TBM File Format Reference & Utility Manual

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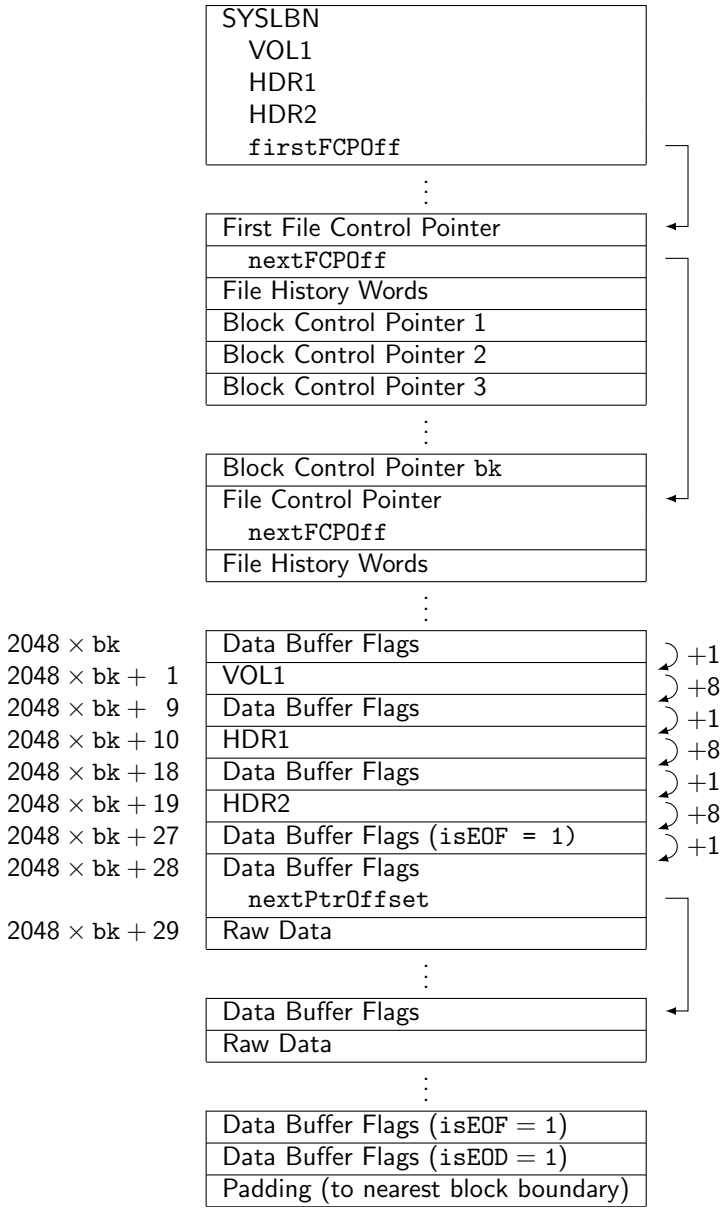


Figure 1: Illustration of the general TBM file layout.

0.1 Introduction

The Ampex TMS-4 Terabit Memory System ("TBM") was a tape storage system used at NCAR from approximately the mid 1970s through to the mid 1980s. Much of the GENPRO-I data from this time period on HPSS was formerly only available in TBM-formatted archives. This document describes the format of these archives, as well as the TBMconv software framework which may be used to extract the contents of TBM files.

0.2 TBM Format Overview

A TBM file begins with a SYSLBN block (see section 2.3) at offset 0. This block contains information such as:

- the machine used to generate the TBM file (e.g., the Cray 1),
- the data type (e.g., CDC DPC),
- the size of a "BK block," and

0	SYSLBN	
51	FCP	
52–59	FHW	(dataSetID = 'NCARSYSTEMHD10001')
60–110	BCP	
111	FCP	
112–119	FHW	(dataSetID = 'NCARSYSTEMHD10002')
120–203	BCP	
204	FCP	
205–212	FHW	(dataSetID = 'NCARSYSTEMHD10003')
213–270	BCP	
271	FCP	
272–279	FHW	(dataSetID = 'NCARSYSTEMHD10003')
280–298	BCP	
299	FCP	(isEOF = 1)
⋮		
16384	DBF	
16385	VOL1	(volSerialName1 = 'G50233', tbmVolSerial = 'TL0110')
16393	DBF	
16394	HDR1	(dataSetID = 'NCARSYSTEMHD10001')
16402	DBF	
16403	HDR2	
16411	DBF	(isEOF = 1)
16412	DBF	
⋮		
840063	DBF	(isEOF = 1)
840064	DBF	(labelRecordFollows = 1)
840065	EOF1	(dataSetID = 'NCARSYSTEMHD10001')
840073	DBF	(isEOF = 1, endLabelGroup = 1)
840074	DBF	(labelRecordFollows = 1)
840075	HDR1	(dataSetID = 'NCARSYSTEMHD10002')

- offsets to specific locations in the file.

Of particular interest are the "BK block" size, expressed in multiples of 2048 60-bit words, the data type, and the offsets.

Bits 59–30 of word 29 ("offset to first file control pointer"; `firstFCPOff` in the API) of this SYSLBN block specify the offset, in 60-bit words, from the start of the file (offset 0) to the first file control pointer (see section 2.4). Each file control pointer is followed by a set of file history words (see section 2.5). After the first set of file history words (which immediately follow the first file control pointer), and up to the second file control pointer is where a series of block control pointers (see section 2.6) reside. Each block control pointer is one 60-bit word in length, and there are `numBKBlocks` of them; as there are this many, one should find the following equivalencies:

$$\texttt{numBKBlocks} = \underbrace{\texttt{nextFCPOff}}_{\substack{\text{From first file}\\ \text{control pointer}\\ \text{located at}\\ \texttt{firstFCPOff}}} - (\texttt{firstFCPOff} + 9)$$

The length of the file is indicated by the values of `numBKBlocks` and `bk` in `SYSLBN`. The length of the file should be:

$$\text{file length}_{\text{8-bit bytes}} = \frac{(\texttt{numBKBlocks} + 1) \times \texttt{bk} \times 2048_{\text{60-bit words}} \times 60_{\text{bits per word}}}{8_{\text{bits per byte}}}.$$

The portions of a TBM file where actual data resides are broken into many *data records*; each data record is preceeded by a data buffer flags (see section 2.7) word, also known as a "record control word." Each data buffer flag contains an offset (relative to it) specifying the location of the next data buffer flag (`nextPtrOffset` in the `DataBufferFlags` struct).

Actual data begins at one TLIB/BK block into the file (after some `DataBufferFlags` and `VOL1`/`HDR1`/`HDR2` metadata). The length of a TLIB block is

$$\begin{aligned}\text{length}_{\text{60-bit words}} &= 2048 \times \texttt{bk},\\ \text{length}_{\text{64-bit words}} &= \frac{2048 \times \texttt{bk} \times 60}{64}.\end{aligned}$$

For example, for the default `bk` value of 8,

$$\begin{aligned}\text{length}_{\text{60-bit words}} &= 2048 \times 8 = 16384 \text{ 60-bit words},\\ \text{length}_{\text{64-bit words}} &= \frac{2048 \times 8 \times 60}{64} = 15360 \text{ 64-bit words}.\end{aligned}$$

0.2.1 Minimum Requirements for Reading a TBM File

The only information that is strictly necessary for reading a TBM file is the "BK block" size (specified in the `bk` element of the `SYSLBN_Data` structure in the API)

Chapter 1

Using `tbmexplore`

`tbmexplore` is a command-line utility for interactively exploring/investigating the contents TBM files. `tbmexplore` permits dumping contents of a TBM file at arbitrary offsets, optionally decoding the

```
$ tbmexplore G51452
Enter an offset:
```

We enter 0 and press enter, and are next prompted with:

```
How would you like to display the data?

         1) 6-bit DPC
         2) Data Buffer Flags (aka ‘‘Record Control Word")
         3) Block Control Pointer
         4) File Control Pointer
         5) File History Word
         6) SYSLBN
         7) NotQuiteSYSLBN
         8) VOL1
         9) HDR1
        10) HDR2
        11) 20-bit integers
        12) 60-bit integers

Enter a choice [1-12]:
```

Choosing 6, we see

```
 ==== SYSLBN ====
offset = 0 (bits) 0+0 (8-bit bytes) 0+0 (60-bit words)
machineType         =       0 (CDC 7600)
density             =       0 (200 BPI)
dataType            =       0 (BCD as DPC)
numTracks           =       1
bk                  =       8
numBKBlocks         =     308
labelBufLen         =    1024
 ===== VOL1 =====
vol1                = "VOL1" (0x58F31C)
volSerialName1      = "G51452"
acc                 = " " (45; unlimited access)
acntNum             = "41113306" (0x01F71C1C79E6E1)
sciNum              = "5&" (0x837)
tbmVolSerial        = "TL0483" (0x50C6DF8DE)
sysLevelCode        = " " (0x2D)
 ===== HDR1 =====
hdr1                = "HDR1" (0x20449C)
dataSetID           = "NCARSYSTEMHD10001"
volSerialName2      = "G51452"
fileSecNum          = "0001"
fileSeqNum          = "0001"
generationNum       = "0001"
versionNum          = "00"
creationDate        = " 82320"
```

```
expDate             = " 83320"
accChar             = " " (0x2D)
blockCount          = "000000"
sysCode             = "NCAR   SYSTEM"
 ===== HDR2 =====
hdr2                = "HDR2" (0x20449D)
hdr2label           = "                                                                                                "
 ==== SYSLBN ====
fileCtrlPtrOff      =      0 ("      ")
blkCtrlPtrOff       =      0 ("      ")
firstFCPOff         =     51 ("     %")
ctrlCardOpenOff     =     35 ("     8")
openMergeAreaOff    =     35 ("     8")
curCtrlCardOpenOff  =     35 ("     8")
fcpToBlkCtrlOff     =     10 ("     J")
```

Chapter 2

TBM Format and API Reference

2.1 API Introduction

`tbmconv` includes a header file containing data structures useful for reading TBM files, as well as a set of routines for printing the contents of these structures to the terminal. These data structures map to structures specified in the reference as illustrated in **??**.

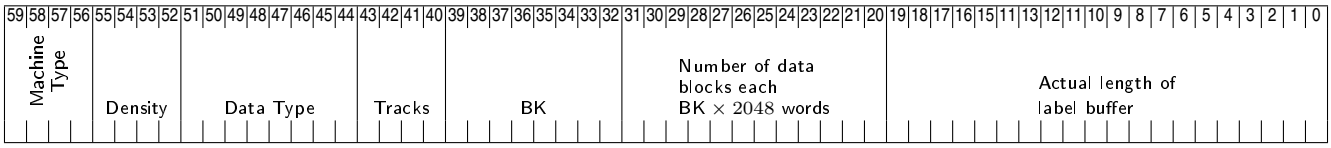
2.2 Accessability critera

The accessability critera characters are a character which indicate "any restrictions on who may have access to the information in this file. A space means unlimited access; any other character means special handling, in a manner to be defined."

2.3 SYSLBN

A SYSLBN block appears at the start of every TBM file, at offset 0. The SYSLBN block could be thought of as being comprised of a header (words 0 through 3), a VOL1 label (words 4–11), a HDR1 label (words 12–19), a HDR2 label (words 27–28), and finally pointers to various locations in the file (words 28–30).

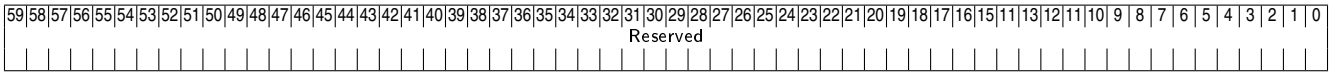
2.3.1 SYSLBN Word 0



Data structure	API data structure names	
	Raw data	DPC
SYSLBN	`SYSLBN_Data`	`SYSLBN_Text`
VOL1	`VOL1_Data`	`VOL1_Text`
HDR1	`HDR1_Data`	`HDR1_Text`
HDR2	`HDR2_Data`	`HDR2_Text`

Length	Bits	Type	API	Description
4	59–56	Binary	machineType	The machine type. 0 7600 1 Cray-1 2 Front end
4	55–52	Binary	density	The original density. 0 200 bpi 1 556 bpi 2 800 bpi 3 1600 bpi
8	51–44	Binary	dataType	The data type. 0 BCD as DPC 1 Binary bit-serial 2 BCD, no conversion from 7-channel stage-in 3 ASCII 4 EBCDIC
4	43–40	Binary	numTracks	The original number of tape tracks 0 7-track 1 9-track
8	39–32	Binary	bk	The value of BK from a TLIB card on the 7600
12	31–20	Binary	numBKBlocks	The number of BK length Data Blocks in this volume
20	19–0	Binary	labelBufLen	Actual length of the label (SYSLBN) buffer

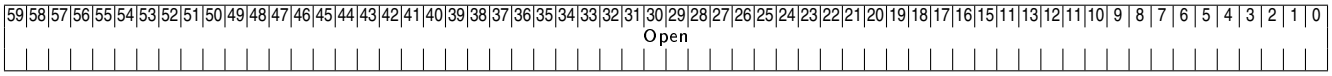
2.3.2 SYSLBN Word 1



Length	Bits	Type	API	Description
60	59–0	—	—	Reserved

2.3.3 SYSLBN Word 2

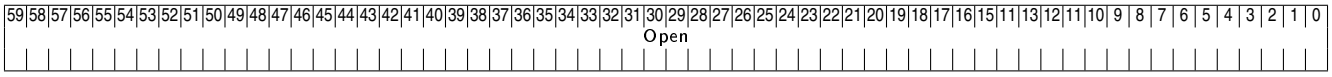
This word is unused and should be set to zero.



Length	Bits	Type	API	Description
60	59–0	—	—	Open

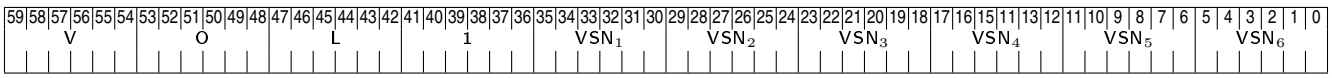
2.3.4 SYSLBN Word 3

This word is unused and should be set to zero.



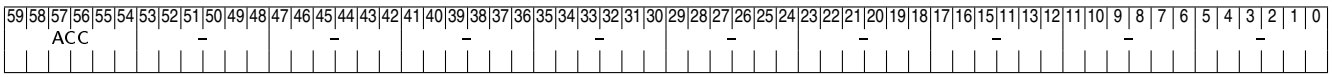
Length	Bits	Type	API	Description
60	59–0	—	—	Open

2.3.5 SYSLBN Word 4 (VOL1 Word 0)



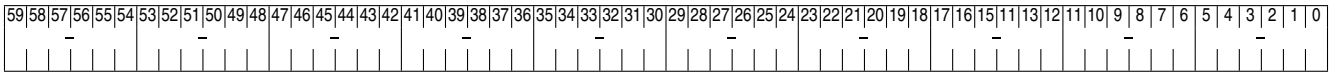
Length	Bits	Type	API	Description
24	59–36	DPC	vol1	VOL1 characters for a Volume One label and the start of the Volume One label
36	35–0	DPC	volSerialName1	Six Volume Serial Name (VSN) characters

2.3.6 SYSLBN Word 5 (VOL1 Word 1)



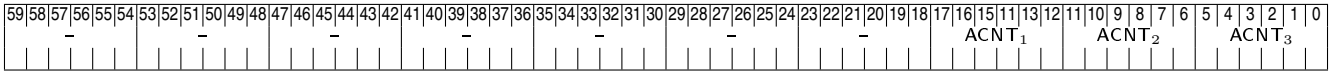
Length	Bits	Type	API	Description
6	59–54	DPC	acc	Volume One label accessability criteria (see section 2.2)
54	53–0	—	—	Blank fill characters

2.3.7 SYSLBN Word 6 (VOL1 Word 2)



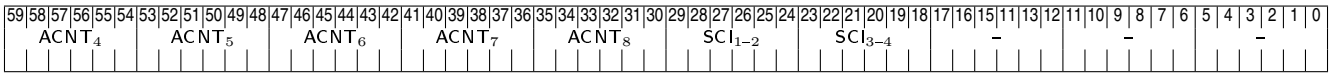
Length	Bits	Type	API	Description
60	59–0	—	—	Blank fill characters

2.3.8 SYSLBN Word 7 (VOL1 Word 3)



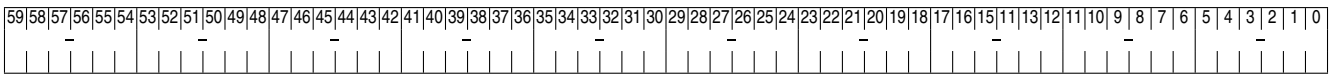
Length	Bits	Type	API	Description
42	59–18	—	—	Blank fill characters
18	17–0	DPC	acntNum_1_3	Characters 1–3 of the *JOB card accounting number

2.3.9 SYSLBN Word 8 (VOL1 Word 4)



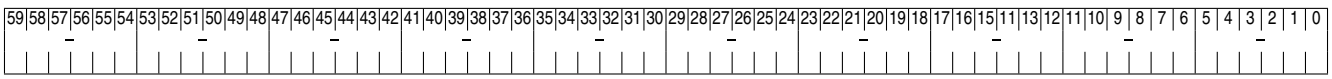
Length	Bits	Type	API	Description
30	59–30	DPC	acntNum_4_8	Characters 4–8 of the *JOB card accounting number
12	29–18	?	sciNum_1_4	The scientist number from the *JOB card
18	17–0	—	—	Blank fill characters

2.3.10 SYSLBN Word 9 (VOL1 Word 5)



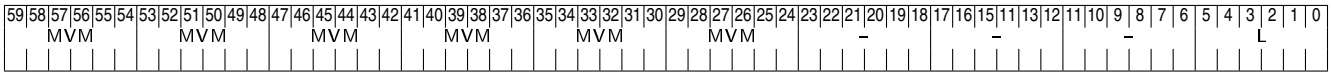
Length	Bits	Type	API	Description
60	59–0	—	—	Blank fill characters

2.3.11 SYSLBN Word 10 (VOL1 Word 6)



Length	Bits	Type	API	Description
60	59–0	—	—	Blank fill characters

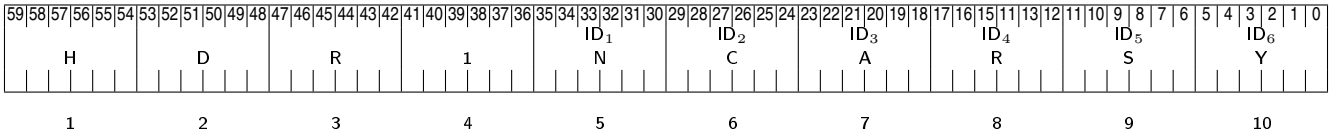
2.3.12 SYSLBN Word 11 (VOL1 Word 7)



Length	Bits	Type	API	Description
36	59–24	DPC	`tbmVolSerial`	TBM Volume Serial Name
18	23–6	—	—	Blank fill characters
6	5–0	DPC	`sysLevelCode`	System level code

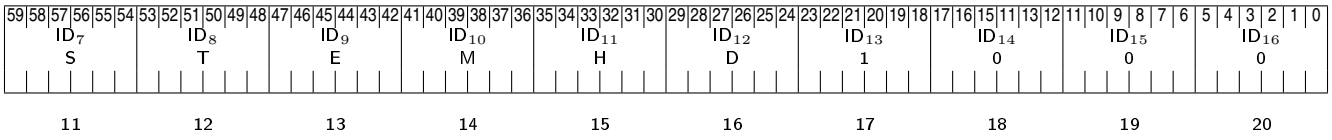
2.3.13 SYSLBN Word 12 (HDR1 Word 0)

This word marks the beginning of the "header one label," which is 80 6-bit characters long.



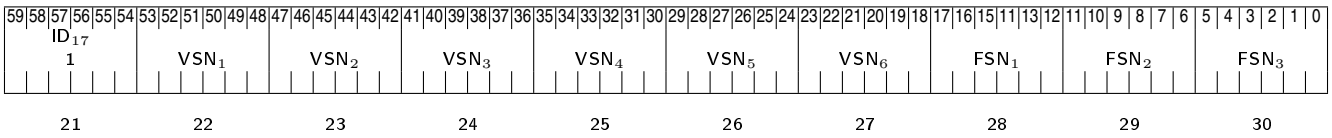
Length	Bits	Type	API	Description
24	59–36	DPC	`hdr1`	HDR1 characters for a Header One label and the start of the first Header One label
36	35–0	DPC	`dataSetID_1_6`	Data Set Identifier (DSI) characters 1–6

2.3.14 SYSLBN Word 13 (HDR1 Word 1)



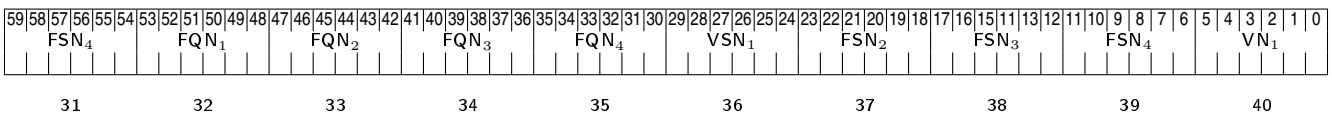
Length	Bits	Type	API	Description
60	59–0	DPC	`dataSetID_7_12` `dataSetID_13_16`	Data Set Identifier (DSI) characters 7–16

2.3.15 SYSLBN Word 14 (HDR1 Word 2)



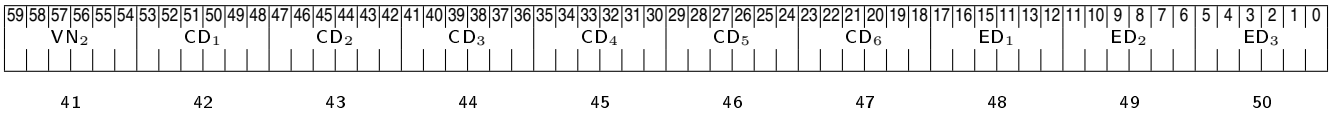
Length	Bits	Type	API	Description
6	59–54	DPC	`dataSetID_17`	Data Set Identifier (DSI) character 17
36	54–18	DPC	`volSerialName2`	Volume Serial Name characters 1–6, equal to the ones in word 4, bits 59–36
18	17–0	DPC	`fileSecNum_1_3`	File section number characters 1–3

2.3.16 SYSLBN Word 15 (HDR1 Word 3)



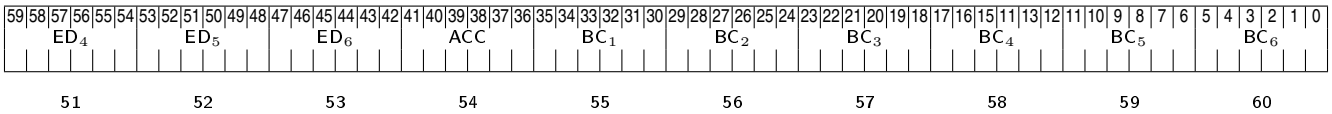
Length	Bits	Type	API	Description
6	59–54	DPC	`fileSecNum_4`	File section number character 4
24	53–30	DPC	`fileSeqNum`	File sequence number characters 1–4
24	29–6	DPC	`generationNum`	Generation number characters 1–4
6	5–0	DPC	`versionNum_1`	Version number character 1

2.3.17 SYSLBN Word 16 (HDR1 Word 4)



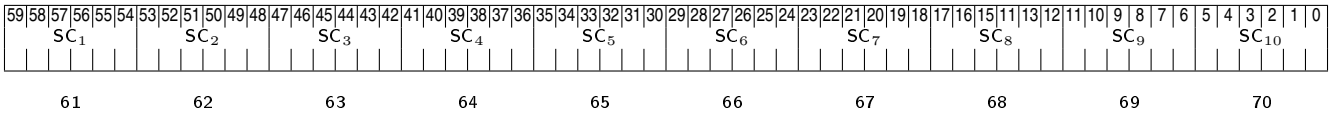
Length	Bits	Type	API	Description
6	59–54	DPC	`versionNum_2`	Version number character 2
36	53–18	DPC	`creationDate`	Creation date characters 1–6
18	17–0	DPC	`expDate_1_3`	Expiration date characters 1–3

2.3.18 SYSLBN Word 17 (HDR1 Word 5)



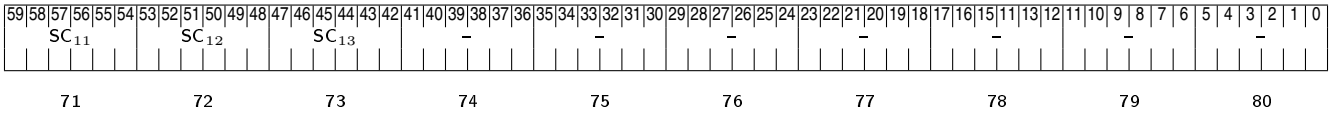
Length	Bits	Type	API	Description
18	59–42	DPC	`expDate_4_6`	Expiration date characters 4–6
6	41–36	DPC	`accChar`	The HDR1 accessability criteria character (see section 2.2)
36	35–0	DPC	`blockCount`	The block count characters

2.3.19 SYSLBN Word 18 (HDR1 Word 6)



Length	Bits	Type	API	Description
60	59–42	DPC	`sysCode_1_10`	System code characters 1–10

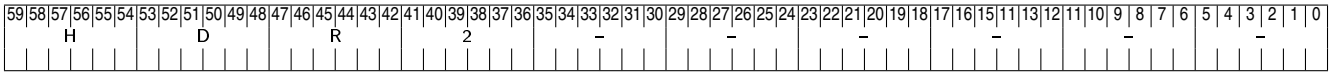
2.3.20 SYSLBN Word 19 (HDR1 Word 7)



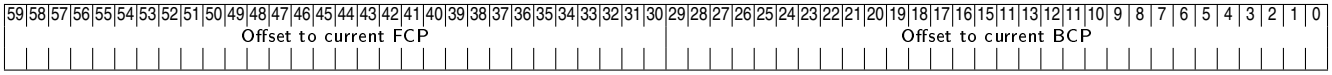
Length	Bits	Type	API	Description
18	59–42	DPC	`sysCode_11_13`	System code characters 11–13
42	41–0	—	—	Spaces

2.3.21 SYSLBN Words 20–27 (HDR2 Words 0–7)

These words contain the HDR2 label.

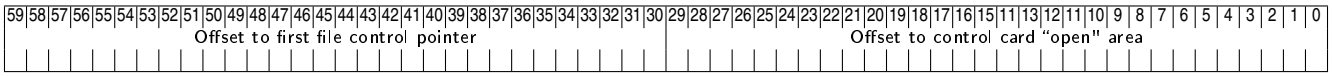


2.3.22 SYSLBN Word 28



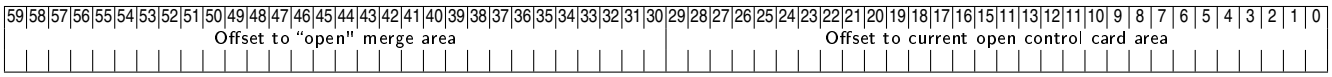
Length	Bits	Type	API	Description
30	59–30	Binary	`fileCtrlPtrOff`	Offset to current file control pointer
30	29–0	Binary	`blkCtrlPtrOff`	Offset to current block control pointer from SYSMSI

2.3.23 SYSLBN Word 29



Length	Bits	Type	API	Description
30	59–30	Binary	`firstFCPOff`	Offset to first file control pointer
30	29–0	Binary	`ctrlCardOpenOff`	Offset to control card “open" area

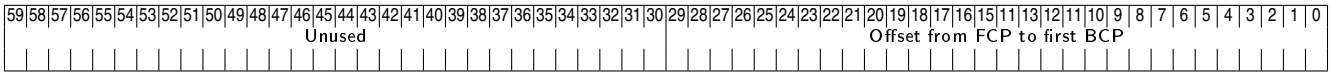
2.3.24 SYSLBN Word 30



Length	Bits	Type	API	Description
30	59–30	Binary	`openMergeAreaOff`	Offset to “open" merge area
30	29–0	Binary	`curCtrlCardOpenOff`	Offset to current open control card area

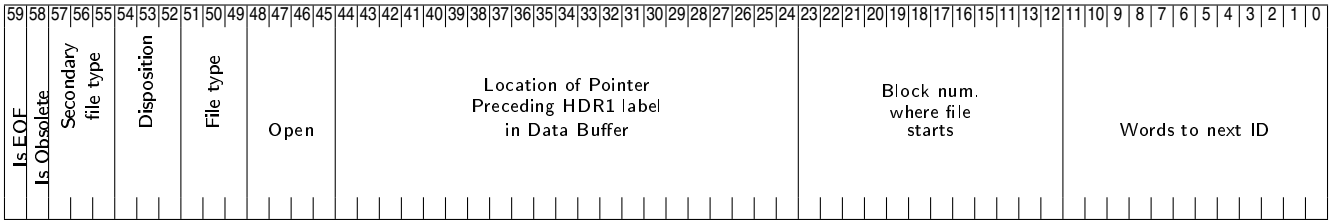
2.3.25 SYSLBN Word 31

Note that `fcpToBlkCtrlOff` appears to be off by one; it has a value of 10 when it should be 9.



Length	Bits	Type	API	Description
30	59–30	—	—	Unused
30	29–0	Binary	`fcpToBlkCtrlOff`	Offset from File Control Pointer to first Block Control Pointer

2.4 File Control Pointers



Length	Bits	Type	API	Description
1	59	Binary	isEOF	If set, this FCP indicates EOF; no other bits used.
1	58	Binary	isObsolete	If set, file is obsolete
3	57–55	Binary	secondaryFileType	Secondary file type 1 old 2 new 4 scatch
3	54-52	Binary	fileDisposition	File disposition 0 keep 1 delete at close 2 delete at termination
3	51-49	Binary	fileType	File type 0 undefined 1 sequential access 2 direct access 3 mixed access
4	48–45	—	—	Open
21	44–24	Binary	bufferPtrOffset	Location of buffer pointer preceding the HDR1 label for this file
12	23–12	Binary	dataBlkNum	Data block number where the file starts
12	11–0	Binary	nextFCPOff	Words to next file control pointer

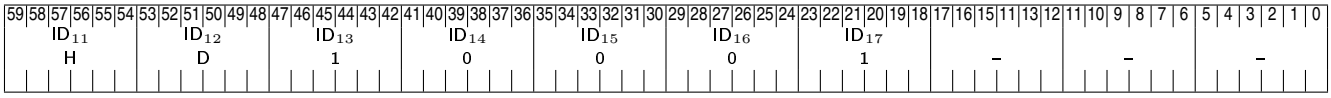
2.5 File History Words

The file histoy words immediately follow every file control pointer.

2.5.1 File History Word 1

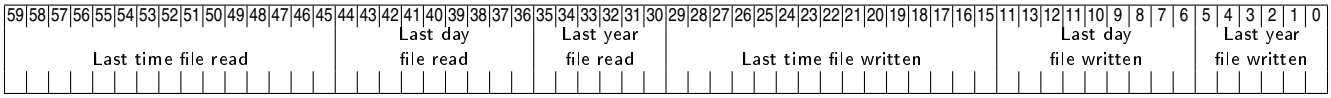
Length	Bits	Type	API	Description
60	59–0	DPC	dataSetID_1_10	Characters 1–10 of the Data Set Identifier (DSI) from the current HDR1 label

2.5.2 File History Word 2



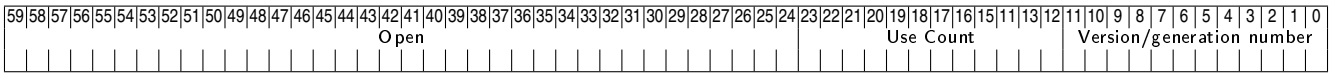
Length	Bits	Type	API	Description
42	59–24	DPC	dataSetID_13_17	Characters 11–17 of the Data Set Identifier (DSI) from the current HDR1 label
18	17–0	—	—	Spaces

2.5.3 File History Word 3



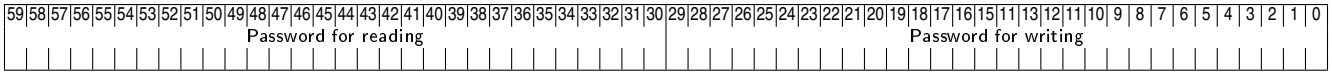
Length	Bits	Type	API	Description
15	59–45	Binary	`lastReadTime`	Last time the file was read
9	44–36	Binary	`lastReadDay`	Last day of year file was read
6	35–30	Binary	`lastReadYear`	Last year file was read ($0 = 1976$)
15	29–15	Binary	`lastWriteTime`	Last time the file was written
9	14–6	Binary	`lastWriteDay`	Last day of year file was written
6	5–0	Binary	`lastWriteYear`	Last year file was written ($0 = 1976$)

2.5.4 File History Word 4



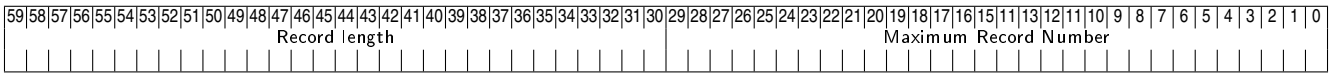
Length	Bits	Type	API	Description
36	59–24	—	—	Open
12	23–12	Binary	`useCount`	Use count; i.e., the number of times the file was referenced. Needed for PLIB.
12	11–0	Binary	`versionNum`	Version number/generation number

2.5.5 File History Word 5



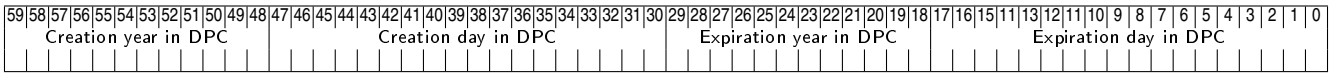
Length	Bits	Type	API	Description
30	59–30	DPC	`readPasswd`	Password for reading
30	29–0	DPC	`writePasswd`	Password for writing

2.5.6 File History Word 6



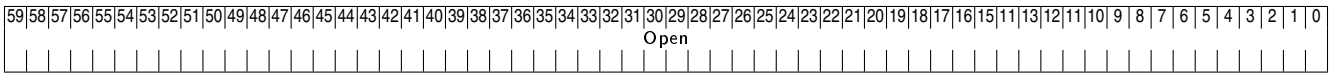
Length	Bits	Type	API	Description
30	59–30	Binary	`recordLen`	Record length
30	29–0	Binary	`maxRecordNum`	Maximum record number

2.5.7 File History Word 7



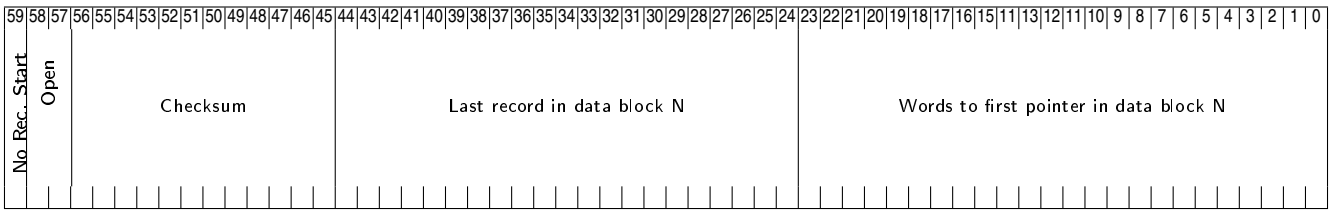
Length	Bits	Type	API	Description
12	59–48	DPC	`creationYear`	Creation year
18	47–30	DPC	`creationDay`	Creation day
12	29–18	DPC	`expirationYear`	Expiration year
18	17–0	DPC	`expirationDay`	Expiration day

2.5.8 File History Word 8



Length	Bits	Type	API	Description
60	59–0	—	—	Open

2.6 Block Control Pointer (BCP)



Length	Bits	Type	API	Description
1	59	Binary	`noRecordStartsHere`	If set, no record starts in this block.
2	58–57	—	—	Open
12	56–45	Binary	`checksum`	Checksum[1]
21	44–24	Binary	`lastRecord`	Last record starting in data block N
24	23–0	Binary	`wordsToFirstPtr`	Words to first pointer in data block N

2.6.1 Further Remarks

Representation in NCAR Technical Note

Note that the way the block control pointer is depicted in the NCAR Technical Note is rather confusing; the technical note shows what at first appear to be three distinct "block control pointers," one which is "word 9", another which is word "$+9 + M - 1$", and another which is word "$+9 + M$". Really what the technical note is trying to convey is that there are M block control pointers (equal to `bk`); the first block control pointer starts at an offset $+9$ after the first file control pointer; and immediately after the last block control pointer ($+9 + M$) is another file control pointer.

`lastRecord`

`lastRecord` is the one-based index of the last record to appear in the $\texttt{bk} \times 2048$-sized data block corresponding to a given buffer control pointer. For example, using `tbmexplore` to view the first three buffer control pointers shows that the "last record in data block N" for these are 35, 72, and 108.

offset	no record starts here	checksum	last record in data block N	words to first pointer in data block N
60	0	3496	35	220
61	0	2517	72	365
62	0	2696	108	520

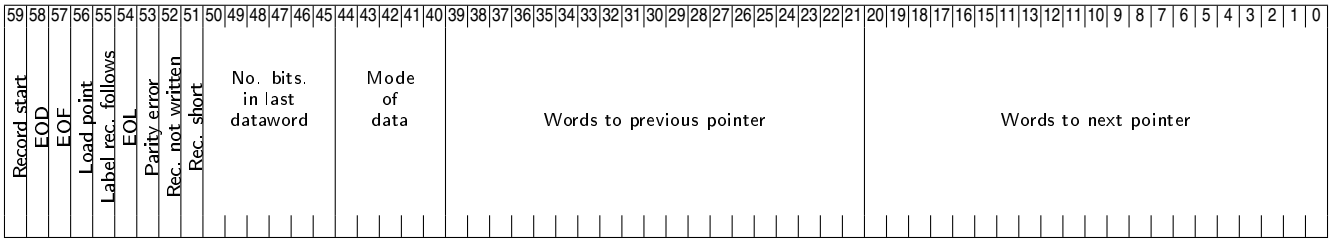
Using `tbmexplore` to dump the offsets of the data buffer flags containing actual data in the same file, then taking those offsets mod 16384 to show where the offsets cross block boundaries, we can see that the indices of the records at the end of each block correspond to the aforementioned values:

[1] Not mentioned in the NCAR Tech Note, but can be seen referenced on line 96 of the `as.s` CAL source file for `tbm2cos`.

Index	Offset to Data Buffer Flag (aka "Record Control Word")	Offset mod 16384
1	16412	28
2	17743	1359
3	18190	1806
	⋮	
33	31600	15216
34	32047	15663
35	32494	16110
36	32941	173
37	33388	620
38	33835	1067
	⋮	
70	48139	15371
71	48586	15818
72	49033	16265
73	49480	328
74	49927	775
75	50374	1222
	⋮	
106	64231	15079
107	64678	15526
108	65125	15973
109	65572	36
110	66019	483
111	66466	930

2.7 Data Buffer Flags

Also known as the "record control word" or the "data buffer field."



Length	Bits	Type	API	Description
1	59	Binary	isRecordStart	Start of record
1	58	Binary	isEOD	End of data in this volume
1	57	Binary	isEOF	End of file
1	56	Binary	isLoadPoint	Load point for tape simulation
1	55	Binary	labelRecordFollows	Label record follows
1	54	Binary	endLabelGroup	End of label group file mark
1	53	Binary	sourceRecordHasParityError	Source record had a parity error
1	52	Binary	recordNotWritten	Record not written (direct access volume)
1	51	Binary	recordIsShorter	Record shorter than words to next pointer-1, length is in bits 0-21 of first data word
6	50–45	Binary	numBits	Number of bits in last data word controlled by this pointer
5	44–40	Binary	recordDataMode	Mode of data in this record (see Data Type bits 51–44 of first word of SYSLBN)
19	39–21	Binary	prevPtrOffset	Words to previous buffer pointer
21	20–0	Binary	nextPtrOffset	Words to next buffer pointer

2.8 First End-Of-File Label (EOF1)

All of the characters in EOF1 correspond directly to those in HDR1, but only characters 5–54 and 61–80 of EOF1 will have the (exact) same values as those of HDR1 in a given file; characters 55-60 contain the block count, which changes between HDR1 and EOF1. Characters 1–4 change from HDR1 to EOF1, so only the first word (word 0) of EOF1 is shown.

For comparison, consider the HDR1 and EOF1 at the offsets shown in the table below from the CODE-II file G51452:

Field	HDR1 Value	EOF1 Value
Offset[2]	16394	5050071
hdr1/eof1	"HDR1" (0x20449C)	"EOF1" (0x14F19C)
dataSetID	"NCARSYSTEMHD10001"	"NCARSYSTEMHD10001"
volSerialName2	"G51452"	"G51452"
fileSecNum	"0001"	"0001"
fileSeqNum	"0001"	"0001"
generationNum	"0001"	"0001"
versionNum	"00"	"00"
creationDate	" 82320"	" 82320"
expDate	" 83320"	" 83320"
accChar	" " (0x2D)	" " (0x2D)
blockCount	"000000"	"011259"
sysCode	"NCAR SYSTEM"	"NCAR SYSTEM"

Observe that the block count changes from 0 to 11259; in this file, there are 11259 records between HDR1 and EOF1.

2.8.1 EOF1 Word 0

Length	Bits	Type	API	Description
18	59–42	DPC		The string "EOF1".
42	41–0	DPC		Same as in HDR1.

offset	offset to next FCP	data blk number	buffer ptr offset	file type	file disposition	2nd type	is obsolete?	is EOF?
51	349	0	201	0	0	0	0	0

[2] "Offset" here is not a field in HDR1 or EOF1, but rather the offset in the file to the start of each of these sequences.

400	10	339	8486	0	0	0	0	0
410	0	0	0	0	0	0	0	1