



*The Institute for
Interconnecting
and Packaging
Electronic Circuits*

IPC-D-355

Printed Board Assembly Description in Digital Form

IPC-D-355

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

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Standardization

In May 1995 the IPC's Technical Activities Executive Committee adopted Principles of Standardization as a guiding principle of IPC's standardization efforts.

Standards Should:

- Show relationship to DFM & DFE
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feed back system on use and problems for future improvement

Standards Should Not:

- Inhibit innovation
- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

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The material in this standard was developed by the IPC-D-355 Task Group (2-11e) of the Data Generation and Transfer Committee (2-10) of the Institute for Interconnecting and Packaging Electronic Circuits.



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INTERCONNECTING
AND PACKAGING
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Developed by the Data Generation and Transfer Committee of the
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Users of this standard are encouraged to participate in the
development of future revisions.

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Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the IPC-D-355

Task Group of the IPC Data Generation and Transfer Committee are shown below, it is not possible to include all of those who assisted in

the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

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Printed Board Assembly Description in Digital Form

1.0 SCOPE

This standard is used to describe the relationship between components (electronic, electro-mechanical, and mechanical) and the printed boards used as the major form of interconnection. Included in these descriptions are the physical characteristics of components and boards required as input to an automated assembly system.

The physical characteristics used in the electronic design process shall be described in digital form, in order to enable the data exchange and archiving capability between systems which support design, fabrication, assembly and testing.

This structure provides the capability for describing all elements in their final form upon completion of manufacturing. It may be used for component preparation (sequencing, lead bonding, etc.), component insertion, adhesive application and component placement.

1.1 Purpose The purpose of IPC-D-355 is to provide the data required to assemble a printed circuit board, including placement information as well as the physical characteristics and locations of all components, sockets, and connectors. The physical dimensions and locations of fiducial marks, glue pattern dispensing, and solder paste dispensing are also included. The standard explicitly does not include determinations of how the manufacturing processes are to be performed (see Figure 1).

1.2 Format Compatibility The concepts detailed in this specification are supplemented by the description defined in the other IPC-D-35X digital description standards. Information redundancy is kept to a minimum by use of the applicable digital description standards described below.

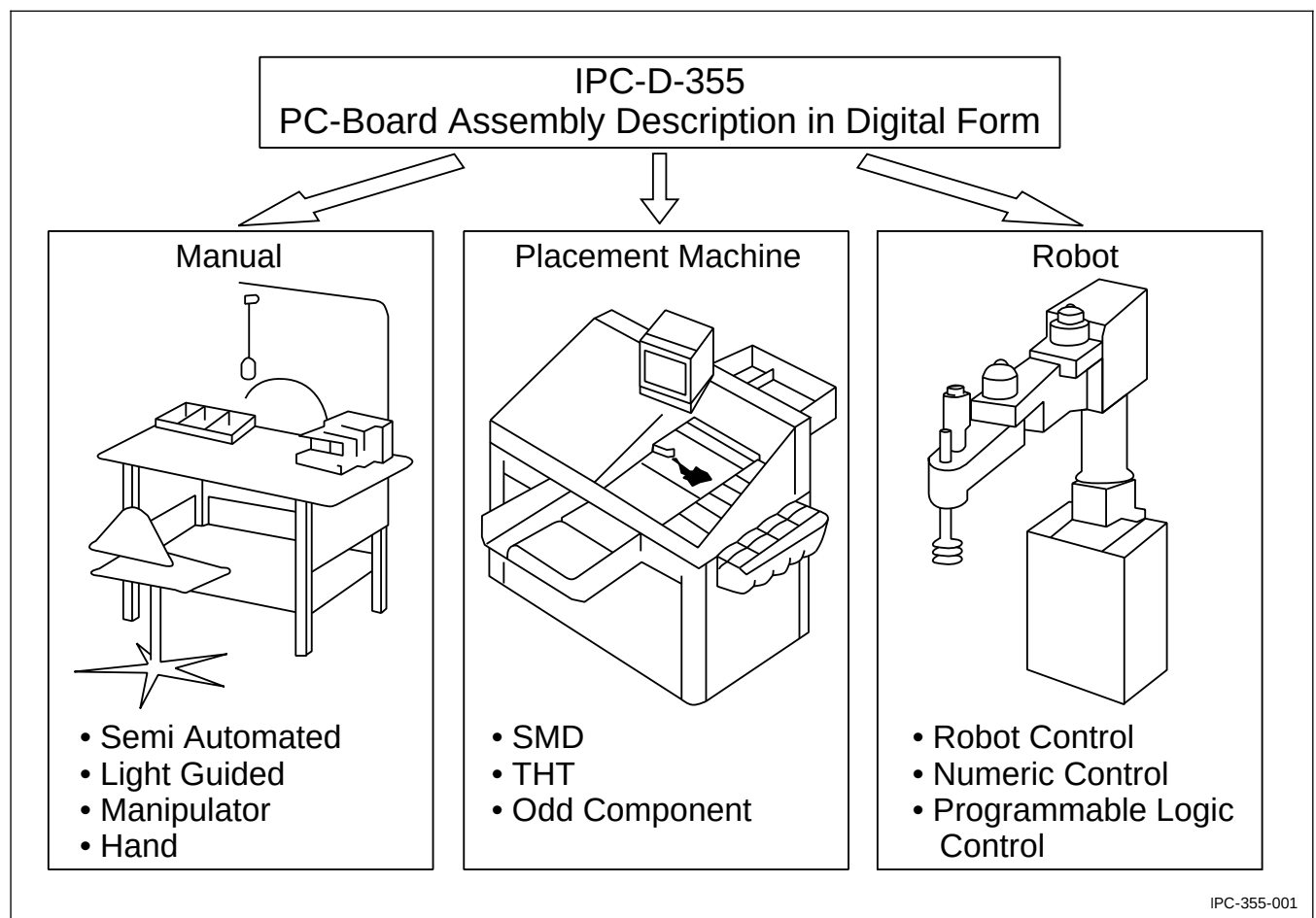


Figure 1 Scope of IPC-D-355 Standard in Assembly Technology

Standards	Record Format
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
IPC-D-355	Printed Board Assembly Records
IPC-D-356	Bare Board Electrical Test Records
IPC-D-357	Automatic Optical Test Records

Users are encouraged to archive data in a self-sufficient form, one that is not affected by changes in supplementary data used in the design process. Thus, library description records may be repeated in archived data. All records shall be in the appropriate format defined in the related IPC standard.

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 IPC¹

IPC-T-50	Terms and Definitions
IPC-D-300	Printed Board Dimensions and Tolerances
IPC-D-310	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 Base Description for Printed Boards in Digital Form
IPC-D-353	Automatic Test Information Description in Digital Form
IPC-D-354	Library Format Description for Printed Board Digital Data Bases

2.2 American National Standards Institute²

ANSI X3/TR-1-77	American National Dictionary for Information Processing
ANSI X3.12	Subroutine Record Format Standardization
ANSI Y14.5	Dimensioning and Tolerancing for Engineering Drawing
ANSI Y32.1	Logic Diagram Standards
ANSI Y32.16	Electrical and Electrical Reference Designators
ANSI Z210.1	Metric Practice Guide (ASTME380-72)

2.3 Department of Defense³

DoD-STD-100 Engineering Drawings

2.4 Electronic Industries Association⁴

3.0 TERMS AND DEFINITIONS

Unless otherwise specified herein, terms and definitions shall be in accordance with IPC-T-50, ANSI X3.12, and the following

3.1 Field A data element (unit of information) which defines a characteristic of the feature(s) being described.

3.2 Record An ordered set of fields (data elements) of ASCII characters. There are four types of records: comment records, data records, parameter records, and general records.

3.3 Comment Record Record that provides or refers to additional descriptive materials which may clarify the meaning of the data set.

3.4 Data Record Record or group of records which describes information related to the physical and location aspects of features, as well as introductions for use of previously defined data.

3.5 Parameter Record Record which defines the characteristics of a subsequent set of records, such as job identification, tolerances, etc. Parameter records direct the computer program on how to interpret the records that follow in the job stream. Parameters are modal (see 3.9). Examples are JOB, UNITS, and FORM.

3.6 General Record Record which continues or terminates a processing sequence. General records include continuation and end-of-job. If a record contains more information than can be placed on one line, continuation records (code 000) may be used. Data in continuation records belong to the record that precedes the continuation records.

1. Publications are available from IPC, 2215 Sanders Road, Northbrook, IL 60062-6135

2. Publications are available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

3. Publications are available from Naval Publications & Forms Center, 5801 Tabor Rd., Philadelphia, PA 19120.

4. Publications are available from Electronic Industries Association, Engineering Department, 2001 Pennsylvania Ave., N.W., Washington, DC 20006.

3.7 Data Information Module (DIM) Group of records which contains related data intended to describe a specific function or task.

3.8 Job Set Group of one or more data information modules.

3.9 Modal Form Technique whereby the description of a unique feature in a data base (interconnection, single identification, conductor with restrictions, etc.) or other pertinent information is given only once at the beginning of a related set of data.

3.10 Location Field/Position Field Fields where the data set describes translation and rotation, prefix “P” is used for “position”. Prefix “L” is used for “location” and describes translation data.

In location records, locations are represented as follows: prefix “L” initiates the location sequence. It is followed by location data, each coordinate having an additional prefix: X, Y, and Z if 3D format is used. Example: L X100.0 Y75.0 Z25.0.

In position records, positions are represented as follows: the prefix “P” initiates the position sequence. It is followed by the position data, each coordinate and angle having an additional prefix, “X”, “Y” (“Z” if 3D format is used) and “A” (“B” and “C” if 3D format is used). Example: P X 100.0 Y75.0 Z25.0 A90.0 B45.0 C30.0.

4.0 GENERAL REQUIREMENTS

Each design shall be described as a separate set of data called a job set. A design data job set may include data record descriptions defined in other IPC-D-35x standards.

4.1 Data Hierarchy Electronic printed board assemblies shall be described in data records within a hierarchical structure as shown below (see figure 2). Formats of records applying to physical description are specified herein.

4.1.1 Job Set Definition The job set is headed by a job record (5.1), and ended by an end-of-job record (5.1.1). A job set shall consist of one or more data information modules (DIMs) pertaining to a single electronic interconnection product. Each unique DIM may occur only once in a job set.

Each DIM shall contain a title (“TITLE” parameter record, see 5.6), a number (“NUM” parameter record, see 5.7), and a revision (“REV” parameter record, see 5.8). Uniqueness of a DIM is established by having a different TITLE, NUM or REV record.

A DIM is terminated by the occurrence of another DIM, or end-of-job record.

4.1.2 Data Information Module (DIM) Definition Data Information Modules (DIM codes B, G, H, K, L and M) are composed of data records, parameter records, and comment records, all of which can be used to describe a particular assembled part.

4.2 Basic Record Types There are 6 DIMs that describe a printed board assembly. Record formats for printed board description (DIM B) are detailed in IPC-D-350, electrical description and bill-of-material information (DIMs G and H) in IPC-D-352, and library information (DIM K, external subroutines, DIM L, internal subroutines) in IPC-D-354.

This section describes the basic records required for the assembly of components to printed boards identified by DIM M.

Information on records is referenced as follows:

- Parameter Records. See 5.0.
- Comment Records. See 6.0.
- Component Placement Records. See 7.0.
- Component Description Records. See 8.0.

4.3 Data Set Descriptions The information in the assembly job shall give the physical description and location of the components of the assembly.

4.3.1 Absolute Data The information to be communicated shall explicitly describe absolute, not incremental, data values.

4.3.2 Electrical/Mechanical Correlation Component descriptions within the data set, whether electrical description or physical/mechanical description, shall be defined in the job set within the DIM M. correlation between component and interconnect (PWB) elements shall be maintained through the use of unique (reference designator) or standard (logic type, part type) descriptions.

4.3.3 Format of Records This standard requires the variable IPC format.

4.3.3.1 Data Formats Records shall contain left-justified data according to the following requirements:

- Data can appear starting in column 4. Columns 1-3 are for operation codes. Our examples use spaces for better readability.
- Prefix letters are used as field delimiters for data fields. When a prefix letter is present, the corresponding value field shall be filled. A prefix letter and blank field, or blank prefix column and filled field are not permitted.

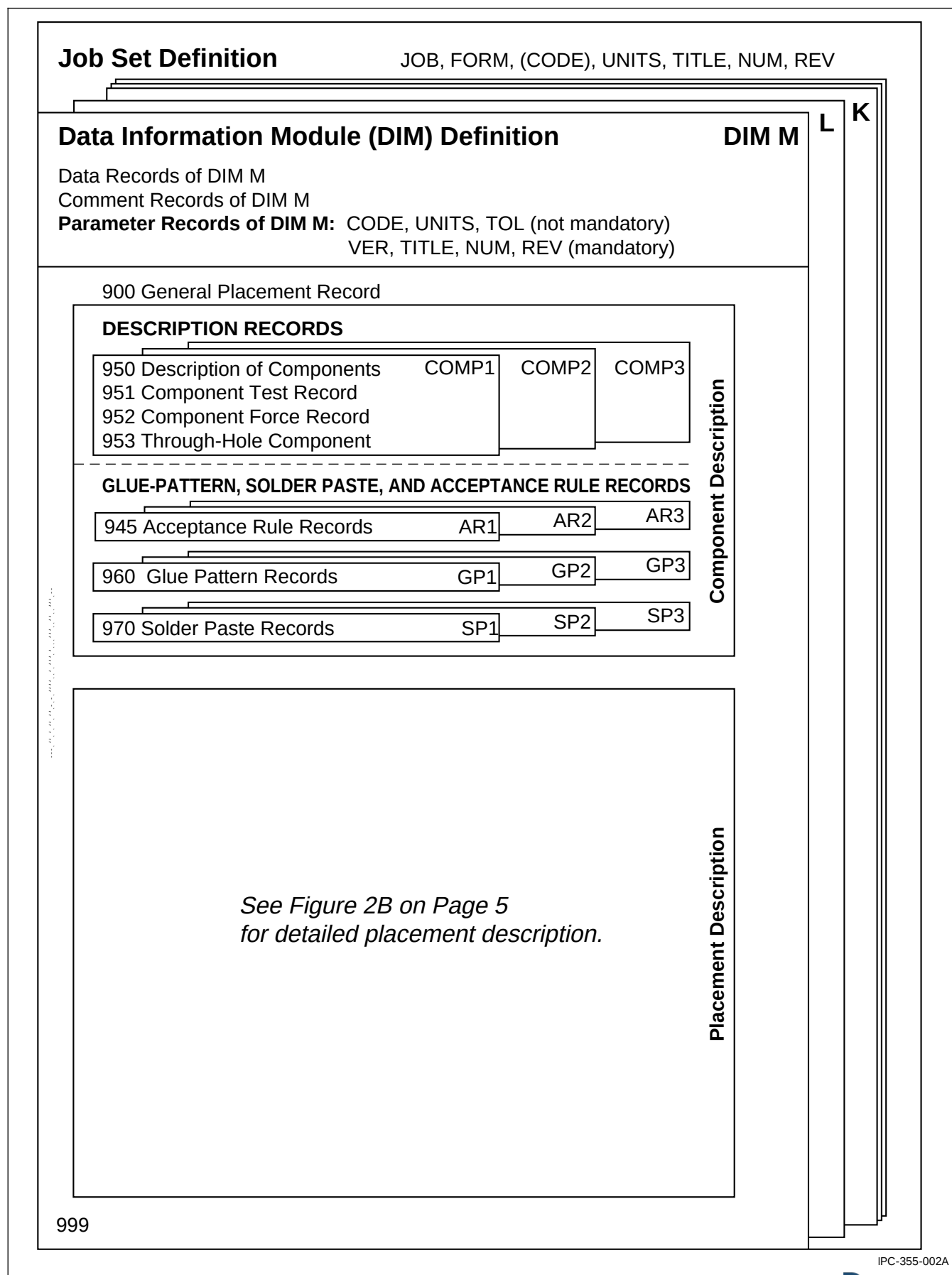


Figure 2A Data Hierarchy of IPC-D-355

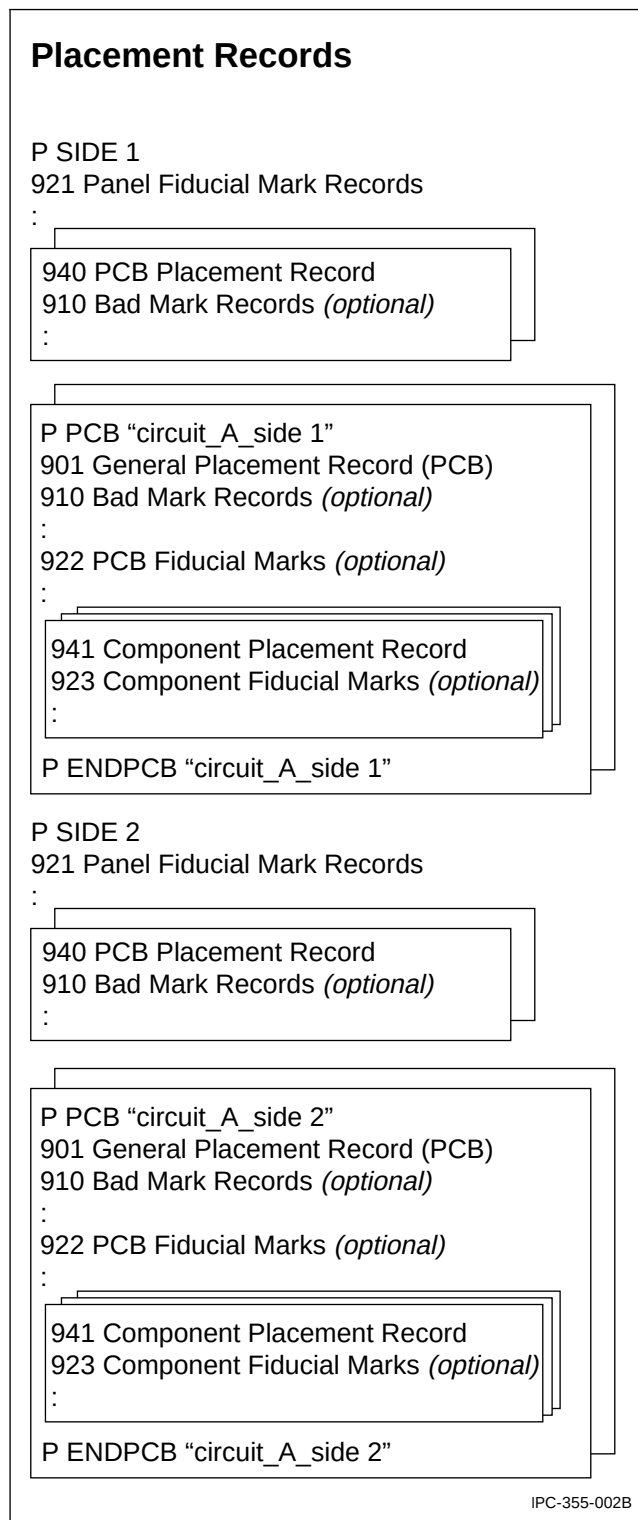


Figure 2B Data Hierarchy of IPC-D-355

- Blanks are permitted. Blanks are required between discrete numerical values that do not have a prefix letter (field delimiter). One or more blank spaces may be left before or after the letters that head up each of the different fields ("I" field (x-coordinate field, y-coordinate field, etc.), but are not required.

- Leading and trailing zeros may be eliminated.
- Order of prefix letters is fixed and as described in the format of each data record.
- The set of optional fields follows mandatory fields in the data record.
- For numerical values, precision shall be indicated by a decimal point.
- Indicating positive numbers with a plus (+) sign is optional. Indicating negative numbers with a minus (-) is mandatory.
- When character string fields are used in data records or parameter records, they shall be preceded and ended by a double quotation mark ("). Example: "Test".
- Numeric data, defined codes and parameter codes do not require delimiters (").
- Data fields shall not be broken up across continuation records.
- Records shall be terminated by an end-of-record. See paragraph 4.3.3.2 for requirements.
- The continuation line indicator at the end of the "to be continued" line shall be a backslash preceding the carriage return and line feed. Starting characters of the continuation line shall be "000."
- When double quotation marks (") are used within character string fields, a backslash shall precede each embedded double quotation character. Example: "Synthesizer\ "Rev B\ ""

4.3.3.2 End-of-Record Every variable-length record shall be terminated by a carriage return and line feed. The line feed shall follow the last character of each record, including continuation records, and shall not appear more than one position beyond the maximum character length, as in a record using 132 characters. The carriage return and line feed shall be referred to in the text of this document as "end-of-record."

4.4 Transfer Media and Character Set Transfer media shall be mutually agreed to by sender and receiver.

The allowable character set for non-comment records shall be referred to as the standard ISO code, and shall be restricted to the ISO 7-coded character set for information interchange (ISO 646) from "space" (decimal value 32) through the tilde (decimal value 126), and the following characters: "null" (decimal value 0) and line feed (decimal value 10).

Characters defined in ISO 646 for currency, number code and national code shall be:

Char.	Definition
\	National Code
#	Number
\$	Currency

Comment records, and TITLE, NUM, and REV parameter records can include characters from any native language character set. See section 6 for requirements of comment records, and paragraph 5.2 for parameter CODE, which specifies the character set for comment records and TITLE, NUM and REV parameter records.

5.0 PARAMETER RECORDS

Parameter record characteristics shall be delineated by “P” as the first character, followed by 2 blank spaces and one of the following words:

JOB, FORM, CODE, DIM, UNITS, TITLE, NUM, REV, VER, PCB, ENDPCB, SIDE1, SIDE2, TOL

5.1 Parameter JOB (required) The word JOB preceded by a “P” shall indicate the beginning of a job set. The following may be used for comments, such as job or PCB identification. This record shall be the first in the data. Each JOB parameter shall be followed by the parameter FORM, UNITS, TITLE, NUM, and REV. This order is mandatory.

Example:

P JOB “Synthesizer/Analyzer 398 - 497- 1 REV - B”

5.1.1 End-of-Job Record The characters 999 at the beginning of a line shall indicate the end of a job. This record shall be the last record in the data.

Example:

C End of Job - Record follows
999

5.2 Parameter FORM (required) The word “FORM” preceded by “P” shall indicate the format for all subsequent records.

The FORM parameter is modal. The format specified by the FORM parameter shall be in force until a new parameter is encountered.

When changing formats within a job set, the FORM parameter shall precede the data information module. Thus, if a job set was using fixed format for DIM A and B, and the variable format for DIM C, prior to the DIM C record, a FORM V record would be used.

5.2.1. Variable Format Records A “V” in character 10 indicates a variable format where all data is left-justified. The FORM V parameter may precede a DIM M section. Within DIM M, no fixed format can be used.

The “V” may be followed by a number indicating the maximum record length (the number of characters, including end of record), followed by a range designator, “R”, and two digits separated by a decimal point followed by an end-of-record.

The range designator is used to establish a limit on the number of digits to the left and right of the decimal place.

The first digit after “R” represents the maximum number of places to the left of the decimal point, the second digit represents the maximum number of places to the right of the decimal point. the maximum allowed value for the first digit is 4. the maximum allowed value for the second digit is 5. Thus, no greater range is allowed than 0.0001-9999.99999, expressed as R4.5, indicating the default for the value range. If the range designator R is not present, the range is limited to 0.0001-9999.99999.

The default for the maximum number of characters in variable format is 132, expressed as V132. If the maximum record length is not given, it is 132 characters.

5.3 Parameter CODE (optional) The word “CODE” preceded by a “P” shall indicate a switch to a native language character set for comment records and TITLE, NUM and REV parameter records. If a parameter CODE record is not present, the standard ISO code shall be assumed. A two digit code specified in columns following the word CODE shall identify the native character language set in accordance with the table.

Example: C Use French Character Set

P CODE 09

5.4 Parameter DIM (Data Information Module) The acronym DIM preceded by a “P” at the beginning of a line shall indicate the start of a DIM. The DIM parameter record may appear anywhere in a job set. A DIM is terminated by the occurrence of another DIM parameter record or an end-of-job record.

When a specific DIM parameter record appears more than once in a job set, each occurrence shall have a unique title, number, or revision level.

The acronym DIM shall be followed by 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 below). 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 DIM in the set. A DIM K is terminated by a 998 record.
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 DIM in the job set. A DIM L is terminated by a 997 record.
3. When DIM G, Electrical Description, is used, the data shall follow the DIM L data. If no DIM L and DIM K data are present, then the DIM G data shall be the first DIM in the job set.

The relationship of DIM records, DIM codes, and IPC standards is shown in the following table. Columns following the code letter may contain the DIM identifier, as shown in the table.