FORTRAN IV XVM OPERATING ENVIRONMENT MANUAL

DEC-XV-LF4EA-A-D

XVM Systems

digital

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DEC-XV-LF4EA-A-D

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COMTEX	INDAC	TYPESET-8
DDT	LAB-8	TYPESET-10
DECCOMM		TYPESET-11

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LIST OF ALL XVM MANUALS

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

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

PREFACE

This manual describes the system software facilities which support the Digital XVM FORTRAN IV compilers together with hardware features which affect the FORTRAN programmer. Included are discussions of monitor features which are of interest to the FORTRAN programmer, the FORTRAN IV Object Time System[1] (OTS), and the Science Library[2]. All descriptions presented apply to the XVM versions of the FORTRAN compiler. Appendix E presents overall outlines and descriptions and detailed data specifying the difference among the various compilers for the XVM/DOS and XVM/RSX software systems.

A companion manual FORTRAN IV XVM LANGUAGE MANUAL describes the elements, syntax and use of the FORTRAN IV language as implemented for the XVM computer.

The following is a list of XVM documents which either support directly or contain information useful in understanding FORTRAN IV XVM and its function:

XVM/DOS User's Manual

XVM/RSX System Manual

Linking Loader XVM Utility Manual

CHAIN XVM/EXECUTE XVM Utility Manual

---

[1]The Object Time System is a set of subroutines which are automatically invoked by certain FORTRAN language elements. A FORTRAN input-output statement, for example, is not compiled directly into executable object code but becomes a call to the appropriate OTS input-output routine.

[2]The Science Library is a set of intrinsic functions, external functions, subfunctions, and subroutines which the user may invoke explicitly in a FORTRAN statement.

CHAPTER 1

INTRODUCTION

A FORTRAN-IV program may be compiled and run in several different environments. The FORTRAN programmer need not be concerned with the details of his environment since the FORTRAN Object-Time System (OTS) will ensure that his statements invoke the appropriate computer instructions. For example, an arithmetic statement such as A = A*B will appear the same in any FORTRAN-IV program. In the object program it may be transformed to a subroutine call or a floating point instruction, depending on the hardware configuration on which the program is produced.

The programmer will need to know procedures for compiling and loading his program and for using the peripheral devices available to him. In addition, a number of software facilities may be of interest to a programmer who requires maximum program efficiency or functions not performed by FORTRAN statements. In this case, he may invoke FORTRAN-callable functions and subroutines from the FORTRAN library or augment his program by linking to MACRO assembler programs and invoking the OTS utility routines.

In this chapter, the basic procedures are described for using FORTRAN and the major facilities available to a FORTRAN program. These facilities are described in greater detail in subsequent chapters, and Appendix C contains a collection of illustrative programming examples. The main discussion is based on the XVM/DOS monitor, and differences for the XVM/RSX environment are noted. The term DOS/RSX implies XVM/DOS and XVM/RSX.

1.1 OPERATING PROCEDURES

The FORTRAN IV compiler is a two-pass system program which produces relocatable object code. This code is then linked with user-specified FORTRAN-compiled or MACRO XVM assembled routines and with required OTS library routines. Program linkage may be

accomplished via the linking loader, LOAD or GLOAD (DOS), which loads the resulting program directly into core for immediate execution. The user may, alternatively, use one of the overlay linkage editors - CHAIN (DOS) or TKB (RSX). These construct core images onto auxiliary storage for later execution.

In DOS, the FORTRAN-IV compiler is called by typing F4 after the monitor has issued a $. When FORTRAN has been loaded, the version name is typed at the left margin as in:

F4M XVM Vnxnnn

A carriage return is issued and the character > at the left margin indicates that a command string is expected with the FORTRAN source program on the appropriate input.

The command string has the form:

optionlist ← filename

where the options are delimited by a left arrow and may optionally be separated by commas, and the string is terminated by a carriage return or ALT MODE. Filename is the name of the source file to compile, and its extension must be SRC. A carriage return specifies that FORTRAN-IV should be restarted after the current program has been compiled. ALT MODE returns control to the monitor.

In RSX, the compiler is invoked from TDV by typing the compiler task name, followed by a command string. As provided with the XVM/RSX monitor, the compiler task name is FOR..., and it is invoked by typing FOR or F4F following the monitor's TDV response. The compiler call plus the command string has the form:

$$\left\{\begin{matrix}\text{FOR}\\ \text{F4F}\end{matrix}\right\}\text{optionlist} \leftarrow \text{filename1}, \text{filename2}, \ldots \text{filenameN}$$

The options are delimited by a left arrow, and may optionally be separated by commas. Any number of filenames, whose extensions are SRC, may be specified, separated by commas. The entire line is terminated by a carriage return or an ALT MODE, and no continuation of the command string is allowed.

For either DOS or RSX, the option list may be empty or contain any of the following options:

Option	Meaning
O	Object Listing
S	Symbol Map
L	Source Listing
B	Binary Output
H	Use subroutine for calculation of array element addresses[1]
R	RSX only - print compiler version and "End Pass 1" on output terminal.

The output listing file always has the extension LST. All file names must be legal FORTRAN symbols. At the end of pass 1, the compiler types

END PASS1

and allows the repositioning of a source tape if using the paper tape reader. When compiling from paper tape in DOS only, to initiate pass 2, the user types ↑P (control P).

The following error messages indicate that the command procedures cannot be carried out:

	Message	Meaning
	?	Bad command string - retype
DOS	IOPS4	I/O device not ready - type CTRL R when ready
DOS	IOPSn	See XVM/DOS User's Manual for IOPS error codes
RSX	FORTRAN-I/O ERROR LUN xx yyyyy	An I/O error occurred during compilation; xx represents the logical unit number (decimal) on which the error occurred; yyyyy is the octal event variable indicating the cause of the error. (See XVM/RSX Reference Manual for details.)

[1] The subroutine .SS is used to calculate the addresses of 2 and 3 dimensional array elements; the default uses in line code in most cases.

Other diagnostics which may be printed at compile time are FORTRAN error messages (see Appendix B, Section B.1). OTS errors are given at run time for those routines whose calls are generated by the compiler (see Appendix B, Section B.2).

When the user program has been successfully compiled, it may be relocated and made absolute (executable) via LOAD, CHAIN, or TKB (the RSX Task Builder).

In DOS, the Linking Loader is called by typing LOAD or GLOAD (load-and-go) after a monitor-issued $. The Linking Loader types

```
LOADER XVM Vnxnnn
>
```

and awaits a command string specifying programs to be loaded and output options. See the LINKING LOADER XVM UTILITY Manual for detailed instructions. Figure 1-1 shows the printout from a typical XVM/DOS session from source-program preparation to loading.

With CHAIN, the DOS user generates a system of overlays - a resident main program which may include resident subprograms, a resident blank COMMON storage area, and a set of subroutines which overlay each other at the user's request. Subroutines are organized into units called links which may overlay each other. Several links may overlay a larger link without overlaying each other. A link is loaded into core when a subroutine within the link is called and it remains resident until overlaid. A link's core image is not recorded or "swapped out" when it is overlaid. The same image is brought into core each time a link is loaded. See the CHAIN XVM/EXECUTE XVM Utility Manual for detailed instructions.

In RSX, linking is accomplished by using the TDV function Task Builder (TKB). TKB is similar in operation to CHAIN. Its function is to record core images in a file in the format expected by the RSX INSTALL Function. The task name is used as the file name, and TSK is used as the extension. TKB accepts the same overlay descriptions as CHAIN. In RSX it is called by typing "TKB" following the Monitor's TDV request. When loaded, TKB types its name and version number and makes the following requests:

```
LIST OPTIONS
NAME TASK
SPECIFY DEFAULT PRIORITY
DESCRIBE PARTITION
DEFINE RESIDENT CODE
DESCRIBE LINKS AND STRUCTURE
```

For further information, see the XVM/RSX System Manual.

```
XVM/DOS V1A000
 ENTER DATE (MM/DD/YY) - 11/6/75


PAGE MODE   32K  API ON  UC15 ON  POLLER ON  SCR

$LOGIN DEM


XVM/DOS V1A000


PAGE MODE   32K  API ON  UC15 ON  POLLER ON  DEM

$PIP

PIP XVM V1A000

>N SY


>^C

XVM/DOS V1A000

$EDIT

EDITOR XVM V1A000
>OPEN IOTST
FILE IOTST SRC NOT FOUND.
INPUT
C
C       TTY:  .DAT 6
C
        WRITE (6,100)
100     FORMAT (1X,$IN:$)
        READ (6,) R1,R2
        WRITE (6,200)
200     FORMAT (1X,'OUT:')
        R3 = R1 ** R2
        WRITE (6,) R3
        STOP
        END

EDIT
>EXIT


XVM/DOS V1A000

$F4

FPF4M XVM V1A001
>B_IOTST
END PASS1
PROGRAM SIZE = 00105, NO ERRORS

XVM/DOS V1A000

$A TT 6

$LOAD
```

Figure 1-1
Sample XVM/DOS Session

```
LOADER XVM V1A000
>P_IOTST
P IOTST       077532
P DDIO   F18  075514
P .BE    F06  075464
P .EE    F02  075372
P .EF    F08  075232
P .EC    F01  075172
P BCDTO  F51  071256
P .SS    009  071146
P STOP   008  071065
P SPMSG  012  070746
P .FLTB  004  070460
P FIOPS  D40  066557
P .FPP   F18  070020
P OTSER  F14  066344
P .CB    004  066322
^S^S
IN:
11.2,3.0

OUT:
'R3'=    1404.9279

STOP  000000


XVM/DOS V1A000

$
```

Figure 1-1 (Cont.)
Sample XVM/DOS Session

1.2 SOFTWARE ENVIRONMENTS

Each version of FORTRAN-IV has its own version of the object time system library so that routines may utilize both hardware and software features. Each of the monitor systems under which FORTRAN operates is summarized below.

1.2.1 XVM/DOS

XVM/DOS is a single-user, interactive, disk-resident operating system. It includes the DOS Monitor, I/O device handlers, and an integrated set of system programs including FORTRAN-IV. Program editing, loading, and debugging facilities are provided as well as powerful file manipulation capabilities. The DOS disk file structure supports both direct and sequential access to disk files, dynamic disk storage allocation, and file protection. The DOS Monitor itself provides the interface between the user and peripheral devices via Monitor calls and allows the user to load system or user programs, for example, FORTRAN programs, via simple commands from the user terminal. The reader is directed to the XVM/DOS User's Manual, for more detailed information.

1.2.2 BOSS XVM

BOSS XVM is a batch-processing monitor which is part of DOS; it, therefore, utilizes the DOS system programs and file structures. DOS itself has a facility to batch commands from cards or paper tape; BOSS, however, is a separate entity from XVM/DOS monitor batch. BOSS command language is batch-oriented, noniterative, easy to use, and highly flexible.

Some highlights of BOSS XVM are:

- Procedure driven command language
- Job timing for accounting purposes
- Line editor
- Facility for user-defined commands

1.2.3 XVM/RSX

XVM/RSX is a monitor system designed to handle real-time information in a multiprogramming environment. RSX controls and supervises all operations within the system including any number of core- and disk-resident programs (called tasks). The user can dynamically schedule tasks via simple time-directed commands issued from the terminal or from within a task. System software includes the FORTRAN IV compiler, the MACRO Assembler, the TASK BUILDER, and numerous utility programs required to edit, debug, and run user programs. Details are available in the XVM/RSX System Manual.

1.3 HARDWARE ENVIRONMENT

Systems with an FP15 Floating-Point Processor (FPP) have a special version of the FORTRAN-IV compiler and OTS which utilizes hardware instructions rather than subroutine calls to handle certain arithmetic functions. For example, RELEAE, the REAL arithmetic package, is not included in FPP systems since REAL arithmetic expressions may be compiled directly into FPP instructions.

The FPP FORTRAN System consists of the standard FORTRAN-IV compiler and Object-Time System (OTS) interfaced (via conditional assembly, and additional routines) to the hardware FPP. The interface applies to Single and Double Precision Floating-Point Arithmetic and Extended Integer Arithmetic (double integers). Single integer arithmetic is still handled by EAE (extended arithmetic element, KE15) instructions and, in part, by software.

CHAPTER 2
INPUT-OUTPUT PROCESSING

FORTRAN data-transmission statements automatically invoke a number of OTS subroutines which serve as an interface between the user program and the Monitor. These routines may also be explicitly referred to in a MACRO program.

The actual transmission of data between memory and a peripheral device is, in general, performed by the FIOPS package, a set of routines which communicate directly with the Monitor. Other packages, each associated with a particular type of data-transmission statement, perform three major functions:

a. Initialization,
b. Transmission of data to and from the FORTRAN line-buffer in the appropriate structure, and
c. Termination;

The packages are:

(1) BCDIO, processes formatted sequential READ or WRITE statements;
(2) BINIO, processes unformatted sequential READ or WRITE statements;
(3) AUXIO, processes auxiliary input-output statements;
(4) RBCDIO and RBINIO, process formatted and unformatted direct-access READ and WRITE statements;
(5) DDIO, manages data-directed input-output;
(6) DCODE, processes ENCODE and DECODE statements.

Also described in this chapter is a set of FORTRAN-callable subprograms which support OTS input-output functions.

2.1 GENERAL INFORMATION

The three major I/O functions:

a. To associate logical devices with physical devices,
b. To associate user data structures with device data structures, and
c. To perform actual transfer of data

are described in the following paragraphs.

2.1.1 Device Assignment

In DOS, device assignment is managed through the monitor Device Assignment Table (.DAT) which associates legal device units to physical ones. .DAT has "slot" numbers which correspond to the FORTRAN logical device numbers. Each slot, at run time, contains the physical device unit number and a pointer to the appropriate device handler in memory. Sixteen[1] entries in .DAT may be used for user-program device assignment performed via monitor ASSIGN commands at run time. Default assignments are defined during system generation. An analogous structure is maintained in the RSX system. It is called the Logical Unit Table (LUT), and for each Logical Unit Number (LUN) assigned, it maintains an address to information about the associated physical device.

2.1.2 Data Structures

Each peripheral device has an associated data structure which governs the manner in which data are stored. There are basically two modes in which data may be stored externally - serially or directoried. For a sequential file, either structure may be used. If it is serial, the physical sequence of records is identical to the logical sequence. If it is directoried, the logical sequence is established by pointers which link one record to another although their physical locations need not be in sequence. For a direct-access file, only disks which are also directoried devices may be used.

Serial devices used for FORTRAN Input-Output include paper tape, magnetic tape and (in certain modes) DECtape. Records are transmitted directly from the user buffer to the device and an end-of-file is written after the last record by a CALL CLOSE or ENDFILE n. A file is accessed simply by virtue of device assignment.

Magnetic tape and DECtape may also be used in a directoried mode. In this case, a directory containing file information is maintained. Each entry contains a filename and extension and a pointer to the first block of the file. Files stored in this way may be referenced in the OTS directoried subroutine calls.

Directoried FORTRAN input-output to a disk, using DOS file structure, is a special case. This structure is based on a hierarchy of directories with a Master File Directory (MFD) pointing to user file directories (UFDs). User files are created sequentially but may be accessed either sequentially or directly. Data blocks (400_8 words per block) which comprise a file are chained via a forward link word (377_8) and backward link word (376_8). Forward links are also stored in a retrieval information block (RIB) for direct access. Files stored in this mode are accessed by name. This name may be assigned by the user via directoried subroutines (e.g., SEEK and ENTER). In DOS only, if this is not done, default names are used. A default name has the form .TM0mn OTS where mn is the logical device number in decimal.

[1] This number is the standard size for DOS but may be changed by system generation and assembly parameters.

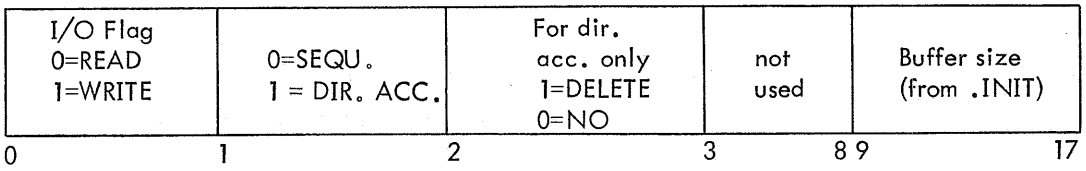
2.1.3 Data Transmission

Data is transmitted to and from the FORTRAN-IV I/O buffer via the OTS FIOPS package. A single I/O buffer of 400_8 words is used. In DOS, the size of the buffer which is to be transmitted for a particular device is set in accordance with information provided in an .INIT to the device used. In RSX, the size used is always that of the FIOPS buffer, 400_8.

2.2 DATA TRANSMISSION (FIOPS)

The FIOPS package provides the necessary communication between the OTS and the I/O Device Handlers. Its two main functions are device assignment and the transfer of data to and from the FORTRAN internal I/O buffer.

FIOPS maintains a status table with one-word entries for each device that is in use. A table entry is as shown below.



The routines of the FIOPS package and their functions are given below. (See also the .ZR call, described in paragraph 4.1.)

FIOPS Package External Calls: OTSER Errors: OTS ERROR 10 - illegal device number	
Routine	**Function**
.FC (initialize I/O Device) Call: LAC DEVICE (address of slot number) JMS* .FC To set I/O flag: DZM* .FH (input) LAC (1) (output) DAC* .FH	.DAT slot numbers are initialized by .FC. The first call to .FC for any device generates a monitor .INIT call which opens the file for I/O and enters the buffer size and I/O flag in the device status table. Subsequent calls to .FC call .INIT only if the I/O flag has been changed or the file has been closed. (In RSX, the first call to .FC sets the I/O flag and a fixed buffer size. Subsequent calls to .FC only reset the I/O flag.)

(continued next page)

FIOPS Package (Cont)

Routine	Function
.FQ Call: LAC (address of .DAT slot number (bits 9-17) IOPS mode (bits 6-8) JMS* .FQ	Data are transferred between the I/O buffer and an I/O device. .FQ checks the monitor I/O flag. If it is zero, a .READ call is made; if it is one, a .WRITE call is made. A call to .WAIT is made in either case. In RSX, the READ, WRITE, and WAITFOR I/O functions are used.
.FP Call: JMS* .FP	Sets all words in the device status table to zero. Called at the beginning of all FORTRAN main programs to indicate that all devices are initialized.

An integer function, IOERR(N), is available to the DOS user and may be invoked at an ERR exit to determine the I/O error which has occurred. The value of IOERR will be one of the following

Value	Error
-1	Parity error
-2	Checksum
-3	Shortline
-5	End-of-file
-6	End-of-medium
OTS error number	Other errors (up to 77)

2.3 SEQUENTIAL INPUT-OUTPUT

Sequential input-output operations access consecutive records of a file, beginning with the first record and then record-by-record until the end of the file. A file which is accessed sequentially may be stored serially (on magnetic tape or if DOS on DECtape) or in directoried mode (on disk and DECtape). That is, the physical sequence of records may or may not conform to the logical sequence.

2.3.1 OTS Formatted Input/Output

The formatted READ and WRITE statements generate calls to routines in the BCDIO package. Input and output operations are performed on a character-to-character basis under the control of a FORMAT statement. All BCDIO routines use FIOPS to perform transfer of data. BCDIO routines may also be called directly by MACRO programs.

Each formatted record is an IOPS ASCII line with a two-word header pair. On output to a printing device, the first character after the header is always a forms-control character. Record length, given in the header, is always in terms of word-pairs. The last character in the last word-pair is always a carriage return.

BCDIO routines are described below.

BCDIO Package	
External Calls:	FIOPS, OTSER, REAL, RELEAE
Errors:	OTS 10 - illegal I/O device number OTS 11 - bad input data (IOPS mode incorrect) OTS 12 - illegal format

Routine	Function
.FR (.FW) Call: JMS* .FR (.FW) .DSA (address of .DAT slot number) .DSA (address of first word of FORMAT statement or array) [1]	Initialize BCDIO for Input (output)
.FE Call: (ones complement of mode in AC) JMS* .FE .DSA (address of data item (first word)) (return with original AC)	Inputs or outputs a data item using format decoder (.FD). Contents of AC prior to call: 777777: INTEGER ØØ LOGICAL 777776: REAL 777775: DOUBLE PRECISION 777774: DOUBLE INTEGER
.FA Call: JMS* .FA .DSA (address of last word in array descriptor block)	Inputs or outputs an entire array using format decoder (.FD).

(continued next page)

[1] This word is 0 for data-directed (implied format) I/O.

BCDIO Package (Cont)

Routine	Function
.FD Call: JMS* .FD	Decodes format into four parameters: .D - decimal places .W - field width .SF - scale factor .S - mode
.FF Call: JMS* .FF	Terminates the current logical record.

As described in the language manual, FORMAT statements may be entered or changed at run time, at which point they are interpreted by BCDIO. In addition to providing the FORTRAN programmer with greater flexibility, this feature permits the MACRO programmer to use the formatted I/O capabilities of BCDIO. (See Appendix C for examples.)

2.3.2 OTS Binary Input/Output (BINIO)

The BINIO package processes unformatted READ and WRITE statements. Data transfer is on a word-to-word basis. A logical record, the amount of data associated with a single READ or WRITE statement, may consist of several physical records whose size (except for the last) is always the standard IOPS I/O buffer size. Thus, when a WRITE statement is processed, each physical record generated contains an ID word (word 3) in addition to the two required header words. This word contains a record identification number. For the first record, this is zero. The last record is indicated by setting bit 0 of the ID word to 1. Up to 377777_8 physical records may be generated for a single logical record.

For example, if four physical records are generated, the four ID words would be:

```
000000
000001
000002
400003
```

If only one record is generated, its ID word will be 400000 signifying the first and last of a set.

An unformatted READ statement accepts logical records of the form described above until its I/O list has been satisfied. If this occurs in the middle of a logical record, the remainder of the record is ignored. That is, the next READ will access the beginning of the next logical record.

The routines of BINIO are described below.

BINIO	
External Calls:	FIOPS, OTSER
Errors:	OTS 10 - illegal I/O device number OTS 11 - illegal input data (IOPS mode)

Routine	Function
.FS Call: JMS* .FS .DSA (address of .DAT slot)	Initializes a device for binary input and reads first record.
.FX Call: JMS* .FX .DSA DEVICE	Initializes a device for binary output; initializes line buffer.
.FJ Call: (one's complement of mode in AC) JMS* .FJ .DSA (address of item (first) word) (returns with original AC)	Transfers a data item to or from the line buffer (all modes). Mode of item is: 777777 = INTEGER or LOGICAL 777776 = REAL 777775 = DOUBLE PRECISION 777774 = DOUBLE INTEGER
.FB Call: JMS* .FB .DSA (address of last word in array descriptor block)	Transfers an array.
.FG Call: JMS* .FG	Terminates current logical record. For WRITE, packs the line buffer with zeroes as required and sets bit 0 of the ID word.

2.3.3 OTS Auxiliary Input/Output (AUXIO)

The AUXIO package processes the commands BACKSPACE, REWIND, and ENDFILE which have different meanings for magnetic tape and disk. In DOS, AUXIO routines issue .MTAPE monitor calls giving .DAT slot and a code specifying the magnetic tape function desired:

Code	Magnetic Tape	Disk
00	Rewind to load point	Close file associated with .DAT slot.
02	Backspace record	Pointers resumed for previous ASCII or binary line.
04	Write end-of-file	N.A.

For magnetic tape, these operations require only calls to system macros. In order to simulate magnetic tape functions on disk, a file active table (.FLTB) must be referenced. This contains four-word entries for every positive .DAT slot indicating whether the file is active (open for input or output) or inactive. The routines of AUXIO and their serial and file-oriented functions are given below.

In RSX, AUXIO issues the magnetic tape I/O functions BSPREC, REWIND, and WREOF. Thus, in RSX, the BACKSPACE, REWIND, and ENDFILE commands should be issued only to an actual magnetic tape device, not to a disk.

AUXIO

External Calls: FIOPS, .FLTB

Errors: OTS 10 - illegal I/O device
OTS 11 - illegal input data (IOPS mode incorrect)

Routine	Magnetic Tape	Disk (DOS only)
.FT (BACKSPACE) Call: JMS* .FT .DSA (address of .DAT slot)	Repositions device at a point just prior to the first physical record associated with the current logical record.	Resumes pointer to previous ASCII or binary line.
.FU (REWIND) Call: JMS* .FU .DSA (address of .DAT slot)	Repositions device at load point.	Closes file. If no file is open, nothing is done.
.FV (ENDFILE) Call: JMS* .FV .DSA DEVICE (address of .DAT slot)	Closes file. Writes an end-of-file mark on tape.	Closes file, zeroes words 0-3 of the associated .FLTB entry.

On a REWIND to disk, the filename is saved; thus, subsequent sequential input-output operations will open that file. On an ENDFILE, the filename is lost and subsequent operations will open a default file.

2.4 DIRECT ACCESS I/O

Direct access input-output files are referenced by name; records are retrieved or accessed by number. The OTS routines which perform direct-access transmission of data are similar to their sequential counterparts. Before they are invoked, however, the user must provide a detailed description of his file.

2.4.1 The DEFINE Routine

The FORTRAN user establishes a direct-access file by calling the DEFINE routine, which is described in Chapter 6 of the FORTRAN IV XVM Language Manual.

The following discusses the DOS implementation of DEFINE; for information on the RSX version, see the above manual.

In DOS, the DEFINE call is:

```
CALL DEFINE (D, S, N, F, V, M, A, L)
```

The parameters provided to OTS for performing direct-access functions are:

D - .DAT slot

S - record size
    number of ASCII characters
  or
    number of binary words

N - number of records ($\leq 131071_{10}$)

F - array reference to filename and extension; if 0, this is a temporary file using a default name

V - associated variable - set to number of the last accessed record plus one

M - mode 0 = IOPS binary (unformatted)
    non-0 = IOPS ASCII (formatted)

A - file size adjustment indicator
    0 = no adjustment
    non-0 = adjust

L - deletion indicator
    0 = no deletion
    non-0 = delete upon closing, if this is a temporary file

The DEFINE routine initializes a file for direct-access in one of four ways, depending on the combination of parameters supplied.

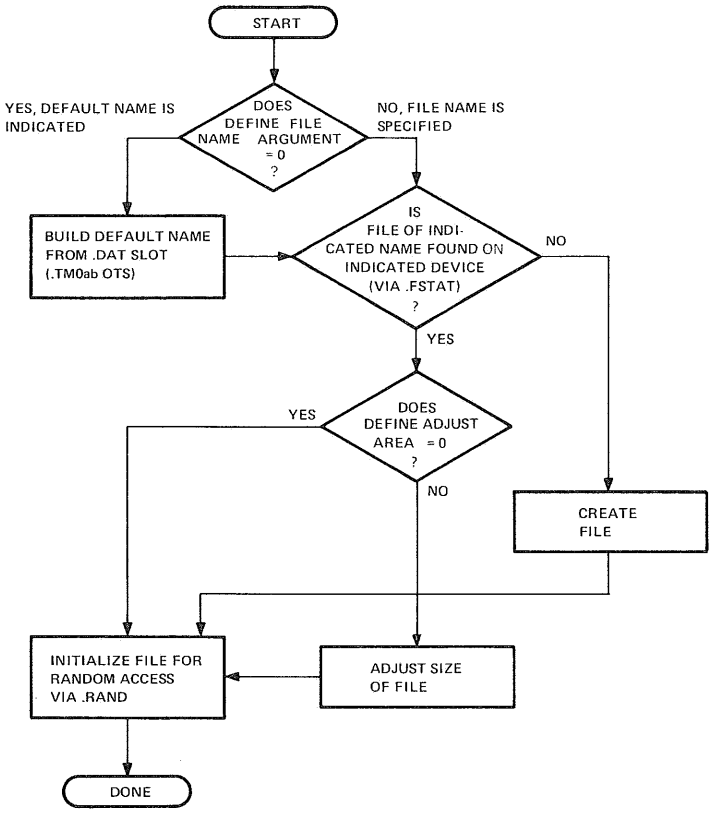
a. Simple Initialization - If F specifies a file which already exists and no adjustment has been indicated, DEFINE opens the file for direct access. The mode and record length parameters must conform to the file's characteristics. The associated variable is set to 1. The number of records N must be less than or equal to the actual number of records.

b. Named File Creation - If F specifies a file which does not exist on .DAT slot D, a file is created according to the characteristics given in the calling arguments. If the mode is ASCII, the data portion is filled with spaces (040_8). If the mode is binary, all data words are set to 0 and the ID word for each record to 400000_8.

c. Default-Named File Creation - If F=0 in the DEFINE call, a file is created as above but given a default name of the form .TM0ab␣OTS (unless a file of that name already exists on .DAT slot D) where ab specifies .DAT slot in decimal. If L=1, a bit is set in the FIOPS status table signifying that the file is to be deleted after an ENDFILE or CALL CLOSE to the .DAT slot.

d. File Size Adjustment - If a file F exists and A is not zero, N is used to adjust the number of records in the file. This is done by creating a temporary file (..TEMP OTS) on .DAT slot D via .DAT slot -1 which is temporarily loaded with the .DAT slot D handler address and UIC. The file is copied into it one record at a time up to the number N. If the file is to be lengthened, null records are added. The adjusted file is then assigned a name according to F. V is set to 1 if the file is reduced. If it is lengthened, it is set to the old length plus one.

The algorithm used for determining the function of DEFINE from its arguments is illustrated in the following flowchart.



From user-supplied arguments, the DEFINE routine establishes a parameter table (.PRMTB) which is available to direct-access input-output routines.

Each device which has a file open for direct-access will have an active four-word entry composed as follows:

Word	Bits	Information
1	0 2-11 12-17	File active bit (1 if active - always set for ASCII files) Number of blocks per record .DAT slot number
2	0 5-11 12-17	mode - 0 if binary; 1 if ASCII Word pairs per record Records per block (0 for binary records larger than one physical block)
3	1-17	Records/file
4	3-17	Address of associated variable

.PRMTB will generally have four such entries but this number may be varied with an assembly parameter.

DEFINE also initializes the file in FIOPS, setting the appropriate bits in the FIOPS status table.

2.4.2 Formatted Input/Output (RBCDIO)

Direct-access operations may be performed on any formatted data file conforming to DOS file structure and with a fixed record length. A direct-access WRITE will output formatted records which have the same form as with sequential operations. The distinction is that the direct-access records are transmitted into a series of records which already exist on the selected file. A single READ or WRITE will access records on the I/O device only as specified in the associated FORMAT statement. This means that a long I/O list will not cause a new record to be accessed, regardless of the length of the list, unless this access is indicated by the FORMAT statement. A carriage return is, as with sequential I/O, appended to each ASCII line. Any information from a previous WRITE made to a record which remains after the carriage return, is inaccessible. The FIOPS buffer and tables are used as with sequential I/O. Data transfer, however, is performed using the .RTRAN system MACRO in DOS, and the DSKGET and DSKPUT I/O functions in RSX.

The RBCDIO routines described below correspond to the sequential I/O routines of BCDIO. Control is transferred to BCDIO for data transmission via the global entry points given.

RBCDIO

External Calls: FIOPS, BCDIO (.FE, .FA), OTSER, RANCOM

Errors: None

Routine	Purpose
.RW (.RR) Call: JMS* .RW(.RP) .DSA (address of .DAT slot) .DSA (address FORMAT) (AC holds integer record number)	BCD direct-access WRITE (READ) sets the direct-access flag; sets mode switch to ASCII; initializes direct-access READ/WRITE (.INRRW in RANCOM); checks mode of existing record; initializes - .STEOR and BFLOC in BCDIO for direct-access, line buffer, and format decoder; sets .HILIM in BCDIO. .RW loads record number into .RCDNM and sets I/O flag in FIOPS to write. .RR loads record number into .RCDNM, sets I/O flag to read.
.RF Call: JMS* .RF	Terminates current logical record. Sets last record flag, reinitializes .ER in OTSER and, for WRITE, .RTRAN out last record. If RSX, the last record is packed, and a DSKPUT is performed if the buffer is full.

Entry points to BCDIO are:

RBCDIO Entry	BCDIO Routine
.RE	.FE
.RA	.FA

2.4.3 Unformatted Input/Output (RBINIO)

Unformatted direct-access I/O differs from formatted in two respects. If a binary record does not totally fill the record into which it is written, the previous contents are still accessible. If a direct-access WRITE requires more words than exist in each record, successive records are accessed and written until the I/O list is exhausted. Records are linked by ID words as for sequential files.

The routines of RBINIO are described below. Direct-access entry points to BINIO follow.

RBINIO

External Calls: FIOPS, RANCOM, BINIO

Errors: None

Routine	Function
.RS (.RX) Call: JMS* .RS(.RX) .DSA (address of .DAT slot) (AC holds integer record number)	Binary direct-access WRITE (READ) sets direct-access flag; sets mode switch to binary; initializes direct READ/WRITE (.INRRW in RANCOM); checks mode of existing record; initializes .BUFLC, .RDTV, and .WRTV in BINIO for direct access; initializes I/O buffer; loads record number into .RCDNM. .RX sets I/O flag to WRITE; .RS sets it to READ.

(continued on next page)

RBINIO (Cont)

Routine	Function
.RG Call: JMS* .RG	Terminates current logical record. Increments associated variable, reinitializes .ER in OTSER; if WRITE, sets last record flag and outputs final records.

Entry points to BINIO are:

RBINIO Entry	BINIO Routine
.RJ	.FJ
.RA	.FA

2.4.4 Initialization and Actual Data Transfer (RANCOM)

RANCOM contains two major routines which are used by both RBCDIO and RBINIO. These routines perform initialization and data transfer functions which are identical to those performed for ASCII and Binary I/O.

RANCOM	
External Calls:	FIOPS, OTSER, DEFINE
Errors:	OTS 10 - illegal I/O device OTS 24 - illegal record number OTS 25 - mode discrepancy OTS 11 - illegal input data (IOPS mode incorrect) OTS 21 - undefined file OTS 23 - size discrepancy

Routine	Function
.INRRW Call: JMS* .INRRW (AC holds address of slot number.)	Initializes a direct access READ or WRITE
.RIO Call: JMS* .RIO	For I/O cleanup: Set up header pair and .RTRAN out block of data. For end-of-record routines: Output (if WRITE) and set pointers to new record.

2.5 DATA-DIRECTED INPUT-OUTPUT (DDIO)

The Data-Directed Input-Output package permits input or output of ASCII data without reference to a FORMAT statement. On input, DDIO extracts individual data fields by scanning the line buffer for terminators. It then determines the mode of the variable to which the item is to be transferred and converts the item to that mode if necessary. Unlike the format decoder, DDIO does not reject an item which is too large but simply assigns the maximum value which the variable can accomodate. On output, DDIO has a set of default format parameters for each type of variable.

The same buffer is used for both data-directed and formatted I/O, and the I/O action for both takes place between device and I/O list variables or vice versa. Thus, DDIO uses the same I/O initialization and termination routines as regular formatted I/O (found within BCDIO for sequential access and within RBCDIO for direct access). DDIO control routines are, however, unique due to the special features described above.

The routines of DDIO are given below.

DDIO

External Calls: BCDIO, .SS, OTSER, FIOPS, REAL, DBLINT

Errors: OTS 42 - bad input data[1]

Routine	Function
.GA Call: (one's complement of mode in AC) JMS* .GA name 1 first 3 characters, radix 50 name 2 last 3 characters, radix 50 .DSA address item (returns with original AC)	Outputs a data item in the 'NAME'=value form. If the mode is 0 (integer-logical), bit 0 of the name word indicates which (0 for integer, 1 for logical).
.GC Call: (one's complement of mode in AC) JMS* .GC name 1 name 2 .DSA item (returns with original AC)	Outputs an array element in 'NAME(I)'=value form. .GC should only be used when .SS has been used to calculate the subscript address.
.GB Call: JMS* .GB name 1 name 2 .DSA array descriptor block (word # 5 address)	Outputs an entire array in 'NAME(I)'=value form.
.GD Call: (one's complement of mode in AC) JMS* .GD .DSA item (returns with original AC)	Inputs an item.
.GE Call: JMS* .GE .DSA addr. of array descriptor block word 5	Inputs an array.

[1]For Terminal input - 'BAD INPUT DATA - RETYPE FROM INPUT WITH ERROR' is typed.

2.6 ENCODE/DECODE (EDCODE)

Encode and Decode perform memory-to-memory transfers and conversions using the apparatus established for formatted input-output. That is, data is transferred from memory to the I/O buffer to memory. Since no peripheral device is involved, the initialization and termination mechanisms of EDCODE are unique while the data transfer is the same as for BCDIO.

The routines of EDCODE are given below.

EDCODE	
External Calls:	OTSER, BCDIO
Errors:	OTS 40 - illegal number of characters OTS 41 - array exceeded

Routine	Function
.GF Call: JMS* .GF .DSA number of characters .DSA array .DSA format	Encode.
.GG Call: JMS* .GG .DSA number of characters .DSA array .DSA format	Decode.

2.7 USER SUBROUTINES

The subroutines given below are FORTRAN-callable subroutines which support input-output operations.

2.7.1 DOS Directoried Subroutines

The directoried subroutines described below comprise a package named FILE. These routines interact with the DOS file-oriented data structure.

FILE

External Calls: FIOPS, .DA

Errors: OTS 10 - illegal device number
OTS 13 - file not found (SEEK)
OTS 14 - directory full (ENTER)

Routine	Call	Purpose
SEEK	CALL SEEK (n,A) Where: n = device number A = name of array containing the 9-character 5/7 ASCII file name and extension	Finds and opens a named input file.
ENTER	CALL ENTER (n,A)	Creates and opens a named output file.
CLOSE	CALL CLOSE (n)	Terminates an input or output file (required when SEEK or ENTER are used).
FSTAT	CALL FSTAT (n,A,I) Where: I = 0 if the file not found; = -1 if found and action complete	Searches for named file.
RENAM	CALL RENAM (n,A,B,I) Where: A is an array containing existing name B is an array containing a new file name I = 0 if file not found; -1 if found and action complete	Searches for named file and renames it.
DLETE	CALL DLETE (n,A,I) Where: A is an array containing existing file name I = 0 if file not found; -1 if found and action complete	Searches for named file and deletes it.

2.7.2 RSX Directoried Subroutines:

Routine	Calling Sequence	Purpose
SEEK	CALL SEEK (n,nHname,nHext[,ev]) Where: n = LUN number nHname = is a Hollerith constant or DOUBLE INTEGER or REAL variable which specifies the 1 to 5 character file name. nHext = is a Hollerith constant or DOUBLE INTEGER or REAL variable which specifies the 1 to 3 character file extension. ev = is an optional integer variable which will if specified, contain upon return, the setting of the returned event variable from the SEEK CPB.	Finds and opens a named input file.

Routine	Calling Sequence	Purpose
ENTER	CALL ENTER (n,nHname,nHext[,ev]) Where: All parameters are as for SEEK	Creates and opens a named output file

Routine	Calling Sequence	Purpose
CLOSE	CALL CLOSE (n[,nHname,nHext[,ev]]) Where: Parameters are as with SEEK, except file name and extension are optional, used only with CALL RENAME.	Terminates an input or output file and closes it. Also is used to specify the new name of a RENAME'd file (see RENAME)

(continued next page)

Routine	Calling Sequence	Purpose
RENAME	CALL RENAME (n,nHname,nHext[,ev]) Where: Parameters are as with SEEK.	Open the specified file for the purpose of renaming it to the name specified in the following CLOSE command.

Routine	Calling Sequence	Purpose
DELETE	CALL DELETE (n,nHname,nHext[,ev]) Where: Parameters are as with SEEK.	Searches for named file and deletes it.

2.7.3 BOSS Routines

These FORTRAN-callable routines affect BOSS I/O when called by a program running under BOSS.

BOSTT
External Calls: None
Errors: None

Routine	Call	Purpose
TTON	CALL TTON	Allows output intended for the teletype to be printed on the teletype.
TTOF	CALL TTOFF	Restores normal BOSS function by directing all teletype output to the line printer.

CHAPTER 3
THE SCIENCE LIBRARY

The FORTRAN Science Library is a set of pre-defined subprograms which may be invoked by a FORTRAN-IV subprogram reference. These include intrinsic functions, external functions, the arithmetic-package functions, and external subroutines. Each of these may also be referenced by a MACRO program as may the sub-functions and OTS routines which are also part of the FORTRAN library.

Descriptions of each type of subprogram are given in the following subsections. Information given for these include errors, accuracy, size, and external calls (to other library subprograms). Each function description also includes the MACRO calling sequence. Where there are two arguments, it is assumed that the appropriate accumulator has been loaded (accumulators are described in Section 3.4). For calling sequences which use the .DSA pseudo-operation to define the symbolic address of arguments, 400000 must be added to the address field for indirect addressing.

FORTRAN library subprograms are called by FORTRAN programs in the manner described in the Language Manual. Subprograms called by MACRO programs must be declared with a .GLOBL pseudo-operation as in:

Examples:

Standard System

```
        .TITLE
        .GLOBL SIN, .AH
        .
        .
        .
        JMS*  SIN
        JMP   .+2          /JUMP beyond argument
        .DSA  A            /+400000 if indirect
        JMS*  .AH          /store in real format at
        .DSA X             /X
        .
        .
        .
X       .DSA 0
        .DSA 0
```

Floating Point (FPP) System

```
        .TITLE
        .GLOBL SIN
FST = 713640
        .
        .
        .
        JMS* SIN
        JMP .+2
        .DSA  A
        FST
        .DSA X
        .
        .
        .
X       .DSA 0
        .DSA 0
```

The number and type of arguments in the MACRO program must agree with those defined for the sub-program.

3.1 INTRINSIC FUNCTIONS

Table 3-1 contains a description of each of the intrinsic functions in the FORTRAN library.

Intrinsic functions may be explicitly named, as when referenced via an arithmetic statement. For example

```
X = ABS(A)
```

They must have proper mode specification, and the correct number of arguments.

References to intrinsic functions are also generated implicitly. For instance, when

```
X = A**B
```

is coded, and A and B are type REAL, a call to .BE is generated.

(Table 3-1 begins on the following page.)

Table 3-1
Intrinsic Functions

Function	Definition	Symbolic Name	Mode	Calling Sequence	Errors	Accuracy (Bits)	External Calls
		.BB	I=I**I	ARG1 IN FLT.ACC JMS*.BB .DSA ADDR of ARG2	15 if base = 0 and exp. ≤ 0	N.A.	INTEGE
		.BC .BC .BL	R**I(or DI) R=R**I R=R**DI	ARG1 IN FLT. ACC JMS* SUBR .DSA ADDR of ARG2	None	N.A.	REAL
		.BD .BD .BM	DP**I(or DI) DP=DP**I DP=DP**DI	ARG1 IN FLT. ACC JMS* SUBR .DSA ADDR of ARG2	None	N.A.	REAL
		.BE .BF .BG .BH	R=R**R DP=R**DP DP=DP**R DP=DP**DP	ARG1 IN FLT. ACC JMS* SUBR .DSA ADDR of ARG2	13 if base ≤ 0 13 if base ≤ 0 14 if base ≤ 0 14 if base ≤ 0	26 26 32 32	.EE,.DF, REAL .EE,.DF, DOUBLE .DE,.DF, DOUBLE .DE,.DF, DOUBLE
		.BI .BI .BJ .BK	I**DI,DI**DI (or I) I=I**DI DI=DI**DI DI=DI**I	ARG1 IN AC (and MQ) JMS* SUBR .DSA ADDR of ARG2	None	N.A.	DBLINT
Absolute Value	|ARG|	ABS IABS JABS DABS	R=ABS(R) I=IABS(I) DI=JABS(DI) DP=DABS(DP)	JMS* SUBR JMP .+2 .DSA ADDR of ARG	None	N.A.	.DA,REAL .DA .DA, DBLINT .DA, DOUBLE
Truncation	Sign of ARG times largest integer ≤ |ARG|	AINT INT IDINT JINT JDINT	R=AINT(R) I=INT(R) I=IDINT(DP) DI=JINT(R) DI=JDINT(DP)	JMS* SUBR JMP .+2 .DSA ADDR of ARG	None	N.A.	.DA, REAL .DA, REAL .DA, REAL, DOUBLE .DA, DOUBLE, DBLINT .DA, DOUBLE, DBLINT

*15 if base = 0 and exp ≤ 0.

Table 3-1 (Cont)
Intrinsic Functions

Function	Definition	Symbolic Name	Mode	Calling Sequence	Errors	Accuracy (Bits)	External Calls
Transfer of Sign	Sign of ARG2 ↓ Sign of ARG1	SIGN ISIGN DSIGN JSIGN	R=SIGN(R,R) I=ISIGN(I,I) DP=DSIGN(DP,DP) DI=JSIGN(DI,DI)	JMS* SUBR JMP .+3 .DSA ADDR of ARG1 .DSA ADDR of ARG2	None	N.A.	.DA, REAL .DA .DA, DOUBLE .DA, DBLINT
Positive Difference	ARG1-MIN(ARG1,ARG2)	DIM IDIM JDIM	R=DIM(R,R) I=IDIM(I,I) DI=JDIM(DI,DI)	JMS*SUBR JMP .+3 .DSA ADDR of ARG1 .DSA ADDR of ARG2	None	N.A.	.DA, REAL .DA, INTEGER .DA,DBLINT
Conversion	VMODE → ARG	FLOAT IFIX SNGL DBLE JFIX ISNGL JDBLE JDFIX FLOATJ DBLEJ	R=FLOAT(I) I=IFIX(R) R=SNGL(D) D=DBLE(R) DI=JFIX(R) or JFIX(DP) I=ISNGL(DI) DI=JDBLE(I) DI=JDFIX(DP) R=FLOATJ(DI) DP=DBLEJ(DI)	JMS* SUBR JMP .+2 .DSA ADDR of ARG	None	N.A.	.DA, REAL .DA, REAL .DA, DOUBLE .DA, REAL .DA, DOUBLE, DBLINT .DA, .DA, DBLINT .DA .DA, DOUBLE,DBLINT .DA, DBLINT .DA, DBLINT
Remaindering	ARG1-[ARG1/ARG2]ARG2 Where: [A1/A2] is an integer whose magnitude does not exceed the magnitude of A1/A2 and whose sign is the same	AMOD MOD DMOD JMOD	R=AMOD(R,R) I=MOD(I,I) DP=DMOD(DP,DP) DI=JMOD(DI,DI)	JMS* SUBR JMP .+3 .DSA ADDR of ARG1 .DSA ADDR of ARG2	None	* N.A. * N.A.	.DA, REAL .DA, INTEGER .DA, DOUBLE .DA, DBLINT

*ARG1/ARG2 < 131072

Table 3-1 (Cont)
Intrinsic Functions

Function	Definition	Symbolic Name	Mode	Calling Sequence	Errors	Accuracy (Bits)	External Calls
Maximum/ minimum value	VAR = max or min value of arglist	Integer min/max (IMNMX) MAX0 MIN0 AMAX0 AMIN0	 I=MAX0(I_1,...I_n) I=MIN0(I_1,...I_n) R=AMAX0(I_1,...I_n) R=AMIN0(I_1,...I_n)		None	N.A.	INTEGER, REAL
		Real min/max (RMNMX) AMAX1 AMIN1 MAX1 MIN1	 R=AMAX1(R_1,...R_n) R=AMIN1(R_1,...R_n) I=MAX1(R_1,...R_n) I=MIN1(R_1,...R_n)	JMS*SUBR JMP .+n+1 .DSA ADDR of ARG1 : .DSA ADDR of ARGn			INTEGER, REAL
		Double-precision (DMNMX) DMAX1 DMIN1	 DP=DMAX1(DP_1,...DP_n) DP=DMIN1(DP_1,...DP_n)				DOUBLE
		Double integer (JMNMX) JMAX0 JMIN0	 DI=JMAX0(DI_1,...DI_n) DI=JMIN0(DI_1,...DI_n)				DBLINT

3.2 EXTERNAL FUNCTIONS

Table 3-2 describes the external functions of the FORTRAN library. An external function is a sub-program which is executed whenever a reference to it appears within a FORTRAN expression and which returns a single value.

A description of the algorithm applied in implementing each of these functions is given below.

3.2.1 Square Root (SQRT, DSQRT)

A first-guess approximation of the square root of the argument is obtained as follows:

If the exponent (EXP) of the argument is odd:

$$P_0 = .5\left(\frac{EXP-1}{2}\right) + ARG\left(\frac{EXP-1}{2}\right)$$

If EXP is even:

$$P_0 = .5\left(\frac{EXP}{2}\right) + ARG\left(\frac{EXP}{2}-1\right)$$

Newton's iterative approximation, below, is then applied four times.

$$P_{i+1} = \frac{1}{2}\left(P_i + \frac{ARG}{P_i}\right)$$

3.2.2 Exponential (EXP, DEXP)

The following description also applies to the sub-functions .EF and .DF.

The function e^x is calculated as $2^{x\log_2 E}$ ($x\log_2 E$ will have an integer portion (I) and fractional portion (F)).

Then:

$$e^x = (2^I)(2^F)$$

Where:

$$2^F = \left(\sum_{i=0}^{n} C_i F^i\right)^2$$

n = 6 for EXP and .EF

n = 8 for DEXP and .DF

(continued page 3-8)

Table 3-2
External Functions

Function	Definition	Symbolic Name	Mode	Calling Sequence	Errors	Accuracy (Bits)	External Calls
Square root	$ARG^{1/2}$	SQRT DSQRT	R=SQRT(R) DP=DSQRT(DP)	JMS* SUBR JMP .+2 .DSA ADDR of ARG	5 if ARG < 0 6 if ARG < 0	26	.DA,.ER,REAL .DA,.ER,DOUBLE
Exponential	e^{ARG}	EXP DEXP	R=EXP(R) DP=DEXP(DP)	Same	13 if ARG < 0 14 if ARG < 0	26 34	.DA,.EF,.ER,REAL .DA,.DF,.ER,DOUBLE
Natural logarithm	$Log_e ARG$	ALOG DLOG	R=ALOG(R) DP=DLOG(DP)	Same	Same	26 32	.DA,.EE,.ER,REAL .DA,.DE,.ER,DOUBLE
Common logarithm	$Log_{10} ARG$	ALOG10 DLOG10	R=ALOG10(R) DP=DLOG10(DP)	Same	Same	Same	Same
Sine	Sin(ARG)	SIN DSIN	R=SIN(R) DP=DSIN(DP)	Same	None	26 34	.DA,.EB,REAL .DA,.DB,DOUBLE
Cosine	cos(ARG)	COS DCOS	R=COS(R) DP=DCOS(DP)	Same	None	26 34	.DA,.EB,REAL .DA,.DB,DOUBLE
Arc tangent	tan^{-1}(ARG)	ATAN DATAN	R=ATAN(R) DP=DATAN(DP)	Same	None	26 34	.DA,.ED,REAL .DA,.DD,DOUBLE
Arc tangent (X/Y)	tan^{-1} (ARG1/ ARG2)	ATAN2 DATAN2	R=ATAN2(R,R) DP=DATAN2 (DP,DP)	JMS* SUBR JMP .+3 .DSA ADDR of ARG1 .DSA ADDR of ARG2	None	26 34	Same
Hyperbolic tangent	tanh(ARG)	TANH	R=TANH(R)	JMS* TANH JMP .+2 .DSA ADDR of ARG	None	26	.DA,.EF,REAL

The values of C_i are given below.

Value of i	Value of C_i
0	1.0
1	0.34657359
2	0.06005663
3	0.00693801
4	0.00060113
5	0.00004167
6	0.00000241
7	0.00000119
8	0.00000518

3.2.3 Natural and Common Logarithms (ALOG, ALOG10, DLOG, DLOG10)

The exponent of the argument is saved as the integral portion of the result plus one. The fractional portion of the argument is considered to be a number between 1 and 2. Z is computed as follows:

$$Z = \frac{X - \sqrt{2}}{X + \sqrt{2}}$$

Then:

$$\log_2 X = \frac{1}{2} + \left(\sum_{i=0}^{n} C_{2i+1} Z^{2i+1}\right)$$

Where:

n = 2 (ALOG)

n = 3 (DLOG)

The values of C are given below:

ALOG and ALOG10

$C_1 = 2.8853913$

$C_3 = 0.96147063$

$C_5 = 0.59897865$

DLOG and DLOG10

$C_1 = 2.8853900$

$C_3 = 0.96180076$

$C_5 = 0.57658434$

$C_7 = 0.43425975$

(continued next page)

The final computation is:

ALOG and DLOG:	$\log_e X = (\log_2 X)(\log_e 2)$
ALOG10 and DLOG10:	$\log_{10} X = (\log_2 X)(\log_{10} 2)$

3.2.4 Sine and Cosine (SIN, COS, DSIN, DCOS)

This description also applies to the sub-functions .EB and .DB.

The argument is multiplied by $2/\pi$ for conversion to quarter-circles. The two low-order bits of the integral portion determine the quadrant of the argument and produce a modified value of the fractional portion (Z) as follows.

Low-Order Bits	Quadrant	Modified Value (Z)
00	I	F
01	II	1-F
10	III	-F
11	IV	-(1-F)

The value of Z is then applied to the polynomial expression:

$$\sin X = \left(\sum_{i=0}^{n} C_{2i+1} Z^{2i+1}\right)$$

n = 4 for SIN, COS, .EB

n = 6 for DSIN, DCOS, .DB

The values of C are as follows:

SIN, COS, .EB	DSIN, DCOS, .DB
$C_1 = 1.570796318$	$C_1 = 1.5707932680$
$C_3 = -0.645963711$	$C_3 = -0.6459640975$
$C_5 = 0.079689677928$	$C_5 = 0.06969262601$
$C_7 = -0.00467376557$	$C_7 = -0.004681752998$
$C_9 = 0.00015148419$	$C_9 = 0.00016043839964$
	$C_{11} = -0.000003595184353$
	$C_{13} = 0.000000054465285$

(continued next page)

The argument for COS and DCOS is adjusted by adding $\pi/2$. The sin subfunction is then used to compute the cosine according to the following relationship:

$$\text{COS } X = \sin\left(\frac{\pi}{2} + X\right)$$

3.2.5 Arctangent (ATAN, DATAN, ATAN2, DATAN2)

The following description also applies to the sub-functions .ED and .DD.

For arguments less than or equal to 1, Z = arg and:

$$\text{arctangent arg} = \left(\sum_{i=0}^{n} C_{2i+1} Z^{2i+1}\right)$$

n = 3 for ATAN and ATAN2

n = 7 for DATAN and DATAN2

For arguments greater than 1, Z = 1/arg and:

$$\text{arctangent arg} = \frac{\pi}{2} - \left(\sum_{i=0}^{n} C_{2i+1} Z^{2i+1}\right)$$

n = 3 for ATAN and ATAN2

n = 8 for DATAN and DATAN2

The values of C are given below.

ATAN and ATAN2	DATAN and DATAN2
$C_1 = 0.9992150$	$C_1 = 0.9999993329$
$C_3 = -0.3211819$	$C_3 = -0.3332985605$
$C_5 = 0.1462766$	$C_5 = 0.1994653599$
$C_7 = -0.0389929$	$C_7 = -0.1390853351$
	$C_9 = 0.0964200441$
	$C_{11} = -0.0559098861$
	$C_{13} = 0.0218612288$
	$C_{15} = -0.0040540580$

3.2.6 Hyperbolic Tangent

The hyperbolic tangent function is defined as:

$$\tanh |X| = \left(1 - \frac{2}{1+e^{2|X|}}\right)$$

e^x is calculated as $2^{x\log_2 e}$ ($x\log_2 e$ will have an integral portion (I) and a fractional portion (F)).

(continued next page)

Then:

$$e^X = (2^I)(2^F)$$

Where:

$$2^F = (\sum_{i=0}^{n} C_i F^i)^2$$

$$n = 6$$

The values of C_i are:

Value of i	Value of C_i
0	1.0
1	0.34657359
2	0.06005663
3	0.00693801
4	0.00060113
5	0.00004167
6	0.00000241

3.3 SUB-FUNCTIONS

Table 3-3 describes the sub-functions which are included in the FORTRAN library. These functions are referenced by intrinsic and external functions but are not directly accessible to the user via FORTRAN. The sub-function .EB, for example, performs the computation of sine and is invoked by the external function SIN. MACRO programs may reference sub-functions directly. Algorithms for all sub-functions which have counterparts among external functions were given in the previous sub-section. This leaves the two general sub-functions Logarithm, base 2 and polynomial evaluator. Their algorithms are given below.

3.3.1 Logarithm, Base 2 (.EE, .DE)

The exponent of the argument is saved as the integer portion of the result plus one. The fractional portion of the argument is considered to be a number between 1 and 2. Z is computed as follows:

$$Z = \frac{X - \sqrt{2}}{X + \sqrt{2}}$$

(continued page 3-14)

Table 3-3
Sub-Functions

Function	Definition	Symbolic Name	Mode	Calling Sequence	Errors	Accuracy (Bits)	External Calls
Sine Computation	Sin (ARG)	.EB .DB	R=.EB(R) DP=.DB(DP)	JMS* SUBR At entry floating accumulator contains ARG; at return contains result	None	19 28	.EC,REAL .DC,DOUBLE
Arc tangent Computation	$\tan^{-1}$(ARG)	.ED .DD	R=.ED(R) DP=.DD(DP)	Same	None	26 34	Same
Logarithm (base 2) Computation	$\log_2$ARG	.EE .DE	R=.EE(R) DP=.DE(DP)	Same	13, ARG < 0 14, ARG < 0	26 32	.ER,REAL .ER,DOUBLE
Exponential Computation	e^{ARG}	.EF .DF	R=.EF(R) DP=DF(DP)	Same	None	26 34	REAL DOUBLE
Polynomial Evaluation	VAR = $\sum_{i=0}^{n} C_i Z^{2i+1}$ VAR = $\sum_{i=0}^{n} C_i Z^{2i+1}$	.EC .DC	R=.EC(R_2,R_1,...R_n) DP=.DC(DP_2,DP_1,...DP_n)	JMS* SUBR CAL PLIST . . . PLIST-N/ - number of terms +1 C_n / last term C_n-1/next to last . . . C_1 /2nd term C_0 /1st term	None	N.A.	REAL DOUBLE

(continued next page)

Table 3-3 (Cont)

Sub-Functions

Function	Definition	Symbolic Name	Mode	Calling Sequence	Errors	Accuracy (Bits)	External
General Get Argument	N.A	.DA	N.A	Calling Routine SUBR CAL 0 JMS* .DA JMP .+n+1 (address of ARG1) (address of ARG2) . . . (address of ARGn) Is Called By JMS* SUBR JMP .+n+1 .DSA ARG1 .DSA ARG2	None	N.A	None

Then:

$$\log_2 X = \frac{1}{2} + \left(\sum_{i=0}^{n} C_{2i+1} Z^{2i+1}\right)$$

n = 2 (.EE)

n = 3 (.DE)

The values of C are:

.EE	.DE
$C_1 = 2.8853913$	$C_1 = 2.8853900$
$C_3 = 0.96147063$	$C_3 = 0.96180076$
$C_5 = 0.59897865$	$C_5 = 0.57658434$
	$C_7 = 0.43425975$

3.3.2 Polynomial Evaluator (.EC, .DC)

A polynomial is evaluated as:

$$X = Z(C_0 + Z^2 (C_1 \ldots + Z^2 (C_n Z^2 + C_{n-1})))$$

3.4 THE ARITHMETIC PACKAGE

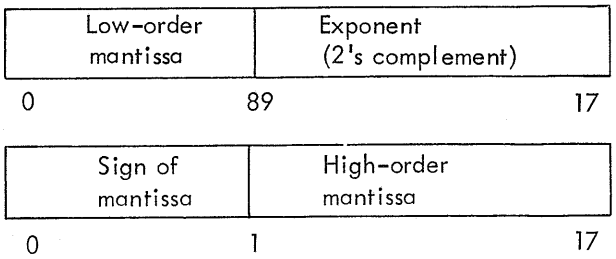
The arithmetic package contains the OTS arithmetic routines which are invoked by FORTRAN arithmetic expressions. These routines may also be called directly by MACRO programs. Versions of FORTRAN-IV designed for use with the Floating Point Processor (FPP) require only single integer arithmetic routines. Double (extended) integer arithmetic will be handled by the hardware.

The three major routines of the arithmetic package are INTEAE, RELEAE, and DOUBLE. INTEAE contains integer arithmetic routines; RELEAE, real and floating arithmetic; and DOUBLE, double-precision arithmetic.

A description of these routines is given in Table 3-4. In the "calling sequence" column, reference is made to three accumulators - the A-register, the floating accumulator, and the held accumulator. The A-register is the standard XVM hardware accumulator. The floating and held accumulators are software accumulators which are part of the RELEAE package. The held accumulator is used as temporary storage by some routines. Both consist of three consecutive XVM words and have the format shown below. (Negative mantissae are indicated by a change of sign.)

Held AC Labels	Floating AC Labels	
CE01	.AA	Exponent (2's complement) — 0 … 17
CE02	.AB	Sign of mantissa | High-order mantissa — 0 … 1 … 17
CE03	.AC	Low order mantissa — 0 … 17

The format shown above is that used for double-precision numbers. Single-precision numbers must be converted before and after use in the floating accumulator to the single-precision format:



RELEAE routines check for underflow and overflow and set a flag (.OVUDF) in the REAL store routine .AH as follows:

Flag	Meaning	Action
non-0 positive value	overflow - an attempt to store a REAL constant whose binary exponent is greater than 377_8	± largest representable real value stored (DOS);
negative value	underflow - an attempt to store a REAL constant whose binary exponent is less than -400_8	zero is stored
zero	default value	value is stored

The user may test this flag under program control using the logical function IFLOW. Recoverable OTS messages are also given (see Appendix B, Section B.2).

Division by zero is also checked and a flag .DZERO set to zero (default value is 777777_8) in the general floating divide routine (.CI). The result of the division is ± the largest representable value. An OTS error message is also given for this condition. The user may test .DZERO under program control using the logical function IDZERO.

The flags .OVUDF and .DZERO can only be initialized by reloading the program, by a separate user program, or by IFLOW or IDZERO. These functions are described below.

Routine	IFLOW
Purpose	Checks underflow and overflow
Call	IORLV = IFLOW(I)
External Calls	.DA
Errors	None

The argument I indicates the check to be performed and values are returned as follows:

I	Action	Value
0	no check	0(.FALSE) flag unchanged
< 0	underflow check	-1(.TRUE) if underflow - flag set to 0; else 0 (.FALSE) and flag unchanged
> 0	overflow check	-1(.TRUE) if overflow - flag set to zero; else 0 (.FALSE) and flag unchanged.

Routine	IDZERO
Purpose	Checks for division by zero
Call	IORLV = IDZERO (I)
External Calls	.DA
Errors	None

If I=0, no check is made, IORLV = 0(.FALSE) and the flag is unchanged. If I≠0, a check is made. If an attempt at division by zero was made, IORLV = -1 (.TRUE) and the flag is reinitialized. Otherwise the flag is unchanged and IORLV = 0(.FALSE).

Table 3-4
Arithmetic Package[1]

	Function	Definition	Symbolic Name	Mode	Calling Sequence			External Calls
INTEAE	Integer Arithmetic				ARG1 A-Register	ARG2		None
	[1]Multiplication	ARG1*ARG2	.AD	I=I*I	multiplicand	multiplier	JMS* SUBR LAC ARG2	
	[1]Division	ARG1/ARG2	.AE	I=I/I	dividend	divisor		
	[1]Reverse division	ARG2/ARG1	.AF	I=I/I	divisor	dividend		
	[1]Subtraction	ARG1-ARG2	.AY	I=I-I	minuend	subtrahend		
	[1]Reverse subtraction	ARG2-ARG1	.AZ	I=I-I	subtrahend	minuend		
DOUBLE	Double-Precision Arithmetic				ARG1 FL.AC	ARG2		REAL
	Load	N.A	.AO	DP=.AO(DP)		address	JMS* SUBR .DSA ARG2	
	Store	N.A	.AP	DP=.AP(DP)	value	address		
	Add	ARG1+ARG2	.AQ	DP=DP+DP	augend	addend		
	Subtract	ARG1-ARG2	.AR	DP=DP-DP	minuend	subtrahend		
	Reverse subtract	ARG2-ARG1	.AU	DP=DP-DP	subtrahend	minuend		
	Multiply	ARG1*ARG2	.AS	DP=DP*DP	multiplicand	multiplier		
	Divide	ARG1/ARG2	.AT	DP=DP/DP	dividend	divisor		
	Reverse divide	ARG2/ARG1	.AV	DP=DP/DP	divisor	dividend		

[1]FPP versions require only Integer Arithmetic (INTEAE).

(continued next page)

Table 3-4 (Cont)
Arithmetic Package

RELEAE

Function	Definition	Symbolic Name	Mode	Calling Sequence			External Calls
Real Arithmetic (includes floating)				ARG1 FL.AC	ARG2		
Load	N.A	.AG	R=.AG(R)		address		
Store	N.A	.AH	R=.AH(R)	value	address		
Add	ARG1+ARG2	.AI	R=R+R	augend	addend		
Subtract	ARG1-ARG2	.AJ	R=R-R	minuend	subtrahend	JMS* SUBR	
Reverse subtract	ARG2-ARG1	.AM	R=R-R	subtrahend	minuend	.DSA ARG2	
Multiply	ARG1*ARG2	.AK	R=R*R	multiplicand	multiplier		
Divide	ARG1/ARG2	.AL	R=R/R	dividend	divisor		
Reverse divide	ARG2/ARG1	.AN	R=R/R	divisor	dividend		
Floating Arithmetic				A-Register	FL.AC		
Float	R← IARG	.AW	R=.AW(I)	integer	F.P num	JMS* SUBR	
Fix	I ← RARG	.AX	I=.AX(R)		F.P num		
Negate	R← RARG	.BA	R=.BA(R)				
				FL.AC	HELD AC		
Multiply	ARG1*ARG2	.CA	R=R*R	multiplicand	multiplier		
Add	ARG1+ARG2	.CC	R=R+R	augend	addend		
Normalize	N.A	.CD	R=.CD(R)	value		JMS* SUBR	
Hold	N.A	.CF	R=.CF(R)	value			
Sign Control	(Footnote 2)	.CG	R=.CG(R)	value	value		
Short get argument	N.A	.CB	R=.CB(R)	CAL 0 JMS* .CB CAL 0	SUBR ENTRY-EXIT STORAGE FOR ARG ADDR		

(continued next page)

Table 3-4 (Cont)
Arithmetic Package

	Function	Definition	Symbolic Name	Mode	Calling Sequence			External Calls
	Floating Arithmetic (Cont)				FL.AC	HELD .AC		
	Divide	ARG1/ARG2	.CI	R=R/R	divisor	dividend	JMS* SUBR[2]	
	Round and sign [1]	N.A	.CH	R=.CHR	value		CONST1 CONST2	
					ARG1 AC,MQ	ARG2		
	Load	N.A	.JG	DI=.JF (DI)		address		
	Store	N.A	.JH	DI=.JH (DI	value	address		
	Add	ARG1+ARG2	.JI	DI=DI+DI	augend	addend		
	Subtract	ARG1-ARG2	.JJ	DI=DI-DI	minuend	subtrahend	JMS* SUBR .DSA ARG2	
	Reverse subtract	ARG2-ARG1	.JM	DI=DI-DI	subtrahend	minuend		
INT	Multiply	ARG1*ARG2	.JK	DI=DI*DI	multiplicand	multiplier		
	Divide	ARG1/ARG2	.JL	DI=DI/DI	dividend	divisor		
	Reverse divide	ARG2/ARG1	.JN	DI=DI/DI	divisor	dividend		
					AC,MQ	FL.AC		
	Float	R←JARG	.JW	R=.JW (DI)	Doub. Int.	F.P.Number	JMS* SUBR	.CD,REAL
	Fix	J←RARG	.JX	DI=.JX (DI)		F.P.Number		REAL
	Negate	J←JARG	.JA	DI=.JA (DI)				

[1] The sign of the result (exclusive OR of the sign bits of .AB and CE02) is stored in .CE. The sign of .AB is saved in CE05.

[2] CONST1 and CONST2 are required for both EAE and NON-EAE operations, however, they are not used only by the NON-EAE version of .CI. CONST1 indicates the number of bits to be generated (-34 for single precision, -44 for double precision). CONST2 is the least significant quotient bit (400 for single precision, 1 for double precision).

CHAPTER 4
UTILITY ROUTINES

Two types of subprogram are described in this chapter - OTS routines, automatically invoked by FORTRAN statements, and external subprograms which may be invoked via a FORTRAN CALL statement. Both types are accessible to MACRO programs.

4.1 OTS ROUTINES

OTS utility routines perform a number of functions specified by FORTRAN statements. These functions of FORTRAN, like the input-output functions discussed previously, use OTS as an interface between the user program and the monitor environment in which it will operate.

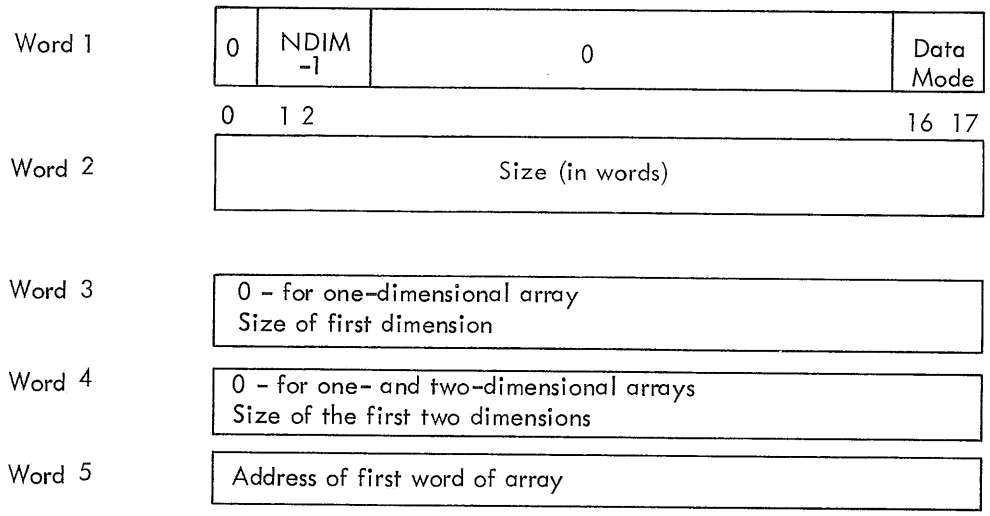
Each of these routines is described below.

.SS

Routine	.SS
Purpose	Calculates the address of an array element
Calling Sequence	.GLOBL .SS JMS* .SS .DSA address of fifth word of array descriptor block LAC or LAC* first subscript value LAC or LAC* second subscript value, omitted if only one subscript LAC or LAC* third subscript value, omitted if only one or two subscripts DAC into location at which subscript is used (This instruction is XCT'd by .SS) (returns at location following DAC, with one's complement of mode of array in AC)
External Calls	None
Errors	None

.SS references the array-descriptor block associated with the array whose element is to be located.

An array descriptor block is a five-word table with the contents described below.



Size is determined by multiplying the dimensions of the array by the number of words (N) used for a data item of the specified mode (M). Thus, an INTEGER array defined by DIMENSION (2,2,2) has the size 8 in word 2, the size 2 in word 3, and the size 4 in word 4. A REAL array of the same dimensions will have 16, 4, and 8 in these locations.

NDIM is the number of dimensions in the array.

The values of M and N for the various data modes are:

Array Mode	M	N
INTEGER, LOGICAL	00	1
DOUBLE INTEGER	11	2
REAL	01	2
DOUBLE PRECISION	10	3

The address of an array element $A(K_1,K_2,K_3)$ is calculated by .SS using the following formula:

$$addr = WD4 + (K_1-1) * N + (K_2-1) * WD2 + (K_3-1) * WD3$$

FORTRAN subprograms maintain an array descriptor block that is local for every array declared, including dummy arrays. Further, the dimensioning information of a dummy array may include integer dummy parameters, such as in

```
SUBROUTINE SUB (X,ARRAY,Y,I,J)
DIMENSION ARRAY (5,I,J)
```

Such arrays are called adjustable arrays. In systems preceding the XVM, it was necessary to use subroutines ADJ, ADJ1, ADJ2, or ADJ3 to perform this type of operation; it is now handled automatically, by implicitly generated calls to the OTS subroutine .DJ. The MACRO program, if it uses .DA to fetch arguments, will not have access to the ADB in a calling program. It will probably need a local ADB, and to make use of .DJ. Further information about this appears in Section 5.1.

.DJ

Routine	.DJ
Purpose	Completes dimensioning information in array descriptor block of an adjustable array
Calling Sequence	JMS* .DJ .DSA address of word 5 of array descriptor block .DSA integer value of constant first maximum dimension or .DSA 400000 + address of dummy integer used as first maximum dimension .DSA same for second subscript, if any .DSA same for third subscript, if any
External Calls	None
Errors	None

A .DJ call is generated for each adjustable array in a subprogram. It uses constant and adjustable dimensions to complete the dimensioning information in the array descriptor block, to the format described above.

GO TO

Routine	.GO
Purpose	Computes index of computed GO TO
Calling Sequence	LAC V / index value in A-register JMS* .GO -N / number of statement address STMT(1) STMT(2) STMT(N)
External Calls	OTSER
Errors	OTS 7 - illegal index (< 0)

STOP

Routine	.ST
Purpose	Processes STOP statement (returns to monitor)
Calling Sequence	LAC (number) /octal number to be printed JMS* .ST
External Calls	.SP
Errors	None

PAUSE

Routine	.PA
Purpose	Processes PAUSE. Waits for ↑P and returns control to user program (DOS), waits for operator to RESUME task being executed (RSX).
Calling Sequence	LAC (number) /octal number JMS* .PA
External Calls	.SP
Errors	None

Routine	.SP
Purpose	Prints octal number for PAUSE and STOP (DOS). Zero assumed if none supplied. See 4.4 for RSX behavior.
Calling Sequence	LAC (number) /octal integer JMS* .SP .DSA (control return for PAUSE) LAC (first character) . . . LAC (sixth character)
External Calls	None
Errors	None

OTSER

Routine	.ER
Purpose	To print error messages on Teletype and take action according to class of error
Calling Sequence	JMS* .ER .DSA (error number)
External Calls	None
Errors	None

OTSER
(continued)

Routine	.ZR
Purpose	Initializes END and ERR exits in READ and WRITE statements
Calling Sequence	JMS* .ZR .DSA END address .DSA ERR address (The AC is saved and restored to accommodate Direct Access I/O. Both addresses appear if either END or ERR is coded; if one of the two exits is not specified a zero appears instead of an address. The call sets a gate in OTSER to allow branching to the specified address when an OTS error would have occurred in the absence of the special exit.)
External Calls	None
Errors	None

Recoverable errors are indicated when bit 0 of the error number is a 1. In this case, the AC and link are restored to their original contents and control is returned to the calling program at the first location following the error.

Unrecoverable errors are indicated when bit 0 of the error number is 0. Control is returned to the monitor by means of an .EXIT function. In the case of an unrecoverable error in a FORMAT statement, the current 5/7 ASCII word pair of the erroneous FORMAT is also printed. The calling sequence for .ER for a FORMAT statement differs from other calls and is:

```
JMS* .ER
.DSA 12          / error number
LAC chars        / current 5 characters
LAC chars
```

PARTWD

Routine	.PB
Purpose	Part word fetch result in AC or ACMQ
Calling Sequence	JMS* .PB .DSA address
External Calls	None
Errors	None

PARTWD (continued)

Routine	.PC
Purpose	Stores contents of AC or ACMQ
Calling Sequence	JMS* .PC .DSA address
External Calls	None
Errors	None

4.2 FLOATING POINT PROCESSOR ROUTINES

General Interface Routine .FPP	Routine	.AX
	Purpose	FPP version of software .AX
	Routine	.AW
	Purpose	FPP version of software .AW
	Routine	.ZA
	Purpose	Loads high order mantissa of FPP AC into the regular AC
	Routine	.ZB
	Purpose	Initializes FPP error handling
	Routine	Entry point defined by JEA address
	Purpose	Error handling

Extended Integer (Double Integer) Interface Routines	Routine	.ZC
	Purpose	Converts integer in CPU AC to extended integer in FPP AC
	Routine	.ZD
	Purpose	Converts extended integer in FPP AC to single integer in CPU AC
	Routine	.ZE
	Purpose	Return, in AC, Ø if DI=Ø, 1 if DI>Ø, -1 if DI<Ø.

4.3 FORTRAN-CALLABLE UTILITY ROUTINES

These routines are described in Table 4-1.

4.4 RSX LIBRARY (.LIBRX BIN OR .LIBFX BIN) ROUTINES

A special set of routines is provided for use with XVM/RSX. These libraries include, in addition to the subprograms described previously, numerous FORTRAN-callable external subroutines for operations peculiar to RSX. For further details refer to the XVM/RSX System Manual.

Table 4-1
FORTRAN-Callable Utility Routines

Routine	ENTRY Name	Purpose	Calling Sequence	Examples	External Calls	Errors
Clock Handling - only one call may be active at any point in a user's program	TIME [1]	Records elapsed time in minutes and seconds on 60hz or 50hz machines	CALL TIME(IMIN,ISEC,IOFF) Where: IMIN = minutes ISEC = seconds IOFF = zero to start clock (Later setting IOFF to non-zero stops clock)	CALL TIME(IM,IS,IOF) A . . . IOF = 1 WRITE(4,100)IM,IS [outputs time to execute A]	.DA .TIMER	None
	TIME10 [1]	Records elapsed time in minutes, seconds, and tenths of seconds on 60hz or 50hz machines	CALL TIME10(IMIN,ISEC, ISEC10,IOFF) Where: IMIN = minutes ISEC = seconds ISEC10 = tenths of seconds IOFF = zero to start clock	See TIME	.DA .TIMER	None
Error Handling	ERRSET	Controls the number of run-time arithmetic errors output by OTSER	CALL ERRSET(N) Where: N = integer giving number of times message to be output before suppression. If ERRSET is not given, OTSER assumes N = 75. If N ≤ 0, no messages output.			

[1] Not supported with RSX. Other RSX supplied routines can be used for this purpose.

(continued next page)

OTS routines which have been modified for RSX are:

FIOPS - modified to use the RSX I/O CAL'S. .FP, which initializes the I/O status table has been converted to a dummy subroutine.

If a Negative Event Variable occurs as a result of a FIOPS issued I/O request, an error message (OTS 20) is issued and the task is EXITed.

SPMSG - rewritten to include the task name. The message is output to LUN 4 in the following format:

STOP - 000001 - TSKNAM

The PAUSE message is always output, but the STOP message is output only if its argument is non-zero.

STOP - uses RSX EXIT CAL

PAUSE - SUSPENDs the issuing task. To continue, the RESUME MCR function is used.

OTSER - passes its name and an octal OTS error message number to SPMSG.

Additional routine used by RSX for bank/page mode determination is .BP.

Two additional OTS routines are given below:

.ASCII to .SIXBT Conversion

Routine	.FTSB
Purpose	To convert two words from .ASCII to .SIXBT
Calling Sequence:	SUBA 0 JMS* .DAA / get call args JMP ARGEND FROM 0 / Pointer to ASCII word-pair ARGEND JMS* .FTSB .DSA FROM .DSA TO . . . TO .BLOCK 2 / two .SIXBT words

.DAA is a routine which performs the argument list transfer function formerly performed by .DA. The calling sequence has not been changed, but the transfer stops with the end of the shortest argument.

CHAPTER 5
FORTRAN-IV AND MACRO

In previous chapters, MACRO calling sequences have been given for OTS and Science Library Subprograms. This general form is used in a MACRO program to call any FORTRAN external subroutine or function. A FORTRAN program may also invoke MACRO subprograms. The method for each type of linkage is given below.

5.1 INVOKING MACRO SUBPROGRAMS FROM FORTRAN

A FORTRAN program may invoke any MACRO program whose name is declared in a MACRO .GLOBL statement. The MACRO subprogram must also include the same number of open registers as there are arguments. These will serve as transfer vectors for arguments supplied in the FORTRAN CALL statement or function reference. A FORTRAN-IV program and the MACRO subprogram it invokes are shown below. More extensive examples are given in Appendix C.

FORTRAN	MACRO

```
C                                       .TITLE  MIN
C       TEST MACRO SUBR                 .GLOBL  MIN,.DA
C       READ A NUMBER (A)       MIN     0               /ENTRY & EXIT
C                                       JMS*    .DA     /GENERAL GET
1       READ (1,100) A                                  /ARGUMENT.
100     FORMAT (E12.4)                  JMP     .+2+1   /JUMP AROUND
C                                                       /THE ARGUMENTS.
C       NEGATE THE NUMBER       MIN1    .DSA    0       /ARG1
C       AND PUT IT IN B         MIN2    .DSA    0       /ARG2
C                                       LAC*    MIN1    /FIRST WORD OF A
        CALL MIN (A,B)                  DAC*    MIN2    /STORE AT B
C                                       ISZ     MIN1    /POINT TO SECOND WORD
C       WRITE OUT NUMBER (B)            ISZ     MIN2    /OF A AND B.
C                                       LAC*    MIN1    /SECOND WORD OF A.
        WRITE (2,100) B                 RAL             /SIGN BIT = 1.
        STOP                            CML             /
        END                             RAR             /
                                        DAC*    MIN2    /STORE IN SECOND
                                                        /WORD OF B.
                                        JMP*    MIN     /EXIT
                                        .END
```

The FORTRAN statement CALL MIN(A,B) is expanded by the compiler to:

```
 00013   JMS* MIN              / to MACRO subprog
 00014   JMP  $00014
 00015   .DSA A
 00016   .DSA B
$00014 = 00017
```

When the FORTRAN-IV program is loaded, the addresses (plus relocation factor) of A and B are stored in registers 15 and 16, respectively. When the MACRO program invokes .DA, these addresses are stored in MIN1 and MIN2 and the values themselves are accessed by indirect reference.

Arguments are, as described above, transmitted by .DA using a single word. Bits 1-17 contain the 17-bit address of the first word. FORTRAN uses bit 0 to indicate that the word specifying the argument contains the address of a word containing the address of the first word of the argument. The MACRO argument word always contains the address of the first word of the argument. For array name arguments (unsubscripted), the address of the first word in the array is given. If the MACRO program needs to know the array dimensions, either they must be passed as parameters or .DA must not be used. The parameter list entry in a calling FORTRAN program for an array reads .DSA 400000 +address of last word of the Array Descriptor Block (ADB). From this, if .DA is not used at the called entry point, the address of the ADB can be obtained.

For external functions, the MACRO subprogram must return with a value in the AC (LOGICAL, INTEGER), AC-MQ (DOUBLE INTEGER) or in the floating accumulator (REAL or DOUBLE PRECISION).

5.2 INVOKING FORTRAN SUBPROGRAMS FROM MACRO

The MACRO calling conventions for FORTRAN subprograms are: the name of the subprogram must be declared as global; there must be a jump around the argument address; and the number and mode of arguments in the call must agree with those of the subprogram. This form is shown below.

```
.TITLE   MACPRG
.GLOBL   SUBR
JMS*     SUBR
JMP      .+N+1          / jump around arguments ignored by .DA
.DSA     ARG1           / address of first argument - bit 0 set to 1
.DSA     ARG2           / indicates indirect reference
   .
   .
   .
.DSA     ARGN
   .
   .
   .
```

When the subprogram is compiled, a call is generated to .DA which performs the transmission of arguments from MACRO. The beginning of a subroutine might be expanded as follows.

```
                C                       TITLE SUBR
                                        SUBROUTINE SUBR(A,B)
000000                                  CAL 0
000001                                  JMS* .DA
000002                                  JMP $000002
000003                                  .DSA A
000004                                  .DSA B
$000002 = 000005
```

If a value is to be returned by the subroutine, it is most convenient to have this be one of the calling arguments. An external function is called in the same manner as a subroutine but returns a value in the AC (single integers), AC-MQ (double integers), or floating accumulator (real and double-precision). To store the AC, the MACRO program uses a DAC instruction. Values from the floating accumulator may be stored via the OTS routines .AH (real) and .AP (double-precision). For FPP systems, values are returned in a hardware accumulator and stored with an FST instruction.

A number of examples of MACRO-FORTRAN linkage are given in Appendix C.

5.3 COMMON BLOCKS

FORTRAN COMMON blocks (and block-data subprograms) may be linked to MACRO programs.

Note that if the values are REAL (two words) or DOUBLE PRECISION (three words), the MACRO program must account for the number of words when accessing specific variables.

DOS and RSX MACRO programs may also use the .CBD pseudo-op. For instance

```
BASE1  .CBD     NAME, 1
```

will provide the base address of the common block NAME in the word that is created and labeled BASE1; the size of the common block is 1. For blank common (which is given the special system name of .XX), use for example:

```
BASE2  .CBD     .XX, 2
```

APPENDIX A

FORTRAN LANGUAGE SUMMARY

A.1 EXPRESSION OPERATORS

Operators in each type are shown in order of descending precedence.

Type	Operator		Operates Upon
Arithmetic	**	exponentiation	arithmetic or logical constants, variables, array elements, function references and expressions
	-	unary minus	
	*,/	multiplication, division,	
	+,-	addition and subtraction (but not unary minus)	
Relational	.GT.	greater than	arithmetic or logical constants, variables, array elements, function references and expressions (all relational operators have equal priority)
	.GE.	greater than or equal to	
	.LT.	less than	
	.LE.	less than or equal to	
	.EQ.	equal to	
	.NE.	not equal to	
Logical	.NOT.	.NOT.A is true if and only if A is false	logical or integer constants, variables, array elements, function references and expressions
	.AND.	A.AND.B is true if and only if A and B are both true	
	.OR.	A.OR.B is true if and only if either A or B or both are true	
	.XOR.	A.XOR.B is true if and only if A is true and B is false or B is true and A is false	

A.2 STATEMENTS

The following summary of statements available in the FORTRAN IV XVM language defines the general format for the statement. If more detailed information is needed, the reader is referred to the Section(s) in the FORTRAN IV XVM Language Manual dealing with that particular statement.

Statement Formats	Effect	FORTRAN IV XVM Language Manual Section
Arithmetic/Logical Assignment		
$v_1=v_2=\ldots v_n=e$		3.1
v_i	is a variable name or an array element name	
e	is an expression	
	The value of the arithmetic or logical expression is assigned to each variable, from right to left.	
Arithmetic Statement Function		
f(p[,p]...)=e		8.1.1
f	is a symbolic name	
p	is a symbolic name	
e	is an arithmetic expression	
	Creates a user-defined function having the variables p as dummy arguments. When referenced, the expression is evaluated using the actual arguments in the function call.	
ASSIGN s TO v		3.3
s	is an executable statement label	
v	is an integer variable name	
	Associate the statement number s with the integer variable v for later use in an assigned GO TO statement.	

Statement Formats	Effect	FORTRAN IV XVM Language Manual Section
BACKSPACE u		6.8.2
u	is an integer variable or constant	
	The currently open file on logical unit number u is backspaced one record.	
BLOCK DATA		8.1.5
	Specifies the subprogram which follows as a BLOCK DATA subprogram.	
CALL s[(a[,a]...)]		4.5
s	is a subprogram name	
a	is an expression, a procedure name, or an array name	
	Calls the SUBROUTINE subprogram with the name specified by s, passing the actual arguments a to replace the dummy arguments in the SUBROUTINE definition.	
COMMON [/[cb]/] nlist [/[cb]/ nlist] ...		5.4
cb	is a common block name	
nlist	is a list of one or more variable names, array names, or array declarators separated by commas.	
	Reserves one or more blocks of storage space under the name specified to contain the variables associated with that block name.	
CONTINUE		4.4
	Causes no processing, and is most often used to terminate DO loops.	
DATA nlist/clist/[,nlist/clist/]...		5.7
nlist	is a list of one or more variable names, array names, or array element names separated by commas. Subscript expressions must be constant.	
clist	is a list of one or more constants separated by commas, each optionally preceded by j*, where j is a nonzero, unsigned integer constant.	
	Causes elements in the list of values to be initially stored in the corresponding elements of the list of variable names.	

Statement Formats	Effect	FORTRAN IV XVM Language Manual Section
DECODE (c,a[f][,ERR=s])[list]		6.9
c	is an integer expression	
a	is an array name	
f	is a FORMAT statement label or array name	
s	is a statement label	
list	is an I/O list	
	Changes the elements in the I/O list from ASCII into the desired internal format; c specifies the number of characters, f specifies the format, and a is the name of an array containing the ASCII characters to be converted.	
DIMENSION a(d)[,a(d)]...		5.3
a(d)	is an array declarator	
	Specifies storage space requirements for arrays.	
DO s i = v1,v2[,[-]v3]		4.3
s	is the label of an executable statement	
i	is an integer variable name	
vn	are integer expressions	
	1. Set i = v1	
	2. Execute statements through statement number s	
	3. Evaluate i = i+v3	
	4. Repeat 2 through 3 for INT((v2-v1)/v3) iterations	
ENCODE (c,a,[f][,ERR=s])[list]		6.9
c	is an integer expression	
a	is an array name	
f	is a FORMAT statement label or an array name	
s	is a statement label	
list	is an I/O list	

Statement Formats	Effect	FORTRAN IV XVM Language Manual Section
ENCODE (cont.)	Changes the elements in the list of variables into ASCII format; c specifies the number of characters in the buffer, f specifies the format statement number, and a is the name of the array to be used as a buffer.	
END	Specifies the physical end of a program unit.	4.9
ENDFILE u u is an integer variable or constant	An end-file record is written on logical unit u, following output statements to that unit.	6.8.3
ENTRY nam(p[,p]...) nam is a symbolic name p is a symbolic name	Defines an alternate entry point within a SUBROUTINE or FUNCTION subprogram.	8.1.4
EQUIVALENCE (nlist)[,(nlist)]... nlist is a list of two or more variable names, array names, or array element names separated by commas. Subscript expressions must be constant.	Each of the names (nlist) within a set of parentheses is assigned beginning at the same storage location.	5.5
EXTERNAL v[,v]... v is a procedure name	Informs the system that the names specified are those of FUNCTION or SUBROUTINE programs.	5.6
EXTERNAL v[,v]... v is a procedure name	Informs the system that the names specified are user-defined.	5.6

Statement Formats	Effect	FORTRAN IV XVM Language Manual Section
FORMAT (field specification, ...)	Describes the format in which one or more records are to be transmitted; a statement label must be present.	7.1 - 7.8
[typ] FUNCTION nam(p[,p]...)	Begins a FUNCTION subprogram, indicating the program name and any dummy argument names, p. An optional type specification can be included.	8.1.2
typ	is a type specifier	
nam	is a symbolic name	
p	is a symbolic name	
GO TO s	(Unconditional GO TO) Transfers control to statement number s.	4.1.1
s	is an executable statement label	
GO TO (slist), v	(Computed GO TO) Transfers control to the statement label specified by the value v. (If v=1 control transfers to the first statement label. If v=2 it transfers to the second statement label, etc.) If v is less than 1 or greater than the number of statement labels present, no transfer takes place.	4.1.2
slist	is a list of one or more executable statement labels separated by commas.	
v	is an integer variable	
GO TO v[,(slist)]	(Assigned GO TO) Transfers control to the statement most recently associated with v by an ASSIGN statement.	4.1.3
v	is an integer variable name	
slist	is a list of one or more executable statement labels separated by commas	

Statement Formats	Effect	FORTRAN IV XVM Language Manual Section
IF (e) v1,v2,v3		4.2.1
e	is an expression	
vi	are executable statement labels or variables to which statement labels have been ASSIGNed	
	(Arithmetic IF) Transfers control to statement number vi depending upon the value of the expression. If the value of the expression is less than zero, transfer to v1; if the value of the expression is equal to zero, transfer to v2; if the value of the expression is greater than zero, transfer to v3.	
IF (e) st		4.2.2
e	is an expression	
st	is any executable statement except a DO or a logical IF statement	
	(Logical IF) Executes the statement if the logical expression is true.	
IMPLICIT typ (a[,a]...)[,typ(a[,a]...)]...		5.1
typ	is a data type specifier	
a	is either a single letter, or two letters in alphabetical order separated by a dash (i.e., x-y)	
	The elements a represent single (or a range of) letter(s) whose presence as the initial letter of a variable specifies the variable to be of that type.	
PAUSE [disp]		4.7
disp	is an octal integer constant	
	Suspends program execution and prints the display, if one is specified.	
PRINT	See WRITE for which PRINT is a synonym.	6.4.5
READ (u,[f][,END=s][,ERR=s])[list]		6.4.1
u	is an integer variable or constant	
f	is a FORMAT statement label or an array name	
s	is an executable statement label	

Statement Formats	Effect	FORTRAN IV XVM Language Manual Section
READ (u,[f][,END=s][,ERR=s])[list] (cont.)		
list	is an I/O list	
	(Formatted Sequential) Reads at least one logical record from device u according to format specifications f and assigns values to the variables in the optional list.	
READ (u'r ,[f][,ERR=s])(list)		6.6.1
u	is an integer variable or constant	
r	is an integer expression	
f	is a FORTRAN statement label or an array name	
s	is an executable statement label	
list	is an I/O list	
	(Formatted Direct Access READ) Reads record number r from unit u and assigns values to the elements of the list according to format f.	
READ(u[,END=s][,ERR=s])[list]		6.3.1
u	is an integer variable or constant	
s	is an executable statement label	
list	is an I/O list	
	(Unformatted Sequential READ) Reads one unformatted record from device u, assigning values to the variables in the optional list.	
READ(u'r[,ERR=s])[list]		6.5.1
u	is an integer variable or constant	
r	is an integer expression	
s	is an executable statement label	
list	is an I/O list	
	(Unformatted Direct Access READ) Reads record r from logical unit u, assigning values to the variables in the optional list.	

Statement Formats	Effect	FORTRAN IV XVM Language Manual Section
RETURN [v]		4.6
v	is an integer variable	
	Returns control to the calling program from the current subprogram. If v is specified, control is returned to the statement label associated with v in the subprogram call.	
REWIND u		6.8.1
u	is an integer variable or constant	
	Repositions logical unit number u to the beginning of the physical medium or to the currently opened file.	
STOP [disp]		4.8
disp	is an octal integer constant	
	Terminate program execution and print the display, if one is specified.	
SUBROUTINE nam[(p[,p]...)]		8.1.3
nam	is a symbolic name	
p	is a symbolic name	
	Begins a SUBROUTINE subprogram, indicating the program name and any dummy argument names, p.	
TYPE	See WRITE, for which TYPE is a synonym.	
Type Declaration		
typ v[,v]...		5.2
typ	is a data type specifier, one of:	
	DOUBLE PRECISION REAL DOUBLE INTEGER INTEGER LOGICAL	
v	is a variable name, an array name, a function or function entry name, or an array declarator.	

Statement Formats	Effect	FORTRAN IV XVM Language Manual Section
typ v[,v]... (cont.)	(Type Declarations) The symbolic names, v, are assigned the specified data type in the program unit.	
WRITE (u,[f][,ERR=s])[list]		6.4.2
u	is an integer variable or constant	
f	is a FORMAT statement label or an array name	
s	is an executable statement label	
list	is an I/O list	
	(Formatted sequential WRITE) Causes one or more logical records containing the values of the variables in the optional list to be written onto device u, according to the format specification f.	
WRITE (u'r,[f][,ERR=s])[list]		6.6.2
u	is an integer variable or constant	
r	is an integer expression	
f	is a FORMAT statement label or an array name	
s	is an executable statement label	
list	is an I/O list	
	(Formatted Direct Access WRITE) Causes a record formed from the list and format f to be written onto record r of unit u.	
WRITE (u[,ERR=s])[list]		6.3.2
u	is an integer variable or constant	
s	is an executable statement label	
list	is an I/O list	
	(Unformatted Sequential WRITE) Causes one unformatted record containing the values of the variables in the optional list to be written onto device u.	

Statement Formats	Effect	FORTRAN IV XVM Language Manual Section
WRITE (u'r[,ERR=s]) [list]		6.5.2
u	is an integer variable or constant	
r	is an integer expression	
s	is an executable statement label	
list	is an I/O list	
	(Unformatted Direct Access WRITE) Causes a record containing the values of the variables in the list to be written onto record r of logical unit u.	
END=s,ERR=s		6.7
	(Transfer of control on end-of-file or error condition) Is an optional element in each type of I/O statement allowing the program to transfer to statement number s on an end-of-file (END=) or error (ERR=) condition.	

Table A-1
FORTRAN Library Functions

FORM	DEFINITION	ARGUMENT TYPE	RESULT TYPE
ABS(X)	Real absolute value	Real	Real
IABS(I)	Integer absolute value	Integer	Integer
DABS(X)	Double precision absolute value	Double P	Double P
JABS(I)	Double Integer absolute value	Double I	Double I
FLOAT(I)	Integer to Real conversion	Integer	Real
IFIX(X)	Real to Integer conversion IFIX(X) is equivalent to INT(X)	Real	Integer
SNGL(X)	Double precision to Real conversion	Double P	Real
DBLE(X)	Real to Double precision conversion	Real	Double P
JFIX(X)	Real to Double integer conversion	Real	Double I
JFIX(X)	Double precision to Double integer conversion	Double P	Double I
ISNGL(I)	Double integer to integer conversion	Double I	Integer
JDBLE	Integer to Double integer	Integer	Double I
JDFIX(X)	Double precision to Double integer conversion	Double P	Double I
FLOATJ(I)	Double integer to Real conversion	Double I	Real
DBLEJ(I)	Double integer to Double precision conversion	Double I	Double P
	Truncation functions return the sign of the argument * largest integer $\leq$ |arg|		
AINT(X)	Real to Real truncation	Real	Real
INT(X)	Real to Integer truncation	Real	Integer
IDINT(X)	Double precision to Integer truncation	Double P	Integer
JINT(X)	Real to Double integer truncation	Real	Double I
JDINT(X)	Double precision to Double integer truncation	Double P	Double I
	Remainder functions return the remainder when the first argument is divided by the second.		
AMOD(X,Y)	Real remainder (x/y<131072)	Real	Real
MOD(I,J)	Integer remainder	Integer	Integer
DMOD(X,Y)	Double precision remainder (x/y<131072)	Double P	Double P
JMOD(I,J)	Double integer remainder (I/J < 131072)	Double I	Double I
	Maximum value functions return the largest value from among the argument list; $\geq$ 2 arguments.		
AMAXØ(I,J,...)	Real maximum from Integer list	Integer	Real
AMAX1(X,Y,...)	Real maximum from Real list	Real	Real
MAXØ (I,J,...)	Integer maximum from Integer list	Integer	Integer
MAX1(X,Y,...)	Integer maximum from Real list	Real	Integer

(continued on next page)

Table A-1 (Cont.)
FORTRAN Library Functions

FORM	DEFINITION	ARGUMENT TYPE	RESULT TYPE
DMAX1(X,Y,...)	Double precision maximum from Double precision list	Double P	Double P
JMAXØ(I,J,...)	Double integer maximum from Double integer list	Double I	Double I
	Minimum value functions return the smallest value from among the argument list; ≥ 2 arguments.		
AMINØ(I,J,...)	Real minimum of Integer list	Integer	Real
AMIN1(X,Y,...)	Real minimum of Real list	Real	Real
MINØ(I,J,...)	Integer minimum of Integer list	Integer	Integer
MIN1(X,Y,...)	Integer minimum of Real list	Real	Integer
DMIN1(X,Y,...)	Double minimum of Double list	Double P	Double P
JMINØ(I,J,...)	Double integer minimum of Double integer list	Double I	Double I
	The transfer of sign functions return (sign of the second argument) * (absolute value of the first argument).		
SIGN(X,Y)	Real transfer of sign	Real	Real
ISIGN(I,J)	Integer transfer of sign	Integer	Integer
DSIGN(X,Y)	Double precision transfer of sign	Double P	Double P
JSIGN(I,J)	Double integer transfer of sign	Double I	Double I
	Positive difference functions return the first argument minus the minimum of the two arguments.		
DIM(X,Y)	Real positive difference	Real	Real
IDIM(I,J)	Integer positive difference	Integer	Integer
JDIM(I,J)	Double integer positive difference	Double I	Double I
	Exponential functions return the value of e raised to the argument power.		
EXP(X)	e^x $(x \geq Ø)$	Real	Real
DEXP(X)	e^x $(x \geq Ø)$	Double P	Double P
ALOG(X)	Returns $\log_e(X)$	Real	Real
ALOG1Ø(X)	Returns $\log_{1Ø}(X)$	Real	Real
DLOG(X)	Returns $\log_e(X)$	Double P	Double P
DLOG1Ø(X)	Returns $\log_{1Ø}(X)$	Double P	Double P
	$x \geq Ø$		
SQRT(X)	Square root of Real argument $(x \geq Ø)$	Real	Real
DSQRT(X)	Square root of Double precision argument $(x \geq Ø)$	Double P	Double P
SIN(X)	Real sine	Real	Real
DSIN(X)	Double precision sine	Double P	Double P

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Table A-1 (Cont.)
FORTRAN Library Functions

FORM	DEFINITION	ARGUMENT TYPE	RESULT TYPE
COS(X)	Real cosine	Real	Real
DCOS(X)	Double precision cosine	Double P	Double P
TANH(X)	Hyperbolic tangent	Real	Real
ATAN(X)	Real arc tangent	Real	Real
DATAN(X)	Double precision arc tangent	Double P	Double P
ATAN2(X,Y)	Real arc tangent of (X/Y)	Real	Real
DATAN2(X,Y)	Double precision arc tangent of (X/Y)	Double P	Double P

APPENDIX B
ERROR MESSAGES

B.1 COMPILER ERROR MESSAGES

Compiler error messages are printed in the form:

>mnA<

where:

mn is the error number
A is the alphabetic mnemonic characterizing the error class.

All error messages are given below.

Number	Letter	Meaning
		Common, equivalence, data errors:
01	C	No open parenthesis after variable name in DIMENSION statement
02	C	No slash after common block name
03	C	Common block name previously defined
04	C	Variable appears twice in COMMON
05	C	EQUIVALENCE list does not begin with open parenthesis
06	C	Only one variable in EQUIVALENCE class
07	C	EQUIVALENCE distorts COMMON
08	C	EQUIVALENCE extends COMMON down
09	C	Inconsistent EQUIVALENCing
10	C	EQUIVALENCE extends COMMON down
11	C	Illegal delimiter in EQUIVALENCE list

(continued on next page)

Number	Letter	Meaning
		Common, equivalence, data errors: (cont)
12	C	Non-COMMON variables in BLOCK DATA
15	C	Illegal repeat factor in DATA statement
16	C	DATA statement stores in COMMON in non-BLOCK DATA statement or in non-COMMON in BLOCK DATA statement
		DO errors:
01	D	Statement with unparenthesized = sign and comma not a DO statement
04	D	DO variable not followed by = sign
05	D	DO variable not integer
06	D	Initial value of DO variable not followed by comma
07	D	Improper delimiter in DO statement
09	D	Illegal terminating statement for DO loop
		External symbol and entry-point errors:
01	E	Variable in EXTERNAL statement not simple non-COMMON variable or simple dummy variable
02	E	ENTRY name non-unique
03	E	ENTRY statement in main program
04	E	No = sign following argument list in arithmetic statement function
05	E	No argument list in FUNCTION subprogram
06	E	Subroutine list in CALL statement already defined as variable
08	E	Function or array name used in expression without open parenthesis
09	E	Function or array name used in expression without open parenthesis
		Format errors:
01	F	Bad delimiter after FORMAT number in I/O statement
02	F	Missing field width, illegal character or unwanted repeat factor
03	F	Field width is 0
04	F	Period expected, not found
05	F	Period found, not expected
06	F	Decimal length missing (no "d" in "Fw.d")
07	F	Missing left parenthesis

(continued on next page)

Number	Letter	Meaning
		Format errors: (cont)
08	F	Minus without number
09	F	No P after negative number
10	F	No number before P
12	F	No number or 0 before H
13	F	No number or 0 before X
15	F	Too many left parentheses
		Hollerith errors:
02	H	More than two characters in Integer or logical Hollerith constant
03	H	Number preceding H not between 1 and 5
04	H	Carriage return inside Hollerith field
05	H	Number preceding H not an integer
06	H	More than five characters inside quotes
07	H	Carriage return inside quotes
		Various illegal errors:
01	I	Unidentifiable statement
02	I	Misspelled statement
03	I	Statement out of order
04	I	Executable statement in BLOCK DATA subroutine
05	I	Illegal character in I/O statement, following unit number
06	I	Illegal delimiter in ASSIGN statement
07	I	Illegal delimiter in ASSIGN statement
08	I	Illegal type in IMPLICIT statement
09	I	Logical IF as target of logical IF
10	I	RETURN statement in main program
11	I	Semicolon in COMMON statement outside of BLOCK DATA
12	I	Illegal delimiter in IMPLICIT statement
13	I	Misspelled REAL or READ statement
14	I	Misspelled END or ENDFILE statement
15	I	Misspelled ENDFILE statement
16	I	Statement function out of order or undimensioned array
17	I	Typed FUNCTION statement out of order
18	I	Illegal character in context
19	I	Illegal logical or relational operator

(continued on next page)

Number	Letter	Meaning
		Various illegal errors: (cont)
20	I	Illegal letter in IMPLICIT statement
21	I	Illegal letter range in IMPLICIT statement
22	I	Illegal delimiter in letter section of IMPLICIT statement
23	I	Illegal character in context
24	I	Illegal comma in GOTO statement
26	I	Illegal variable used in multiple RETURN statement
		Pushdown list errors:
01	L	DO nesting too deep
02	L	Illegal DO nesting
03	L	Subscript/function nesting too deep
04	L	Backwards DO loop (also caused by some illegal I/O lists). Appears after END statement.
		Overflow errors:
01	M	EQUIVALENCE class list full
02	M	Program size exceeds 8K
03	M	Local array length larger than 8K
04	M	Element position in local array larger than 8K or in common array larger than 32K (EQUIVALENCE, DATA)
06	M	Integer negative or larger than 131071
07	M	Exponent of floating point number larger than 76
08	M	Overflow accumulating constant - too many digits
09	M	Overflow accumulating constant - too many digits
10	M	Overflow accumulating constant - too many digits
		Statement number errors:
01	N	Multiply defined statement number or compiler error
02	N	Statement erroneously labeled
03	N	Undefined statement number
04	N	FORMAT statement without statement number
05	N	Statement number expected, not found
07	N	Statement number more than five digits
08	N	Illegal statement number
09	N	Invalid statement label or continuation

(continued on next page)

Number	Letter	Meaning
		Partword errors:
01	P	Expected colon, found none
02	P	Expected close bracket, found none
03	P	Last bit number larger than 35
04	P	First bit number larger than last bit number
05	P	First and last bit numbers not simple integer constants
		Subscripting errors:
01	S	Illegal subscript delimiter in specification statements
02	S	More than three subscripts specified
03	S	Illegal delimiter in subroutine argument list
04	S	Non-integer subscript
05	S	Non-scalar subscript
06	S	Integer scalar expected, not found
10	S	Two operators in a row
11	S	Close parenthesis following an operator
12	S	Adjustable dimension not in dummy array
13	S	Adjustable dimension not a dummy integer
14	S	Two arguments in a row
15	S	Digit or letter encountered after argument conversion
16	S	Number of subscripts stated not equal to number declared
		Table overflow errors:
01	T	Arithmetic statement, computed GOTO list, or DATA statement list too large
02	T	Too many dummy variables in arithmetic statement function
03	T	Symbol and constant tables overlap
		Variable errors:
01	V	Two modes specified for same variable name
02	V	Variable expected, not found
03	V	Constant expected, not found
04	V	Array defined twice
05	V	Error: variable is EXTERNAL or argument (EQUIVALENCE, DATA)
07	V	More than one dimension indicated for scalar variable

(continued on next page)

Number	Letter	Meaning
		Variable errors: (cont)
08	V	First character after READ or WRITE not open parenthesis in I/O statement
09	V	Illegal constant in DATA statement
11	V	Variables outnumber constants in DATA statement
12	V	Constants outnumber variables in DATA statement
14	V	Illegal dummy variable (previously used as non-dummy variable)
16	V	Logical operator has non-integer, non-logical arguments
17	V	Illegal mixed mode expression
19	V	Logical operator has non-integer, non-logical arguments
21	V	Signed variable left of equal sign
22	V	Illegal combination for exponentiation
25	V	.NOT. operator has non-integer, non-logical argument
27	V	Function in specification statement
28	V	Two exponents in one constant
29	V	Illegal redefinition of a scalar as a function
30	V	No number after E or D in a constant
32	V	Non-integer record number in random access I/O
35	V	Illegal delimiter in I/O statement
36	V	Illegal syntax in READ, WRITE, ENCODE, or DECODE statement
37	V	END and ERR exits out of order in I/O statement
38	V	Constant and variable modes don't match in DATA statement
39	V	ENCODE or DECODE not followed by open parenthesis
40	V	Illegal delimiter in ENCODE/DECODE statement
41	V	Array expected as first argument of ENCODE/DECODE statement
42	V	Illegal delimiter in ENCODE/DECODE statement
		Expression errors:
01	X	Carriage return expected, not found
02	X	Binary WRITE statement with no I/O list
03	X	Illegal element in I/O list
04	X	Illegal statement number list in computed or assigned GOTO
05	X	Illegal delimiter in computed GOTO
07	X	Illegal computed GOTO statement

(continued on next page)

Number	Letter	Meaning
		Expression errors: (cont)
10	X	Illegal delimiter in DATA statement
11	X	No close parenthesis in IF statement
12	X	Illegal delimiter in arithmetic IF statement
13	X	Illegal delimiter in arithmetic IF statement
14	X	Expression on left of equals sign in arithmetic statement
15	X	Too many right parentheses
16	X	Illegal open parenthesis (in specification statements)
17	X	Illegal open parenthesis
19	X	Too many right parentheses
20	X	Illegal alphabetic in numeric constant
21	X	Symbol contains more than six characters
22	X	.TRUE., .FALSE., or .NOT. preceded by an argument
23	X	Unparenthesized comma in arithmetic expression
24	X	Unary minus in I/O list
26	X	Illegal delimiter in I/O list
27	X	Unterminated implied - DO loop in I/O list
28	X	Illegal equals sign in I/O list
29	X	Illegal partword operator
30	X	Illegal arithmetic expression
31	X	Illegal operator sequence
32	X	Illegal use of =.

B.2 OTS ERROR MESSAGES

Following is a list of OTS error messages. (R) indicates a recoverable error; (T) a terminal error.

Error Number	Error Description	Possible Source
05 (R)	Negative REAL square root argument	SQRT
06 (R)	Negative DOUBLE PRECISION square root argument	DSQRT
07 (R)	Illegal index in computed GO TO	.GO
10 (T)	Illegal I/O device number	.FR, .FW, .FS, .FX, DEFINE, RANCOM
11 (T)	Bad input data - IOPS mode incorrect	.FR, .FA, .FE, .FF, .FS, RANCOM, RBINIO, RBCDIO

(continued on next page)

	12 (T)	Bad FORMAT	.FA, .FE, .FF
	13 (T)	Negative or zero REAL logarithmic argument	.BC, .BE, ALOG
	14 (R)	Negative or zero DOUBLE PRECISION logarithmic argument	.BD, .BF, .BG, .BH, DLOG, DLOG10
	15 (R)	Zero raised to a zero or negative power (zero result is passed)	.BB, .BC, .BD, .BE, .BF, .BG, .BH
	16 (R)	ATAN2 (Ø.Ø,Ø.Ø) attempted; PI/2 returned	ATAN2
	17 (R)	DATAN2 (Ø.Ø,DØ,Ø.ØDØ) attempted; PI/2 returned	DATAN2
	20 (T)	Fatal I/O error (RSX only)	FIOPS
direct access errors	21 (T)	Undefined file	RANCOM
	22 (T)	Illegal record size	DEFINE
	23 (T)	Size discrepancy	RANCOM
	24 (T)	Too many records per file or illegal record number	DEFINE, RANCOM
	25 (T)	Mode discrepancy	RANCOM
	26 (T)	Too many open files	DEFINE
	30 (R)	Single integer overflow[1]	RELEAE, .FPP
	[2] 31 (R)	Extended (double) integer overflow[4]	DBLINT, JFIX, JDFIX, ISNGL
	[2] 32 (R)	Single floating point overflow	RELEAE
	[2] 33 (R)	Double floating point overflow†	
	[2] 34 (R)	Single floating point underflow	RELEAE
	[2] 35 (R)	Double floating point underflow†	
	[2] 36 (R)	Floating point divide check	RELEAE
	[3] 37 (R)	Integer divide check	INTEAE
	40 (T)	Illegal number of characters specified [legal: $0 < c \leq 625$]	ENCODE
	41 (R)	Array exceeded	ENCODE
	42 (T)	Bad input data	DD10
	[2] 50 (T)	FPP memory protect/non-existent memory	
	51 (T)	READ to WRITE illegal I/O Direction Change to Disk without intervening CLOSE or REWIND	BCDIO, BINIO
	52 (T)	Attempt to initialize JEA register on a machine without floating point hardware	

[1]Only detected when fixing a floating point number.
[2]Also prints out PC with FPP system
[3]If extended integer divide check, prints out PC with FPP system.
[4]With non-floating Point Processor system, only detected when fixing a floating point number.
†Not detected by software floating point routines (only by FPP system).

B.3 OTS ERROR MESSAGES IN FPP SYSTEMS

In software systems, arithmetic errors resulting in the OTS error messages summarized above are detected in the arithmetic package (RELEAE and INTEAE). In the hardware FPP systems, these errors are detected by the hardware (with the exception of single integer divide check) and serviced by a trap routine in the FPP routine .FPP.

Where applicable, on such error conditions, a value is assumed as the final result of the computation. Where a "none" value is indicated, the results are meaningless. Results differ depending upon whether or not floating point hardware is used.

Error	ASSUMED VALUE	
	FPP Hardware	FPP Software
Single Floating Overflow (.OTS 32)	± largest single floating value	±largest single floating value
Double Floating Overflow (.OTS 33)	± largest single floating value	not detected
Single Floating Underflow (.OTS 34)	zero	zero
Double Floating Underflow (.OTS 35)	zero	not detected
Floating Divide Check (.OTS 36)	± largest single floating value	±largest single floating value
Integer Overflow (.OTS 30)	limited detection [1]	limited detection
Double Integer Overflow (.OTS 31)	none [2]	limited detection [1]
Integer Divide Check (.OTS 37)	none	none

Further, when converting an extended integer, the magnitude of which is $2^{17}-1$, to a single integer, no error is indicated and the high order digits are lost.

[1]When fixing a floating point number, integer and extended integer overflow is detected. In these instances, plus or minus the largest integer for the data mode is assumed as the result.

[2]With the FPP hardware all extended double integer overflow conditions are detected, but the results are meaningless.

APPENDIX C
PROGRAMMING EXAMPLES

C.1 A FUNCTION TO READ THE AC SWITCHES

It is frequently desirable to use the AC switches of the XVM CPU to alter the sequence of instructions executed in a FORTRAN program. The following program can be used as a function in an arithmetic IF statement to conditionally branch.

```
        .TITLE  ITOG
/
/ SUBROUTINE TO READ AC SWITCHES
/
/ MACRO CALLING SEQUENCE
/               .GLOBL  ITOG
/               JMS*    ITOG
/               JMP     .+2       /JUMP OVER ARGUMENT
/               .DSA    (MASK)    /ADDRESS OF MASK
/                                 /RETURN WITH MASKED ACS IN AC.
        .GLOBL  ITOG..DA
ITOG    0                         /INTEGER FUNCTION
        JMS*    .DA               /GET ARGUMENTS
        JMP     .+1+1             /ONE ARGUMENT
MASK    0                         /MASK ADDRESS
        LAS                       /LOAD AC FROM SWITCHES
        AND*    MASK              /MASK AC
        JMP*    ITOG              /RETURN WITH MASKED AC SWITCHES
        .END
```

C.2 IFLOW AND IDZERO EXAMPLES

The following is a programming example of both the IFLOW and IDZERO functions.

```
C
C       MAIN PROGRAM TO SHOW USE OF IFLOW AND IDZERO
C
        A = 10. ** 70
        B = 10. ** 10
1       C = A * B
C
C       CALL SUBROUTINE TO CHECK FOR UNDERFLOW , OVERFLOW
C       AND DIVISION BY ZERO.
C
        CALL CHECK (1)
        PAUSE 1
2       C = (10. ** (-70)) * 10. ** (-20)
        CALL CHECK (1)
```

(continued on next page)

```
        PAUSE 2
3       C = A/0.
        CALL CHECK (1)
        PAUSE 3
        STOP
        END


C       SUBROUTINE TO CHECK FOR UNDERFLOW, OVERFLOW OR
C       DIVISION BY ZERO IN FLOATING POINT ARITHMETIC.
C       PASSING A NON-ZERO POSITIVE ARGUMENT WILL CHECK
C       FOR ALL.  A ZERO ARGUMENT RESULTS IN NO CHECKING.
C
        SUBROUTINE CHECK (N)
        LOGICAL IFLOW,IDZERO
        IF (IFLOW(N)) WRITE (1,10)
        IF (IFLOW(-N)) WRITE (1,11)
        IF (IDZERO(N)) WRITE (1,12)
10      FORMAT (/9H OVERFLOW)
11      FORMAT (/10H UNDERFLOW)
12      FORMAT (/13H DIV. BY ZERO)
        RETURN
        END
```

The result of running these programs is (with .DAT slot 1 assigned to the TTA):

NOTE

The "OTS nn" and "PC=nnnnnn" lines are not typed on systems which do not have hardware floating point.

```
 .OTS 32
PC=077522


OVERFLOW
PAUSE 000001
^P .OTS 34
PC=077553

UNDERFLOW
PAUSE 000002
^P .OTS 36
PC=077564

DIV. BY ZERO
PAUSE 000003
^P
STOP  000000
```

C.3 INPUT-OUTPUT EXAMPLES

The following is a program composed mainly of I/O statements with no connected purpose. The program is presented to illustrate the possible combinations of the different types of I/O (sequential access, direct access, data-directed, ENCODE/DECODE).

```
0001     C
0002     C        PROGRAM EXAMPLE TO SHOW OBJECT CODE OUTPUT FOR
0003     C        VARIOUS TYPES OF I/O STATEMENTS.
0004     C
0005              IMPLICIT REAL (N)
0006              DIMENSION RL1(2),RL2(3),ARR(20),NM1(2),NM2(2)
0007              DATA NM1/'NAME1','ASRC'/,NM2/'NAME2','ASRC'/
 00646 472031 542542
 00650 406472 241500
 00657 472031 542544
 00661 406472 241500
0008     C
0009     100      FORMAT (I5,G10.3,2(E12.2))
 00000  JMP  $00000
 00001  .DSA 242226
 00002  .DSA 526216
 00003  .DSA 305405
 00004  .DSA 631530
 00005  .DSA 311210
 00006  .DSA 530544
 00007  .DSA 271445
 00010  .DSA 124500
 $00000 = 00011
0010     200      FORMAT (1X,I5,G10.3,2(E12.2))
 00011  JMP  $00011
 00012  .DSA 241433
 00013  .DSA 026222
 00014  .DSA 325310
 00015  .DSA 730540
 00016  .DSA 271465
 00017  .DSA 431120
 00020  .DSA 42542b
 00021  .DSA 227144
 00022  .DSA 245224
 00023  .DSA 020100
 $00011 = 00024
0011              CALL DEFINE (2,100,5,5,JVB,0,0,0)
 00024  JMS* DEFINE
 00025  JMP  00036
 00026  .DSA (000002
 00027  .DSA (000144
 00030  .DSA (000005
 00031  .DSA (000005
 00032  .DSA JVB
 00033  .DSA (000000
 00034  .DSA (000000
 00035  .DSA (000000
0012              CALL DEFINE (4,600,10,0,JVA,5,0,0)
 00036  JMS* DEFINE
 00037  JMP  00050
 00040  .DSA (000004
 00041  .DSA (001130
 00042  .DSA (000012
 00043  .DSA (000000
 00044  .DSA JVA
 00045  .DSA (000005
```

```
 00046   .DSA (000000
 00047   .DSA (000000
0013              CALL SEEK (5,NM1)
 00050   JMS* SEEK
 00051   JMP  00054
 00052   .DSA (000005
 00053   .DSA 400000 +NM1
0014              CALL ENTER (6,NM2)
0015     C
0016     C         1.  BINARY
0017     C                   A.  DIRECT ACCESS
0018     C
 00054   JMS* ENTER
 00055   JMP  00060
 00056   .DSA (000006
 00057   .DSA 400000 +NM2
0019              READ (2'JVB) INT,RL2(3),RL1
 00060   LAC  JVB
 00061   JMS* .RS
 00062   .DSA (000002
 00063   .DSA 777777
 00064   JMS* .RJ
 00065   .DSA INT
 00066   CMA!CLA
 00067   TAD  (000003
 00070   RCL
 00071   TAD  RL2
 00072   DAC  $00072
 00073   .DSA 77777o
 00074   JMS* .RJ
$00072 = 00075
 00075   .DSA $00075
 00076   JMS* .RB
 00077   .DSA RL1
 00100   JMS* .RG
0020              WRITE (2'3) INT,RL2(3),RL1
 00101   LAC  (000003
 00102   JMS* .RX
 00103   .DSA (000002
 00104   .DSA 777777
 00105   JMS* .RJ
 00106   .DSA INT
 00107   CMA!CLA
 00110   TAD  (000003
 00111   RCL
 00112   TAD  RL2
 00113   DAC  $00113
 00114   .DSA 77777o
 00115   JMS* .RJ
$00113 = 00116
 00116   .DSA $00110
0021     C
0022     C                   B.  SEQUENTIAL ACCESS
0023     C
 00117   JMS* .RB
 00120   .DSA RL1
```

```
 00121  JMS* .RG
0024              READ (1) INT,RL2(3),RL1
 00122  JMS* .FS
 00123  .DSA (000001
 00124  .DSA 777777
 00125  JMS* .FJ
 00126  .DSA INT
 00127  CMA!CLA
 00130  TAD  (000003
 00131  RCL
 00132  TAD  RL2
 00133  DAC  $00133
 00134  .DSA 777776
 00135  JMS* .FJ
 $00133 = 00136
 00136  .DSA $00136
 00137  JMS* .FB
 00140  .DSA RL1
 00141  JMS* .FG
0025              WRITE (3) INT,RL2(3),RL1
 00142  JMS* .FX
 00143  .DSA (000003
 00144  .DSA 777777
 00145  JMS* .FJ
 00146  .DSA INT
 00147  CMA!CLA
 00150  TAD  (000003
 00151  RCL
 00152  TAD  RL2
 00153  DAC  $00153
 00154  .DSA 777776
 00155  JMS* .FJ
 $00153 = 00156
 00156  .DSA $00156
0026    C
0027    C         II.  ASCII
0028    C                 A.  DIRECT ACCESS
0029    C                         1.  FORMATTED
0030    C
 00157  JMS* .FB
 00160  .DSA RL1
 00161  JMS* .FG
0031              READ (4'JVA,100) INT,RL2(3),RL1
 00162  LAC  JVA
 00163  JMS* .RR
 00164  .DSA (000004
 00165  .DSA .100
 00166  .DSA 777777
 00167  JMS* .RE
 00170  .DSA INT
 00171  CMA!CLA
 00172  TAD  (000003
 00173  RCL
 00174  TAD  RL2
 00175  DAC  $00175
 00176  .DSA 777776
```

```
 00177  JMS* .RE
 $00175 = 00200
 00200  .DSA $00200
 00201  JMS* .RA
 00202  .DSA RL1
 00203  JMS* .RF
0032              WRITE (4'5,200) INT,RL2(3),RL1
 00204  LAC  (000005
 00205  JMS* .RW
 00206  .DSA (000004
 00207  .DSA .200
 00210  .DSA 777777
 00211  JMS* .RE
 00212  .DSA INT
 00213  CMA!CLA
 00214  TAD  (000003
 00215  RCL
 00216  TAD  RL2
 00217  DAC  $00217
 00220  .DSA 77777b
 00221  JMS* .RE
 $00217 = 00222
 00222  .DSA $00222
0033    C
0034    C                              2.  DATA DIRECTED
0035    C
 00223  JMS* .RA
 00224  .DSA RL1
 00225  JMS* .RF
0036              READ (4'7,) INT,RL2(3),RL1
 00226  LAC  (000007
 00227  JMS* .RR
 00230  .DSA (000004
 00231  .DSA 000000
 00232  .DSA 777777
 00233  JMS* .GD
 00234  .DSA INT
 00235  CMA!CLA
 00236  TAD  (000003
 00237  RCL
 00240  TAD  RL2
 00241  DAC  $00241
 00242  .DSA 77777b
 00243  JMS* .GD
 $00241 = 00244
 00244  .DSA $00244
 00245  JMS* .GE
 00246  .DSA RL1
 00247  JMS* .RF
0037              WRITE (4'8,) INT,RL2(3),RL1
 00250  LAC  (000010
 00251  JMS* .RW
 00252  .DSA (000004
 00253  .DSA 000000
 00254  .DSA 777777
 00255  JMS* .GA
```

```
 00256  .DSA 035204
 00257  .DSA 000000
 00260  .DSA INT
 00261  JMS* .SS
 00262  .DSA RL2
 00263  LAC  (000003
 00264  DAC  $00264
 00265  JMS* .GC
 00266  .DSA 071177
 00267  .DSA 000000
 $00264 = 00270
 00270  .DSA $00270
0038    C
0039    C                    B.  SEQUENTIAL ACCESS
0040    C                          1.  FORMATTED
0041    C
 00271  JMS* .GB
 00272  .DSA 071176
 00273  .DSA 000000
 00274  .DSA RL1
 00275  JMS* .RF
0042            READ (5,100) INT,RL2(3),RL1
 00276  JMS* .FR
 00277  .DSA (000005
 00300  .DSA .100
 00301  .DSA 777777
 00302  JMS* .FE
 00303  .DSA INT
 00304  CMA!CLA
 00305  TAD  (000003
 00306  RCL
 00307  TAD  RL2
 00310  DAC  $00310
 00311  .DSA 77777b
 00312  JMS* .FE
 $00310 = 00313
 00313  .DSA $00313
 00314  JMS* .FA
 00315  .DSA RL1
 00316  JMS* .FF
0043            WRITE (6,200) INT,RL2(3),RL1
 00317  JMS* .FW
 00320  .DSA (000006
 00321  .DSA .200
 00322  .DSA 777777
 00323  JMS* .FE
 00324  .DSA INT
 00325  CMA!CLA
 00326  TAD  (000003
 00327  RCL
 00330  TAD  RL2
 00331  DAC  $00331
 00332  .DSA 777776
 00333  JMS* .FE
 $00331 = 00334
 00334  .DSA $00334
```

```
 00335  JMS* .FA
 00336  .DSA RL1
 00337  JMS* .FF
0044              ENCODE (10,ARR,100) INT,RL2(3),RL1
 00340  JMS* .GF
 00341  .DSA (000012
 00342  .DSA ARR
 00343  .DSA .100
 00344  .DSA 777777
 00345  JMS* .FE
 00346  .DSA INT
 00347  CMA!CLA
 00350  TAD  (000003
 00351  RCL
 00352  TAD  RL2
 00353  DAC  $00353
 00354  .DSA 777776
 00355  JMS* .FE
$00353 = 00356
 00356  .DSA $00356
 00357  JMS* .FA
 00360  .DSA RL1
 00361  JMS* .FF
0045              DECODE (10,ARR,100) INT,RL2(3),RL1
 00362  JMS* .GG
 00363  .DSA (000012
 00364  .DSA ARR
 00365  .DSA .100
 00366  .DSA 777777
 00367  JMS* .FE
 00370  .DSA INT
 00371  CMA!CLA
 00372  TAD  (000003
 00373  RCL
 00374  TAD  RL2
 00375  DAC  $00375
 00376  .DSA 777776
 00377  JMS* .FE
$00375 = 00400
 00400  .DSA $00400
0046    C
0047    C                              2.  DATA DIRECTED
0048    C
 00401  JMS* .FA
 00402  .DSA RL1
 00403  JMS* .FF
0049              READ (5,) INT,RL2(3),RL1
 00404  JMS* .FR
 00405  .DSA (000005
 00406  .DSA 000000
 00407  .DSA 777777
 00410  JMS* .GD
 00411  .DSA INT
 00412  CMA!CLA
 00413  TAD  (000003
 00414  RCL
```

```
 00415   TAD   RL2
 00416   DAC   $00416
 00417   .DSA 77777o
 00420   JMS* .GO
$00416 = 00421
 00421   .DSA $00421
 00422   JMS* .GE
 00423   .DSA RL1
 00424   JMS* .FF
0050              WRITE (6,) INT,RL2(3),RL1
 00425   JMS* .FW
 00426   .DSA (000006
 00427   .DSA 000000
 00430   .DSA 777777
 00431   JMS* .GA
 00432   .DSA 035204
 00433   .DSA 000000
 00434   .DSA INT
 00435   JMS* .SS
 00436   .DSA RL2
 00437   DAC   (000003
 00440   DAC   $00440
 00441   JMS* .GC
 00442   .DSA 071177
 00443   .DSA 000000
$00440 = 00444
 00444   .DSA $00444
 00445   JMS* .GB
 00446   .DSA 07117o
 00447   .DSA 000000
 00450   .DSA RL1
 00451   JMS* .FF
0051              DECODE (15,ARR,) INT,RL2(3),RL1
 00452   JMS* .GG
 00453   .DSA (000017
 00454   .DSA ARR
 00455   .DSA 000000
 00456   .DSA 777777
 00457   JMS* .GO
 00460   .DSA INT
 00461   CMA!CLA
 00462   TAD   (000003
 00463   RCL
 00464   TAD   RL2
 00465   DAC   $00465
 00466   .DSA 77777o
 00467   JMS* .GO
$00465 = 00470
 00470   .DSA $00470
 00471   JMS* .GE
 00472   .DSA RL1
 00473   JMS* .FF
0052              ENCODE (25,ARR,) INT,RL2(3),RL1
 00474   JMS* .GF
 00475   .DSA (000031
 00476   .DSA ARR
```

```
 00477   .DSA 000000
 00500   .DSA 777777
 00501   JMS* .GA
 00502   .DSA 035204
 00503   .DSA 000000
 00504   .DSA INT
 00505   JMS* .SS
 00506   .DSA RL2
 00507   LAC  (000003
 00510   DAC  $00510
 00511   JMS* .GC
 00512   .DSA 071177
 00513   .DSA 000000
$00510 = 00514
 00514   .DSA $00514
 00515   JMS* .GB
 00516   .DSA 071170
 00517   .DSA 000000
 00520   .DSA RL1
 00521   JMS* .FF
0053             ENDFILE 1
 00522   JMS* .FV
 00523   .DSA (000001
0054             ENDFILE 2
 00524   JMS* .FV
 00525   .DSA (000002
0055             ENDFILE 3
 00526   JMS* .FV
 00527   .DSA (000003
0056             ENDFILE 4
 00530   JMS* .FV
 00531   .DSA (000004
0057             ENDFILE 5
 00532   JMS* .FV
 00533   .DSA (000005
0058             ENDFILE 6
 00534   JMS* .FV
 00535   .DSA (000006
0059             STOP
 00536   LAC  (000000
 00537   JMP* .SI
0060             END
 00540   CLA
 00541   JMP* .SI
 00542   JMS* .ZB
 00543   JMS* .FP
 00544   JMP  00000
 00545   .BLK 000004
 00551   .DSA 000001
 00552   .DSA 000004
 00553   .DSA 000000
 00554   .DSA 000000
 00555   .DSA RL1
 00556   .BLK 000006
 00564   .DSA 000001
 00565   .DSA 000006
```

```
00566   .DSA 000000
00567   .DSA 000000
00570   .DSA RL2
00571   .BLK 000050
00641   .DSA 000001
00642   .DSA 000059
00643   .DSA 000000
00644   .DSA 000000
00645   .DSA ARR
00646   .BLK 000004
00652   .DSA 000001
00653   .DSA 000004
00654   .DSA 000000
00655   .DSA 000000
00656   .DSA NM1
00657   .BLK 000004
00663   .DSA 000001
00664   .DSA 000004
00665   .DSA 000000
00666   .DSA 000000
00667   .DSA NM2
00670   .DSA DEFINE
00671   .BLK 000001
00672   .BLK 000001
00673   .DSA SEEK
00674   .DSA ENTER
00675   .DSA .RS
00676   .BLK 000001
00677   .DSA .RJ
00700   .DSA .RR
00701   .DSA .RG
00702   .DSA .RX
00703   .DSA .FS
00704   .DSA .FJ
00705   .DSA .FR
00706   .DSA .FG
00707   .DSA .FX
00710   .DSA .RR
00711   .DSA .RE
00712   .DSA .RA
00713   .DSA .RF
00714   .DSA .RW
00715   .DSA .GD
00716   .DSA .GE
00717   .DSA .GA
00720   .DSA .SS
00721   .DSA .GC
00722   .DSA .GB
00723   .DSA .FR
00724   .DSA .FE
00725   .DSA .FA
00726   .DSA .FF
00727   .DSA .FA
00730   .DSA .GF
00731   .DSA .GG
00732   .DSA .FV
```

```
00733   .DSA .ST
00734   .DSA .ZB
00735   .DSA .FP
00736   .DSA 000002
00737   .DSA 000144
00740   .DSA 000005
00741   .DSA 000009
00742   .DSA 000004
00743   .DSA 001130
00744   .DSA 000012
00745   .DSA 000006
00746   .DSA 000003
00747   .DSA 000001
00750   .DSA 000007
00751   .DSA 000010
00752   .DSA 000017
00753   .DSA 000031
   RL1     00545
   RL2     00556
   ARR     00571
   NM1     00646
   NM2     00657
   .100    00000
   .200    00011
 * DEFINE  00670
   JVB     00671
   JVA     00672
 * SEEK    00673
 * ENTER   00674
 * .RS     00675
   INT     00676
 * .RJ     00677
 * .RB     00700
 * .RG     00701
 * .RX     00702
 * .FS     00703
 * .FJ     00704
 * .FB     00705
 * .FG     00706
 * .FX     00707
 * .RR     00710
 * .RE     00711
 * .RA     00712
 * .RF     00713
 * .RW     00714
 * .GD     00715
 * .GE     00716
 * .GA     00717
 * .SS     00720
 * .GC     00721
 * .GB     00722
 * .FR     00723
 * .FE     00724
 * .FA     00725
 * .FF     00726
 * .FW     00727
 * .GF     00730
 * .GG     00731
 * .FV     00732
 * .ST     00733
 * .ZB     00734
 * .FP     00735
PROGRAM SIZE = 00754, NO ERRORS
```

APPENDIX D
SYSTEM LIBRARIES

D.1 DOS-15 PAGE MODE NON-FPP LIBRARY

LIBRARY FILE LISTING FOR .LIBRP PAGE 1

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
BOSTT	001	16	
RBCDIO	007	136	
RBINIO	006	113	
RANCOM	014	504	
DEFINE	017	1126	
DDIO	017	2045	
EDCODE	003	253	
EOF	000	30	
UNIT	001	66	
JABS	001	15	
JDFIX	001	13	
JFIX	001	13	
FLOATJ	001	13	
JDBLE	001	10	
ISNGL	002	30	
JSIGN	004	23	
JDIM	001	21	
JMOD	003	23	
JMNMX	03P	103	
ERRSET	000	25	
IOERR	002	40	
FILE	010	366	
TIME	011	70	
TIME10	010	117	
ABS	002	16	
IABS	000	14	
DABS	001	16	
AINT	002	15	
INT	002	13	
IDINT	005	13	
AMOD	003	27	
MOD	000	24	
DMOD	004	30	
FLOAT	002	11	
IFIX	002	13	
SIGN	004	31	
DSIGN	004	31	
ISIGN	000	20	
DIM	002	22	
IDIM	000	15	
SNGL	004	27	
DBLE	001	11	
IMNMX	07P	107	
RMNMX	11P	120	
DMNMX	09P	106	
.BB	004	60	

LIBRARY FILE LISTING FOR .LIBRP PAGE 2

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
.BC	010	133	
.BD	010	133	
.BE	006	33	
.BF	005	34	
.BG	008	35	
.BH	005	34	
.BI	004	121	
SQRT	008	73	
SIN	003	13	
COS	003	20	
ATAN	002	13	
ATAN2	008	70	
EXP	002	13	
ALOG	002	20	
ALOG10	002	20	
TANH	004	47	
.EB	004	102	
.ED	006	67	
.EE	002	71	
.EF	008	143	
.EC	001	44	
DSQRT	007	71	
DSIN	001	13	
DCOS	002	21	
DATAN	001	13	
DATAN2	008	73	
DEXP	001	13	
DLOG	003	21	
DLOG10	001	21	
IDZERO	001	16	
ISENSW	001	30	
IFLOW	001	22	
.DD	006	146	
.DB	004	120	
.DE	003	101	
.DF	001	137	
.DC	001	47	
.DA	11P	56	
.DJ	000	51	
BCDIO	048	4023	
BINIO	020	357	
AUXIO	016	133	
.SS	009	110	
GOTO	003	26	
STOP	008	61	
PAUSE	006	14	

LIBRARY FILE LISTING FOR .LIBRP PAGE 3

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
SPMSG	012	117	
.FLTB	004	266	
FIOPS	035	751	
PARTWD	03P	140	
DBLINT	07P	377	
INTEAE	07P	131	
DOUBLE	004	203	
RELEAE	10P	1077	
OTSER	013	210	
.CB	004	22	C

D.2 DOS-15 BANK MODE NON-FPP LIBRARY

LIBRARY FILE LISTING FOR .LIBRB PAGE 1

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
BOSTT	001	16	
RBCDIO	007	136	
RBINIO	006	113	
RANCOM	014	504	
DEFINE	017	1126	
DDIO	017	2045	
EDCODE	003	253	
EOF	000	30	
UNIT	001	66	
JABS	001	15	
JDFIX	001	13	
JFIX	001	13	
FLOATJ	001	13	
JDBLE	001	10	
ISNGL	002	30	
JSIGN	004	23	
JDIM	001	21	
JMOD	003	23	
JMNMX	03B	103	
ERRSET	000	25	
IOERR	002	40	
FILE	010	366	
TIME	011	70	
TIME10	010	117	
ABS	002	16	
IABS	000	14	
DABS	001	16	
AINT	002	15	
INT	002	13	
IDINT	005	13	
AMOD	003	27	
MOD	000	24	
DMOD	004	30	
FLOAT	002	11	
IFIX	002	13	
SIGN	004	31	
DSIGN	004	31	
ISIGN	000	20	
DIM	002	22	
IDIM	000	15	
SNGL	004	27	
DBLE	001	11	
IMNMX	07B	107	
RMNMX	11B	120	
DMNMX	09B	106	
.BB	004	60	

LIBRARY FILE LISTING FOR .LIBRB PAGE 1

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
.BC	010	133	
.BD	010	133	
.BE	006	33	
.BF	005	34	
.BG	008	35	
.BH	005	34	
.BI	004	121	
SQRT	008	73	
SIN	003	13	
COS	003	20	
ATAN	002	13	
ATAN2	008	70	
EXP	002	13	
ALOG	002	20	
ALOG10	002	20	
TANH	004	47	
.EB	004	102	
.ED	006	67	
.EE	002	71	
.EF	008	143	
.EC	001	44	
DSQRT	007	71	
DSIN	001	13	
DCOS	002	21	
DATAN	001	13	
DATAN2	008	73	
DEXP	001	13	
DLOG	003	21	
DLOG10	001	21	
IDZERO	001	16	
ISENSW	001	30	
IFLOW	001	22	
.DD	006	146	
.DB	004	120	
.DE	003	101	
.DF	001	137	
.DC	001	47	
.DA	11B	56	
.DJ	000	51	
BCDIO	048	4023	
BINIO	020	357	
AUXIO	016	133	
.SS	009	110	
GOTO	003	26	
STOP	008	61	
PAUSE	006	14	

LIBRARY FILE LISTING FOR .LIBRB PAGE 3

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
SPMSG	012	117	
.FLTB	004	266	
FIOPS	035	751	
PARTWD	03B	141	
DBLINT	07B	404	
INTEAE	008	134	
DOUBLE	004	203	
RELEAE	016	1111	
OTSER	013	210	
.CB	004	22	C

D.3 DOS-15 PAGE MODE FPP LIBRARY

LIBRARY FILE LISTING FOR .FPAG PAGE 1

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
BOSTT	001	16	
RBCDIO	007	136	
RBINIO	006	113	
RANCOM	014	304	
DEFINE	017	1128	
DDIO	F17	2016	
EDCODE	003	253	
EOF	000	30	
UNIT	001	66	
JABS	F01	14	
JDFIX	F01	12	
JFIX	F01	12	
FLOATJ	F01	10	
JDBLE	F01	10	
ISNGL	F02	13	
JSIGN	F04	16	
JDIM	F01	17	
JMOD	F03	17	
JMNMX	03U	102	
ERRSET	000	25	
IOERR	002	40	
FILE	010	366	
TIME	011	70	
TIME10	010	117	
ABS	F02	13	
IABS	000	14	
DABS	F01	13	
AINT	F02	14	
INT	F02	12	
IDINT	F05	12	
AMOD	F03	23	
MOD	000	24	
DMOD	F04	23	
FLOAT	002	11	
IFIX	F02	12	
SIGN	F04	24	
DSIGN	F04	24	
ISIGN	000	20	
DIM	F02	17	
IDIM	000	15	
SNGL	F04	16	
DBLE	F01	10	
IMNMX	07P	107	
RMNMX	11U	116	
DMNMX	09U	104	
.BB	004	60	

LIBRARY FILE LISTING FOR .FPAG PAGE 2

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
.BC	F10	127	
.BD	F10	127	
.BE	F06	30	
.BF	F05	31	
.BG	F08	31	
.BH	F05	31	
.BI	F04	114	
SQRT	F08	73	
SIN	F03	12	
COS	F03	16	
ATAN	F02	12	
ATAN2	F08	61	
EXP	F02	12	
ALOG	F02	16	
ALOG10	F02	16	
TANH	F04	46	
.EB	F04	77	
.ED	F06	70	
.EE	F02	72	
.EF	F08	140	
.EC	F01	40	
DSQRT	F07	70	
DSIN	F01	12	
DCOS	F02	17	
DATAN	F01	12	
DATAN2	F08	64	
DEXP	F01	12	
DLOG	F03	17	
DLOG10	F01	17	
IDZERO	001	16	
ISENSW	001	30	
IFLOW	001	22	
.DD	F06	137	
.DB	F04	115	
.DE	F03	104	
.DF	F01	130	
.DC	F01	43	
.DA	11P	56	
.DJ	000	51	
BCDIO	F48	3731	
BINIO	020	357	
AUXIO	016	133	
.SS	009	110	
GOTO	003	26	
STOP	008	61	
PAUSE	006	14	

LIBRARY FILE LISTING FOR .FPAG

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
SPMSG	012	117	
.FLTB	004	266	
FIOPS	035	751	
PARTWD	03U	146	
INTEAE	07P	131	
.FPP	F18	440	
OTSER	F13	210	
.CB	004	22	C

D.4 DOS-15 BANK MODE FPP LIBRARY

LIBRARY FILE LISTING FOR .FBNK PAGE 1

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
BOSTT	001	16	
RBCDIO	007	136	
RBINIO	006	113	
RANCOM	014	504	
DEFINE	017	1126	
DDIO	F17	2016	
EDCODE	003	253	
EOF	000	30	
UNIT	001	66	
JABS	F01	14	
JDFIX	F01	12	
JFIX	F01	12	
FLOATJ	F01	10	
JDBLE	F01	10	
ISNGL	F02	13	
JSIGN	F04	16	
JDIM	F01	17	
JMOD	F03	17	
JMNMX	03V	102	
ERRSET	000	25	
IOERR	002	40	
FILE	010	366	
TIME	011	70	
TIME10	010	117	
ABS	F02	13	
IABS	000	14	
DABS	F01	13	
AINT	F02	14	
INT	F02	12	
IDINT	F05	12	
AMOD	F03	23	
MOD	000	24	
DMOD	F04	23	
FLOAT	002	11	
IFIX	F02	12	
SIGN	F04	24	
DSIGN	F04	24	
ISIGN	000	20	
DIM	F02	17	
IDIM	000	15	
SNGL	F04	16	
DBLE	F01	10	
IMNMX	07B	107	
RMNMX	11V	116	
DMNMX	09V	104	
.BB	004	60	

LIBRARY FILE LISTING FOR .FBNK PAGE 2

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
.BC	F10	127	
.BD	F10	127	
.BE	F06	30	
.BF	F05	31	
.BG	F08	31	
.BH	F05	31	
.BI	F04	114	
SQRT	F08	73	
SIN	F03	12	
COS	F03	16	
ATAN	F02	12	
ATAN2	F08	61	
EXP	F02	12	
ALOG	F02	16	
ALOG10	F02	16	
TANH	F04	46	
.EB	F04	77	
.ED	F06	70	
.EE	F02	72	
.EF	F08	140	
.EC	F01	40	
DSQRT	F07	70	
DSIN	F01	12	
DCOS	F02	17	
DATAN	F01	12	
DATAN2	F08	64	
DEXP	F01	12	
DLOG	F03	17	
DLOG10	F01	17	
IDZERO	001	16	
ISENSW	001	30	
IFLOW	001	22	
.DD	F06	137	
.DB	F04	115	
.DE	F03	104	
.DF	F01	130	
.DC	F01	43	
.DA	11B	56	
.DJ	000	51	
BCDIO	F48	3731	
BINIO	020	357	
AUXIO	016	133	
.SS	009	110	
GOTO	003	26	
STOP	008	61	
PAUSE	006	14	

LIBRARY FILE LISTING FOR .FBNK PAGE 3

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
SPMSG	012	117	
.FLTB	004	266	
FIOPS	035	751	
PARTWD	03V	147	
INTEAE	008	134	
.FPP	F18	440	
OTSER	F13	210	
.CB	004	22	C

D.5 RSX PLUS III NON-FPP LIBRARY

LIBRARY FILE LISTING FOR .LIBRX PAGE 1

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
MTGP.2	SRC	53	
FMF.1	SRC	24	
LAB.3	SRC	34	
MNT.1	SRC	24	
BSF.1	SRC	24	
BSP.1	SRC	24	
SPE.2	SRC	20	
SPR.1	SRC	24	
SPF.1	SRC	24	
RDC.2	SRC	33	
ADSMAP	001	114	
ADRMAP	002	126	
ADSSET	003	74	
ADRSET	002	66	
ADSTRT	001	20	
ADSTOP	001	20	
ADCON	001	20	
ADDIS	001	20	
RDP.1	SRC	53	
DOUT.0	SRC	105	
RDDI.6	SRC	205	
RBIN.0	SRC	31	
RBCD.2	SRC	73	
AI.3	SRC	43	
WAIF.1	SRC	4	
EXU.11	SRC	161	
DATF.5	SRC	40	
REQF.2	SRC	27	
SCHF.6	SRC	50	
RUNF.5	SRC	47	
SYNF.4	SRC	55	
CANF.3	SRC	23	
RESF.3	SRC	24	
HINF.1	SRC	17	
FIXF.3	SRC	23	
UNFF.4	SRC	23	
DISF.3	SRC	23	
ENAF.4	SRC	23	
ATTF.3	SRC	20	
DETF.2	SRC	20	
RENF.1	SRC	35	
DELF.1	SRC	35	
SEEF.2	SRC	35	
ENTF.2	SRC	35	
CLOF.5	SRC	57	
DSAF.6	SRC	40	

LIBRARY FILE LISTING FOR .LIBRX PAGE 2

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
DSDF.4	SRC	41	
DSGP.1	SRC	102	
MARF.3	SRC	23	
WAFF.2	SRC	13	
SUSF.1	SRC	4	
EXIF.1	SRC	3	
UPKF.0	SRC	21	
SPYF.1	SRC	24	
SPYR.0	SRC	40	
SPYS.1	SRC	24	
QJOB.1	SRC	43	
EXQT.1	SRC	41	
COMCOM	001	65	
FTS.3	SRC	70	
RBCDIO	007	123	
RBINIO	006	100	
RANCOM	014	525	
DEFINE	018	747	
DDIO	017	2026	
EDCODE	003	253	
JABS	001	15	
JDFIX	001	13	
JFIX	001	13	
FLOATJ	001	13	
JDBLE	001	10	
ISNGL	002	30	
JSIGN	004	23	
JDIM	001	21	
JMOD	003	23	
JMNMX	003	105	
ERRSET	000	25	
IOERR	002	40	
ABS	002	16	
IABS	000	14	
DABS	001	16	
AINT	002	15	
INT	002	13	
IDINT	005	13	
AMOD	003	27	
MOD	000	24	
DMOD	004	30	
FLOAT	002	11	
IFIX	002	13	
SIGN	004	31	
DSIGN	004	31	
ISIGN	000	20	

LIBRARY FILE LISTING FOR .LIBRX

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
DIM	002	22	
IDIM	000	15	
SNGL	004	27	
DBLE	001	11	
IMNMX	007	111	
RMNMX	011	122	
DMNMX	009	110	
.BB	004	60	
.BC	010	133	
.BD	010	133	
.BE	006	33	
.BF	005	34	
.BG	008	35	
.BH	005	34	
.BI	004	121	
SQRT	008	73	
SIN	003	13	
COS	003	20	
ATAN	002	13	
ATAN2	008	70	
EXP	002	13	
ALOG	002	20	
ALOG10	002	20	
TANH	004	47	
.EB	004	102	
.ED	006	67	
.EE	002	71	
.EF	008	143	
.EC	001	44	
DSQRT	007	71	
DSIN	001	13	
DCOS	002	21	
DATAN	001	13	
DATAN2	008	73	
DEXP	001	13	
DLOG	003	21	
DLOG10	001	21	
IDZERO	001	16	
ISENSW	001	30	
IFLOW	001	22	
.DD	006	146	
.DB	004	120	
.DE	003	101	
.DF	001	137	
.DC	001	47	
.DA	011	101	

LIBRARY FILE LISTING FOR .LIBRX PAGE 4

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
.DJ	000	51	
BCDIO	048	3733	
BINIO	020	267	
AUXIO	016	133	
.SS	009	110	
GOTO	003	26	
STOP	007	14	
PAUSE	006	14	
FIOPS	035	676	
PARTWD	03P	140	
DBLINT	07P	377	
INTEAE	07P	131	
DOUBLE	004	203	
RELEAE	10P	1077	
OTSER	013	242	
SPMSG	012	124	
.CB	004	22	
.BP	000	10	
.FP	000	2	C

D.6 RSX PLUS III FPP LIBRARY

LIBRARY FILE LISTING FOR .LIBFX PAGE 1

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
MTGP.2	SRC	53	
FMF.1	SRC	24	
LAB.3	SRC	34	
MNT.1	SRC	24	
BSF.1	SRC	24	
BSP.1	SRC	24	
SPE.2	SRC	20	
SPR.1	SRC	24	
SPF.1	SRC	24	
RDC.2	SRC	33	
ADSMAP	001	114	
ADRMAP	002	126	
ADSSET	003	74	
ADRSET	002	66	
ADSTRT	001	20	
ADSTOP	001	20	
ADCON	001	20	
ADDIS	001	20	
RDP.1	SRC	53	
DOUT.0	SRC	105	
RDDI.6	SRC	205	
RBIN.0	SRC	31	
RBCD.2	SRC	73	
AI.3	SRC	43	
WAIF.1	SRC	4	
EXU.11	SRC	161	
DATF.5	SRC	40	
REQF.2	SRC	27	
SCHF.6	SRC	50	
RUNF.5	SRC	47	
SYNF.4	SRC	55	
CANF.3	SRC	23	
RESF.3	SRC	24	
HINF.1	SRC	17	
FIXF.3	SRC	23	
UNFF.4	SRC	23	
DISF.3	SRC	23	
ENAF.4	SRC	23	
ATTF.3	SRC	20	
DETF.2	SRC	20	
RENF.1	SRC	35	
DELF.1	SRC	35	
SEEF.2	SRC	35	
ENTF.2	SRC	35	
CLOF.5	SRC	57	
DSAF.6	SRC	40	

LIBRARY FILE LISTING FOR .LIBFX PAGE 2

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
DSDF.4	SRC	41	
DSGP.1	SRC	102	
MARF.3	SRC	23	
WAFF.2	SRC	13	
SUSF.1	SRC	4	
EXIF.1	SRC	3	
UPKF.0	SRC	21	
SPYF.1	SRC	24	
SPYR.0	SRC	40	
SPYS.1	SRC	24	
QJOB.1	SRC	43	
EXOT.1	SRC	41	
COMCOM	001	65	
FTS.3	SRC	70	
RBCDIO	007	123	
RBINIO	006	100	
RANCOM	014	525	
DEFINE	018	747	
DDIO	F17	1777	
EDCODE	003	253	
JABS	F01	14	
JDFIX	F01	12	
JFIX	F01	12	
FLOATJ	F01	10	
JDBLE	F01	10	
ISNGL	F02	13	
JSIGN	F04	16	
JDIM	F01	17	
JMOD	F03	17	
JMNMX	F03	104	
ERRSET	000	25	
IOERR	002	40	
ABS	F02	13	
IABS	000	14	
DABS	F01	13	
AINT	F02	14	
INT	F02	12	
IDINT	F05	12	
AMOD	F03	23	
MOD	000	24	
DMOD	F04	23	
FLOAT	002	11	
IFIX	F02	12	
SIGN	F04	24	
DSIGN	F04	24	
ISIGN	000	20	

LIBRARY FILE LYSTING FOR .LIBFX PAGE 3

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
DIM	F02	17	
IDIM	000	15	
SNGL	F04	16	
DBLE	F01	10	
IMNMX	007	111	
RMNMX	F11	120	
DMNMX	F09	106	
.BB	004	60	
.BC	F10	127	
.BD	F10	127	
.BE	F06	30	
.BF	F05	31	
.BG	F08	31	
.BH	F05	31	
.BI	F04	114	
SQRT	F08	73	
SIN	F03	12	
COS	F03	16	
ATAN	F02	12	
ATAN2	F08	61	
EXP	F02	12	
ALOG	F02	16	
ALOG10	F02	16	
TANH	F04	46	
.EB	F04	77	
.ED	F06	70	
.EE	F02	72	
.EF	F08	140	
.EC	F01	40	
DSQRT	F07	70	
DSIN	F01	12	
DCOS	F02	17	
DATAN	F01	12	
DATAN2	F08	64	
DEXP	F01	12	
DLOG	F03	17	
DLOG10	F01	17	
IDZERO	001	16	
ISENSW	001	30	
IFLOW	001	22	
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.DB	F04	115	
.DE	F03	104	
.DF	F01	130	
.DC	F01	43	
.DA	011	101	

LIBRARY FILE LISTING FOR .LIBFX PAGE 4

PROGRAM NAME	SOURCE EXTENSION	PROGRAM SIZE	ACTION
.DJ	000	51	
BCDIO	F48	3641	
BINIO	020	267	
AUXIO	016	133	
.SS	009	110	
GOTO	003	26	
STOP	007	14	
PAUSE	006	14	
FIOPS	035	676	
PARTWD	F3P	146	
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.BP	000	10	
.FP	000	2	C

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Operating Environment
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