



*THE INSTITUTE FOR  
INTERCONNECTING  
AND PACKAGING  
ELECTRONIC CIRCUITS*

# IPC-D-354

## Library Format Description for Printed Boards in Digital Form

### ANSI/IPC-D-354

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A standard developed by the Institute for Interconnecting  
and Packaging Electronic Circuits

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- Just include spec information
- Focus on end product performance
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# **Library Format Description for Printed Boards in Digital Form**

Developed by the Computerized Data Format Standardization  
Subcommittee of the Computer Aided Technology Committee of  
the Institute for Interconnecting and Packaging Electronic Circuits

Users of this standard are encouraged to participate in the  
development of future revisions.

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# Library Format Description for Printed Boards in Digital Form

## 1.0 SCOPE

The information contained in this standard is intended to supplement the IPC-D-350 through IPC-D-353 standard series. This document describes the usage of libraries within the processing and generation of information files. The data contained within covers both the definition and usage of internal (exist within the information file) and external libraries. The libraries can be used to make the data generated more compact and thus facilitate data exchange and archival. The subroutines within a library can be used one or more times within any Data Information Module (see 5.2), and also in one or more Data Information Modules. As a supplement, this document will not cover the specifics of the other standards in the series.

**1.1 Format Compatibility** The concepts detailed in this standard are supplemented by the descriptions defined in other companion IPC standards. It is the intent that the family of IPC-D-35X standards detail the various record formats.

Data redundancy is kept to a minimum by using various standards for appropriate data descriptions dependent upon the use of the data.

The following shows the correlation between the IPC standard and the record formats that are defined in each particular standard.

### IPC-D-35X

*Standards Record Description*

**IPC-D-350** Artwork Records

**IPC-D-350** Board Description Records

**IPC-D-351** Schematic Drawing Records

**IPC-D-351** Master Drawing Records

**IPC-D-351** Assembly Drawing Records

**IPC-D-351** Miscellaneous Part Drawing Records

**IPC-D-352** Electrical Description Records

**IPC-D-352** Bill of Material Records

**IPC-D-353** Testing Format Records

**IPC-D-354** Library Description Records

Users are encouraged to maintain data in a form that is self-sufficient, and is not impacted by changes in supplementary data used in the design process. Thus, library description records may be repeated on archived data. All

records shall be in the appropriate format defined in the IPC standard related to the particular record type.

## 2.0 APPLICABLE DOCUMENTS

The following documents, of the issue currently in effect, form a part of this standard to the extent specified herein.

### 2.1 IPC<sup>1</sup>

**IPC-T-50** Terms and Definitions

**IPC-D-300** Printed Board Dimensions and Tolerances

**IPC-D-310** Suggested Guidelines for Artwork Generation and Measurement Techniques for Printed Circuits

**IPC-D-325** Printed Board Documentation

**IPC-D-350** Printed Board Description in Digital Form

**IPC-D-351** Printed Board Drawings in Digital Form

**IPC-D-352** Electronic Design Data Description for Printed Boards in Digital Form

### 2.2 American National Standards Institute<sup>2</sup>

**ANSI X3/TR-1-77** American National Dictionary for Information Processing

**ANSI X3.12** Subroutine Record Format Standardization

**ANSI X3.22** Recorded Magnetic Tape for Information Interchange

**ANSI X3.26** Hollerith Punched Card Code

**ANSI X3.39** Recorded Magnetic Tape

**ANSI X3.54** Recorded Magnetic Tape

**ANSI Y14.5** Dimensioning and Tolerancing for Engineering Drawing

**ANSI Y32.1** Logic Diagram Standards

**ANSI Y32.16** Electrical and Electronic Reference Designations

**ANSI Z210.1** Metric Practice Guide (ASTM E380-72)

1. Publications are available from the IPC, 2215 Sanders Road, Northbrook, IL 60062-6135.2

2. To obtain documents, write: American National Standards Institute, 1430 Broadway, New York, NY 10018.

## 2.3 Department of Defense<sup>3</sup>

**W-T-0051** Tape, Electronic Data Processing, 1971

**DOD-STD-100** Engineering Drawings

## 3.0 TERMS AND DEFINITIONS

Unless otherwise specified herein, terms and definitions shall be in accordance with IPC-T-50 and the following:

**3.1 Annotation** Text or legend pertinent to a design; text may appear as data related to legend on a printed wiring board, lettering on a drawing, or other types of symbols.

**3.2 Comment Records** A record that provides, or refers to, additional descriptive material needed to further clarify the control of the data set.

**3.3 Complex or Composite Records** A term used to define a collection of records that make up an electrical pattern or function used repeatedly in a design. Both the definition and relationship of such records are covered and referred to as subroutine definition and subroutine definition call.

**3.4 Data Information Module (DIM)** A group of records which contain related data intended to describe a specific function or task.

**3.5 Data Layer** A specific group of related records within any individual Data Information Module.

**3.6 Feature Location Record** A type of record that defines lines, points, or annotations.

**3.7 Job Set** A group of one or more Data Information Modules.

**3.8 Modal Form** The technique where the description of a unique feature in a data base (interconnection, single identification, conductor width restrictions, etc.) or other pertinent information is given only once at the beginning of a related set of data.

**3.9 Parameter Record** A record that defines the characteristics of a subsequent set of records, such as job identification, electrical description, tolerances, etc. Parameter records direct the computer program on how to interpret the records that follow in the job stream.

**3.10 Physical Layer** A conductive board layer or artwork image representing a complete conductive layer.

**3.11 Subroutine** As noted in ANSI X3.12 but defined using IPC record format descriptions. This record type provides a framework for constructing complex or composite records.

**3.12 Subroutine Call** As noted in ANSI X3.12 but defined using IPC record format. This record type provides a framework for the manner in which complex or composite records are used in the data stream.

## 4.0 GENERAL REQUIREMENTS

The data format for internal libraries (contained within the job set) or external libraries (outside the jobs set) is identical. Data shall be composed of various segments consisting of 80-column records. The types and formats of such records shall be in accordance with IPC-D-350, IPC-D-351, IPC-D-352 and IPC-D-353 unless otherwise specified herein. Parameter records, title, number, revision and end of library records are slightly different. Between libraries differences and similarities between the two libraries are described in the following paragraphs.

**4.1 External Libraries** An external library shall be treated as its own job set. The job parameter record shall identify that the following records are part of an external library. The DIM K parameter record used in an external library job set shall be considered to be a reference to another external library. All references to external libraries shall be terminated by an end of external library record 998 in columns 1-3. The external library may contain as many Data Information Modules as are necessary to describe all library information. The end of a job set which is an external library shall be terminated with a 999 in columns 1 to 3. This record shall be the last record in the data. See Figure 4-1.

**4.2 Internal Libraries** An internal library is one where all library data is contained in a single job set. The data follows the occurrence of a DIM L parameter record and is terminated by an end of internal library record 997 in columns 1-3. The internal library may contain as many Data Information Modules as necessary to describe the library information; DIM K may not be used although description from the DIM K library may be referenced. See Figure 4-2.

## 4.3 Other Requirements

**4.3.1 Artwork and Printed Boards** When a subroutine describes artwork on a board, any physical layer description (lands, conductors, annotation, etc.), the data shall be in IPC-D-350 format.

**4.3.2 Drawings** When a subroutine describes a drawing any sheet layer description (schematics, parts, assembly drawing, etc.), the data shall be in IPC-D-351 format.

3. To obtain documents, write: Naval Publications & Forms Center, 5801 Tabor Road., Philadelphia, PA 19120.

|                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------|
| P JOB LIB                                                                                                            |
| P TITLE                                                                                                              |
| P NUMBER                                                                                                             |
| P REVISION                                                                                                           |
| P UNITS                                                                                                              |
| P DIM K                                                                                                              |
| P TITLE                                                                                                              |
| P NUMBER                                                                                                             |
| P REVISION                                                                                                           |
| 411 Subroutine 1<br>(feature record)<br>(feature record)<br>411 Subroutine 2<br>(feature record)<br>(feature record) |
| 998                                                                                                                  |
| P DIM L                                                                                                              |
| 211 Subroutine L1<br>(feature record)<br>(feature record)                                                            |
| 299                                                                                                                  |
| 211 Subroutine L2<br>(feature record)                                                                                |
| 299                                                                                                                  |
| 997                                                                                                                  |
| P DIM G<br>411 Subroutine 1<br>(feature record)<br>(feature record)<br>411 Subroutine 2<br>999                       |

IPC -354-4-1

Figure 4-1 Board Data Set

**4.3.3 Electrical Description** When a subroutine describes electrical parameters of the design or bill of material description, the data shall be in IPC-D-352 format.

**4.3.4 Test Descriptions** When a subroutine describes a test sequence or testing parameter, the data shall be in IPC-D-353 format.

**4.3.5 Library References** No library shall be allowed to reference itself via a DIM K or DIM L parameter record. The information in the subroutine data set may access other subroutines within the same library or libraries.

**4.4 Job Set Definition** The job set is headed by a job record, followed immediately by parameter records which describe the title, number, and revision of the job. The job set is ended by an end of job record (999).

A job set shall consist of one or more Data Information Modules that pertain to a single electronic interconnection

|                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------|
| P JOB LIB                                                                                                            |
| P TITLE                                                                                                              |
| P NUMBER                                                                                                             |
| P REVISION                                                                                                           |
| P UNITS                                                                                                              |
| P DIM K                                                                                                              |
| P TITLE                                                                                                              |
| P NUMBER                                                                                                             |
| P REVISION                                                                                                           |
| 411 Subroutine 1<br>(feature record)<br>(feature record)<br>411 Subroutine 2<br>(feature record)<br>(feature record) |
| 998                                                                                                                  |
| P DIM L                                                                                                              |
| 211 Subroutine L1<br>(feature record)<br>(feature record)                                                            |
| 299                                                                                                                  |
| 211 Subroutine L2<br>(feature record)                                                                                |
| 299                                                                                                                  |
| 997                                                                                                                  |
| P DIM G<br>411 Subroutine 1<br>(feature record)<br>(feature record)<br>411 Subroutine 2                              |
| P DIM A                                                                                                              |
| P SUB Subroutine 1<br>P SUB Subroutine 2<br>211 Subroutine 1<br>(feature record)<br>(feature record)                 |
| 299                                                                                                                  |
| 211 Subroutine 2<br>(feature record)<br>(feature record)                                                             |
| 299                                                                                                                  |
| 999                                                                                                                  |

IPC-354-4-2

Figure 4-2 Internal Library in Standard Job Set

product in a single external library. Each different Data Information Module shall have its own title, number, and revision level; these characteristics describe the uniqueness of a DIM. Except for DIM K or DIM L, all Data Information Modules are terminated by the occurrence of another DIM or end of job or end of library record. Specific Data Information Modules such as DIM A, DIM B, DIM C, etc., may occur more than once in a job set, however the data contained within the individual DIM shall be unique. There shall be no redundancy in the data between like Data Information Modules.

**4.5 Data Information Module Definition** Artwork and Board Data Information Modules (codes DIM A and DIM B) are composed of data records, parameter records and comment records, which describe Artwork or Board Related Data. Drawing Data Information Modules (DIM C, D, E and F) are composed of data records, parameter records and component records, which are used to describe schematics, master drawings, assembly drawing and part drawings. Electrical description data subroutines are contained in DIM G, bill of material subroutines in DIM H, and testing subroutines are contained in DIM J.

Parameter records are used to direct the computer program as to how to interpret the records that follow in the job set. Comment records are used to provide additional descriptive material for review by the user, but are not interpreted by the computer. Data records provide the detailed data describing either artwork, board, drawing, electrical, part, or test data. Some typical examples are:

- Feature Dimensions
- Hole Size
- Type of Hole
- Annotation
- Character Height or Width
- Conductor End Characteristics
- Data Layer Codes
- Node Electrical Identification
- Line Width

The data shall explicitly describe in absolute (not incremental) values, a contour or location of an individual feature or composite feature of an electronic interconnection product.

The location of each of the individual elements of a composite element shall be defined with reference to the composite datum using data records.

Individual features shall be defined as being either lands, holes, line segments, annotation or individual elements of a complex/composite feature. A feature shall not be defined more than once at a specific location in any Data Information Module.

**4.6 Data Orientation** (see Figure 4-3) All data relating to the physical description of an electronic interconnection product shall be viewed from the side of the assembly that contains the components, looking through to the opposite side. For those electronic assemblies that have components on more than one side, any external side may be designated as the primary side; the opposite external side shall be designated as the secondary side. The primary side shall be defined as physical layer 1. Physical layers may be conductive or nonconductive as required to describe the physical or electrical properties of the interconnection product.

When coordinates are used to describe physical information, the origin shall be the same for all layers of interconnection description within a Data Information Module (DIM) and shall follow the standard Cartesian coordinate reference system. Positive and negative X, Y and Z values are permitted.

All feature and location records shall be defined at 1:1 scale. When data is to be scaled, the data may be modified through the use of a SCALE parameter record. See paragraph 5.8.

Physical layers shall be numbered consecutively starting from the primary side as layer 1. (See IPC-D-325.)

**4.7 Transfer Media and Data Formats** The data shall be restricted to the printable ASCII character set, and be transmitted on standard 80 column punched cards, on magnetic tape (9 track), or on other storage media, such as disk (removable, hard or floppy), or direct electronic transfer which shall be mutually agreed to by the sender and receiver.

**4.7.1 Punched Cards** Punched cards shall conform to the requirements of ANSI X3.26.

**4.7.2 Magnetic Tape** Unrecorded tape shall conform to W-T-0051.

Nine-track recording tape shall conform to ANSI X3.22 for 800 BPI, X3.39 for 1600 BPI and X3.54 for 6250 BPI.

Magnetic tape recording format shall be 80-column card-image, packed 20 records (1600 bytes) to the block. No magnetic labels shall be written on the tape.

A magnetic tape may contain several job sets. Each job set must be terminated with a hardware generated “end-of-file” mark. The last job set shall be terminated with two “end-of-file” marks.

**4.7.3 Other Transfer Media** Logical record length requirements as specified for magnetic tape above shall also apply to disk and electronic transfer record lengths.

## 5.0 PARAMETER RECORDS

Parameter record characteristics shall be delineated by a “P” in column 1 followed by one of the words: JOB, DIM, UNITS, TITLE, NUM, REV, SHEET, LAYER and IMAGE.

**5.1 Parameter—JOB** (See Figure 5-1) The word JOB in columns 4-6 preceded by a “P” in column 1 shall indicate the beginning of a job set that is an external library. Columns 10-12 shall contain the letters LIB. This record shall be the first record in the data for an external library description.



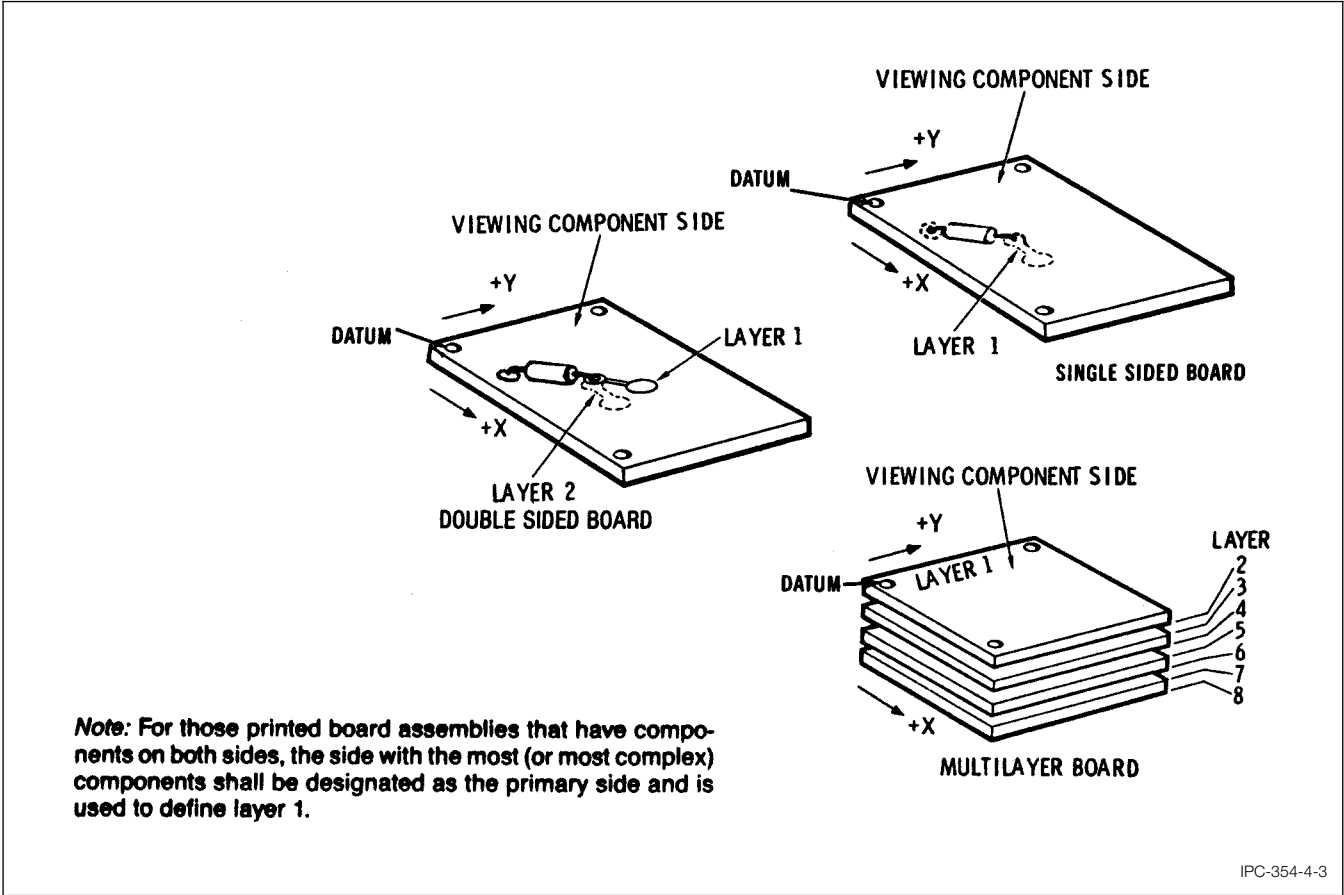


Figure 4-3 Printed Wiring Viewing

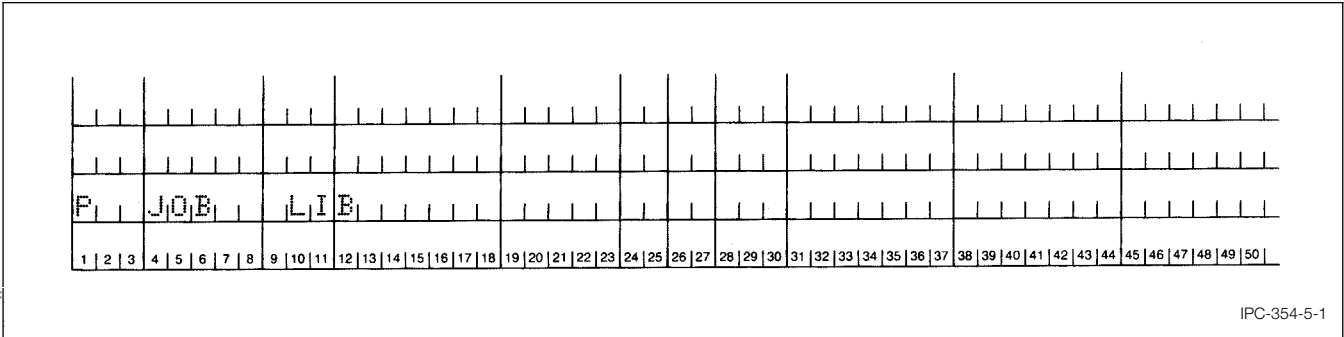


Figure 5-1 Parameter—"JOB"

**5.1.1 End-of-Job** The characters 999 in columns 1-3 shall indicate the end of job. This record shall be the last record in the data.

**5.1.2 Layer Identification** All data layers described in a Data Information Module shall be identified with a unique two-digit number (see paragraph 7.3.2). Data within a subroutine is "layerless." The subroutine data is assigned to the current layer when the subroutine is called.

**5.2 Parameter—DIM (Data Information Module)** (See Figure 5-2) The word DIM in columns 4-6, preceded by a "P" in column 1 shall indicate the start of a Data Information Module. The DIM parameter record may appear

anywhere in a job set (see Figure 4-1 and 4-2). Each different DIM parameter record may occur only once in a job set, except for DIM F. (A Data Information Module is terminated by the occurrence of another DIM parameter record or end of job record. (See paragraphs 4.1 and 4.2.)

Column 10 shall contain a unique letter code describing the type of records that follow the DIM parameter record. The DIM parameter record is also described in other IPC-D-35X standards (see Table 5-1).

The order of DIM subsets is optional except as follows:

- (1) When DIM K, External Library Description, is used, this data shall be the first Data Information Module in the job set. A DIM K is terminated by a blank line.

**Table 5-1 Record Interrelationship**

| Record Type | Code Ltr | DIM Identifier                       | IPC Standard |
|-------------|----------|--------------------------------------|--------------|
| P DIM       | A        | Artwork Records                      | IPC-D-350    |
| P DIM       | B        | Board Description Records            | IPC-D-350    |
| P DIM       | C        | Schematic Drawing Records            | IPC-D-351    |
| P DIM       | D        | Master Drawing Records               | IPC-D-351    |
| P DIM       | E        | Assembly Drawing Records             | IPC-D-351    |
| P DIM       | F        | Miscellaneous Part Drawing Records   | IPC-D-351    |
| P DIM       | G        | Electrical Description Records       | IPC-D-352    |
| P DIM       | H        | Bill of Material Records             | IPC-D-352    |
| P DIM       | J        | Testing Format Records               | IPC-D-353    |
| P DIM       | K        | External Library Description Records | IPC-D-354    |
| P DIM       | L        | Internal Job Library Description     | IPC-D-354    |

Columns 12 through 72 may contain the DIM identifier shown in Table 5-1.

Figure 5-2 shows a grid representing the layout of a DIM record. The grid is 25 columns wide and 2 rows high. The first row contains the text 'DIM' in columns 4-6 and 'C' in column 9. The second row contains the text 'DIM' in columns 4-6 and 'E' in column 9. The grid is labeled 'IPC-351-5-2' at the bottom right.

**Figure 5-2 Parameter—"DIM"**

- (2) When DIM L, Internal Job Library, definitions are used, the data shall follow the DIM K data. If no DIM K data are present, then the DIM L data shall be the first Data Information Module in the job set. A DIM L is terminated by a 997 record.
- (3) When DIM G, Electrical Description, is used, the data shall immediately follow the DIM L data. If no DIM L and/or DIM K data are present, then the DIM G data shall be the first Data Information Module in the job set.

The relationship of DIM records, DIM codes, and IPC standards is shown in Table 5-1.

**5.3 Parameter—UNITS** (See Figure 5-3) The word UNITS in columns 4-8, preceded by a "P" in column 1, shall indicate units-of-measurement-specification. Columns 10-11 shall contain the word SI or columns 10-13 shall contain the word CUST to indicate metric or customary units of measurement. ANSI Z210.1-1971 should be reviewed by those using metric units. The UNITS record shall immediately follow the job record, thus having one

unit record in a single job set. The units specified shall match the units of the calling routine.

Figure 5-3 shows a grid representing the layout of a UNITS record. The grid is 25 columns wide and 2 rows high. The first row contains the text 'P' in column 1, 'UNITS' in columns 4-8, and 'SI' in columns 10-11. The second row contains the text 'P' in column 1, 'UNITS' in columns 4-8, and 'CUST' in columns 10-13. The grid is labeled 'IPC-351-5-3' at the bottom right.

**Figure 5-3 Parameter—"UNITS"**

**5.4 Parameter—TITLE** (See Figure 5-4) The word TITLE in columns 4-8, preceded by a "P" in column 1, shall indicate the title of a Data Information Module defined by a DIM parameter record (artwork title, schematic title, etc.). Columns 10 through 72 shall be used to contain the exact title, which shall also be used in the title block of the appropriate drawing(s). Titles requiring more than one line of text shall use separate title records for each line of text (see Figure 5-4). Any printable ASCII characters are allowed.

The title record shall follow directly after (except for comment records) the DIM record or a job record, and relate to that particular Data Information Module. Titles may be similar or identical on job sets. There may be several title records in a complete job set.

Figure 5-4 shows a grid representing the layout of a NUM record. The grid is 25 columns wide and 6 rows high. The first row contains the text 'P' in column 1, 'TITLE' in columns 4-8, and 'IPC 35X SAMPLE' in columns 10-13. The second row contains the text 'P' in column 1, 'TITLE' in columns 4-8, and 'DEMONSTRATIONJOB' in columns 10-13. The third row contains the text 'C' in column 1. The fourth row contains the text 'P' in column 1, 'NUM' in columns 4-6, and 'IPC-B-25-35X' in columns 10-13. The fifth row contains the text 'C' in column 1. The sixth row contains the text 'P' in column 1, 'REV' in columns 4-6, and 'A' in column 9. The grid is labeled 'IPC-354-5-4' at the bottom right.

**Figure 5-4 Parameter—"NUM"**

**5.5 Parameter—NUM** (See Figure 5-4) The word NUM in columns 4-6, preceded by a "P" in column 1, shall indicate the part number for a Data Information Module defined by a DIM parameter record (artwork number, schematic number, etc.). Columns 10 through 72 are used to contain the number which shall be left justified and shall also be used in the number block(s) of the appropriate drawing(s). Any printable ASCII characters are allowed.

The NUM record shall follow directly after (except for comment records) the title record to which it applies. There may be several NUM records in the job set.

**5.6 Parameter—REV** (See Figure 5-4) The word REV in columns 4-6 preceded by a “P” in column 1, shall indicate the revision identifier of data defined by a DIM parameter record. Columns 10 through 72 shall be used to contain the revision identifier, left justified. The revision identifier shall also be used in the revision block(s) of the appropriate drawing(s). Any printable ASCII characters are allowed.

**5.7 Parameter—SHEET** (See Figure 5-5) The word SHEET in columns 4-8, preceded by a “P” in column 1, shall indicate a composite data specification. The sheet parameter record is used to relate data layer(s) to sheets of drawings. A two-digit number contained in columns 10-11 shall identify the sheet on which the described features are located. Columns 13-16 shall contain the code COMP to indicate that the subsequent data layer(s) are used to compose the sheet noted in columns 10-11. Columns 18-19, 21-22, . . . . , 69-70 shall contain the numbers of the one or more data layers which make up the particular sheet(s) of the drawing(s).

[illegible]

**5.7.1** Data layer numbers correspond to entries in the Feature Dimension L-field; see paragraph 7.3.2.

Diagram illustrating the layout of a 25-column data card. The card is divided into three rows. The top row contains 25 vertical lines. The middle row contains 25 vertical lines. The bottom row contains 25 vertical lines. The text "P SCALE 00085000" is printed in the middle row, starting from the first column and ending at the 12th column. The columns are numbered 1 through 25 at the bottom.

**5.9 Parameter—LAYER** (See Figure 5-7) The code LAYER in columns 4-8 preceded by a “P” in column 1 shall indicate a layer composite specification. The layer composite specification parameter card is used to relate physical layers of the board to data layers. A 2-digit number contained in columns 10-11 shall identify the physical layer on which the described features are located. Columns 13-16 shall contain the code COMP to indicate that the subsequent data layer(s) are used to compose the physical layer noted in columns 10-11. Columns 18-19, 21-22, . . . , 69-70 shall contain the numbers of the one or more data layers which make up the physical layer.

Timing diagram showing the relationship between the P1, LAYER, ID1, COMP, S1, and I1 signals. The diagram is organized into 25 columns, numbered 1 to 25 at the bottom. Each column has a vertical line with a tick mark. The signals are represented by horizontal lines with vertical ticks indicating signal transitions. The P1 signal is high for the first 10 bits and low for the last 15 bits. The LAYER signal is high for the first 10 bits and low for the last 15 bits. The ID1 signal is high for the first 10 bits and low for the last 15 bits. The COMP signal is high for the first 10 bits and low for the last 15 bits. The S1 signal is high for the first 10 bits and low for the last 15 bits. The I1 signal is high for the first 10 bits and low for the last 15 bits.

**5.9.1** Physical layer numbers are defined as shown in Figure 5-7. A “01” designates the first conductive layer. Subsequent conductive layers are numbered sequentially “02”, “03”, . . . as viewed looking down through the board from the first layer.

**5.10 Parameter—IMAGE** (see Figure 5-8) The word IMAGE in columns 4-8, preceded by a “P” in column 1, shall indicate conductive or nonconductive (clearance) features. An IMAGE parameter card shall precede each group of data layer records.

**5.10.2** If production masters are to be delivered as an end item, columns 15 through 17 shall contain the word POS to indicate a clear field with a dark feature of the word NDC.

|                |       |      |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----------------|-------|------|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| P <sub>1</sub> | IMAGE | COND |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|                |       |      |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| P <sub>1</sub> | IMAGE | NCON |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 1              | 2     | 3    | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |

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**Figure 5-8 Parameter—"IMAGE"**

to indicate a dark field with a clear feature. These POS and NEG options do not apply when the end item is a printed board product.

- A. *Example 1* The format in Figure 5-9 indicates that subsequent data describes nonconductive clearance features in the board pattern, and that the production master provides dark features as shown in Figure 5-10.
- B. *Example 2* The format in Figure 5-11 indicates that subsequent data describes nonconductive clearance in the board pattern, and that the production master provides clear features (opposite of Figure 5-10).

[illegible]

Figure 5-9 Example 1

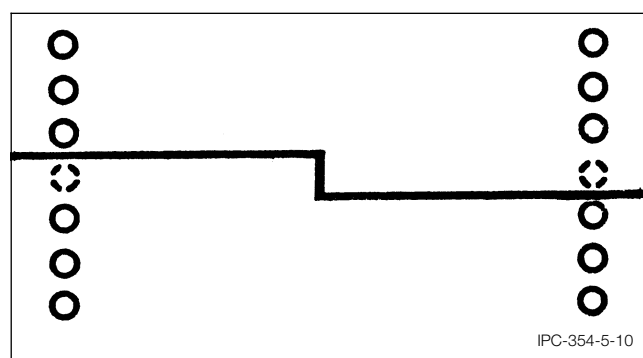


Figure 5-10 “IMAGE” Example

|   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| P |   |   |   | I | M | A | G | E |    |    | N  | C  | O  | N  |    | N  | E  | G  |    |    |    |    |    |    |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |

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Figure 5-11 Example 2

## 6.0 COMMENT RECORDS

The letter “C” in column 1 of a record shall indicate “comment.” Columns 4 through 72 may be used for comment of descriptive material in any form desired except as otherwise specified herein. Comment records support the numeric data by referencing pertinent descriptive information, specifications and documents. Use of the printable ASCII character set is permitted in Comment Records. (See Figure 6-1.)

## 7.0 FEATURE/LOCATION AREA FORMAT

## 7.1 General Information

**7.1.1 Major Data Areas Within Each Record** The Feature/Location records shall consist of 80 columns divided into four major areas as shown in Table 7-1.

**7.1.2 Subgroups Within Major Areas** Specific data fields or subgroups exist within the FDA (Area 2) and LDA (Area 3). Each of these subgroups shall be prefixed by a specific letter. When a prefix letter is present, the corresponding value field shall be filled (a prefix letter and a blank field or a blank prefix and filled value field is not permitted). Leading zeros within the FDA value fields shall be included; leading zeros within the LDA value fields may be dropped.

**7.2 Operations Code Description Area** (See Table 7-2). Columns 1, 2, and 3 shall be reserved for the Operations Code used in conjunction with the FDA and LDA area. This code shall delineate the type of feature being defined. Feature types are LINE, POINT, ANNOTATION, SUBROUTINE DEFINITION and SUBROUTINE CALL. The Operations Code shall be explicitly stated on each record.

Since each column of the Operations Code contains a particular type of information, the Operations Code field can be interpreted as being three separate codes in adjacent positions. A zero in any position shall represent a continuation of the operation defined by the previous entry in that column. When the basic record type (column 1 code) changes, column 2 shall be explicitly redefined.

**7.2.1 Operations Code Column 1** Column 1 values of the three-column Operations Code shall be in accordance with Table 7-3.

**7.2.2 Operations Code Column 2** Column 2 values of the three-column Operations Code shall be used for specifying the functional interpretation of the following data record when column 1 contains a “1”, “3”, or “5”. See Table 7-2 for examples.

**7.2.3 Operations Code Column 3** The third column of the Operations Code field shall describe the format of XY fields in the LDA.

|   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| C | P | A | R | T | O | F | C | O | N  | T  | R  | A  | C  | T  | 2  | 7  | 5  | 3  | 4  | D  | A  | T  | A  | D  | E  | V  | E  | L  | O  | P  | E  | D  | T  | O  | I  | P  | C  | -  | D  | -  | 1  |    |    |    |    |    |    |    |    |
| C | O | R | T | H | O | G | O | N | A  | L  | A  | N  | D  | 4  | 5  | -  | D  | E  | G  | R  | E  | E  | D  | I  | R  | E  | C  | T  | I  | O  | N  | O  | N  | L  | Y  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| C | B | O | A | R | D | M | A | T | E  | R  | I  | A  | L  | P  | E  | R  | M  | I  | L  | -  | P  | -  | 1  | 3  | 9  | 4  | 9  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |

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Figure 6-1 Examples of Comment Records

Table 7-1 Major Data Areas of Feature/Location Record

| AREA | COLUMNS | FUNCTION                                                                                                                                                                     |
|------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | 1-3     | Operations Codes (paragraph 7.2)                                                                                                                                             |
| 2    | 4-30    | Features Description Area (FDA) (paragraph 7.3)                                                                                                                              |
| 3    | 31-72   | Locations Description Area (LDA) (paragraph 7.4)                                                                                                                             |
| 4    | 73-80   | This area is recommended for alphanumeric identification and/or sequence number (paragraph 7.5). This area shall not contain data necessary to the printed board definition. |

Interpretation of data in the LDA differs for each column 2 code. The content of each XY field in the LDA shall be based upon the type of LINE being defined, such as straight or circular. Relationships of each column 2 code to the LDA XY values are shown in Table 7-4. Complex geometries can be defined by combining these basic constructions.

**7.3 Features Description Area (FDA)** Columns 4-30 shall be reserved for a physical description of a given unique feature or for other pertinent data. The specific information used in this area shall be placed into preassigned columns forming fields of a record. Each field shall be prefaced by a letter code to identify function. See Table 7-5. The number of fields and type of information contained in these fields shall vary according to the record used. Table 7-6 defines the considerations for the FDA field for line, point, annotation and subroutine records.

#### 7.3.1 Feature Dimension Field

**7.3.1.1 Column 4** There shall be a “D” in column 4 for a Feature Dimension.

**7.3.1.2 Columns 5-8** Columns 5-8 shall be reserved for a description of feature size. This information shall denote line width, or feature (land) size at the location described in subsequent LDA fields (paragraph 7.4). The values in this field shall represent the feature size in ten-thousandths (0.0001) of an inch or one-thousandths (0.001) of a millimeter. This same feature size shall continue to apply to all

locations described in this record and all following records until a new value is placed in columns 5-8.

When subsequent records supply positional information for the same feature, columns 4-8 may be left blank; this is referred to as modal form. See Figure 7-1.

**7.3.2 Data Layer Code Field** The Data Layer is not applicable to library subroutine definition data.

#### 7.3.3 Node Identification Field—Columns 12-18

**7.3.3.1 Column 12** There shall be an “S” in column 12 of Line and Point records for “Node Identification.”

**7.3.3.2 Columns 13-18** Where a record describes an electrical feature and no continuity test is required, the only information required shall be NULL in columns 15-18 for electrical circuit paths. Where continuity test information is required, columns 13-18 shall contain a unique alphanumeric code for each circuit network (electrically continuous path). Identifiers may be duplicated on different layers and shall be part of the same composite (after lamination) electrical network. NO shall be entered in columns 17 and 18 for all nonelectrical features (e.g., non-plated holes, symbols, heatsinks).

**7.3.4 Rotation, Hole Size, Character Height Field** (Columns 19-23) There shall be an “H” in column 19 when the H field is used. The “H” field is not used with line records. Use of the “H” field is defined in paragraph 9.5. for point records (hole size), paragraph 10.1.4 for annotation records (character height), and paragraph 11.3.1.2 for subroutine calls (rotation).

**7.3.5 Hole Type/Spacing Field** (Columns 24-25) There shall be a “P” in column 24 when the “P” field is used. The P field is not used with line records. Use of the “P” field is defined in paragraph 9.6 for point records (hole type) and paragraph 10.1.5 for annotation records (spacing).

**7.3.6 Generic Field** (Columns 26-27) There shall be a “G” in column 26 when the G field is used. Use of the “G” field is defined in paragraph 8.8 for line records, paragraph 9.7 for point records, paragraph 10.1.6 for annotation records, 11.2.2.1 for subroutine definitions and 11.3.1.3 for subroutine calls.



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Table 7-2 Operations Codes Descriptions

All Operations Codes have three digits. The use of the decimal-point symbol ( . ) in the listing below indicates the position of a digit and illustrates that the Operations Code for these records also may be interpreted as three single-digit Operations Codes in adjacent positions.

**GENERAL RECORDS**

Columns  
123

000 or 0 . . or . 0 . or . . 0 Continuation in present mode; valid for all types of records.

999 End of job.

**LINE RECORDS**

Columns  
123

1 . . Begin new line containing one or more line segments.

. 1 . Linear interpolation.

. 2 . Circular interpolation.

. 4 . Linear "paint in" area outline.

. 5 . Circular "paint in" area outline.

\* . 7 . Linear part outline.

\* . 8 . Circular part outline

. . 1 Format #1

. . 2 Format #2

. . 3 Format #3

. . 4 Format #4

**SUBROUTINE DEFINITION RECORDS**

Columns  
123

2 . . Begin subroutine definition

. 1 . Subroutine definition of a complex feature (executed by a subroutine CALL)

. 2 . Definition of a Point Record special shape (executed as a point record with generic code of G4)

. 3 . Subroutine for dimension description or call out with arrow head

. . 1 Format #1

. . 2 Format #2

. . 3 Format #3

. . 4 Format #4

299 End of subroutine

**POINT RECORDS**

Columns  
123

3 . . Begin new point record.

\* . 1 . Feature (land) and hole concentric at the point.

. 2 . Feature (land) only at the point.

\* . 3 . Hole only at the point.

\* . 4 . Tooling feature and hole at the point.

. 5 . Tooling feature only at the point.

\* . 6 . Tooling hole only at the point.

. . 1 Format #1

. . 2 Format #2

. . 3 Format #3

. . 4 Format #4

**SUBROUTINE CALL RECORDS**

Columns  
123

4 . . Subroutine call

. 1 . Linear repeat or step-and-repeat

. 2 . Rotary repeat or step-and-repeat

. . 1 Format #1<sup>1</sup>

. . 2 Format #2<sup>1</sup>

. . 3 Format #3

. . 4 Format #4

**ANNOTATION RECORDS**

Columns  
123

5 . . Begin annotation/dimension record

. 1 . Begin new annotation record

. 2 . Subroutine call for dimension guidelines, call out guidelines, and the appropriate annotation records to go along with that subroutine.

. . 1 Format #1<sup>2</sup>

. . 2 Format #2<sup>2</sup>

. . 3 Format #3

. . 4 Format #4

000 Columns 4-72 contain the text. This record must follow 51.

Format #1: Positional data (LDA Columns 31-72) formatted as three adjacent X and Y fields.

Format #2: Positional data (LDA Columns 31-72) formatted as two adjacent X and Y fields.

Format #3: Positional data (LDA Columns 31-72) formatted as two adjacent XYZ fields.

Format #4: Positional data (LDA Columns 31-72) formatted as one set of XYZ fields. The second set of XYZ fields must be on the following continuation record.

1. The first X, Y data points define the position of the subroutine pattern datum point, or origin. The second and third X, Y data points are used for linear or rotary replications arguments. The angle is specified in degrees for U.S. units and radians for metric units.
2. The first field contains the XY coordinate for the point of the arrow head, if only one arrow head is present. The second field contains the X and Y coordinate for either the line end or the center of a circle subscribing the call out designator. If two arrow heads are present, the first X and Y coordinate will be for the point of the arrow head closest to datum 00. The third field is left blank.

\*NOTE: See Section 4.1.3. Asterisks only for DIM A or DIM B data subsets (see IPC-D-350).

```

C
C THE FOLLOWING IS AN EXAMPLE OF A CIRCULAR LINE SEGMENTS COMBINED WITH
C STRAIGHT LINE SEGMENTS ON LAYER 1, ROUND LINE ENDS. SEE FIGURE 7-2(B).
C BLANK FIELDS IN THE FOA OF EACH RECORD IMPLY MODAL DATA.
C RECORD 1 STRAIGHT LINE
C RECORD 2 90 DEG ARC CLOCKWISE (CW)
C RECORD 3 90 DEG ARC COUNTERCLOCKWISE (CCW)
C RECORD 4 CONTINUATION OF CCW ARC RECORD ABOVE
C RECORD 5 STRAIGHT LINE
C
111 L01 G1 X+01250Y+01000X+02125Y+01000 RECORD 1
021 X+02125Y+00000X+90000Y+00000X+01000Y-10000 RECORD 2
022 X+00041250Y+00000000X+01800000Y+02700000 RECORD 3
000 X+00010000Y+00010000 RECORD 4
011 X+04125Y-01000X+06133Y-01000 RECORD 5
C
C THE FOLLOWING IS AN EXAMPLE OF A PAINT-IN AREA USING BOTH LINEAR
C AND CIRCULAR MODES. MODAL FOA IS ASSUMED, EXCEPT FOR D-FIELD WHICH
C PROVIDES THE STARTING TOOL DIAMETER USED TO TRAVERSE THE FEATURE
C EXTREMITIES. TOOL DIAMETERS FOR SUBSEQUENT MOVEMENTS USED TO FILL
C IN THE REMAINING PAINT-IN AREA IS LEFT TO THE DISCRETION OF THE
C USER WITH THE ONLY REQUIREMENT BEING COMPLETE PAINT-IN.
C SEE FIGURE 8-1.
C
14100100 X 0Y 1200X 1000Y 1200X 2000Y 1400
051 X 2000Y 800X 9000Y 0X 600Y- 1000
041 X 2600Y 800X 2600Y 0X 0Y 0
000 X 0Y 400
051 X 0Y 600X-9000Y 9000X 200Y+01000
041 X 0Y 800X 0Y 1200
C
C THE FOLLOWING IS AN EXAMPLE OF A PART-OUTLINE USING BOTH LINEAR
C AND CIRCULAR MODES. MODAL FOA IS ASSUMED.
C SEE FIGURE 8-2.
C
182 X 0Y 0X 1605290Y 1994710
000 X 18000Y- 10000
072 X- 16970Y- 6000X- 12000Y- 6000
081 X- 1200Y- 400X-9000Y 0X 200Y 1000
072 X- 10000Y- 4000X- 10000Y 4000
081 X- 1200Y 400X 0Y 9000X 200Y 1000
072 X- 12000Y 6000X- 16970Y 6000
C
C THE FOLLOWING IS AN EXAMPLE OF A 40 MIL LINE FOR ANALOG GND
C CONSISTING OF 5 LINE SEGMENTS ON LAYER 1, ROUND LINE ENDS.
C
11100400L01 G1 X+00275Y+02300X+00278Y+02251X+00400Y+02125
000 X+00400Y+02025X+00575Y+01850X+00575Y+01500
C
C THE FOLLOWING IS AN EXAMPLE OF A 150 MIL SQUARE PAD USED AS A TOOLING
C FEATURE WITH A 125 MIL HOLE AT THREE LOCATIONS. NO PLATING.
C
331D1500L00 H1250P0G3 X+00000Y+00000X+00000Y+03650X+03200Y+03650
C
C THE FOLLOWING IS AN EXAMPLE OF A CHARACTER STRING, OFF THE BOARD AREA
C 100 MIL HIGH, DRAWN WITH A 20 MIL LINE, IN ORIENTATION 4.
C
511D0200L02 H1000 G4 X+01250Y-00050
000SYNTHESIZER/ANALYZER 398-49724-1 REV-B
C
C COMMENTING ON JOB IS A STRONGLY RECOMMENDED PRACTICE
C - BLANK COMMENTS CARDS PROVIDE PARAGRAPHING WHICH ENHANCES
C READABILITY

```

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Figure 7-1 Sample Computer Printout