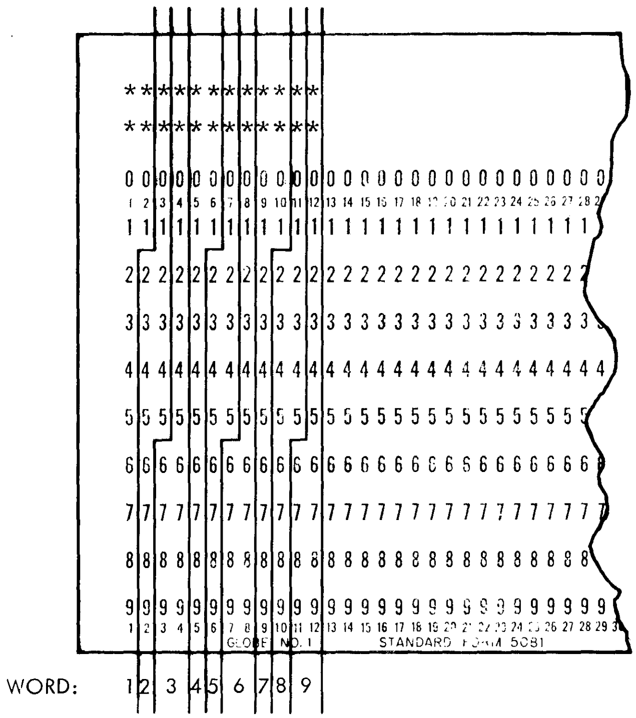
Binary information is stored with sixty 16-bit words per card. The information is serial with bit 15 of the first word in row 12 of column 1, bit 14 in row 11, etc. (figure C-3).

C.2.2 Alphanumeric Mode

Alphanumeric information is stored one character per card column (figure C-4) using the standard punch patterns.

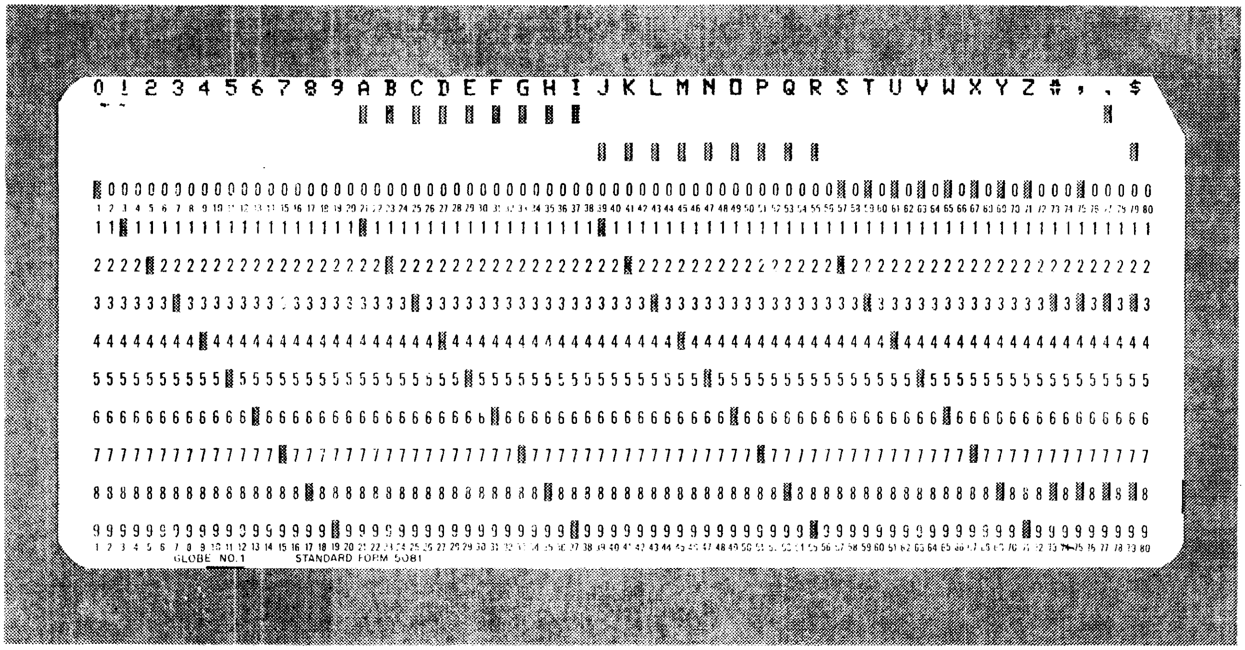
C.2.3 Unformatted Mode

The data are handled, one column per computer word, right-justified, and without validity-checking.



VTII-1376

Figure C-3. Card Binary Record Format


0 1 2 3 4 5 6 7 8 9 A B C D E F G H I J K L M N O P Q R S T U V W X Y Z # , . $
GLOBE NO.1
STANDARD FORM 5081

VTII-0957

Figure C-4. Card Alphanumeric Record Format (IBM 026)

C.2.4 Special Character

An end of file is represented on cards by a 2-7-8-9 punch in column 1 of an otherwise blank 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.

APPENDIX D
STANDARD CHARACTER CODES

IBM 026 Punch			IBM 029 Punch	
Symbol	ASCII	Hollerith	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

STANDARD CHARACTER CODES

IBM 026 Punch			IBM 029 Punch	
Symbol	ASCII	Hollerith	ASCII	Symbol
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	%
,	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
TELETYPE AND CRT CHARACTER CODES

Character	620 Internal ASCII	Character	620 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
↑	336	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

TELETYPE AND CRT CHARACTER CODES

Character	620 Internal ASCII	Character	620 Internal ASCII
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
620-05 Memory Protection	045	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 overflow error	030	n/a	
		MP I/O and overflow error	032	n/a	
		MP write and overflow error	034	n/a	
		MP jump and overflow error	036	n/a	
620-12 Power Failure/ Restart	----	Power failure	040	n/a	Wired as system priority 2
		Power restart	042	n/a	
620-13 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
620-16 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

VORTEX HARDWARE CONFIGURATIONS

Device	Device Address	Interrupt	Interrupt Address	BIC	Comments
620 Buffer Interlace Controller (BIC)	020-026 070-073	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
620-47, -43C, D Disc -48, -49 Drum Memory	014	BIC complete	0100-0277	Yes	RMD assigned to highest system BIC (no other devices can be so assigned)
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)
620-35 Disc Memory	015	BIC complete Cylinder-search complete	0100-0277 0100-0277	Yes	RMD assigned to highest system BIC (no other devices can be so assigned)
620-30, -31A, -31B, or -31C,-32 Magnetic Tape Unit	010-013	BIC complete Tape motion complete	0100-0277 0100-0277	Yes	
620-25 Card Reader	030	BIC complete	0100-0277	Yes	
620-77 Line Printer	035-036	BIC complete	0100-0277	Yes	
620-27 Card Punch	031	BIC complete	0100-0277	Yes	

Device	Device Address	Interrupt	Interrupt Address	BIC	Comments
620-55, -55A Paper Tape System	037,034	Character ready	0100-0277	No	
620-6, -7, -8 Teletype	001-007	Read buffer ready Write buffer ready	0100-0277 0100-0277	No	
620-(E-2250) CRT with E-2184 Controller	----	Read buffer ready Write buffer ready	0100-0277 0100-0277	No	Compatible with Teletype
Front Panel	----		00-01	No	Wired as system priority 6; not used by VORTEX
620/f-10 Optional Instruction Set	----		n/a	n/a	
620/f-15 Automatic Bootstrap Loader (PT only)	----		n/a	n/a	

NOTES

(1) The priority look-ahead option is required if there are more than eight priority devices in the system.

(2) PIM assignments are arranged from the fastest devices to the slowest.

(3) No two output devices are assigned to the same BIC.

INDEX

INDEX

ADDENDUM 1
VORTEX Reference Manual

Varian Document 98 A 9952 101
September 1972

This addendum lists changes and supplementary information for the VORTEX Reference Manual.

Page	Action

3-7 Change the FCB expansion at the top left for word 4 to "current END-OF-FILE address".

3-10 Add to function codes under line printer.
Statos 31 7 Advance paper to bottom of form
8 Normal print size
9 Large print size
Plot data may be transmitted to the Statos 31 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 left-most dot position.

3-12 Change table 3-3 word 6 REW to "set to ending address of logical unit."

4-5 Add to 4.2.22 /EXEC the following paragraph and examples:
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

5-13 Add as numbering indicates

5.3.3 Execution-Time I/O Errors
The FORTRAN execution-time I/O 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 is checked by executing a subroutine or function call in the form.

Page Action

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

$label_1$ — is a statement label to which control is transferred, if and 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, FORTRAN will abort execution of the task upon the next entry to the execution-time 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.

12-2 Correct reference in section 12.1.1 to 12.2.3 instead of 12.3.

12-3 Correct reference in section 12.2.1 to 12.2.3 instead of 12.3.

13-9 Replace paragraph in section 13.5.3 with the following:

Logical units 101 through 106 inclusive have preassigned protection codes. Any attempt to change these codes is ignored.

Preassigned Protection Codes

Unit Number	101	102	103	104	105	106
Code	S	B	C	D	E	F

Page Action

13-10 Replace the table 13-3 titled "Preset logical-unit/RMD partition relationships" with the following:

Logical	Logical			Minimum
Unit	Unit	Partition	Protection	VORTEX Sector
Name	Number	Name	Key	Allocation
CL	103	D00A	C	025
FL	106	D00B	F	0106
BL	105	D00C	E	01135
OM	104	D00D	D	0417
CU	101	D00E	S	0310[1]
SW	102	D00F	B	0310[2]

Optional logical-unit/RMD-partition relationships

GO	9	D00G	none	0310[3]
SS	8	D00H	none	varies
PO	10	D00H	none	0515[4]
BI	6	D00I	none	varies
BO	7	D00I	none	varies

13-12 Add in section 13.5.11 under q(n)

TIDB names must be taken from TDF block of SMAIN listing

16-2 Change key-in loader locations 1154 through 1157 for the 620-35 as follows:

1154	100021
1155	103120
1156	103221
1157	100020

16-2 ~~17-2~~ Add location 1177 and 1200 for the 620-35 as follows

1177	1000
1200	1146

16-3 Delete paragraph beginning "The listing of the RAZI..." and the last two lines from the paragraph following "EXIT".

Page Action

16-4 Add under the definition of s(n) in 16.3.1 "This value must be greater than zero".

Add immediately prior to examples the following:

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.

Add in section 16.3.1 to the paragraph before example the following:

Consecutive PRT directives redefine partitions, if p(n) has been specfied, or adds partitions if p (n) is new partition letter.

Under example, delete from the paragraph "(11 and 13)"" and "(13 through 50, inclusive)".

Add to second paragraph of 16.4 "Execution begins at 01354".

17-1 Replace the definition of I004 with "Invalid protection code".

17-2 Add to the description of JC06 in section 17.4

...load/go operation; or insufficent symbol table memory (insufficient /MEM directive); or an EOF was encountered before an END statement.

17-3 Add to Terminating Errors "TO I/O Error".

17-5 Change IU05 error message to IU05, nnnn and add where nnnn = the number of remaining records when an end-of-file or end-of-device occurred.

17-10 Add to section 17.16

RZ12	No core available to allocate for new bad-track table	RAZI is terminated Reschedule when concurrent foreground tasks release core
RZ13	Total number of tracks specified in PRT directive exceeds size of the device or is incompatible with the FRM directive	Input correct PRT and FRM on SO, or input C to continue processing

Page Action

B-1 On function - Write Unformatted Record - change the 4 to 9 under LP.

B-2 Add note (9) as follows:

620-77 line printer -- All modes are treated as alphanumeric.

620-75 printer/plotter -- Unformatted records are transmitted without interpretation as plot data

C-4 Add as numbering indicates

C.4 Statos Printer/Plotter

Information may be output to the 620-75 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 88 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.

ADDENDUM 2
VORTEX Reference Manual

Varian Document Number 98 A 9952 101
September, 1972

Page Action

5-11 Change first line of second column to "Four different cases of FORTRAN units ..."

5-12 Add to "Case 3," "Normal RMD file executing in foreground or background"

5-13 Insert immediately preceding 5.4, deleting "NOTE":

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
lun	is the name or number of the logical unit
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.

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 $\geq$ 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 named 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 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 number.

5.3.3 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$RERR is also in the nucleus portion of the SGL. SYSGEN then automatically loads V$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.

Page Action

5.3.5 I/O Checking

After any FORTRAN READ, WRITE, auxiliary I/O, and open or close CALL, the status of the operation may be checked by the statement:

```
CALL IOCHK (I)
```

where:

I, on return, has the meanings:

I = -1 Error
I = 0 Normal Completion
I = +1 EOF/EOD Detected

IOCHK loads I from a status flag and clears this flag. If IOCHK is not called and this status flag is not zero, the next FORTRAN statement of any of the types above will cause a program abort.

IOCHK can be referenced either as a subroutine,subprogram (as above), or as a function subprogram, e.g., the statement:

```
IF (IOCHK (I) ) 1, 2, 3
```

12-13 In Table 12-1. Address 0320 through 0327 PIM numbers should be 0-7, replacing 1-8.

13-9 Replace the second to last paragraph in the first column with:

"Logical units 101 through 106, inclusive, have preassigned protection codes (101 = S, 102 = B, 103 = C, 104 = D, 105 = E, and 106 = F)."

Delete the rest of the paragraph.

EVALUATION QUESTIONNAIRE

TITLE ______________________________

MANUAL NUMBER ______________________

The purpose of this questionnaire is to provide suggestions about how the manual can be improved when it is revised. It is the goal of the Technicai Publications Department to make each manual as useful as possible and at the same time eliminate material that is of no practical value to the user or Customer Service Representative in acquiring initial knowledge of, and in maintaining, the equipment in the field. You, as the person working most closely with the manual and the equipment, can best provide the input needed by the writer to make the best possible manual for your use.

1. Please complete the following chart.

CHAPTER/SECTIONS		MOST USEFUL			NEEDS MORE				NEEDS LESS		
			Field Reference	Training		Big Picture Description	Illustration	Detailed Description			Detailed Description

2. Please list any errors, omissions, or difficult areas noticed in the manual. ______________________

____

____

3. Please list any improvements you recommend for this manual. ______________________

____

____

4. In an overall evaluation of this manual, how do you rate it in the following?

□ Above Average □ Average □ Below Average

5. Personal Information

a. Company ______________________

b. Years with Varian ______________

c. EDP experience (years) __________
Years college ______________
Years technical training __________

d. NAME ______________________

Fold

FIRST CLASS
PERMIT NO. 323
NEWPORT BEACH,
CALIFORNIA

BUSINESS REPLY MAIL

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

varian data machines /a varian subsidiary
2722 michelson drive / irvine / california / 92664

ATTN: TECHNICAL PUBLICATIONS

Fold

Staple