FTIO - FORTRAN I/O PACKAGE

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ABSTRACT

The orginal documentation and routines were developed by Alan R. Thompson of the Federal Systems Division of International Business Machine Corporation. The original documentation was replaced by the NASA document entitled IBM System/360 General I/O Package, March 1973, and was prepared by C. Dickman, Code 664, Goddard Space Flight Center, Greenbelt, Maryland.

This document is a revision of the NASA document cited above and describes a set of general I/O routines, for the IBM System/360 computers. These routines are intended to be used in lieu of FORTRAN I/O routines in situations where the FORTRAN routines are too inefficient or restrictive. Although intended for use by FORTRAN programmers, these routines may also be called from PL/1 of ALC programs.

Summary of Revisions

1. A "Summary of Calling Sequences" has been added.
2. Description of parameters N and IO under "Detailed Parameter Description"
3. Description of DCB parameters BLKSIZE and EROPT under "DD Card Considerations"
4. User abend U201 has been eliminated, and user abend U206 has been added, under "User Abends"
5. Appendix B, "Tips and Techniques" has been added
6. Appendix C, "Open, Close, End-of-Volume Errors" has been added
7. Description of the DAIO package has been deleted. DAIO will be documented in a separate writeup.

Introduction

In the process of writing data reduction or data analysis programs for the IBM/360 computer, it often becomes necessary or desirable to write specialized assembly language I/O routines because FORTRAN or PL/1 I/O routines are either too restrictive or too inefficient. After experience with individual specialized I/O routines was gained, it was decided to develop a generalized 360 I/O package which could be used in conjunction with FORTRAN or PL/1 programs and which would provide maximum efficiency with minimum restrictions.

Although FTIO checks for internal consistency, the myriad of options available to the user allows for situations in which FTIO may not be able to discern when restrictions are being violated. Results occurring from violations of restrictions as set forth herein which cannot be detected by FTIO are generally unpredictable and, therefore, the user should be careful to heed the documented restrictions.

Fortran I/O Package (FTIO)

When FORTRAN unformatted READ and WRITE statements are used for I/O operations, a considerable amount of CPU time is spent collecting data items from the list and assembling them into data records. This time is wasted if the data is already contigous in core and can be eliminated by using the FORTRAN I/O package (FTIO) described here. In addition to saving time, there are several other advantages gained by using these routines. These advantages are:

1) Capability of reading and writing multiple file tapes without multiple DD cards.

2) Capability of using the read backward mode for tapes.

3) Record format is not restricted to variable or variable blocked.

4) It is not necessary to know the length of a record before it is read.

5) Program may select tape to be mounted.

6) Partitioned data sets may be read or written.

7) Data set name may be altered by the program.

8) Capability of processing several labeled tapes with different DCB attributes on the same units. (See Appendix B)

9) Ability to override Fortran DD naming conventions.

10) Ability to read tapes BLP.

11) Prevention of wait state timeouts (completion code S522) due to failure of operator to mount the requested tape.

12) Automatic interrupt preprocessing to insure retention of all 16 general registers and the PROGRAM OLD PSW in user core upon the occurrence of system 0C0-0CF interruptions while maintaining any user (eg. FORTRAN) error handling routines.

The FTIO routines use QSAM LOCATE mode for all I/O operations. Before they can be used the following conditions must be satisfied:

1) The data to be contained in a record must be located contiguously in core (this can be done by placing it all in a common area or array, or by using the EQUIVALENCE statement).

2) Backspacing must not be needed.

If these conditions are satisfied, any FORTRAN unformatted READ or WRITE statement may be replaced with an appropriate call to an FTIO routine.

FTIO Routines:

1.	FREAD	-Reads a record
2.	FREADB	-Reads a record backwards
3.	FWRITE	-Writes a record
4.	POSN	-Positions to specified file
5.	REWIND	-Closes DCB (REREAD)
6.	UNLOAD	-Closes DCB (DISP)
7.	LEAVE	-Closes DCB (LEAVE)
8.	MOUNT	-Mounts specified tape
9.	MEMBER	-Selects a PDS member to be read or written

Summary of Calling Sequences

(Parameters are described below under "Detailed Parameter Description").

I. FORTRAN DD naming conventions are being used (i.e. DD name is of the form FTxxF001).

1. Call FREAD(A, N, L, &end, &err)
2. Call FREADB(A, N, L, &end, &err)
3. Call FWRITE(A, N, L)
4. Call POSN(IO, N, NF)
   Call POSN(IO, N, NF, NC, DSN) DSN specified
5. Call REWIND(N)
6. Call UNLOAD(N)
7. Call LEAVE(N)
8. Call MOUNT(IO, N, DT)
   Call MOUNT(IO, N, DT, NF) File number specified

Call MOUNT(IO, N, DT, NC, DSN) DSN specified

Call MOUNT(IO, N, DT, NC, DSN, NF) DSN and file number specified

9. Call MEMBER(IO, N, DM)

II. Non-FORTRAN DD naming conventions are being used (i.e. DD name is optional) not of the form FTxxF001).

1. Call FREAD(A, DDN, L, LC, &end, &err)
2. Call FREADB(A, DDN, L, LC, &end, &err)
3. Call FWRITE(A, DDN, L, LC)
4. Call POSN(IO, DDN, NF)

   Call POSN(IO, DDN, NF, NC, DSN) DSN specified
5. Call REWIND(DDN)
6. Call UNLOAD(DDN)
7. Call LEAVE(DDN)
8. Call MOUNT(IO, DDN, DT)

   Call MOUNT(IO, DDN, DT, NF) File number specified

   Call MOUNT(IO, DDN, DT, NC, DSN) DSN specified

   Call MOUNT(IO, DDN, DT, NC, DSN, NF) DSN and file number specified
9. Call MEMBER(IO, DDN, DM)

DD N = number of unit

Detailed Parameter Description

A = Beginning of the area into which data is to be moved.

N = Fullword integer value corresponding to the FORTRAN logical unit number being addressed.

If a negative unit number is passed, its absolute value is used as the unit number and a special "locate mode" switch is set. When this switch is set, FREAD will not move the data into the users area. It will instead store the address of the data in the users area. The first parameter, A, passed in this case should be the full word in which the address will be stored. The record will be available in the buffer until FREAD is called again. If this switch is set when

Call MOUNT(2, 12, 'EWRHBL', 8, DSN)

FWRITE is called, the first parameter passed will be taken as a pointer to the data record. This type of call to FWRITE can be used in conjunction with a similar type call to FREAD to save movement of data in core. Records with record format VS or VBS can not be read in locate mode (ie. with a negative unit number) unless BFTEK = A is specified on the appropriate DD statement.

DDN = Eight character DD name of the unit being addressed.

DDN = number of unit 6

If the high order byte of the unit parameter contains an EBCDIC alphabetic character, it is assumed that the user wishes to address a unit with the DD name specified in the unit parameter instead of following the FORTRAN naming conventions. In this case the DD name is passed instead of the FORTRAN unit number. The name is assumed to be 8 EBCDIC characters, left justified, and must be padded with blanks to 8 characters. It is not necessary, however, to place the DD name on a doubleword boundary.

L = Fullword location in which the length in bytes of the record read or to be written is returned to the caller or passed to FWRITE, respectively.

LC = Locate mode switch under user DD name format.

If a user DD name is passed, a fourth argument, LC, must be included in the call. This fullword integer variable is used to determine whether the data or the address of the data should be moved to the user's area as noted above. If LC is negative, FREAD functions as though a negative unit number were passed. If LC is positive or zero, the program functions as though a positive unit number were passed.

end = Statement number to which control is to be given when an end of file or end of volume is encountered.

err = Statement number to which control is to be given when a permanent I/O error is encountered.

IO = A fullword integer which contains a value corresponding to the next I/O operation to be performed on the subject unit as follows:

IO = 1; read forward

IO = -1; read forward BLP

IO = 2; write

IO = 3; read backward

IO = -3; read backward BLP

NF = A fullword integer which contains the file sequence number to be processed next on the subject unit. Only the low order halfword of this parameter is used but the parameter must be 4 bytes long and reside on a fullword boundary.

DSN = The starting location of an area in core which contains the fully qualified EBCDIC data set name of the data set next to be processed on the subject unit. This area must contain at least one non-blank, alphabetic character, left justified, at the location passed. A maximum of 44 characters are allowed. The parameter NC must accompany DSN in all calls to an FTIO routine. No boundary alignment is assumed for DSN.

NC = A fullword integer which contains the number of characters in DSN beginning at DSN, one character per byte. NC must be greater than zero and less than 45. NC must accompany DSN in all calls to an FTIO routine.

DT = The starting location of an area in core which contains a six character tape volume identifier packed one EBCDIC character per byte, left justified, and padded with blanks to six characters if necessary. If more than six non-blank characters are present at the address passed, only the first six will be used. No boundary alignment is assumed for DT.

DM = The starting location of a core area containing an eight character member name packed one EBCDIC character per byte, left justified, and padded with blanks to eight characters if necessary. If more than eight non-blank characters are present at the address passed, only the first eight will be used. No boundary alignment is assumed for DM.

Operational Description of Routines

1. Call FREAD (A, N, L, &end, &err)

   Call FREAD (A, DDN, L, LC, &end, &err)

This routine reads a data record from the unit specified into contiguous locations starting with the first parameter. The length of the record read is returned in the third parameter. The first alternate return is used if the end-of-file is reached and the second if an I/O error is encountered.

The first call format is used when FORTRAN DD naming conventions are being followed and the second format is used when the user desires to provide his own DD name.

2. Call FREADB (A, N, L, &end, &err)

   Call FREADB (A, DDN, L, LC, &end, &err)

This routine reads a data record backwards from the logical unit specified into contiguous locations starting with the first parameter. This routine can only be used for reading tapes with fixed length (blocked or unblocked) or undefined records. Disk data sets and data sets with variable length records may not be read backwards. The records read from tape using this routine are presented to the calling program in an order opposite to that in which they were written, (i.e. the last one written is the first read). The order in core of data from an individual record, however, is the same as it was when written. The data in a record is not reversed, but the order of the records is. The length of the record read is returned in the third parameter. The first alternate return is used if the beginning of file (or beginning of tape) is reached, and the second if an I/O error is encountered.

The first call format is used when FORTRAN DD naming conventions are being followed and the second format is used when the user desires to provide his own DD name.

Note: TRTCH = C is ignored for 7-track tapes read backwards.

3. Call FWRITE (A, N, L)

Call FWRITE (A, DDN, L, LC)

This routine writes a record on the logical unit specified. The first parameter gives the address of the beginning of the record, and the third gives its length (variable and undefined records only). The third parameter is ignored if fixed length (F or FB) records are being written. OS/MVT will not allow user processing of the end of volume or error conditions. If a permanent I/O error occurs during a write operation, the task issuing the operation will be abnormally terminated with a completion code of S001. If the system is able to sense an end of volume condition (i.e. by encountering the reflective strip) a scratch tape will be called for. If the reflective strip is missing, the system will write on the tape until it is pulled from the reel whereupon the next access to the unit will cause the issuing task to abend with a completion code of S001.

The first call format is used when FORTRAN DD naming conventions are being followed and the second format is used when the user desires to to provide his own DD name.

4. Call POSN (IO, N, NF)

Call POSN (IO, DDN, NF)

Call POSN (IO, DDN, NF, NC, DSN)

This routine positions the tape on the unit specified so that the next I/O operation on this unit will access the file of the data set specified. If the data set was being written, a file mark is written and data set labels are processed before positioning. Care must be taken to avoid passing a file number which does not exist on the tape. For input operations there

must be at least NF files on the tape. For output operations there must be at least NF-1 files on the tape. If this restriction is violated, a completion code of S613 or SA13 will result. Care must also be exercised in passing a data set name which does not match that on the data set label of an input tape. If the DD card which pertains to the specified unit has DISP = (OLD, -----, -----) coded and the data set name on the data set label does not agree with that passed to POSN, a completion code of S813 will result. Any data set name passed to POSN which is defined as a NEW data set on the corresponding DD card will have the data set name written in the HDR1 record of the label contained on the data set. This allows one to define multi-file data sets of which more than one such data set may reside on the same tape volume. One may also define single-file multi-volume data sets and multi-file single-volume data sets. This routine should not be used for disk data sets.

The first call format is used when FORTRAN DD naming conventions are being followed and the data set name specified on the DD card is desired. The second call format is for use when specifying a user DD name and using the data set name as it appears on the DD card. The third format is used to specify a data set name which overrides that on the DD card where the DD name follows the FORTRAN DD naming conventions. The fourth call format is used to pass both a user defined DD name and a data set name which overrides that on the DD card.

5. Call REWIND (N)

Call REWIND (DDN)

This routine positions the unit specified to the beginning of the data set (the physical end of a data set being read backwards). If the data set is being written, a file mark will be written and data set labels will be processed before rewinding. The first call format is used if FORTRAN DD naming conventions are being followed and the second is used when a non-FORTRAN DD name is required.

6. Call UNLOAD (N)

Call UNLOAD (DDN)

This routine logically disconnects the unit specified and frees all core associated with it. If the unit is used subsequently, core storage will be reallocated. If the data set is being written, a file mark will be written and data set labels will be processed before disconnecting the unit. The first call format is used if FORTRAN DD naming conventions are being followed and the second is used when a non-FORTRAN DD name is being used.

7. Call LEAVE (N)

Call LEAVE (DDN)

This routine positions the unit to the end of the data set (the physical beginning of a data set being read backwards). If the data set is being written, a file mark is written and data set labels are processed before positioning. The first call format is for use when FORTRAN DD naming conventions are being followed and the second is for use with non-FORTRAN DD names.

8. 1) Call MOUNT (IO, N, DT)

2) Call MOUNT (IO, DDN, DT)

3) Call MOUNT (IO, N, DT, NF)

4) Call MOUNT (IO, DDN, DT, NF)

5) Call MOUNT (IO, N, DT, NC, DSN)

6) Call MOUNT (IO, DDN, DT, NC, DSN)

7) Call MOUNT (IO, N, DT, NC, DSN, NF)

8) Call MOUNT (IO, DDN, DT, NC, DSN, NF)

This routine mounts the tape indicated on the specified unit. If NF is specified, the tape is positioned to the specified file. If NF is not specifieid, the file number last passed to POSN or MOUNT for the specified unit will be used. If POSN or MOUNT have not been called previously for the specified unit and NF is not coded, the file number specified in the LABEL

parameter on the DD card for this unit will be used. If NC and DSN are coded, the data set name as specified on the DD card of the subject unit is overridden. The same precautions with respect to file number and data set name as were described for POSN apply to MOUNT as well.

Call formats 1, 3, 5 and 7 are used when FORTRAN DD naming conventions are being followed while formats 2, 4, 6 and 8 are used for non-FORTRAN DD names. Formats 1 and 2 are for specifying the volume serial number only. Call formats 3 and 4 are used to pass both volume number and file number while formats 5 and 6 are used to pass volume number and data set name. Formats 7 and 8 are used to pass volume number, data set name, and file number.

9. Call MEMBER (IO, N, DM)

   Call MEMBER (IO, DDN, DM)

This routine is used to process partitioned data sets. When used for input, the member specified is read with subsequent calls to FREAD. If the member requested does not exist, a call to MEMBER will result in a completion code of SF13. If MEMBER is used for output, subsequent calls to FWRITE create a member with the specified name. The member thus created must not already exist within the data set.

DD Card Considerations

The FORTRAN convention for naming DD cards means that if logical unit number xx is used, a DD card named FTxxF001 must be supplied. The following points should be kept in mind when specifying DD card parameters:

1. DSNAME:
   a) Must not be a temporary name if more than one tape is to be processed on this unit by calling MOUNT.
   b) Must specify a dummy member name if MEMBER is used to process a PDS.

2. Volume Serial Number:

   Even if MOUNT will be used to specify the proper volume serial number, a dummy number should be specified on the DD card.

3. UNIT:

   Must indicate deferred mounting if MOUNT is called to specify volume serial number.

4. DISP:

   Must specify KEEP if multiple tape volumes are to be processed using MOUNT.

5. LABEL:

   If POSN or MOUNT is used to specify file sequence number, the sequence number specified in this parameter is ignored. If POSN is not used, this number is.

6. DCB:

   a) RECFM - If not specified and not contained in data set labels will default to U. If V, VB, or VBS is specified, the appropriate control words will be attached by FWRITE and stripped off by FREAD.

   b) LRECL - Required only for FB records. Ignored if RECFM $\neq$ FB.

   c) BLKSIZE - If not specified and not contained in data set lebels, defaults to 32760. If V or VB records are being used, the BLKSIZE should be at least as big as the largest record plus 8.

   d) EROPT - FTIO has EROPT = ACC as default. SKP (but not ABE) may be coded if desired.

I/O Errors

If a permanent I/O error is detected during a read operation, certain information about the error is made available in a common area called FERMSG

before the alternate return is taken. This information can be printed or used by the user if desired. The common area contains a full word array, 26 words long.

The contents of this array is as follows:

Word	
1	Buffer address
2	Number of bytes read
3-22	EBCDIC message for printing
23	IOBFLAG1, IOBFLAG2, Sense bytes 0 and 1
24	Sense bytes 2, 3, 4 and 5
25	ECB completion code and CCW address from the CSW
26	Last 4 bytes of the CSW

To make the information available in the users program, the following common statement may be used:

```
COMMON/FERMSG/IMES(26)
```

The message can then be written when an I/O error occurs with the following write statement:

```
WRITE (6,1000)IMES
1000 FORMAT (1X, Z8, I6, 20A4, 4(IX,Z8))
```

A message written in this manner will contain the following items, separated by blanks and/or commas:

1. Buffer address (hex)
2. Number of bytes read (decimal)
3. Jobname
4. Volume serial number (from UCB)
5. Unit address
6. Device type
7. DD name
8. Operation attempted

9. Error description
10. Tape: block number (decimal)

    Direct access: track address BBCCHHR (hex)

    Unit Record: asterisks
11. Access method
12. IOBFLAG1, IOBFLAG2, UCB sense bytes 0 and 1.
13. Sense bytes 2-5 from the UCB. For a description of these, see the component description manual for the I/O device.
14. ECB completion code and Channel Status Word (CSW) command address portion. See System Control blocks for the ECB code.
15. Last 4 bytes of CSW (status and residual count field.) See the System/360 reference card (green card) for the format of the CSW. The residual count indicates how many bytes were remaining to be read or written when the operation was terminated.

If a permanent I/O error is detected during a write operation, the same information is placed in the common area. The system, however, will abend the program with a completion code of 001 before control is returned to the user.

User Abends

U202 = Subject unit is currently being used by DAIO for direct access.

U203 = Length of data set name is less than or equal to zero or greater than 44.

U204 = An attempt was made to open a tape for output with BLP specified.

U205 = An attempt was made to read a VBS record in locate mode without BFTEK = A specified on the appropriate DD statement.

U206 = First character of volume identifier in a call to MOUNT was a blank.

U210 = Illegal first parameter (IO) in a call to POSN, MOUNT, or MEMBER.

U220 = Invalid record length detected. From FREAD or FREADB: segment descriptor word less than or equal to zero or greater than BLKSIZE. From FWRITE: L less than or equal to zero or greater than BLKSIZE.

U230 = A DD card is missing for the subject unit.

Functional Programming Description

1. FREAD

   a) Gets core and sets up the DCB if this is the first use of the unit, or if UNLOAD was called previously for this unit.

   b) If DCB is open for OUTPUT or RDBACK, it is closed (REREAD).

   c) If DCB is closed it is opened (INPUT).

   d) Record is read using locate mode GET.

   e) If EODAD exit is taken, the program returns with a 4 in GR15. (First alternate return)

   f) If record format is variable (V, VB, or VBS), LRECL is obtained from the control word and the data portion of the record is moved to the user's area.

   g) If record format is not variable (F, FB, or U), LRECL is obtained from the DCB and the record is moved to the user's area.

   h) If no error was encountered reading the record, the program returns with 0 in GR15. (normal return)

   i) If an I/O error was encountered, the program returns with an 8 in GR15. (second alternate return)

2. FREADB

Processing in this routine is the same as in FREAD except that in step b), if DCB is open for OUTPUT or INPUT it is closed (LEAVE). And in step c) DCB is opened (RDBACK).

3. FWRITE

   a) Gets core and sets up the DCB if this is the first use of the unit, or if UNLOAD was called previously for this unit.

   b) If the DCB is open for INPUT or RDBACK it is closed (LEAVE).

   c) If the DCB is closed it is opened (OUTPUT).

   d) If the record format is not fixed or fixed blocked, the DCBLRECL field is set from the length parameter passed.

   e) A locate mode PUT is used to obtain an output buffer.

f) If the record format is fixed, fixed blocked or undefined, the data is moved into the buffer and the routine returns.

g) If the record format is V or VB, a control word is built at the beginning of the buffer area and the data is moved in following this word. The routine then returns.

h) If the record format is VBS, the record is segmented to fit in the block size specified by the user on the DD card, control words are attached and the data is moved to the buffer area. The routine then returns.

4. POSN

a) Gets core and sets up the DCB if this is the first use of the unit, or if UNLOAD was called previously for this unit.

b) If the DCB is open, it is closed (LEAVE)

c) The Job File Control Block for this unit is read.

d) The file number passed is placed in the JFCB.

e) The DCB is opened for INPUT, OUTPUT, or RDBACK, depending on the first parameter.

f) The routine returns.

5. REWIND

a) If the DCB is open, it is closed (REREAD).

b) Core storage occupied by buffers is freed.

6. UNLOAD

a) If the DCB has not been acquired, the routine returns immediately.

b) If the DCB is closed, it is opened for INPUT.

c) The DCB is closed (DISP).

d) The storage occupied by the DCB, the JFCB, and buffers is released and the routine returns.

7. LEAVE

a) If the DCB is open, it is closed (LEAVE).

b) Core storage occupied by buffers is freed.

8. MOUNT

a) Gets core and sets up DCB if this is the first use of the unit, or if UNLOAD was called previously for this unit.

b) If DCB is open, it is closed (DISP).

c) The JFCB is read.

d) The volume serial number is moved to the JFCB.

e) The file number (if specified) is moved to the JFCB.

f) The DCB is opened for INPUT, OUTPUT, or RDBACK depending on the first parameter.

g) The routine returns.

9. MEMBER

a) Gets core and sets up DCB if this is the first use of the unit or if UNLOAD was called previously for this unit.

b) If the DCB is open, it is closed (DISP).

c) The JFCB is read.

d) The member name is moved to the JFCB.

e) The DCB is opened for INPUT, OUTPUT, or RDBACK depending on the first parameter.

10. Prevention of S522 Abends

Before an OPEN SVC is issued anywhere within FTIO, the following events occur:

a) If this is the first OPEN issued by the task, the jobname is retrieved from the TIOT and saved.

b) From the JFCB for the unit about to be opened, the serial number of the volume expected to be on the device at the completion of OPEN is extracted.

c) The unit is checked to determine if DD DUMMY has been coded on the DD card pertaining to that unit and, if so, a flag is set so that FWRITE will not attempt to move data into a non-existent buffer.

d) If the unit name for this unit has not yet been retrieved, it is obtained from the UCB and saved.

e) If the unit is not a tape drive, a return is effected and the OPEN is issued.

f) If the unit is a tape drive and the volume serial number of the tape expected to be mounted on the unit after OPEN is different from the volume serial number of the tape which is currently mounted on the unit, a real-time interval timer is started.

g) A return is effected and the OPEN is issued.

If the interval timer expires before the OPEN has been accomplished, the following events occur:

a) If this is not the first timer expiration for the specific OPEN, the message sent to the operator's scope is deleted.

b) From previously retrieved information, a message is sent to the operator's scope, the tape library console, the system log, and the programmer. This message has the following form:

JJJJJJJJ: - FTIO - YY/DDD @ HH:MM:SS.S -

PLEASE MOUNT TAPE # TTTTTT ON DRIVE UUU.

where JJJJJJJJ = job name

YY = year

DDD = day of year

HH = hour

MM = minute

SS.S = seconds

TTTTTT = tape volume serial number

UUU = unit name

c) The message identifier is saved and a new interval timer is started. As long as a message is sent at least once every 10 minutes, the job will not get a S522 abend while waiting for a tape mount.

If the OPEN is accomplished before an interval timer expires, the following events occur:

a) The outstanding interval timer and exit routine are cancelled.

b) Any message sent to the operator's scope is deleted.

c) Normal processing continues.

11. Preprocessing of System Interrupts 0C0-0CF

a) Upon the first entry to an FTIO control section, a SPIE SVC is issued to inform the system that FTIO wishes to process all 0C0-0CF interrupts.

b) The pointer to any previously issued SPIE is saved and normal processing continues.

Upon the occurrence of an interrupt, the following events occur:

a) A valid copy of the 16 general registers and the program old PSW are made.

b) If no SPIE other than the one issued by FTIO was specified for the task, the task is abnormally terminated (see step g).

c) If this type of interrupt is maskable and the previously issued SPIE chose to ignore it, a return is effected and normal processing continues.

d) If this type of interrupt is not maskable, or the interrupt is maskable and the previously issue SPIE chose to process it, the recovery procedure address is determined.

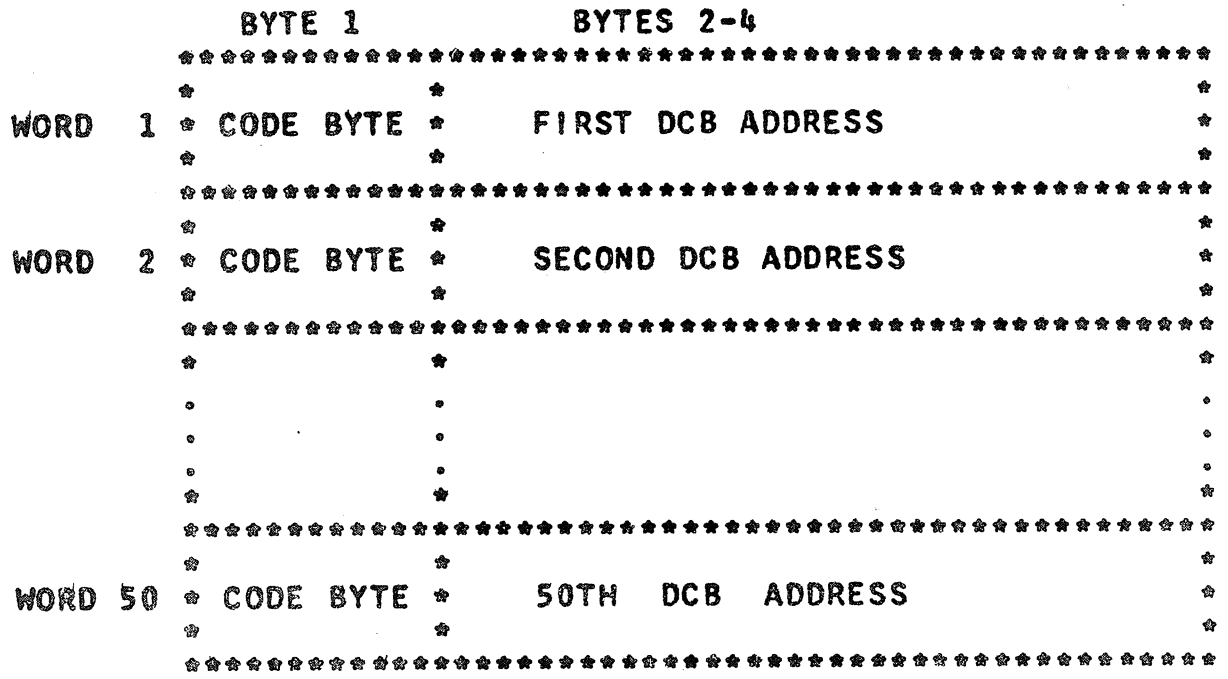
e) If such a recovery routine exists, control is passed to it for interrupt processing. When the recovery routine completes, a return is effected and normal processing continues.

f) If such a recovery routine does not exist, the task is abnormally terminated (see Step g).

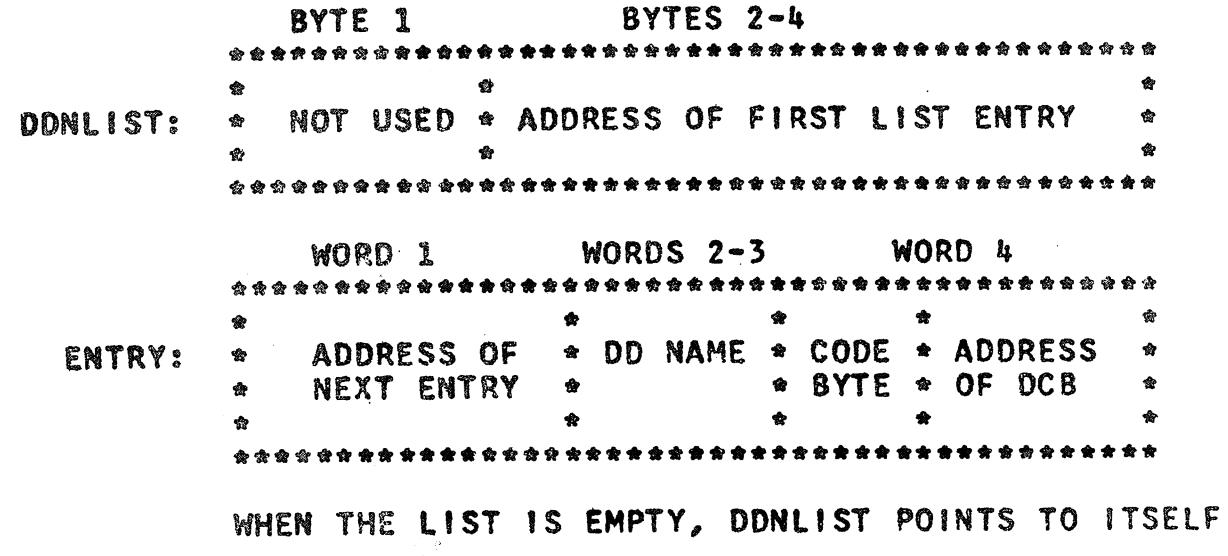
g) When it is determined that the task should be abnormally terminated (steps b and f) and either a SYSUDUMP or a SYSABEND DD card is supplied for the step, FTIO formats the interrupt type, the program old PSW, and the contents of the 16 general registers as they were when the interrupt occurred. This information is printed on the dump data set before the dump formatted by the system. After this information

is printed, an ABEND SVC is issued with the appropriate completion code. If neither the SYSUDUMP nor the SYSABEND DD card is available for the step, the ABEND is issued without formatting the aforementioned information for output.

APPENDIX A - FORTRAN UNIT TABLE FORMAT



DD NAME LIST FORMAT



WHEN THE LIST IS EMPTY, DDNLIST POINTS TO ITSELF

THE LAST LIST ENTRY POINTS TO DDNLIST

The code byte is set as follows:

NUMERIC = 0 - STORAGE FOR DCB NOT ACQUIRED

NUMERIC = 1 - DCB IS OPEN FOR INPUT

NUMERIC = 2 - DCB IS OPEN FOR OUTPUT

NUMERIC = 4 - DCB IS OPEN FOR READING BACKWARDS

NUMERIC = 8 - DCB IS CLOSED

ZONE = 1 - JFCB HAS BEEN READ FOR SUBJECT UNIT

ZONE = 2 - UNIT DOES NOT FOLLOW FORTRAN NAMING CONVENTION

ZONE = 4 - UNIT IS ENABLED FOR TRAPPING O/C/EOV ABENDS

ZONE = 8 - UNIT NAME IS AVAILABLE FOR THIS UNIT

CONTROL BLOCK ITEMS USED

ABS 16	= CVT ADDRESS
CVT + 0	= ADDRESS OF TCB ADDRESS
TCB + 12	= TIOT ADDRESS
UCB + 13	= UNIT NAME
UCB + 18	= UNIT TYPE
DCB + 36	= RECFM (BITS 0 AND 1) 10=F, 01=V, 11=U
DCB + 40	= DDNAME
DCB + 48	= DCBOFLGS
DCB + 62	= BLKSIZE
DCB + 82	= LRECL
JFCB + 0	= DATA SET NAME
JFCB + 44	= MEMBER NAME (FOR PDS PROCESSING)
JFCB + 68	= FILE SEQUENCE NUMBER
JFCB + 76	= JFCBFLGS (MARK JFCB FOR RETURN TO JOB Q)
JFCB + 117	= NUMBER OF VOLUME SERIAL NUMBERS
JFCB + 118	= FIRST VOLUME SERIAL NUMBER
TIOT + 0	= JOBNAME
TIOT + 24	= FIRST DD ENTRY
DD ENTRY + 0	= LENGTH OF DD ENTRY
DD ENTRY + 4	= DDNAME
DD ENTRY + 16	= ADDRESS OF UCB

APPENDIX B - TIPS AND TECHNIQUES

1. Mixing FORTRAN I/O and FTIO

FORTRAN and FTIO may both be used to process the same tape (in the same job step). For example, MOUNT might be used to mount a tape dynamically and then FORTRAN I/O used to perform a formatted read or write on the tape. Or POSN might be used to position to desired files which are then read or written with a format using FORTRAN I/O.

The trick here is that the DCB must be closed before switching from one method to the other. In FORTRAN, one closes the DCB with a REWIND or END FILE (when writing) statement. In FTIO, one closes the DCB by calling REWIND or LEAVE. A sample program illustrating this procedure is given below.

```
      .
      .
      .
C MOUNT TAPE DYNAMICALLY WITH FTIO TO FILE 1
      CALL MOUNT (1, 9, TAPE, 1)
C CLOSE DCB (FTIO) (SO TAPE CAN BE READ WITH FORTRAN I/O)
      CALL REWIND(9)
C READ RECORD FROM FILE 1 WITH FORTRAN I/O
      READ(9, 100) ...
100   FORMAT( ... )
C     CLOSE DCB (FORTRAN) (SO TAPE CAN BE POSITIONED WITH FTIO)
      REWIND 9
C     POSITION TO FILE 2 WITH FTIO
      CALL POSN(1, 9, 2)
```

```
      CALL REWIND(9)
C     READ FILE 2 WITH FORTRAN I/O
      READ(9,200) ...
200   FORMAT( ... )
                .
                .
                .
```

Only one DD card is necessary for the tape in the above program. It should be of the form //GO.FT09F001 DD ...

2. Processing several SL tapes (or files) with different DCB attributes on the same unit

REWIND or LEAVE (but not UNLOAD) must be called between processing of the tapes (or files).

3. FORTRAN unformatted I/O spanning note

FORTRAN users should note that all FORTRAN unformatted I/O gets spanned. I.e., even if RECFM = V(B) is specified, V(B)S is actually used in FORTRAN I/O. However, with FTIO, spanning occurs only if specified. Therefore, tapes that were written using unformatted FORTRAN I/O should be read with FTIO with RECFM = V(B)S specified. See the following table.

WRITE \ READ	FORTRAN VB	FORTRAN VBS	FTIO VB	FTIO VBS
FORTRAN VB	OK	OK	BAD	OK
FORTRAN VBS	OK	OK	BAD	OK
FTIO VB	OK	OK	OK	OK
FTIO VBS	OK	OK	BAD	OK

BAD = will get undesired results if records are truly spanned;
will get desired results if records are not truly spanned.

4. Positioning Tapes

Positioning a tape which is already open for output will cause a tapemark to be written before positioning. Thus, the user should avoid the following common error:

```
CALL MOUNT(2,9,TAPE,1)
CALL POSN(2,9,10)
```

Here, a tape is mounted for output on unit 9 at file 1 and is then positioned for output to file 10. The POSN will cause a tapemark to be written at the beginning of file 1. To avoid this problem, code either:

```
CALL MOUNT(2,9,TAPE,10)
```

or

```
CALL MOUNT(1,9,TAPE,1)
CALL POSN(2,9,10)
```

5. EROPT = SKP

If EROPT = SKP is specified in the DCB parameter of the DD card, any blocks causing an I/O error will be skipped and the next good block will be read. The error exit on the call to FREAD(B) will not be taken (as it used to be in earlier versions of FTIO) and no indication will be given that any block(s) were skipped.

EROPT = SKP should not be used for truly spanned records since problems with control words will occur.

6. Reading Dumps

Most dumps of programs which call FTIO routines contain both a short FORTRAN traceback dump (i.e. STAE dump) and an FTIO register dump, each containing a PSW. In these cases, the PSW in the FTIO dump should be one used to find the approximate, absolute address of the error. (The FORTRAN traceback PSW merely points to FTIO).

7. Using FTIO for Disk Data Sets

Direct access data sets on a direct access device cannot be processed with FTIO. The DAIO package should be used for direct access data sets.

Sequential and partitioned data sets on a direct access device can be processed with FTIO. The routines normally used would be FREAD, FWRITE, and REWIND and in addition, for partitioned data sets, MEMBER. POSN and FREADB should not be used.

APPENDIX C - OPEN, CLOSE, END-OF-VOLUME ERRORS

A new optional feature has been added to the FTIO package to allow user control upon FTIO's encountering an abend condition during OPEN, CLOSE, or end-of-volume (O/C/EOV) processing. These O/C/EOV abend conditions can occur in any of the nine, original FTIO routines. Two new routines, an additional optional argument to all original routines, and a new common block are used to invoke the new feature.

The two new routines are:

1. CAll FTRAP(N1,N2, ... , NN)

This routine enables the trapping of O/C/EOV abend conditions for the specified unit(s). Each argument is either a 4-byte positive integer or an 8-byte EBCDIC DD name of the subject unit. The number of arguments is arbitrary but must be greater than 0. The unit(s) will remain enabled until FALLOW is called.

2. Call FALLOW(N1,N2, ... , NN)

This routine disables the trapping of O/C/EOV abend conditions for the specified unit(s). Each argument is either a 4-byte positive integer or an 8-byte EBCDIC DD name of the subject unit. The number of arguments is arbitrary but must be greater than 0.

The new optional last argument in the calling sequence of all nine original FTIO routines specifies the statement number to be transferred to at O/C/EOV abend conditions (if the unit was enabled for trapping via a call to FTRAP).

The new labeled common block /FPL1/ contains the system completion code and the return code (both in hex). Its format is:

```
COMMON/FPL1/JUNK,SCC,RC
INTEGER*2 SCC,RC
```

Thus to use the new feature, one calls FTRAP to enable the unit for O/C/EOV trapping, and then provides an additional, last argument to the desired FTIO routine specifying where control is to be transferred to at O/C/EOV abend. One may then examine the abend code and return code in common block /FPL1/. After control is returned, the user should not attempt any more operations on the unit in error.

One possible use of the new feature would be using an A13-10 abend code to signal the end of a multiple data set SL tape where the number of data sets is not known.

A sample program using the new feature is given below.

```
C     SAMPLE PROGRAM USING NEW, OPTIONAL O/C/EOV FEATURE OF FTIO
      COMMON /FPL1/ JUNK, SCC, RC
      INTEGER*2 SCC, RC, A13/Z0A13/, TEN/Z0010/
      DIMENSION DATA (100)
C     ENABLE UNIT 9 FOR TRAPPING
      CALL FTRAP(9)
C     READ (NOTE NEW LAST ARGUMENT)
          CALL FREAD(DATA, 9, LEN, &40, &50, &60)
C     END OF FILE
40    . . .
C     READ ERROR
50    . . .
C     O/C/EOV ERROR
60    WRITE(6, 70) SCC, RC
70    FORMAT('-O/C/EOV ERROR: ', Z3, '-', Z2)
      IF (SCC.EQ.A13.AND.RC.EQ.TEN) GO TO 80
      STOP
C     IT WAS AN A13-10
80
                        .
                        .
                        .
```

Even though FTIO may trap an O/C/EOV abend, the appropriate IECxxxx message is still written to the programmer and will appear on the system output message data set (just before the step deallocation messages).

Some O/C/EOV errors cannot be trapped. A list of those which can is given below.

137

213

214

237

240

313

314

413

414

437

513

514

613

614

637

713

714

737

813

837

A13

A14

B14

B37

C13

D37

E37