GDSII™ Stream Format Manual

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calma

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1.0 Notes to the User

Stream format is the standard output format for GDSII data. Stream format is the format written by OUTFORM and STREAMOUT and read by INFORM. Libraries preserved in this format can be easily transferred to other systems for processing. Stream format is upward compatible between releases. Libraries archived under an old release will always be readable by newer releases. For this reason, libraries preserved in Stream format can be archived.

Sections 2 through 4 describe the Stream format components. Sections 5 and 6 describe the Stream syntax. Section 7 provides an example and description of a Stream format file.

2.0 Record Description

The Stream format output file is composed of variable length records. The minimum record length is four bytes. Records can be infinitely long. The first four bytes of a record are the header. The first two bytes of the header contain a count (in eight-bit bytes) of the total record length. The count tells you where one record ends and another begins. The next record begins immediately after the last byte included in the count.

The third byte of the header is the record type. The fourth byte of the header describes the type of data contained within the record. The fifth through last bytes of a record are data. *Figure 2-1* shows a typical record header.

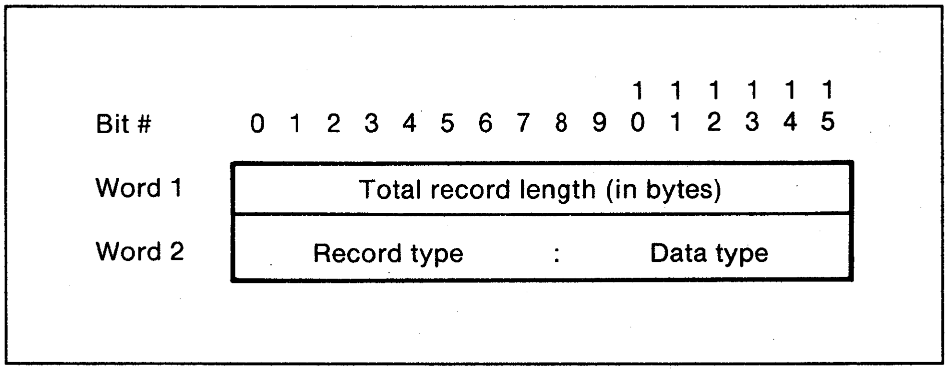


Figure 2-1. Typical Record Header

If the output file is a magnetic tape, then the records of the library are written out in 2048-byte physical blocks. Records may overlap physical block boundaries; a record is not required to be wholly contained in a single physical block.

A null word consists of two consecutive zero bytes. Use null words to fill the space between

- the last record of a library and the end of its physical block, or
- the last record of a tape in a multi-reel Stream file and the end of its physical block.

Sections 3 and 4 describe data and record types. Section 5 shows how the Stream records must be arranged.

3.0 Data Type Description

Table 3-1 lists the possible data types and their values. You can find the type value in the fourth byte of the record.

Table 3-1. Stream Data Types

Data Type	Value
No Data Present	0
Bit Array	1
Two-Byte Signed Integer	2
Four-Byte Signed Integer	3
Four-Byte Real	4 (at present, this data type is not used)
Eight-Byte Real	5
ASCII String	6

The following paragraphs describe the data types listed in *Table 3-1*.

Remember: A word consists of 16 bits, numbered 0 to 15, left to right.

- *Bit Array (1):*

  A bit array is a word which uses the value of a particular bit or group of bits to represent data. A bit array allows one word to represent a number of simple pieces of information.

- *Two-Byte Signed Integer (2):*

  2-byte integer = 1 word 2s-complement representation

  The range of two-byte signed integers is -32,768 to 32,767.

  Following is a representation of a two-byte integer, where S is the sign and M is magnitude.

  ```
  SMMMMMMM MMMMMMM
  ```

  Following are examples of two-byte integers:

  ```
  00000000 00000001 = 1
  00000000 00000010 = 2
  00000000 10001001 = 137
  11111111 11111111 = -1
  11111111 11111110 = -2
  11111111 01110111 = -137
  ```

- *Four-Byte Signed Integer (3):*

  4-byte integer = 2 word 2s-complement representation

  The range of four-byte signed integers is -2,147,483,648 to 2,147,483,647.

  Following is a representation of a four-byte integer, where S is the sign and M is magnitude.

  ```
  SMMMMMMM MMMMMMMM MMMMMMMM MMMMMMMM
  ```

  Examples of four-byte integers:

  ```
  00000000 00000000 00000000 00000001 = 1
  00000000 00000000 00000000 00000010 = 2
  00000000 00000000 00000000 10001001 = 137
  11111111 11111111 11111111 11111111 = -1
  11111111 11111111 11111111 11111110 = -2
  11111111 11111111 11111111 01110111 = -137
  ```

- *Four-Byte Real (4) and Eight-Byte Real (5):*

  4-byte real = 2 word floating point representation

  8-byte real = 4 word floating point representation

  For all non-zero values:

  - A floating point number is made up of three parts: the sign, the exponent, and the mantissa.
  - The value of a floating point number is defined to be:

    (Mantissa) x (16 raised to the true value of the exponent field).
  - The exponent field (bits 1-7) is in Excess-64 representation. The 7-bit field shows a number that is 64 greater than the actual exponent.
  - The mantissa is always a positive fraction >=1/16 and <1. For a 4-byte real, the mantissa is bits 8-31. For an 8-byte real, the mantissa is bits 8-63.
  - The binary point is just to the left of bit 8.
  - Bit 8 represents the value 1/2, bit 9 represents 1/4, etc.
  - In order to keep the mantissa in the range of 1/16 to 1, the results of floating point arithmetic are *normalized*. Normalization is a process whereby the mantissa is shifted left one hex digit at a time until its left FOUR bits represent a non-zero quantity. For every hex digit shifted, the exponent is decreased by one. Since the mantissa is shifted four bits at a time, it is possible for the left three bits of a normalized mantissa to be zero. A zero value, also called *true zero*, is represented by a number with all bits zero.

Following are representations of 4-byte and 8-byte reals, where S is the sign, E is the exponent, and M is the magnitude. Examples of 4-byte reals are included. The representation of the negative values of real numbers is exactly the same as the positive, except that the highest order bit is 1, not 0.

In the eight-byte real representation, the first four bytes are exactly the same as in the four-byte real representation. The last four bytes contain additional binary places for more resolution.

4-byte real:

```
SEEEEEEE MMMMMMMM MMMMMMMM MMMMMMMM
```

8-byte real:

```
SEEEEEEE MMMMMMMM MMMMMMMM MMMMMMMM
MMMMMMMM MMMMMMMM MMMMMMMM MMMMMMMM
```

Examples of 4-byte real:

Note: In the first six lines of the following example, the 7-bit exponent field = 65. The actual exponent is 65-64=1.

```
01000001 00010000 00000000 00000000 = 1
01000001 00100000 00000000 00000000 = 2
01000001 00110000 00000000 00000000 = 3
11000001 00010000 00000000 00000000 = -1
11000001 00100000 00000000 00000000 = -2
11000001 00110000 00000000 00000000 = -3

01000000 10000000 00000000 00000000 = .5
01000000 10011001 10011001 10011001 = .6
01000000 10110011 00110011 00110011 = .7
01000001 00011000 00000000 00000000 = 1.5
01000001 00011001 10011001 10011001 = 1.6
01000001 00011011 00110011 00110011 = 1.7
```

```
00000000 00000000 00000000 00000000 = 0
01000001 00010000 00000000 00000000 = 1
01000001 10100000 00000000 00000000 = 10
01000010 01100100 00000000 00000000 = 100
01000011 00111110 10000000 00000000 = 1000
01000100 00100111 00010000 00000000 = 10000
01000101 00011000 01101010 00000000 = 100000
```

- *ASCII String (6):*

  A collection of ASCII characters, where each character is represented by one byte. All odd length strings must be padded with a null character (the number zero) and the byte count for the record containing the ASCII string must include this null character. Stream read-in programs must look for the null character and decrease the length of the string by one if the null character is present.

4.0 Record Types

Records are always an even number of bytes long. If a character string is an odd number of bytes long it is padded with a null character.

Following are records and a brief description of each, where the first two numbers in brackets are the record type and the last two numbers in brackets are the data type. All record numbers are expressed in hexidecimal.

0 HEADER
[0002]

Two-Byte Signed Integer

Contains two bytes of data representing the version number. *Table 4-1* lists corresponding version numbers and GDSII Release numbers. Note that with Release 6.0, the version number changes to three digits.

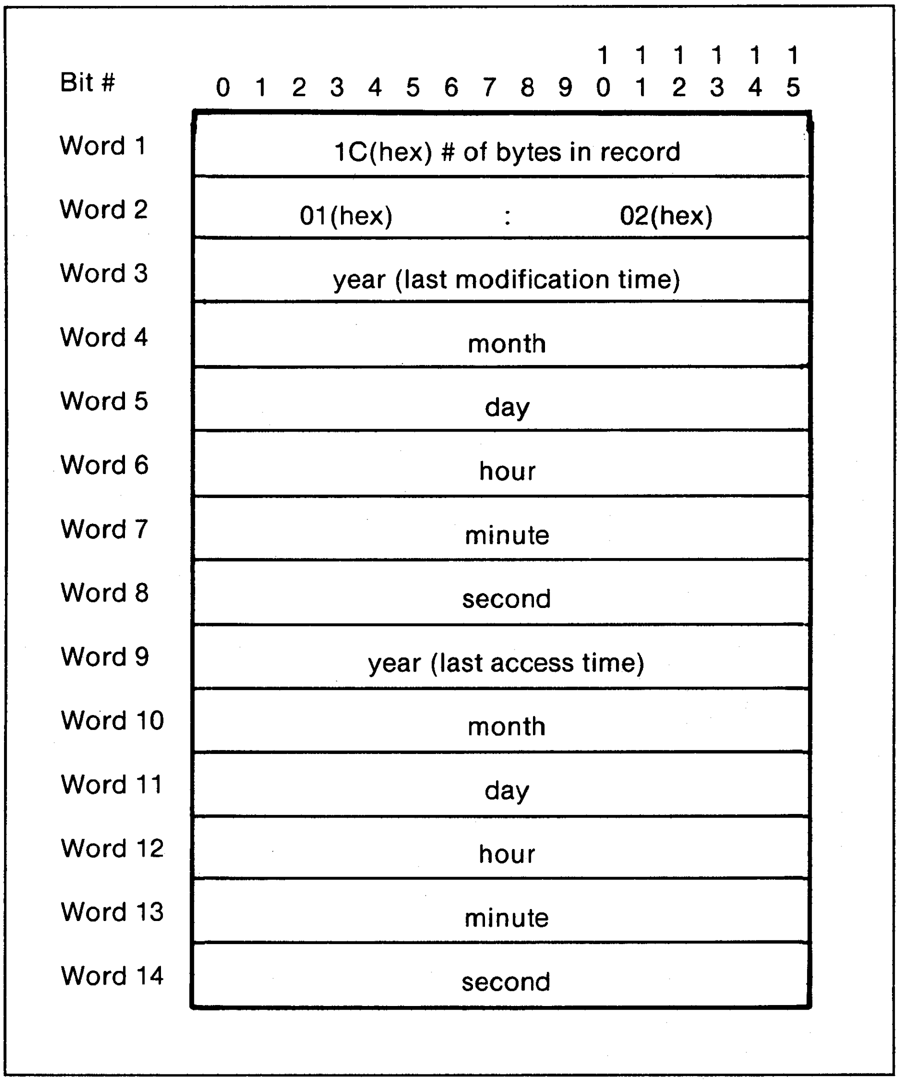
Table 4-1. GDSII Release and Version numbers

Release Number	Version Number
Prior to 3.0	0
3.0	3
4.0	4
5.0	5
6.0	600 (258 Hex)

1 BGNLIB
[0102]

Two-Byte Signed Integer

Contains last modification time of library (two bytes *each* for year, month, day, hour, minute,and second) as well as time of last access (same format) and marks beginning of library. Refer to *Figure 4-1.*



Bit #	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Word 1	1C(hex) # of bytes in record
Word 2	01(hex) : 02(hex)
Word 3	year (last modification time)
Word 4	month
Word 5	day
Word 6	hour
Word 7	minute
Word 8	second
Word 9	year (last access time)
Word 10	month
Word 11	day
Word 12	hour
Word 13	minute
Word 14	second

Figure 4-1. A BGNLIB Record

2 LIBNAME
[0206]

ASCII String

Contains a string which is the library name. The library name must adhere to CDOS file name conventions for length and valid characters. The library name may include the file extension (.DB in most cases).

3 UNITS
[0305]

Eight-Byte Real

Contains 2 8-byte real numbers. The first is the size of a database unit in user units. The second is the size of a database unit in meters. For example, if your library was created with the default units (user unit = 1 micron and 1000 database units per user unit), then the first number would be .001 and the second number would be 1E-9. Typically, the first number is less than 1, since you use more than 1 database unit per user unit.

To calculate the size of a user unit in meters, divide the second number by the first.

4 ENDLIB
[0400]

No Data Present

Marks the end of a library.

5 BGNSTR
[0502]

Two-Byte Signed Integer

Contains creation time and last modification time of a structure (in the same format as for the BGNLIB record) and marks the beginning of a structure.

6 STRNAME
[0606]

ASCII String

Contains a string which is the structure name. A structure name may be up to 32 characters long. Legal structure name characters are:

- A through Z
- a through z
- 0 through 9
- Underscore (_)
- Question mark (?)
- Dollar sign ($)

7 ENDSTR
[0700]

No Data Present

Marks the end of a structure.

8 BOUNDARY
[0800]

No Data Present

Marks the beginning of a boundary element.

9 PATH
[0900]

No Data Present

Marks the beginning of a path element.

10 SREF
[0A00]

No Data Present

Marks the beginning of an SREF (structure reference) element.

11 AREF
[0B00]

No Data Present

Marks the beginning of an AREF (array reference) element.

12 TEXT
[0C00]

No Data Present

Marks the beginning of a text element.

13 LAYER
[0D02]

Two-Byte Signed Integer

Contains 2 bytes which specify the layer. The value of the layer must be in the range of 0 to 63.

14 DATATYPE
[0E02]

Two-Byte Signed Integer

Contains 2 bytes which specify datatype. The value of the datatype must be in the range of 0 to 63.

15 WIDTH
[0F03]

Four-Byte Signed Integer

Contains four bytes which specify the width of a path or text lines in data base units. A negative value for width means that the width is absolute, i.e., it is not affected by the magnification factor of any parent reference. If omitted, zero is assumed.

16 XY
[1003]

Four-Byte Signed Integer

Contains an array of XY coordinates in database units. Each X or Y coordinate is four bytes long.

Path and boundary elements may have up to 200 pairs of coordinates. A path must have at least 2, and a boundary at least 4 pairs of coordinates. The first and last point of a boundary must coincide.

A text or SREF element must have only one pair of coordinates.

An AREF has exactly three pairs of coordinates, which specify the orthogonal array lattice. In an AREF the first point is the array reference point. The second point locates a position which is displaced from the reference point by the inter-column spacing times the number of columns. The third point locates a position which is displaced from the reference point by the inter-row spacing times the number of rows.

A node may have from 1 to 50 pairs of coordinates.

A box must have five pairs of coordinates with the first and last points coinciding.

For an example of an array lattice, see *Figure 4-2*.

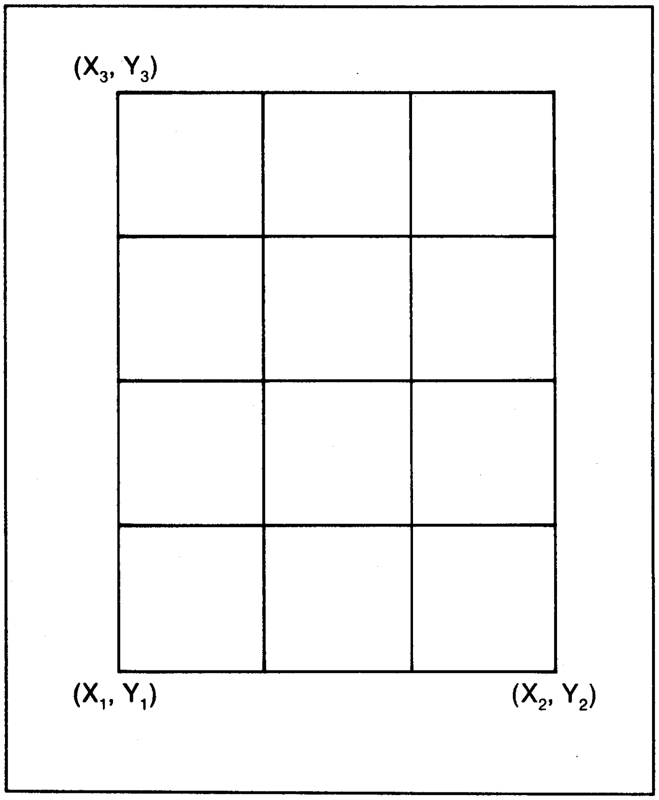


Figure 4-2. An Array Lattice

17 ENDEL
[1100]

No Data Present

Marks the end of an element.

18 SNAME
[1206]

ASCII String

Contains the name of a referenced structure. See also **STRNAME**.

19 COLROW
[1302]

Two-Byte Signed Integer

Contains 4 bytes. The first 2 bytes contain the number of columns in the array. The third and fourth bytes contain the number of rows. Neither the number of columns nor the number of rows may exceed 32,767 (decimal), and both are positive.

20 TEXTNODE
[1400]

No Data Present

Marks the beginning of a text node. (Not currently used.)

21 NODE
[1500]

No Data Present

Marks the beginning of a node.

22 TEXTTYPE
[1602]

Two-Byte Signed Integer

Contains 2 bytes representing texttype. The value of the texttype must be in the range 0 to 63.

23 PRESENTATION
[1701]

Bit Array

Contains 1 word (2 bytes) of bit flags for text presentation. Bits 10 and 11, taken together as a binary number, specify the font (00 means font 0, 01 means font 1, 10 means font 2, and 11 means font 3). Bits 12 and 13 specify the vertical presentation (00 means top, 01 means middle, and 10 means bottom). Bits 14 and 15 specify the horizontal presentation (00 means left, 01 means center, and 10 means right). Bits 0 through 9 are reserved for future use and must be cleared. If this record is omitted, then top-left justification and font 0 are assumed.

Figure 4-3 shows a presentation record.

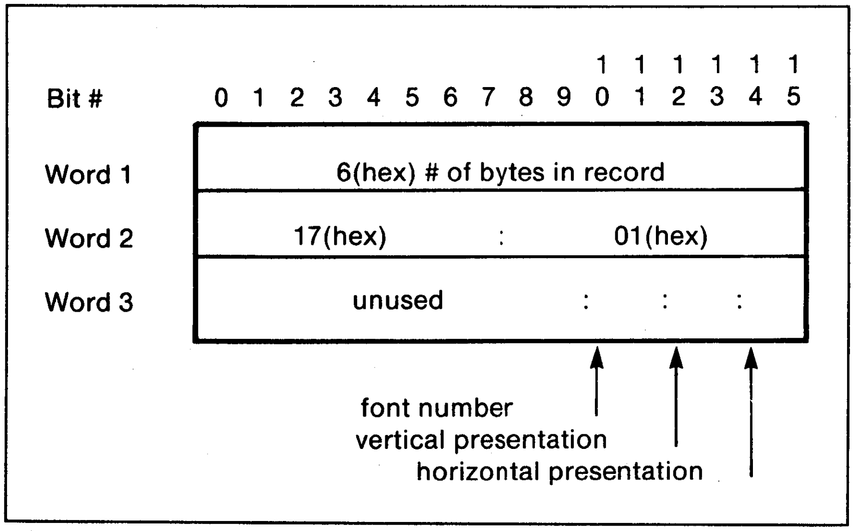


Figure 4-3. A PRESENTATION Record

24 SPACING Discontinued

25 STRING
[1906]

ASCII String

Contains a character string for text presentation, up to 512 characters long.

26 STRANS
[1A01]

Bit Array

Contains two bytes of bit flags for SREF, AREF, and text transformation. Bit 0 (the leftmost bit) specifies reflection. If it is set, then reflection about the X-axis is applied before angular rotation. For AREFs, the entire array lattice is reflected, with the individual array elements rigidly attached. Bit 13 flags absolute magnification. Bit 14 flags absolute angle. Bit 15 (the rightmost bit) and all remaining bits are reserved for future use and must be cleared. If this record is omitted, then the element is assumed to have no reflection and its magnification and angle are assumed to be non-absolute.

Figure 4-4 shows an STRANS record.

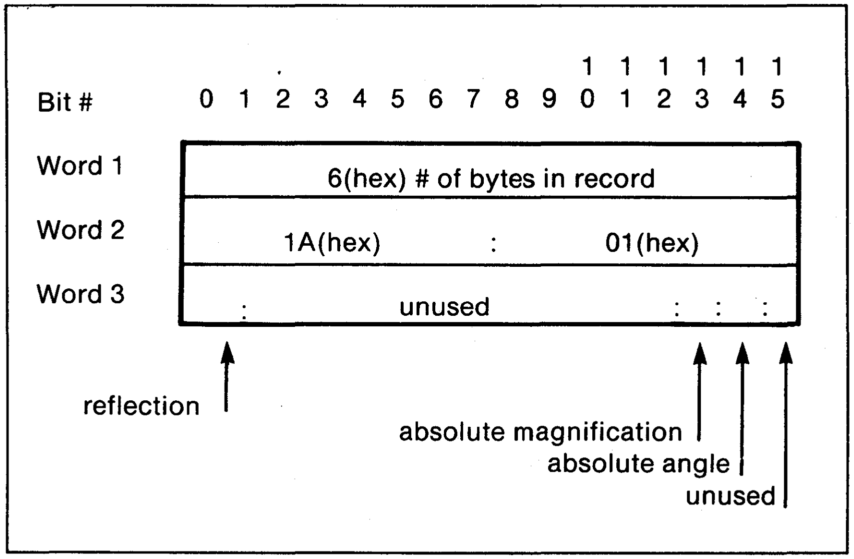


Figure 4-4. An STRANS Record

27 MAG
[1B05]

Eight-Byte Real

Contains a double-precision real number (8 bytes) which is the magnification factor. If omitted, a magnification of 1 is assumed.

28 ANGLE
[1C05]

Eight-Byte Real

Contains a double-precision real number (8 bytes) which is the angular rotation factor, measured in degrees and in counterclockwise direction.

For an AREF, the **ANGLE** rotates the entire array lattice (with the individual array elements rigidly attached) about the array reference point. If this record is omitted, an angle of zero degrees is assumed.

29 UINTEGER

User Integer (No longer used)

User Integer data was used in Release 2.0 only. If any Stream format files from Release 2.0 are read in to the current software, the Stream format input program **INFORM** converts the User Integer data to property data having attribute number 126. See also **PROPATTR** and **PROPVALUE.**

30 USTRING

Character String (No longer used)

User String data, formerly called character string data (CSD), was used in Releases 1.0 and 2.0. If any Stream format files from these releases are read in to the current software, the Stream format input program **INFORM** converts the User String data to property data having attribute number 127. If this record is not present then it is the null string. See also PROPATTR and PROPVALUE.

31 REFLIBS
[1F06]

ASCII String

Contains the names of the reference libraries. This record must be present if there are any reference libraries bound to the current library.

The name for the first reference library starts at byte 0 and the name of the second library starts at byte 45 (decimal). The reference library names may include directory specifiers (separated with ":") and an extension (separated with "."). If either library is not named, its place is filled with nulls.

32 FONTS
[2006]

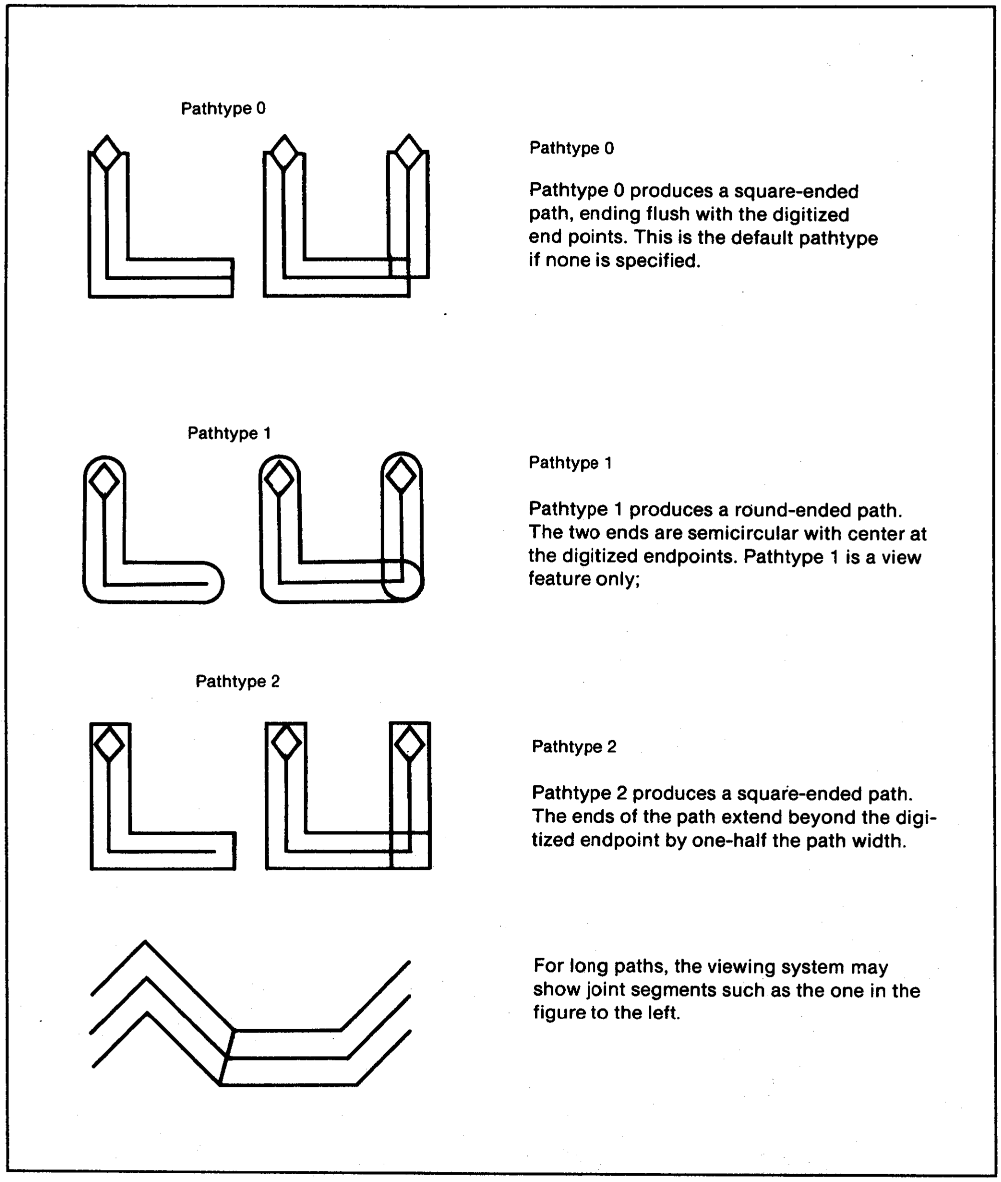
ASCII String

Contains names of textfont definition files. This record must be present if any of the 4 fonts have a corresponding textfont definition file. This record must not be present if none of the fonts have a textfont definition file. The name of font 0 starts the record, followed by the remaining 3 fonts. Each name is 44 bytes long and is null if there is no corresponding textfont definition. Each name is padded with nulls if it is shorter than 44 bytes. The textfont definition file names may include directory specifiers (separated with ":") and an extension (separated with ".").

33 PATHTYPE
[2102]

Two-Byte Signed Integer

This record contains a value of 0 for square-ended paths that end flush with their endpoints, 1 for round-ended paths, and 2 for square-ended paths that extend a half-width beyond their endpoints. Pathtype 4 (for the CustomPlus product only) signifies a path with variable square-end extensions (see records 48 and 49). If not specified, a Pathtype of 0 is assumed. *Figure 4-5* shows the pathtypes.



Pathtype 0

Pathtype 0 produces a square-ended path, ending flush with the digitized end points. This is the default pathtype if none is specified.

Pathtype 1

Pathtype 1 produces a round-ended path. The two ends are semicircular with center at the digitized endpoints. Pathtype 1 is a view feature only;

Pathtype 2

Pathtype 2 produces a square-ended path. The ends of the path extend beyond the digitized endpoint by one-half the path width.

For long paths, the viewing system may show joint segments such as the one in the figure to the left.

Figure 4-5. Pathtypes

34 GENERATIONS
[2202]

Two-Byte Signed Integer

This record contains a positive count of the number of copies of deleted or backed-up structures to retain. This number must be at least 2 and not more than 99. If the GENERATIONS record is not present, a value of 3 is assumed.

35 ATTRTABLE
[2306]

ASCII String

Contains the name of the attribute definition file. This record is present only if there is an attribute definition file bound to the library. The attribute definition file name may include directory specifiers (separated with ":") and an extension (separated with "."). Maximum size is 44 bytes.

36 STYPTABLE
[2406]

ASCII String (Unreleased feature)

37 STRTYPE
[2502]

Two-Byte Signed Integer (Unreleased feature)

38 ELFLAGS
[2601]

Bit Array

Contains 2 bytes of bit flags. Bit 15 (the rightmost bit) specifies Template data. Bit 14 specifies External data (also referred to as Exterior data). All other bits are currently unused and must be cleared to 0. If this record is omitted, then all bits are assumed to be 0.

For additional information on Template data, consult the **GDSII Reference Manual.** For additional information on External data, consult the **CustomPlus User's Manual.** *Figure 4-6* shows an ELFLAGS record.

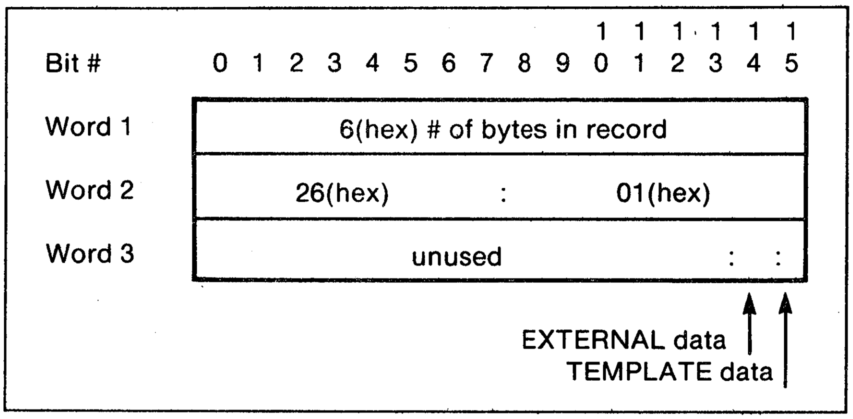


Figure 4-6. An ELFLAGS Record

39 ELKEY
[2703]

Four-Byte Signed Integer (Unreleased feature)

40 LINKTYPE
[28]

Two-Byte Signed Integer (Unreleased feature)

41 LINKKEYS
[29]

Four-Byte Signed Integer (Unreleased feature)

42 NODETYPE
[2A02]

Two-Byte Signed Integer

Contains 2 bytes which specify nodetype. The value of the nodetype must be in the range of 0 to 63.

43 PROPATTR
[2B02]

Two-Byte Signed Integer

Contains 2 bytes which specify the attribute number. The attribute number is an integer from 1 to 127. Attribute numbers 126 and 127 are reserved for the user integer and user string (CSD) properties, which existed prior to Release 3.0. (User string and user integer data from previous releases is converted to property data having attribute number

127 and 126 by the Stream format input program INFORM.)

44 PROPVALUE
[2C06]

ASCII String

Contains the string value associated with the attribute named in the preceding PROPATTR record. Maximum length is 126 characters. The attribute-value pairs associated with any one element must all have distinct attribute numbers. Also, there is a limit on the total amount of property data that may be associated with any one element: the total length of all the strings, plus twice the number of attribute-value pairs, must not exceed 128 (or 512 if the element is an SREF, AREF, or node).

For example, if a boundary element used property attribute 2 with property value "metal", and property attribute 10 with property value "property", then the total amount of property data would be 18 bytes. This is 6 bytes for "metal" (odd-length strings must be padded with a null) + 8 for "property" + 2 times the 2 attributes (4) = 18.

45 BOX
[2D00]

No Data Present

Marks the beginning of a box element.

46 BOXTYPE
[2E02]

Two-Byte Signed Integer

Contains 2 bytes which specify boxtype. The value of the boxtype must be in the range of 0 to 63.

47 PLEX
[2F03]

Four-Byte Signed Integer

A unique positive number which is common to all elements of the plex to which this element belongs. The head of the plex is flagged by setting the seventh bit; therefore, plex numbers should be small enough to occupy only the rightmost 24 bits. If this record is omitted, then the element is not a plex member.

48 BGNEXTN
[3003]

Four-Byte Signed Integer. (This record type only occurs in CustomPlus.)

Applies to Pathtype 4. Contains four bytes which specify in database units the extension of a path outline beyond the first point of the path. Value can be negative.

49 ENDEXTN
[3103]

Four-Byte Signed Integer. (This record type only occurs in CustomPlus.)

Applies to Pathtype 4. Contains four bytes which specify in database units the extension of a path outline beyond the last point of the path. Value can be negative.

50 TAPENUM
[3202]

Two-Byte Signed Integer

Contains two bytes which specify the number of the current reel of tape for a multi-reel Stream file. For the first tape, the TAPENUM is 1; for the second tape, the TAPENUM is 2; etc.

51 TAPECODE
[3302]

Two-Byte Signed Integer

Contains 12 bytes. This is a unique 6-integer code which is common to all the reels of a multi-reel Stream file. It verifies that the correct reels are being read in.

52 STRCLASS
[3401]

Two-Byte Bit Array. (Only for Calma internal use with CustomPlus structures.)

If Stream tapes are produced by non-Calma programs, then this record should either be omitted or cleared to zero.

53 RESERVED
[3503]

Four-Byte Signed Integer. (Reserved for future use.)

This record type was used for NUMTYPES but was not required.

54 FORMAT
[3602]

Two-Byte Signed Integer. (Optional)

Defines the format type of a Stream tape in two bytes. The two possible values are: 0 for Archive format, 1 for Filtered format.

An Archive Stream file contains elements for all the layers and data types. It is created with OUTFORM. In an Archive Stream file, the FORMAT record is followed immediately by the UNITS record. A file which does not have the FORMAT record is assumed to be an Archive file.

A Filtered Stream file contains only the elements on the layers and with the data types specified by the user during execution of STREAMOUT. The list of layers and data types specified for STREAMOUT follows the FORMAT record in MASK records. The MASK records are terminated with the ENDMASKS record. At least one MASK record must immediately follow the FORMAT record. The Filtered Stream file is created with STREAMOUT.

See MASK and ENDMASKS below.

55 MASK
[3706]

ASCII String. (Required for Filtered format, and present only in Filtered Stream file.)

Contains the list of layers and data types specified by the user for STREAMOUT. At least one MASK record must follow the FORMAT record. More than one MASK record may follow the FORMAT record. The last MASK record is followed by the ENDMASKS record.

See FORMAT above and ENDMASKS below.

In the MASK list, data types are separated from the layers with a semi-colon. Individual layers or data types are separated with a space. A range of layers or data types is specified with a dash. An example MASK list looks like this:

```
1 5-7 10 ; 0-63
```

56 ENDMASKS
[3800]

No Data Present. (Required for Filtered format, and present only in Filtered Stream file.)

Terminates the MASK records. The ENDMASKS record must follow the last MASK record. ENDMASKS is immediately followed by the UNITS record.

See FORMAT and MASK above.

57 LIBDIRSIZE
[3902]

Two-Byte Signed Integer

Contains the number of pages in the Library directory. This information is used only if INFORM is reading the data into a new library. If this record is present, it should occur between the BGNLIB record and the LIBNAME record.

58 SRFNAME
[3A06]

ASCII String

Contains the name of the Sticks Rules File, if one is bound to the library. This information is used only if INFORM is reading the data into a new library. If this record is present, it should occur between the BGNLIB record and the LIBNAME record.

59 LIBSECUR
[3B02]

Two-Byte Signed Integer

Contains an array of Access Control List (ACL) data. There may be from 1 to 32 ACL entries, each consisting of:

- A group number
- A user number
- Access rights

This information is used only if INFORM is reading the data into a new library. If this record is present, it should occur between the BGNLIB record and the LIBNAME record.

5.0 Stream Syntax

Following is a Bachus Naur representation of the Stream syntax. An element shown in ALL CAPS is the name of an actual record type. An element shown in lower case means that name can be further broken down into a set of actual record types. *Table 5-1* shows the meaning of the different symbols used.

Table 5-1. Bachus Naur Symbols

Symbol Name	Symbol	Meaning
Double Colon	::	"Is composed of"
Square brackets	[]	An element which can occur zero or one time.
Braces	{}	Choose one of the elements within the braces.
Braces with an asterisk	{}*	The elements within the braces can occur zero or more times.
Braces with a plus	{}+	The elements within braces must occur one or more times.
Angle brackets	<>	These elements are further defined in the Stream syntax list.
Vertical bar	|	"Or"

```
<stream format>::=      HEADER BGNLIB [LIBDIRSIZE] [SRFNAME]
                        [LIBSECUR] LIBNAME [REFLIBS] [FONTS]
                        [ATTRTABLE] [GENERATIONS] [<FormatType>]
                        UNITS {<structure>}* ENDLIB

<FormatType>::=         FORMAT | FORMAT {MASK}+ ENDMASKS

<structure>::=          BGNSTR STRNAME [STRCLASS] {<element>}*
                        ENDSTR

<element>::=            {<boundary> | <path> | <SREF> | <AREF>
                        | <text> | <node> | <box>} {<property>}*
                        ENDEL

<boundary>::=           BOUNDARY [ELFLAGS] [PLEX] LAYER DATATYPE XY

<path>::=               PATH [ELFLAGS] [PLEX] LAYER DATATYPE
                        [PATHTYPE] [WIDTH] [BGNEXTN] [ENDEXTN] XY

<SREF>::=               SREF [ELFLAGS] [PLEX] SNAME [<strans>] XY

<AREF>::=               AREF [ELFLAGS] [PLEX] SNAME [<strans>]
                        COLROW XY

<text>::=               TEXT [ELFLAGS] [PLEX] LAYER <textbody>

<node>::=               NODE [ELFLAGS] [PLEX] LAYER NODETYPE XY

<box>::=                BOX [ELFLAGS] [PLEX] LAYER BOXTYPE XY

<textbody>::=           TEXTTYPE [PRESENTATION] [PATHTYPE] [WIDTH]
                        [<strans>]XY STRING

<strans>::=             STRANS [MAG] [ANGLE]

<property>::=           PROPATTR PROPVALUE
```

6.0 Multi-Reel Stream Format

You can put Stream format onto multiple reels of tape. The first tape must end with the records TAPENUM, TAPECODE, and LIBNAME, in that order. Each subsequent tape must begin with the same records, in the same order, and must end with the record TAPENUM. Stream tapes must contain only complete Stream records, i.e., no Stream record should begin on one tape and continue on the next tape.

> **Note:** Use TAPENUM and TAPECODE only as described. These records cannot appear anywhere else in the Stream file.

The records TAPENUM, TAPECODE, and LIBNAME, used in this manner, are used only for identification of the tapes and are not incorporated into the library in any way. LIBNAME occurs normally as the third record of a Stream file. Tapes may end after any record in Stream format.

Following are illustrations of multi-reel Stream tapes.

Tape 1:

HEADER	Several Complete Stream records	TAPENUM (1)	TAPECODE <code>	LIBNAME <library name>

Intermediate Tape (i):

TAPENUM (i)	TAPECODE <code>	LIBNAME <library name>	More Complete Stream records	TAPENUM (i)

Last Tape (n):

TAPENUM (n)	TAPECODE <code>	LIBNAME <library name>	More complete Stream records	ENDLIB

Following is a Bachus Naur representation of multi-reel Stream tapes. Refer to *Table 5-1* for an explanation of the symbols used.

```
<multi-reel Stream tape>::=   <tape1> {<continuation tapes>}+

<tape1>::=                    HEADER {<complete records in Stream
                              syntax>}* <tape-id>

<continuation tapes>::=       <tape-id> {<complete records continuing
                              in Stream syntax>}+ TAPENUM

<tape-id>::=                  TAPENUM TAPECODE LIBNAME
```

The entire concatenation of Stream records, without the tape-id groups and TAPENUMs, should conform to the Stream syntax described in **Section 5.0.**

7.0 Example of a Stream Format File

Figure 7-1 shows an FPRINT of a Stream format file. An explanation follows the example.

```
? FPRINT
Source File Name: EXAMPLE.SF
Format (Octal): HEX
Output File: $TTO
000 0006 0002 0258 001C 0102 0055 0009 0003 ...........U....
008 0000 0000 0000 0055 0009 0003 000A 0010 .......U........
010 0000 0006 3902 0028 000A 3B02 0003 0005 ....9..(..;.....
018 0007 000E 0206 4558 414D 504C 452E 4442 ......EXAMPLE.DB
020 005C 1F06 4744 5349 493A 5245 4631 2E44 ...GDSII:REF1.D
028 4200 0000 0000 0000 0000 0000 0000 0000 B...............
030 0000 0000 0000 0000 0000 0000 0000 0000 ................
****
048 0000 0000 0000 0000 0000 0000 00B4 2006 .............. .
050 4744 5349 493A 4341 4C4D 4146 4F4E 542E GDSII:CALMAFONT.
058 5458 0000 0000 0000 0000 0000 0000 0000 TX..............
060 0000 0000 0000 0000 0000 0000 4744 5349 ............GDSI
068 493A 5445 5854 2E54 5800 0000 0000 0000 I:TEXT.TX.......
070 0000 0000 0000 0000 0000 0000 0000 0000 ................
078 0000 0000 0000 0000 4744 5349 493A 464F ........GDSII:FO
080 4E54 2E54 5800 0000 0000 0000 0000 0000 NT.TX...........
088 0000 0000 0000 0000 0000 0000 0000 0000 ................
090 0000 0000 4744 5349 493A 5047 464F 4E54 ....GDSII:PGFONT
098 2E54 5800 0000 0000 0000 0000 0000 0000 .TX.............
0A0 0000 0000 0000 0000 0000 0000 0000 0000 ................
0A8 0012 2306 4744 5349 493A 4154 5452 532E ..#.GDSII:ATTRS.
```

Figure 7-1. Sample Stream Format File (Page 1 of 2)

```
0B0 4154 0006 2202 0003 0014 0305 3E41 8937 AT.."......>A.7
0B8 4BC6 A7EF 3944 B82F A09B 5A51 001C 0502 K...9D./..ZQ....
0C0 0055 0007 000C 0011 001D 000A 0055 0007 .U...........U..
0C8 0011 0011 003A 0014 000C 0606 4558 414D ....:.......EXAM
0D0 504C 4532 0004 0B00 000C 1206 4558 414D PLE2........EXAM
0D8 504C 4531 0006 1A01 8000 000C 1C05 425A PLE1..........BZ
0E0 0000 0000 0000 0008 1302 0002 0002 001C ................
0E8 1003 0000 4E20 0000 4E20 0000 4E20 0001 ....N ..N ..N ..
0F0 4FF0 0001 3880 0000 4E20 0004 1100 0004 O...8...N ......
0F8 0700 001C 0502 0055 0007 000C 000B 001C .......U........
100 0009 0055 0008 001C 000F 0039 003A 000C ...U.......9.:..
108 0606 4558 414D 504C 4531 0004 0C00 0006 ..EXAMPLE1......
110 0D02 0000 0006 1602 0000 0006 1701 0005 ................
118 0006 1A01 8006 000C 1B05 4120 0000 0000 ..........A ....
120 0000 000C 1003 0000 4E20 0000 4E20 000E ........N ..N ..
128 1906 4920 414D 2048 4552 450D 0004 1100 ..I AM HERE.....
130 0004 0800 0006 2601 0001 0006 0D02 0002 ......&.........
138 0006 0E02 0003 0024 1003 0000 1388 0000 .......$........
140 6D60 0000 2EE0 0000 6D60 0000 1F40 0000 m‘......m‘...@..
148 84D0 0000 1388 0000 6D60 0004 1100 0004 ........m‘......
150 0900 0006 0D02 0004 0006 0E02 003F 0006 ..............?..
158 2102 0001 0008 0F03 0000 03E8 0024 1003 !............$..
160 0000 3A98 0000 36B0 0000 6590 0000 36B0 ..:...6...e...6.
168 0000 84D0 0000 2328 0000 55F0 0000 1770 ......#(..U....p
170 0006 2B02 0002 000A 2C06 4D45 5441 4C00 ..+......,.METAL.
178 0006 2B02 000A 000C 2C06 5052 4F50 4552 ..+.....,.PROPER
180 5459 0004 1100 0004 0700 0004 0400 TY............
```

Figure 7-1. Sample Stream Format File (Page 2 of 2)

The database that produced this stream format output had only two structures. They were called EXAMPLE1 and EXAMPLE2. EXAMPLE2 contained only one element, a 2 x 2 AREF of EXAMPLE1. EXAMPLE1 contained a boundary that was template data, a path with two properties, and a middle-center justified text element containing the string I AM HERE.

The records contained in this stream file are as follows:

```
0006 0002 0258
```

The first word says that this record is 6 bytes long. The second word says that this is the `HEADER` record (00 hex), and that it contains data of type 2-byte signed integer (02 hex). The information in the third word is the GDSII version number, which in this case is version 600 (258 hex).

```
001C 0102 0055 0009 0003 0000 0000 0000 0055 0009 0003 000A 0010
0000
```

This record is 28 (1C hex) bytes long. It is the `BGNLIB` (01 hex) record and it contains data of type 2-byte signed integer (02). The 24 bytes of information following the first two header words contain the modification and last access date and time. The last 6 words of information, for example, contain: the year - 85 (55 hex), the month - September (9 hex), the day - 3 (3 hex), the hour - 10 a.m. (A hex), the minute - 16 (10 hex) and the seconds - 0. All together this record says that this library was last modified on September 3, 1985 at 10:16:00 a.m.

```
0006 3902 0028
```

This record is 6 bytes long. It is the `LIBDIRSIZE` (39 hex) record, and it contains data of type 2-byte signed integer (02). In this example, the directory size is 40 (28 hex) pages.

```
000A 3B02 0003 0005 0007
```

This record is 10 (A hex) bytes long. It is the `LIBSECUR` (3B hex) record and it contains data of type 2-byte signed integer (02). In this example, there is only 1 ACL entry. The entry has a group number of 3, a user number of 5, and access rights of 7. This means that the only one with any access rights to this library is user number 5 in group number 3. The access code (0007) means this user has read and write access and is also the owner of the library.

```
000E 0206 4558 414D 504C 452E 4442
```

This record is 14 (E hex) bytes long. It is the `LIBNAME` (02 hex) record and it contains data of type ASCII string (06). The 5 words of information contain the library name `EXAMPLE.DB`.

```
005C 1F06 4744 5349 493A 5245 4631 2E44 4200 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000
```

This record is 92 (5C hex) bytes long. It is the REFLIBS (1F hex) record and it contains data of type ASCII string (06). All 92 bytes of this record must be present if there are any reference libraries bound to the working library. In this example, the library GDSII:REF1.DB is the bound reference library. The library name is padded with nulls to equal 44 bytes. There is no second reference library, so the last 44 bytes are filled with nulls.

```
00B4 2006 4744 5349 493A 4341 4C4D 4146 4F4E 542E 5458 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 4744 5349
493A 5445 5854 2E54 5800 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000 4744 5349 493A 464F 4E54 2E54
5800 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 4744 5349 493A 5047 464F 4E54 2E54 5800 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000
```

This record is 180 (B4 hex) bytes long. It is the FONTS (20 hex) record and it contains data of type ASCII string (06). All 180 bytes of this record must be present if there are any textfont definition files bound to this library. In this example, there are four (the maximum possible) textfont definition files bound to this library. They are GDSII:CALMAFONT.TX, GDSII:TEXT.TX, GDSII:FONT.TX, and GDSII:PGFONT.TX. Each string is padded with nulls out to 44 bytes.

```
0012 2306 4744 5349 493A 4154 5452 532E 4154
```

This record is 18 (12 hex) bytes long. It is the ATTRTABLE (23 hex) record and it contains data of type ASCII string (06). This record is only present if an attribute table is bound to the library. The name of the attribute table is GDSII:ATTRS.AT.

```
0006 2202 0003
```

This record is 6 bytes long. It is the GENERATIONS (22 hex) record and it contains data of type 2-byte signed integer (02). In this example, 3 generations of a structure are retained in the library.

```
0014 0305 3E41 8937 4BC6 A7EF 3944 B82F A09B 5A51
```

This record is 20 (14 hex) bytes long. It is the UNITS (03 hex) record and it contains data of type 8-byte real (05). In this example, 3E41 8937 4BC6 A7EF is 1E-3. This implies that a database unit is 1 thousandth of a user unit. The record 3944 B82F A09B 5A51 is 1E-9. This implies that a database unit is 1E-9 meters (1E-3 microns).

```
001C 0502 0055 0007 000C 0011 001D 000A 0055 0007 0011 0011 003A
0014
```

This record is 28 (1C hex) bytes long. It is the BGNSTR (05 hex) record and it contains data of type 2-byte signed integer (02). The information in this record is the creation time and last modification time of the structure and is in the same format as in the BGNLIB record. This structure was created July 12, 1985 at 5:29:10 p.m. and last modified July 12, 1985 at 5:48:20 p.m.

```
000C 0606 4558 414D 504C 4532
```

This record is 12 (C hex) bytes long. It is the STRNAME (06 hex) record and it contains data of type ASCII string (06). The structure name is EXAMPLE2.

```
0004 0B00
```

This record is 4 bytes long. It is the AREF (0B hex) record and it contains no data (00). It marks the start of an AREF.

```
000C 1206 4558 414D 504C 4531
```

This record is 12 (C hex) bytes long. It is the SNAME (12 hex) record and it contains data of type ASCII string (06). This element contains an SNAME of structure EXAMPLE1.

```
0006 1A01 8000
```

This record is 6 bytes long. It is the STRANS (1A hex) record and it contains bit array data (01). In this example, only bit 0 is set, which implies that this AREF is reflected. Since bits 13 and 14 are not set, this structure's magnification and angle, respectively, are not absolute.

```
000C 1C05 425A 0000 0000 0000
```

This record is 12 (C hex) bytes long. It is the ANGLE (1C hex) record and it contains 8-byte real data (05). The data 425A 0000 0000 0000 represents 90.0, which implies that this AREF was placed at an angle of 90 degrees.

```
0008 1302 0002 0002
```

This record is 8 bytes long. It is the COLROW (13 hex) record and it contains 2-byte signed integer data (02). In this example, we have a 2 x 2 AREF.

```
001C 1003 0000 4E20 0000 4E20 0000 4E20 0001 4FF0 0001 3880 0000
4E20
```

This record is 28 (1C hex) bytes long. It is the XY (10 hex) record and it contains data of type 4-byte signed integer (03). The data, taken 2 words at a time, can be translated to decimal as: 20000, 20000, 20000, 86000, 80000, 20000. Multiply these numbers by 1 thousandth (because a data base unit is 1 thousandth of a user unit) and we get the coordinates: (20, 20), (20, 86), and (80, 20). The first coordinate is the array reference point. The second coordinate is a point which is displaced from the array reference point in the Y-direction by the number of columns times the inter-column spacing. In this example, the second point was displaced 66 (86 - 20) units from the array reference point. Since there are 2 columns, this implies that the inter-column spacing was 33 units. A similar calculation could be carried out to verify that the inter-row spacing was 30 units.

```
0004 1100
```

This record is 4 bytes long. It is the ENDEL (11 hex) record and it contains no data (00). It marks the end of an element.

```
0004 0700
```

This record is 4 bytes long. It is the ENDSTR (07 hex) record and it contains no data (00). It marks the end of a structure.

```
001C 0502 0055 0007 000C 000B 001C 0009 0055 0008 001C 000F 0039
003A
```

This is another BGNSTR record. This structure was created July 12, 1985 at 11:28:09 a.m. and last modified August 28, 1985 at 3:57:58 p.m.

```
000C 0606 4558 414D 504C 4531
```

This is another STRNAME record. It contains the string EXAMPLE1.

```
0004 0C00
```

This record is 4 bytes long. It is the TEXT (0C hex) record and it contains no data (00). It marks the start of a text element.

```
0006 0D02 0000
```

This record is 6 bytes long. It is the LAYER (0D hex) record and it contains data of type 2-byte signed integer (02). This text element is on layer 0.

```
0006 1602 0000
```

This record is 6 bytes long. It is the TEXTTYPE (16 hex) record and it contains data of type 2-byte signed integer (02). This text element is of text type 0.

```
0006 1701 0005
```

This record is 6 bytes long. It is the PRESENTATION (17 hex) record and it contains bit array data (01). The hex number 0005 in binary has all bits set to zero except bits 13 and 15. Since bits 10 and 11 are 00, the text element used font 0. Since bits 12 and 13 are 01, the text has a middle vertical presentation. And since bits 14 and 15 are 01, the text has a center horizontal presentation.

```
0006 1A01 8006
```

This is another STRANS record. This text is reflected and has an absolute magnification and absolute angle.

```
000C 1B05 4120 0000 0000 0000
```

This record is 12 (C hex) bytes long. It is the MAG (1B hex) record and it contains data of type 8-byte real (05). The data in this record represents 2.0, therefore, this text is magnified 2 times.

```
000C 1003 0000 4E20 0000 4E20
```

This is another XY record. The text is placed at coordinate (20, 20).

```
000E 1906 4920 414D 2048 4552 450D
```

This record is 14 (E hex) bytes long. It is the STRING (19 hex) record and it contains data of type ASCII string (06). The text string is I AM HERE.

```
0004 1100
```

This is another ENDEL record.

```
0004 0800
```

This record is 4 bytes long. It is the BOUNDARY (08 hex) record and it contains no data (00). It marks the start of a boundary element.

```
0006 2601 0001
```

This record is 6 bytes long. It is the ELFLAGS (17 hex) record and it contains bit array data (01). Since bit 15 is set, this element is template data. However, since bit 14 is not set, it is not external data.

```
0006 0D02 0002
```

This is another LAYER record. The boundary is on layer 2.

```
0006 0E02 0003
```

This record is 6 bytes long. It is the DATATYPE (0E hex) record and it contains data of type 2-byte signed integer (02). This boundary is of data type 3.

```
0024 1003 0000 1388 0000 6D60 0000 2EE0 0000 6D60 0000 1F40 0000
84D0 0000 1388 0000 6D60
```

This is another XY record. The coordinates are (5, 28), (12, 28), (8, 34), 5(5, 28).

```
0004 1100
```

This is another ENDEL record.

```
0004 0900
```

This record is 4 bytes long. It is the PATH (09 hex) record and it contains no data (00). It marks the start of a path element.

```
0006 0D02 0004
```

This is another LAYER record. The path is on layer 4.

```
0006 0E02 003F
```

This is another DATATYPE record. The path is data type 63 (3F hex).

```
0006 2102 0001
```

This record is 6 bytes long. It is the PATHTYPE (21 hex) record and it contains data of type 2-byte signed integer (02). This path is of path type 1.

```
0008 0F03 0000 03E8
```

This record is 8 bytes long. It is the WIDTH (0F hex) record and it contains data of type 4-byte signed integer (03). The number 03E8 hex is 1000 in decimal. Multiply this by 1 thousandth (because a data base unit is 1 thousandth of a user unit) and the result is 1. Therefore, the width of this path is 1.

```
0024 1003 0000 3A98 0000 36B0 0000 6590 0000 36B0 0000 84D0 0000
2328 0000 55F0 0000 1770
```

This is another XY record. This path's coordinates are (15, 14), (26, 14), (34, 9), (22, 6).

```
0006 2B02 0002
```

This record is 6 bytes long. It is the PROPATTR (2B hex) record and it contains data of type 2-byte signed integer (02). This path has a property with attribute number 2.

```
000A 2C06 4D45 5441 4C00
```

This record is 10 (A hex) bytes long. It is the PROPVALUE (2C hex) record and it contains data of type ASCII string (06). The property value for the property attribute described in the PROPATTR record is METAL. Note that this odd length string is padded with a null.

```
0006 2B02 000A
```

This is another PROPATTR record. This path has another property associated with it and it has attribute number 10 (A hex).

```
000C 2C06 5052 4F50 4552 5459
```

This is another PROPVALUE record. Property attribute 10 (above) has the property PROPERTY.

```
0004 1100
```

This is another ENDEL record.

```
0004 0700
```

This is another ENDSTR record.

```
0004 0400
```

This record is 4 bytes long. This record is the ENDLIB (04 hex) record and it contains no data (00). ENDLIB marks the end of a stream format file.