



ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES

IPC-D-350

Printed Board Description in Digital Form

ANSI/IPC-D-350

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A standard developed by IPC

Technical Content Identical
to IEC 1182-1

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ELECTRONICS INDUSTRIES

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A joint standard developed by Technical Committee 52 of the International Electrotechnical Commission (IEC) and the Computerized Data Format Standardization Subcommittee (2-11) of the Data Generation and Transfer Committee (2-10) of IPC.

This document bears two reference numbers, and may be obtained from IPC, IEC, or ANSI. IPC-D-350D and IEC 1182-1 are identical in technical content.

The IEC version of this document also contains a French translation. The IEC is responsible for the accuracy of that translation.

APPROVED JUNE 17, 1990 BY



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Printed Board Description in Digital Form

1.0 SCOPE

This standard specifies record formats used to describe printed board products with detail sufficient for tooling, manufacturing and testing requirements. These formats may be used for transmitting information between a printed board designer and a manufacturing facility. The records are also useful when the manufacturing cycle includes computer-aided processes and numerically controlled machines.

The information can be used for both manual and for digital interpretation. The data may be defined in either English or SI units.

1.1 Format Compatibility The concepts detailed in this standard may be supplemented by descriptions defined in other companion IPC Standards. It is the intent that a family of standards be developed with applicability for various record formats.

Data redundancy shall be kept to a minimum by using companion standards for appropriate data descriptions, depending upon the use of the data. The following shows the correlation between standards and record formats that are to be defined:

Table 1-1 Correlation Between IPC-D-35X Standards and Record Formats

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	Parts List Records
IPC-D-354	Library Description Records
IPC-D-356	Bare Board Electrical Test Information

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

IPC-D-354 Library Format Description for Printed Board Digital Data Bases

IPC-D-390 Automated Design Guidelines

2.2 American National Standards Institute²

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

ANSI X3.4 Standard Code for Information Exchange

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

2.3 Department of Defense³

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

2.4 International Electrotechnical Commission (IEC)⁴ International Standards Organization⁴

IEC Publication 194 Terms and Definitions for Printed Circuits

ISO Publication 646 Information Processing. ISO 7-Bit Coded Character Set for Information Exchange

3.0 TERMS AND DEFINITIONS

Unless otherwise specified herein, terms and definitions shall be in accordance with IPC-T-50, IEC 194, ANSI X3.12 and the definitions in the following paragraphs. Useful terms from the referenced standards are reprinted in Appendix B and C to assist in the understanding of this document.

1. To obtain documents, write: IPC, 2215 Sanders Road, Northbrook, IL 60062-6135

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

3. To obtain documents, write: Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094

4. To obtain documents, write: (ISO or IEC) Central Office, 3 Rue De Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland

3.1 Annotation Record A type of Data Record which describes a text or legend feature. An annotation record consists of letters and symbols and their locations.

3.2 Comment Record A record that provides, or refers to, additional descriptive material which may clarify the meaning of the data in the job set.

3.3 Composite Records A sequence of Data and General Records that describe a complex feature which: 1) is used repeatedly in a design or 2) cannot be described by a single type of Data Record (Line, Point, or Annotation) or 3) both. The first record in a set of composite records is its Subroutine Definition Record, the last record is an End of Subroutine Record. The set of Composite Records may be thought of as a Subroutine.

3.4 Data Information Module (DIM) A group of records which contain related data which describes a specific product, function, or task.

3.5 Data Layer A group of related records within any Data Information Module that contains a subset of the description of one or more physical layers of a product.

3.6 Data Record(s) A type of record or group of records which describe information related to the physical and locational aspects of features, as well as instructions for use of previously defined data. Data Records include Point, Line, Annotation, Subroutine Definition and Subroutine Call Records.

3.7 Datum Reference The theoretically-exact point that is the origin from which the location of geometric characteristics of features are established.

3.8 Feature The make, shape, or appearance of characteristics of a printed board or artwork (i.e., lands, conductors, holes, cutouts, dielectric separation, legend, etc.). Features are described by records.

3.9 Field A data element (a unit of information) which defines a characteristic of the feature(s) being described. Records are made up of ordered fields.

3.10 General Record A record which continues or terminates a processing sequence. General records include Continuation, End of Subroutine and End of Job Records.

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

3.12 Line Record(s) A type of Data Record that describes a linear feature. A Line Record(s) provides the beginning and end point of all segments that comprise the

linear feature, and may have linear or circular characteristics.

3.13 Modal Form The technique whereby a data description or other command is given only once at the beginning of a related set of data and is in effect until otherwise instructed.

3.14 Parameter Record A record that describes the characteristics of the subsequent Data Records. Parameter records are modal. Examples of parameter records are: Job, Units, Scale and Tol.

3.15 Point Record A type of Data Record which describes a feature which is located at a single position or discrete positions.

3.16 Physical Layer A printed wiring board (or other layered product) layer or artwork image representing a complete conductive or nonconductive layer.

3.17 Record An ordered set of fields (data elements) of ASCII characters. In the context of D-350, there are four types of records: Comment Records, Data Records, General Records and Parameter Records.

3.18 Subroutine Definition Record A type of Data Record which labels a subroutine and is the first record in a Composite Record set. (See Composite Records)

3.19 Subroutine Call Record A type of Data Record which describes the placement (location and rotation) of a previously defined complex feature (Subroutine). Subroutines called may be defined in the current Job or in a D-350 library. (See Composite Records.)

4.0 GENERAL REQUIREMENTS

Figure 4–1 shows the hierarchical structure of the data within a job set. Letters have been assigned to each data information module, to identify their characteristics within the job set. It should be noted that the conclusion of a job is identified by the numbers “999.”

4.1 Data Hierarchy Printed boards and/or artwork shall be described in data records within a hierarchical structure as shown in Figure 4–1. The formats of the records applying to the boards or artwork are specified herein.

4.1.1 Job Set Definition The job set is headed by a job record (paragraph 5.1) and ended by an end of job record (paragraph 5.1.2). A job set shall consist of one or more Data Information Modules (DIM) that pertain to a single electronic interconnection product. Each unique Data Information Module may occur only once in a job set. Each DIM shall contain a title (Parameter Title, paragraph

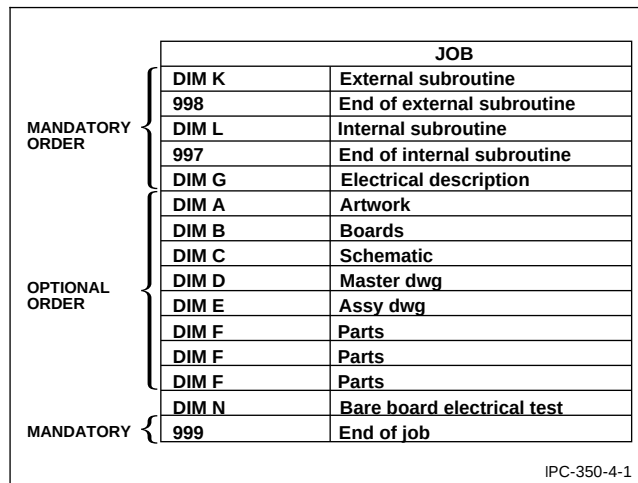


Figure 4-1 Hierarchy of data in a job set

5.6), number (Parameter NUM, paragraph 5.7), and revision level (Parameter REV, paragraph 5.8). Title, number and revision identify the unique characteristics of a DIM. A Data Information Module is terminated by the occurrence of another DIM or end-of-job record.

This standard is intended to describe the format for the following data information modules:

DIM A Artwork

DIM B Printed Boards

4.1.2 Data Information Module Definition Artwork Data Information Modules (DIM A), and Board Information Modules (DIM B) are composed of data records, parameter records, and comment records, which describe artwork or related board data.

Parameter records inform the computer program how to interpret the records that follow in the job set. Comment records provide additional descriptive material for review by the user, but are not interpreted by the computer. Data records provide the detailed data describing either the artwork or the board.

Some typical examples of information supplied by data records are listed below:

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

4.2 Basic Record Types The following are the basic record types discussed in this document:

Parameter Records (Section 5.0)

Comment Records (Section 6.0)

General Information on Data (Feature/Location) Records (Section 7.0)

Line Records (Section 8.0)

Point Records (Section 9.0)

Annotation Records (Section 10.0)

Complex or Composite (Subroutine) Records (Section 11.0)

End of Job Record (Paragraph 5.1.1)

End of Job Library

4.3 Record Format Two methods of formatting data are supported by this standard. One is a fixed format, the other is a variable format.

In the fixed format, information is specified for each of the 80 columns. In the variable format, data may be left-justified, and the length of the record may vary. Data may be described identically between the two types of formats, or one may choose to compact data in the variable format by moving the information to the left.

The use of the specific format is determined by the occurrence of a parameter record that describes the format type. In the absence of a format parameter record, the fixed format will be assumed.

4.3.1 Form “F”—Fixed Format The basic text of this standard deals with fixed formats (specific information for each of the 80 columns). The first three columns are delegated to operation codes (line records, point records, etc., are specified). See paragraph 7.2.

In the fixed format concept, columns 4–30 are reserved for feature description information. Included are feature dimension, data layer codes, node identification, hole sizes and types, and generic characteristics of features. See paragraph 7.3.

The third major data area in the fixed-record format is the Location Description Area in columns 31–72. In the fixed-record format these columns contain the (x,y,z) coordinates for location description. See paragraph 7.4.

Columns 73–80 may be used for sequencing. This area shall not contain data necessary to the printed board definition. See paragraph 7.5.

4.3.2 Form “V”—Variable Format Variable format records shall be preceded by a parameter identification (see paragraph 5.2, “Parameter FORM”) that specifies the use of the variable format. The maximum variable record length may be any number of columns, includes the end-of-record delimiter, and is specified by Parameter Form (see paragraph 5.2).

4.3.2.1 Positioning of the Data Data must be entered in variable format records in the order specified, positioned as far left as possible (“left-justified”). Positioning is controlled by the following criteria:

- All data may be left-justified, starting in column 4. Columns 1–3 are for operation codes. Data fields shall follow the same order used in fixed format records.
- 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 a blank field, or a blank prefix column and a filled field are not permitted).
- Blank columns are permitted. Blanks are required between discrete numerical values that do not have a prefix letter (field delimiter), or groups of letters that represent discrete pieces of information (e.g., to indicate the data information module for artwork, use “DIM A,” leaving a space before the “A.” One or more blank spaces may be left before the letters that head up each of the different fields (“D” field, “H” field, x-coordinate field, y-coordinate field, etc.), but are not required.
- Leading and trailing zeros may be omitted provided the numeric value contains a decimal point. Leading zeros may be omitted when the number is an identifier, such as “D” Field SUBROUTINE identifiers and layer numbers.
- For numerical values, precision shall be indicated by a decimal point. See paragraph 4.3.2.2 for requirements.
- Indicating positive numbers with a plus (“+”) sign is optional; indicating negative numbers with a minus sign (“-”) is mandatory.
- Data fields (including LDA coordinates) shall not be broken up across (continuation) records.
- Records shall be terminated by an end-of-record. See paragraph 4.3.2.3 for requirements.

4.3.2.2 Decimal Point The fixed format (Form “F”) has requirements to dictate the precision of numbers (for example, English dimensions for feature location can be expressed in thousandths of an inch, with an allowable space of five digits). The variable format (Form “V”) requires the use of a decimal point to indicate the precision of the specified number.

The decimal point shall be used in the variable format to indicate precision for both English (“CUST”) and SI units. Numeric data in the variable length format must include a decimal point, e.g., LDA values, scale factors and “D” Field identifiers. Decimal points may be omitted for whole numbers.

The range of values shall be limited to numbers with digits that occupy no more than four places to the left of the decimal point and five places to the right of the decimal point; e.g. 0.00001–9999.99999. This is true for both English (“CUST”) and SI units. Leading and trailing zeros may be omitted.

The limitation of 0.00001–9999.99999 on the range of values is the default limit. A method for specifying other limits is given under paragraph 5.2, which defines Parameter FORM.

4.3.2.3 End-of-Record Every variable-length record shall be terminated by a line feed, (the line feed is a non-printable character). For example, in a variable format record that uses all 132 columns, the line feed would occupy column 133.

The line feed may be used for comment or annotation records in the fixed format to truncate trailing unused columns

Note: The carriage return was used for this function in previous revisions of IPC-D-350.

The line feed, shall be referred to in the text of this document as “end-of-record.” The illustrations in this standard use a left arrow (←) to indicate end-of-record.

4.4 Data Set Descriptions The data shall explicitly describe absolute (not incremental) values, and the contour and location of each individual feature, or a composite feature of the 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 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.

4.5 Data Orientation All data shall describe the physical properties of an electronic interconnection product from the viewpoint of the side of the assembly that contains the components (primary 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. Physical layers may be conductive or nonconductive as required to satisfy the physical or electrical properties of the interconnection product (see Figure 4–2).

Physical layers shall be numbered consecutively starting from the primary side as layer one (1) (see IPC-D-325). The convention for physical layer definition (numbering of layers) is given in Table 4–1.

When coordinates are used to describe physical information, the origin (0,0) shall be the same for all layers of interconnection description within a Data Information Module, and shall follow the standard Cartesian coordinate reference system. Positive and negative coordinate values are permitted.

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

4.6 Transfer Media and Data Formats Data shall be transmitted by magnetic tape (9-track), disk (compact disk,

Table 4-1 Physical Layer Definitions

Layer Number	Definition
00	Holes (vias) that go all the way through the board. (Holes that only go partially through the board, such as buried or blind vias, are noted on layers on which they occur.)
01	First conductive layer.
02 through N	Second conductive layer through Nth conductive layer.
N + 1	First external non-conductive layer (solder mask, legend, cover coat, etc.) near conductive layer 1 (viewing from the primary side).
N + 2	Second non-conductive layer (viewing from the primary side) requiring image or topology description.
N + 3, N + 4, etc.	All remaining non-conductive layers that require image or topology descriptions.

hard or floppy), or by direct electronic transfer. 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-bit coded character set for information interchange (ISO 646) from “space” (decimal value 32) through “tilde” (decimal value 126) and the following characters: “null” (decimal value 0), carriage return (decimal value 13), and “line feed” (decimal value 10). The default mode for characters defined in ISO 646 for currency, number code and national code shall be according to Table 4-2. (Identical to ANSI/ASCII, see Table 5-1.)

Refer to Table 13-1 for the standard ISO code character set.

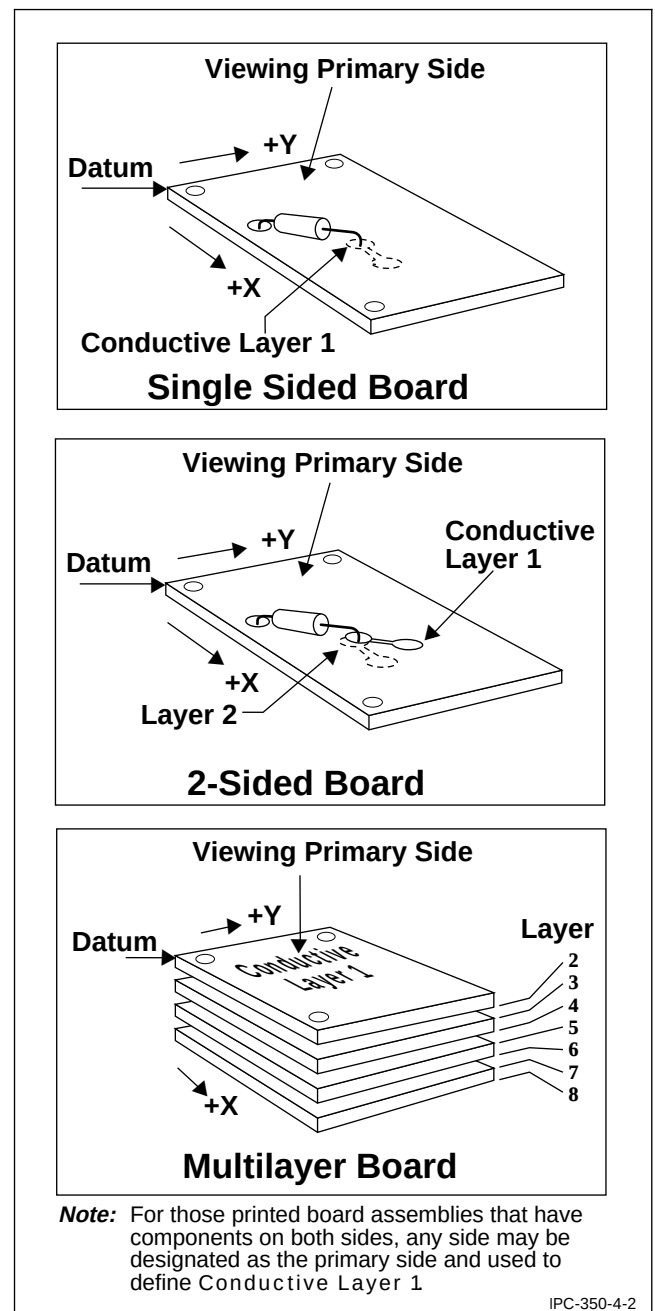
Comment records, and TITLE, NUM, and REV parameter records can include characters from any native language character set. See section 6 for requirements of comment records, and paragraph 5.3 for parameter CODE, which specifies the character set for comment records and TITLE, NUM, and REV parameter records.

Table 4-2 Special Character Definition

Character	Definition	Decimal Value
\	national code	92
#	number	35
\$	currency	36

4.6.1 Other Transfer Media Formats for disk or direct electronic transfer shall be mutually agreed upon by sender and receiver. This may include size of file, end-of-file indicators, type of packing/unpacking routines, etc.

Transfer media may contain several job sets. Each job set shall be uniquely identified (e.g. terminated by an End-of-File mark).

**Figure 4-2 Printed board viewing**

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

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

For fixed format, magnetic tape recording shall be packed 1600 bytes to the block. No magnetic labels shall be written on the tape. For variable format, the tape format shall be mutually agreed upon between sender and receiver.

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

Note: The “end-of-file” (EOF) mark may be substituted for the “end-of-tape” or “end-of-transmission” (EOT) mark. Caution is urged, however, since almost all magnetic tape readers recognize EOT marks, but not all readers recognize EOF marks.

5.0 PARAMETER RECORDS

A “P” and two spaces in columns 1–3 indicate a parameter record, and shall be followed by one of the parameter record designations in column 4. The parameter record designations are: JOB, FORM, CODE, DIM, UNITS, TITLE, NUM, REV, LANG, SCALE, TOL, LAYER, IMAGE, FAB, and AREA.

5.1 Parameter JOB (See Figure 5–1) The designation “JOB” in columns 4–6, preceded by a “P” in column 1, shall indicate the beginning of a job set. Columns 10 through 72 may be used for comments such as job or other identification. See Figure 5–1.

The JOB parameter shall be in fixed format.

This record shall be the first record in the data for both fixed and variable formats. The second parameter may be the FORM parameter (see paragraph 5.2).

5.1.1 Data Management Each JOB record shall be followed by (FORM, and CODE, when needed) UNITS, TITLE, NUM, and REV parameter records. These records are mandatory to identify the characteristics of the job, and to indicate revision level of the total file.

5.1.2 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.

5.2 Parameter FORM (See Figure 5–2.) The designation “FORM” in columns 4–7, preceded by a “P” and two spaces in columns 1–3, shall indicate the format (fixed or variable) for all subsequent records.

An “F” in column 10 signifies a fixed format, where all data is delegated to a particular set of columns. The “F” shall NOT be followed by a line feed. The absence of a “FORM” parameter record shall signify fixed format.

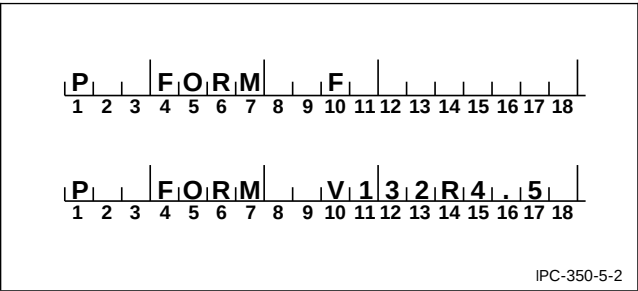


Figure 5–2 Parameter FORM

Duplicate FORM records may exist in subsequent DIMs, and are assumed to be identical.

The FORM parameter is modal: the format specified by the FORM parameter shall be in force until a new FORM parameter record 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 DIMs A and B, and then 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 column 10 indicates a variable format, where all data is left-justified.

The “V” shall be followed by a number indicating the maximum record length (the number of columns, including the end of record), followed by the 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 the “R” represents the maximum number of places to the left of the decimal point, the 2nd 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.” The code “R4.5” indicates the default for the value range (see paragraph 4.3.2.2). If the range designator “R” is not present, the range is limited to 0.0001–9999.99999.

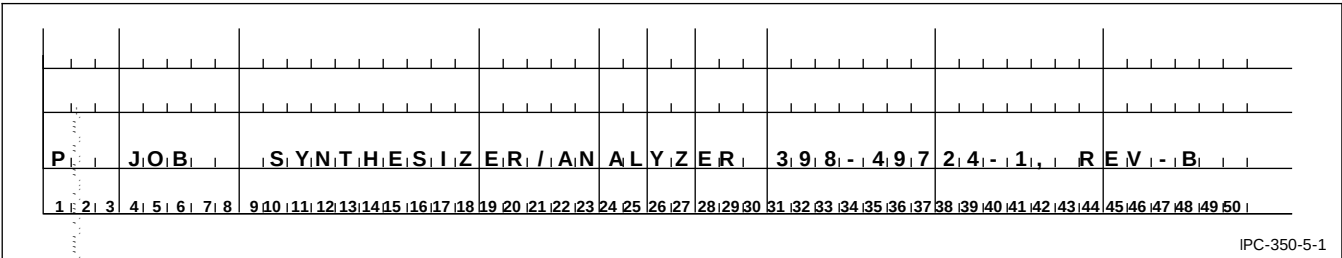


Figure 5–1 Parameter JOB

P FORM is in fixed format only, and determines whether the records following are fixed or variable.

5.3 Parameter CODE (See Figure 5–3.) The designation “CODE” in columns 4–7, preceded by a “P” in column 1, 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 ANSI/ASCII (identical to ISO 646 plus character definition in Table 4–2) code shall be assumed.

A 2-digit code specified in columns 10–11 of the parameter CODE record shall identify the native language character set in accordance with Table 5–1.

Duplicate CODE records may exist in subsequent DIMs, and are assumed to be identical.

P | C | O | D | E | 1 | 6 |
 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

P | F | O | R | M | V | ◀ |
 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

P | C | O | D | E | 1 | 6 | ◀ |
 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 5-3 Parameter CODE

5.3.1 Variable Format Records Data shall be left-justified, starting after the “CODE” designation in columns 4–7. A minimum of one blank is required after the “CODE” designation. The data shall be terminated by an end-of-record.

5.4 Parameter DIM (Data Information Module) (See Figure 5-4.) The designation “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). A Data Information Module is terminated by the occurrence of another DIM parameter record, an end of internal or external library description (DIM L or DIM K) or end of job record (see paragraphs 4.1 and 4.2).

When a specific DIM parameter record appears more than once in a job set, each occurrence shall have a unique title and number or a unique revision level. Column 10 shall contain a unique letter code describing the type of records that follow the DIM parameter record. The DIM parameter

P				D	I	M			C															
P				D	I	M			C	←														
P				D	I	M				E														
P				D	I	M				E	←													
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 5–4 Parameter DIM

record is also described in other IPC-D-35X standards (see Table 5–2). 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 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 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 Modules in the job set.

The relationship of DIM records, DIM codes, and IPC standards is shown in Table 5–2. Columns 12–72 may contain the DIM identifier (i.e., artwork records, board records, etc.)

5.4.1 Variable Format Records For variable format records, data shall be left-justified, starting after the “DIM” designation in columns 4–6. Blanks are permitted. A minimum of one blank is required after the “DIM” designation. The data shall be terminated with an end-of-record.

5.5 Parameter UNITS (See Figure 5–5.) The designation “UNITS” in columns 4–8, preceded by a “P” and two spaces in columns 1–3, shall indicate units of measurement. The code “SI” in columns 10–11 shall indicate the International System (metric) of units. The code “CUST” in columns 10–13, followed by a space followed by a number in column 15, shall indicate units in accordance with Table 5–3.

The UNITS record shall immediately follow the JOB (and FORM and CODE) record. There will therefore be one UNITS parameter in a single job set. The units specified shall match the units of the calling routine.

Duplicate UNITS records may exist in subsequent DIMs, and are assumed to be identical.

Table 5-1 Native Language Codes

Columns 10-11 Code	Language	Character Set Designation	Standard	ISO Registration Number
00	English	ANSI ASCII	ANSI X3.4	006*
01	English	ISO 7-bit coded character set	ISO 646	002*
02	Arabic			
03	Arabic—W			
04	Chinese—S			
05	Chinese—T			
06	Danish			
07	Dutch			
08	Finnish			
09	French			025
10	German			021
11	Greek			
12	Hebrew			
13	Icelandic			
14	Italian			015
15	Kanji (Japanese)	JIS Kanji-code	JIS X0208	
16	Katakana (Japanese)	JIS code	JIS X0201	013
17	Korean			
18	Norwegian—1			060
19	Norwegian—2			061
20	Portuguese			016
21	Russian			
22	Spanish			017
23	Swedish			010
24	Turkish			

*ISO registration number 006 is equivalent to 002 plus the character definition in Table 4-2

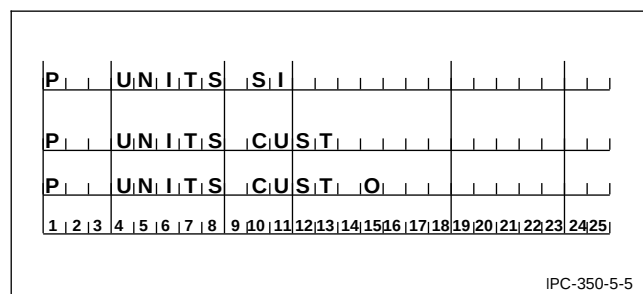


Figure 5-5 Parameter UNITS

5.5.1 Variable Format Records For variable format records, data shall be left-justified starting after the “UNITS” designation in columns 4-8. Blanks are permitted. A minimum of one blank is required after the “UNITS” and “CUST” designations. The data shall be terminated with an end-of-record.

5.6 Parameter TITLE (See Figure 5-6.) The designation “TITLE” in columns 4-8, preceded by a “P” in column 1, shall indicate the title of data defined in a job set or in a DIM parameter record (artwork title, schematic title, etc.).

Columns 10-72 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 5-6). Permissible characters for columns 10-72 shall be in accordance with the requirements for comment records (see section 6), and the CODE parameter.

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

5.6.1 Variable Format Records For variable format records, all data may be left-justified starting after the “TITLE” designation in columns 4-8. Blanks are permitted. A minimum of one blank is required after the “TITLE” designation. The data shall be terminated with an end-of-record.

5.7 Parameter NUM (See Figure 5-6.) The designation

Table 5-2 Record Interrelationship

DIM Code Letter	DIM Identifier	IPC Standard
A	Artwork Records	IPC-D-350
B	Board Description Records	IPC-D-350
C	Schematic Drawing Records	IPC-D-351
D	Master Drawing Records	IPC-D-351
E	Assembly Drawing Records	IPC-D-351
F	Miscellaneous Part Drawing Records	IPC-D-351
G	Electrical Description Records	IPC-D-352
H	Parts List Records	IPC-D-352
J	Testing Format Records	IPC-D-353
K	External Library Description Records	IPC-D-354
L	Internal Job Library Description Records	IPC-D-354
M	Automated Assembly Description Records	IPC-D-355
N	Bare Board Electrical Test Description Records	IPC-D-356

Table 5-3 Codes for "CUST" Units

Code	Explanation
CUST 0 (zero does not need to be indicated)	English units (i.e., inches and degrees)
CUST 1	Combination: Linear measurements are SI, angular measurements are English (i.e., millimeters and degrees).
CUST 2	Combination: Linear measurements are English, angular measurements are SI (i.e., inches and radians).

"NUM" in columns 4-6, preceded by a "P" and two spaces in columns 1-3, shall indicate the part number for data defined in a job set or in a DIM parameter record (artwork number, schematic number, etc.) or a job. Columns 10-72 shall be used to contain the left-justified number (fixed format) that is used in the number block(s) of the appropriate drawing(s). Permissible characters for columns 10-72 shall be in accordance with the requirements for comment records (see section 6) and the CODE parameter.

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, however they must be unique and pertain only to the data information module in which they occur.

5.7.1 Variable Format Records For Variable format records, all data shall be left-justified starting after the "NUM" designation in columns 4-6. Blanks are permitted.

A minimum of one blank is required after the "NUM" designation. The data shall be terminated with an end-of-record.

5.8 Parameter REV (See Figure 5-6.) The designation "REV" in columns 4-6, preceded by a "P" and two spaces in columns 1-3, shall indicate the revision identifier for data defined in a job set or in a DIM (artwork revision, schematic revision, etc). Columns 10-72 shall be used to contain the revision identifier, left-justified (fixed format). The revision identifier shall also be used in the revision block(s) of the appropriate drawing(s). Permissible characters for columns 10-72 shall be in accordance with the requirements for comment records (see section 6) and the CODE parameter.

The revision record shall follow the TITLE and NUM parameter records and pertain only to the DIM in which it is referenced. The REV parameter record may appear several times in the job set.

The REV parameter record shall be changed each time changes are made to any record within the file. Since letters may be used to indicate revision level, once the single-letter alphabet is depleted, a double-letter alphabet (i.e., "AA," "BB," "CC," etc.) may be used.

5.8.1 Variable Format Records For variable format records, all data shall be left-justified starting after the "REV" designation in columns 4-6. Blanks are permitted. A minimum of one blank is required after the "REV" designation. The data shall be terminated with an end-of-record.

5.9 Parameter LANG (See Figure 5-7.) The designation "LANG" in columns 4-7, preceded by a "P" and two spaces in columns 1-3, shall indicate a change of data exchange format from the D-35X (IEC 1182-X) series. The IEC/IPC Standard Data Exchange Format (SDEF) shall be assumed if the language parameter is not invoked. The LANG parameter record is considered modal until the occurrence of a new LANG parameter. A LANG parameter to another format shall be preceded by DIM, TITLE, NUM, and REV parameters. If data not defined by a Data Information Module is required, then DIM "X" shall be used. The new format must assure a return to the SDEF format, if required.

5.9.1 Columns 10-16 The information in columns 10-16 shall indicate the data exchange format specification in accordance with the following:

SDEF	IEC/IPC Standard Data Exchange Format
IGES	Initial Graphic Exchange Specification
EDIF	Electronic Design Interchange Format

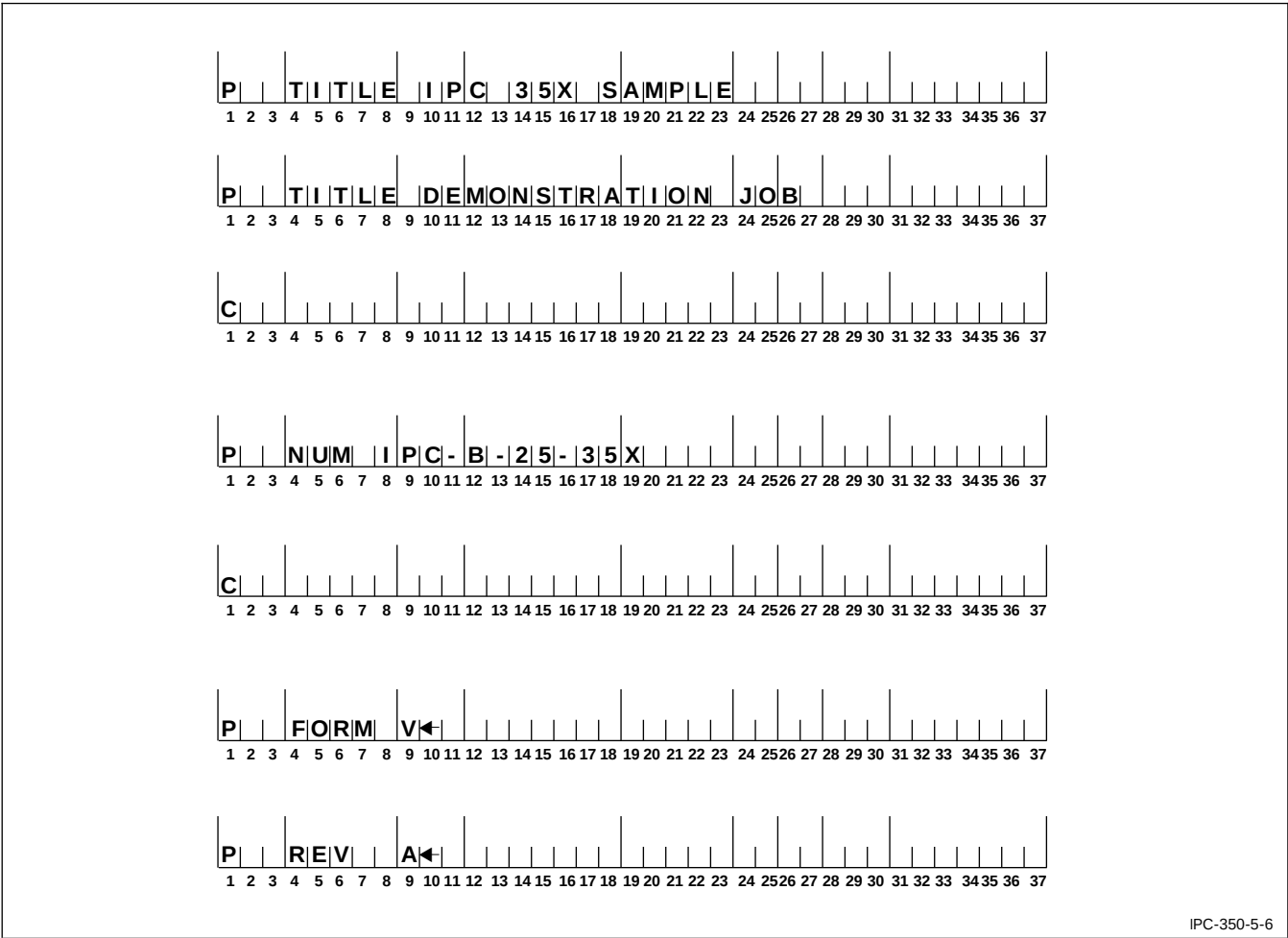


Figure 5-6 Parameters TITLE, NUM, and REV

P	LANG	SD	EF		
P	LANG	IG	ES		
P	LANG	PD	ES		
P	LANG	VH	DL		
P	LANG	IP	C		
P	LANG	ED	IF		
1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24

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Figure 5-7 Parameter LANG

- PDES Product Data Exchange Specification
- VHDL Very High Speed Integrated Circuit Description Languages
- IPC IPC Standard (use SDEF for new design)

5.9.2 Columns 18-72 Columns 18-72 may contain the left-justified alphanumeric that indicates the revision level of the data exchange specification. The revision level of the SDEF format is indicated by a 2-digit number in accordance with Table 5-4.

Table 5-4 Codes for Revision Levels of IEC/IPC Standards

Columns 18-19 Revision Level Code	IPC Standard	IEC Equivalent Standard
01	IPC-D-350A	—
02	IPC-D-350B	—
03	IPC-D-350C	IEC 52 (Central Office) 363
04	IPC-D-350D	IEC 1182-1

5.9.3 Variable Format Records Variable format records shall be the same as fixed format, except that all data may be left-justified starting after the “LANG” designation in columns 4-7. Blanks are permitted. A minimum of one blank is required after the “CODE” and the “LANG” designations. Records shall be terminated by an end-of-record.

5.10 Parameter TOL (See Figure 5-8.) The designations “TOL” in columns 4-6, preceded by a “P” and two spaces in columns 1-3, shall indicate the tolerance specification associated with the various attributes of the subsequent data.

The following records are examples of assigning tolerances by allowable variation from nominal values (a "1" in column 13). These allowable variations apply to any nominal value for line width, land diameter, hole diameter, etc. (The following examples assume English units.)

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
P			T	O	L						3	1		0	0	0	0	0	0		0	0	0	0	2	0			

-0.000/+0.002 in. for line widths

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
P			T	O	L						4	1		0	0	0	0	2	0		0	0	0	0	2	0			

±0.002 in. for land diameters

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
P			T	O	L						5	1		0	0	0	0	0	0		0	0	0	0	2	0			

-0.000/+0.002 in. for hole diameters

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
P			T	O	L						6	1		0	0	0	0	2	0		0	0	0	0	2	0			

±0.002 in. for hole locations

The following records are examples of assigning tolerances by establishing minimum and/or maximum values (a "2" in column 13). The min/max values establish a range within which the normal values must fall. A nominal value outside the previously established tolerance range is an error. The following examples apply to a given nominal land diameter of 0.100 in.

P			T	O	L						4		2		0	0	0	9	8	0			0	0	1	0	2	0				
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			

Allowable range 0.098-0.102 in.

P			T	O	L						4		2		0	0	0	9	8	0												
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			

Allowable range 0.098-0.100 in.
(Max. = nominal when no value is given)

P			T	O	L						4		2		0	0	1	0	0	0			0	0	1	0	2	0				
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			

Allowable range 0.100-0.102 in.

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Figure 5-8 Parameter TOL

The tolerance shall be modal by application, applying to all subsequent data until changed by another TOL declaration for that particular application. TOL records which are applicable to all data layers affected by the LAYER and IMAGE parameter records should come after those LAYER or IMAGE parameter records. TOL records which apply to specific layers of data should come directly before the description for those layers.

If the “TOL” parameter is omitted from the data set, no tolerance values shall be assumed or established.

5.10.1 Column 11 Column 11 of the TOL record shall contain one numeral in the range 0 through 8, indicating the tolerance applications in accordance with Table 5-5.

5.10.2 Column 13 Column 13 shall contain either a “1” or a “2.” A “1” indicates that the values expressed will be

Table 5-5 Tolerance Applications

Column 11 Numeral	Tolerance Application
0	Overall printed board size (periphery)
1	Overall printed board thickness
2	Overall layer thickness (see para.5.14)
3	Line width
4	Land diameters
5	Finished hole diameter
6	Hole locations
7	Tolerance specific to other features or areas
8	Registration

the amount of allowable variation between the nominal value and the actual value. A “2” indicates that the values expressed will be absolute minimum or maximum values.

5.10.3 Columns 15–20 Columns 15–20 shall contain one value, to be interpreted as follows:

If a column 13 is a “1,” columns 15–20 shall contain the minus variation allowance (if assigned). If column 13 is a “2,” columns 15–20 shall contain the minimum allowable value (if assigned).

Blanks in all columns 15–20 shall mean that no value is assigned. The 6-digit value in columns 15–20 shall represent the tolerance in ten-thousandths of an inch (smallest value is 0.0001 in) or in one-thousandths of a millimeter (smallest value is 0.001 mm). No sign shall appear in this field. If a value is assigned, no blanks shall appear in columns 15–20.

5.10.4 Columns 22–27 Columns 22–27 shall contain one value, to be interpreted as follows:

If column 13 is a “1,” columns 22–27 shall contain the plus variation allowance (if assigned). If column 13 is a “2,” columns 22–27 shall contain the maximum allowable value (if assigned).

Blanks in all columns 22–27 shall mean that no value is assigned. The 6-digit value in columns 22–27 shall represent the tolerance in ten-thousandths of an inch (smallest value is 0.0001 in.) or in one-thousandths of a millimeter (smallest value is 0.001 mm). No sign shall appear in this field. If a value is assigned, no blanks shall appear in columns 22–27.

5.10.5 Variable Format Records For variable format records, all data may be left-justified starting after the “TOL” designation in columns 4–6. A minimum of one blank is required after the “TOL” designation.

Precision of all numbers shall be indicated by a decimal point. Leading zeros and trailing zeros may be omitted. A minimum of one blank is required between all discrete numbers (see Figure 5–8), such as tolerance application numbers (5.10.1), codes for allowable variation (5.10.2), and tolerance values (5.10.3).

All data shall be terminated with an end-of-record.

5.11 Parameter SCALE (See Figure 5–9.) The designation SCALE in columns 4–8, preceded by a “P” and two blanks in columns 1–3, shall indicate a change in the scale factor of the data.

Columns 10 through 17 shall be used to contain the scale factor. The scale factor may be any number greater than 0. The 8-digit number shall represent the scale factor in ten thousandths of the unit to be scaled (smallest value is 0.0001). If a value is assigned, no blanks shall appear in columns 10–17.

The scale factor is modal and multiplicative. Column 19 shall be used to contain the scale code. The scale code shall

signify the scaling of a line width, land width, (identified in the “D” field) or (X, Y, Z) coordinate data in accordance with Table 5–6. The scale factor does not apply to angular values or rotation direction values in the LDA field. Scale factors do not affect parameter records.

5.11.1 Variable Format Records For variable format records, all data may be left-justified starting after the “SCALE” designation in columns 4–8. A minimum of one blank shall follow the “SCALE” designation.

The designation “SCALE,” preceded by a “P” and two spaces in columns 1–3, shall indicate the scale factor. Following the designation “SCALE,” there shall be at least one blank column, followed by a scale factor. The scale factor shall be modal and multiplicative.

Following the scale factor, there shall be at least one blank column, followed by a scale code in accordance with Table 5–6. The scale code shall signify the scaling of line width or land width (width is specified in the “D” Field), or (x,y,z) coordinate data.

Following the scale code, there shall be at least one blank column, followed by the scale factor. The scale factor shall be modal and multiplicative.

Precision shall be indicated by a decimal point. Leading and trailing zeros may be omitted. Blanks are permitted. A minimum of a single space between the scale code and the scale factor is required. The data shall be terminated with an end-of-record.

5.12 Parameter LAYER (See Figure 5–10.) The designation “LAYER” in columns 4–8, preceded by a “P” and two spaces in columns 1–3, shall indicate a layer composite specification. The layer composite specification is used to relate data layers to physical layers of the board. 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.

Data within a subroutine is “layerless.” The subroutine data is assigned to the current layer, specified by subroutine CALL, when the subroutine is called.

If the LAYER parameter is not specified, all FDA “L” fields describe physical layers.

5.12.1 Physical Layer Numbers Physical layer numbers are defined according to the requirements of paragraph 4.5, as shown in Table 4–1 and Figure 4–2. A “01” designates the first conductive layer. Subsequent conductive layers

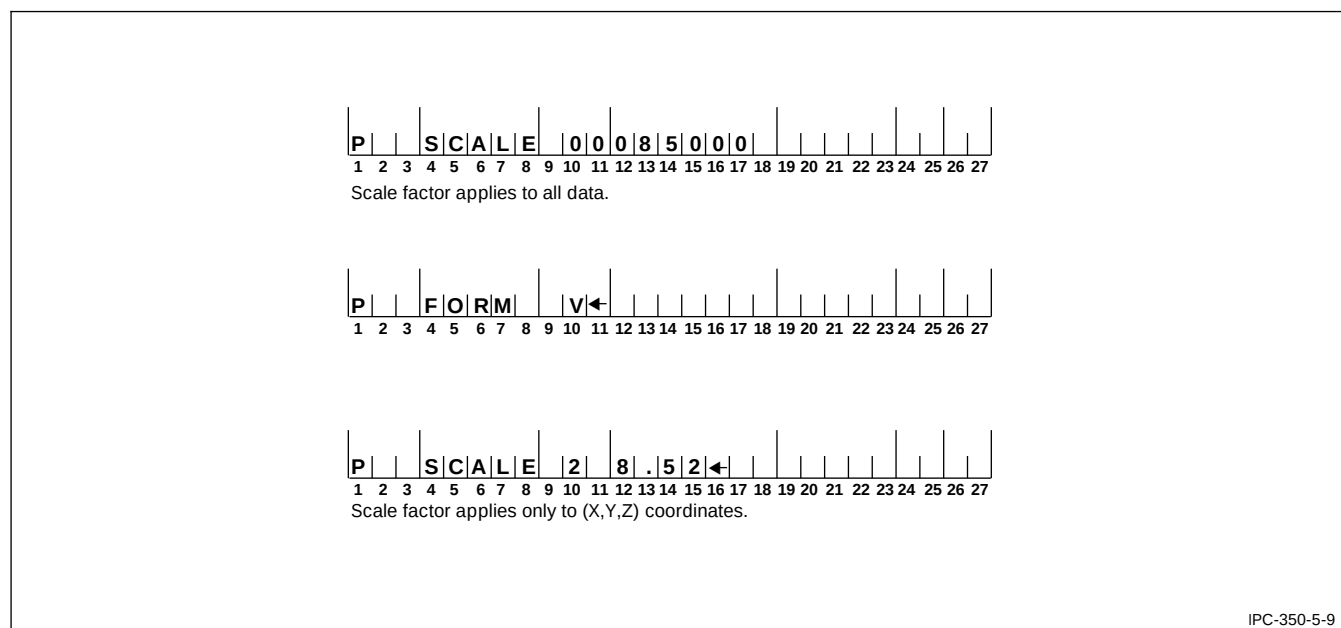


Figure 5-9 Parameter SCALE

Table 5-6 Scale Codes

Code*	Definition
0	All data (FDA and LDA)
1	Conductor dimensions (line records) only ("D" Field only)
2	(x,y,z) coordinates (LDA only)
3	Land dimensions (point records) only ("D" Field only)
4	x-coordinates only (LDA only)
5	y-coordinates only (LDA only)
6	z-coordinates only (LDA only)

*Does not affect parameter records.

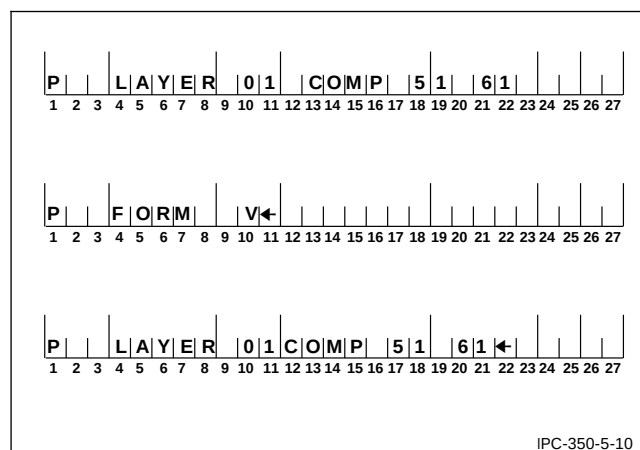


Figure 5-10 Parameter LAYER

numbered sequentially "02," "03," ... as viewed looking down through the board from the first layer.

5.12.2 Data Layer Numbers Data layer numbers correspond to entries in the Feature Dimension L-field.

5.12.3 Variable Format Records For variable format records, all data is left-justified starting after the "LAYER" designation in columns 4-8. A minimum of one blank is required after the "LAYER" and "COMP" designations. There is no limit on the number of layers. Leading zeros may be eliminated. No decimals or commas shall be used. A minimum of a single space is required between all layer numbers. The data shall be terminated by an end-of-record.

5.13 Parameter IMAGE (See Figure 5-11.) The designation "IMAGE" in columns 4-8, preceded by a "P" and two spaces in columns 1-3, shall indicate conductive or non-conductive (clearance) features. An IMAGE parameter record shall precede each group of data records.

The IMAGE parameter shall be modal by application, applying to all subsequent data until changed by another IMAGE declaration.

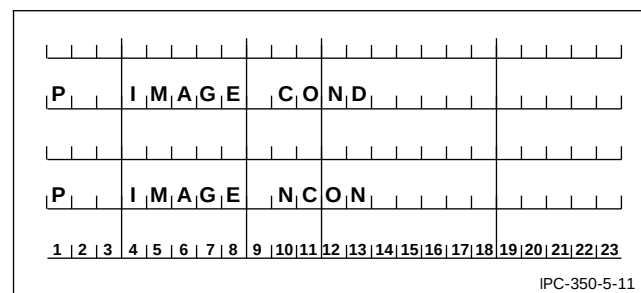


Figure 5-11 Parameter IMAGE

5.13.1 Conductive and Non-conductive Images The designation "COND" in columns 10 through 13 shall indicate that conductive features are described. The word

“NCON” in columns 10 through 13 shall indicate that non-conductive clearance features are described.

5.13.2 Positive and Negative Images of production masters are to be delivered as an end item, columns 15 through 17 shall contain the designation “POS” to indicate a clear field with a dark feature or the designation “NEG” 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.

Example 1. The format in Figure 5-12 indicates that subsequent data describes non-conductive clearance features in the board pattern, and that the production master provides dark features.

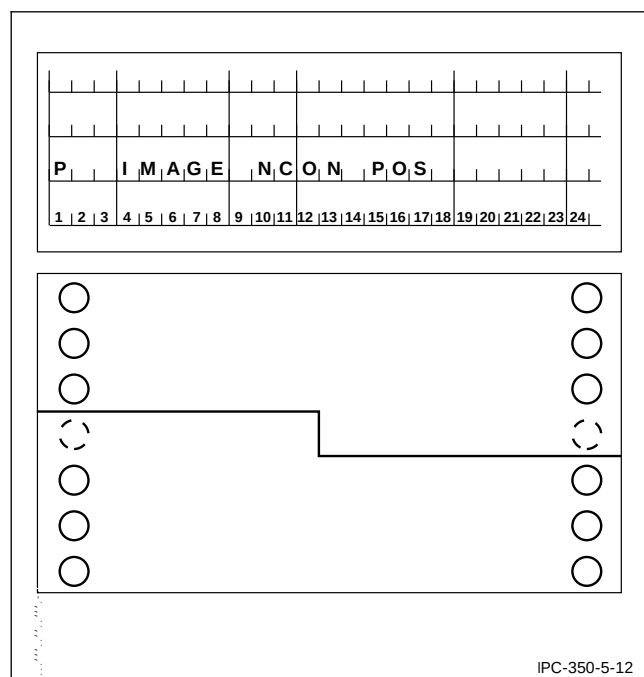


Figure 5-12 Example 1: Positive IMAGE (dark features show non-conductive areas)

Example 2. The format in Figure 5-13 indicates that subsequent data describes non-conductive clearance in the board pattern, and that the production master provides clear features (photo-negative of Figure 5-12).

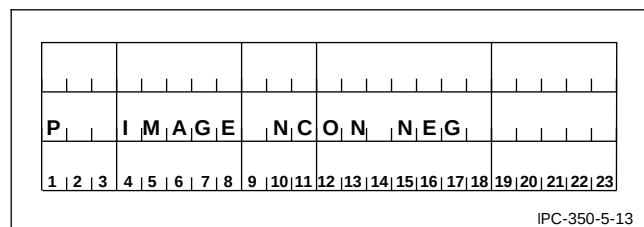


Figure 5-13 Example 2: Format for Negative IMAGE (non-conductive areas are transparent)

5.13.3 Feature Zone (See Figure 5-14) Coordinates can

be used to establish within a data layer a rectangular zone that is the area affected by the IMAGE parameter. This applies only to a specified layer.

The boundaries of the area shall be defined by minimum and maximum (x, y) coordinates that establish the end points of a diagonal of a rectangular zone. The coordinates shall be described in two 20-column fields (31-50 and 51-70). Columns 71-72 shall not be used.

5.13.3.1 Layer Number (Columns 19-21) Columns 19-21 are used to specify the applicable layer number for the feature zone. If a LAYER parameter has not been specified, the layer number refers to a physical layer.

Physical layer numbers are specified according to the requirements of paragraph 4.5. Data layer numbers correspond to entries in the Feature Dimension Area “L” Field.

Column 19 shall contain an “L,” followed by a two-digit number in columns 20-21 to specify the layer number.

5.13.3.2 Minimum (x, y) Coordinate (Columns 31-50)

Column 31 shall contain an “X.” Column 32 shall contain either a plus (“+”) or minus (“-”) sign. A blank may be substituted for the plus sign. Columns 33-40 shall contain an 8-digit number. The 8-digit number shall represent the minimum x-coordinate value (in accordance with the UNIT parameter in ten-thousandths of an inch (smallest value is 0,0001 in) or in one-thousandth of a millimeter (smallest value is 0.001 mm). Blanks may be substituted for leading zeros.

5.13.3.3 Maximum (x, y) Coordinate (Columns 51-72)

Column 51 shall contain an “X.” Column 52 shall contain either a plus (“+”) or minus (“-”) sign. A blank may be substituted for the plus sign. Columns 53-60 shall contain an 8-digit number. The 8-digit number shall represent the minimum x-coordinate value (in accordance with the UNIT parameter in ten-thousandths of an inch (smallest value is 0,0001 in) or in one-thousandth of a millimeter (smallest value is 0.001 mm). Blanks may be substituted for leading zeros.

Column 61 shall contain a “Y.” Column 62 shall contain either a plus (“+”) or minus (“-”) sign. A blank may be substituted for the plus sign. Columns 63-70 shall contain an 8-digit number. The 8-digit number shall represent the minimum x-coordinate value (in accordance with the UNIT parameter in ten-thousandths of an inch (smallest value is 0.0001 inch) or in one-thousandth of a millimeter (smallest value is 0.001 mm). Blanks may be substituted for leading zeros.

5.13.4 Variable Format Records For variable format records, data may be left-justified starting after the designation “IMAGE” in columns 4-8. Leading zeros may

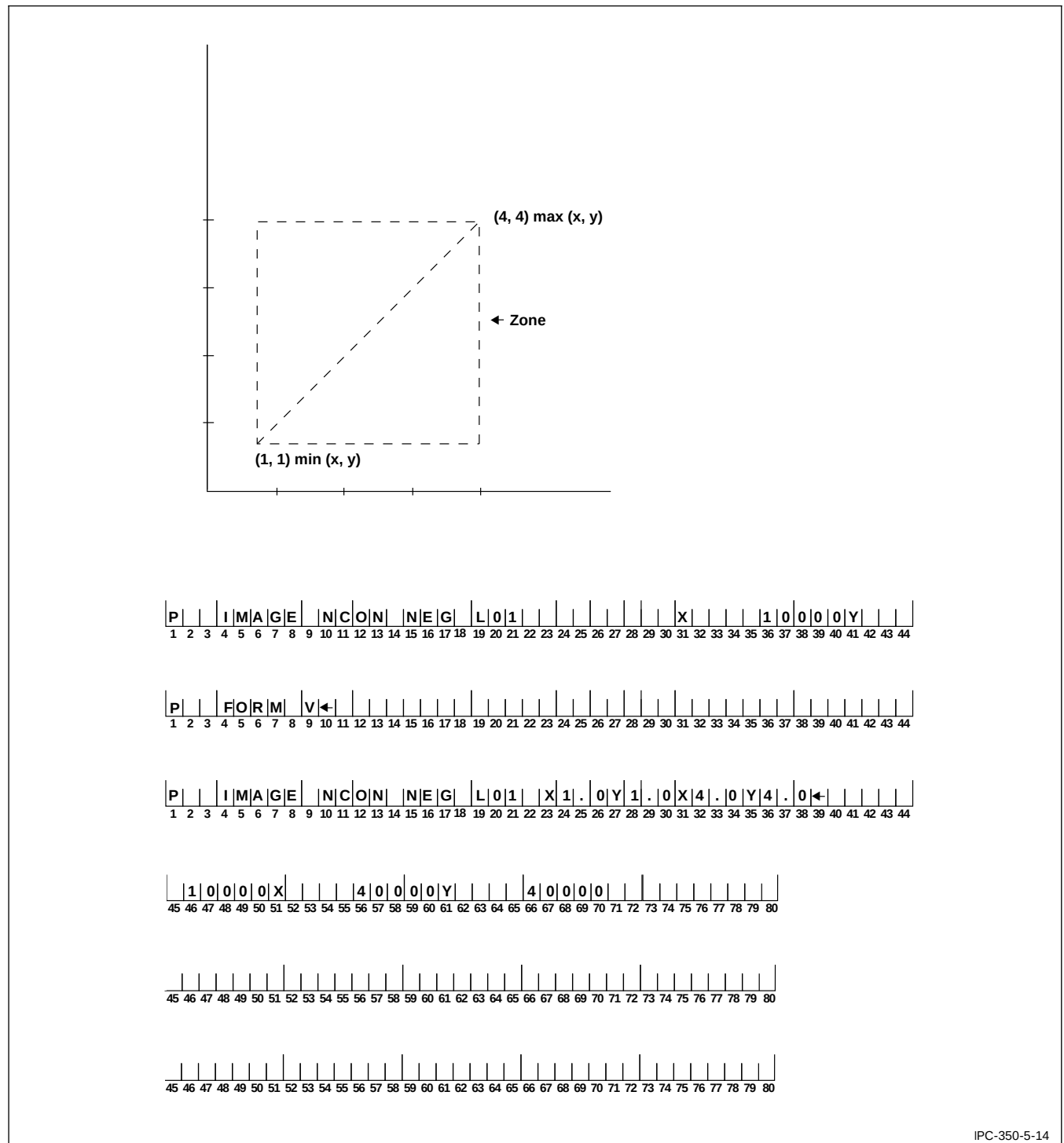


Figure 5-14 Negative feature zone

zeros may be omitted. Blanks are permitted. A minimum of one blank is required after the designations "IMAGE," "COND," "NCON," "POS," and "NEG." Precision shall be indicated by a decimal point. Indicating positive numbers with a plus ("+") sign is optional. Indicating negative numbers with a minus ("−") sign is mandatory. The data shall be terminated by an end-of-record.

5.14 Parameter FAB (See Figure 5–15.) FAB records are used to describe construction characteristics of the printed board. This parameter can be used to define material properties and thicknesses. In addition, the FAB parameter has comment fields that can be used to indicate material specifications and measurement methods.

FAB records may only be used in DIM “B.”

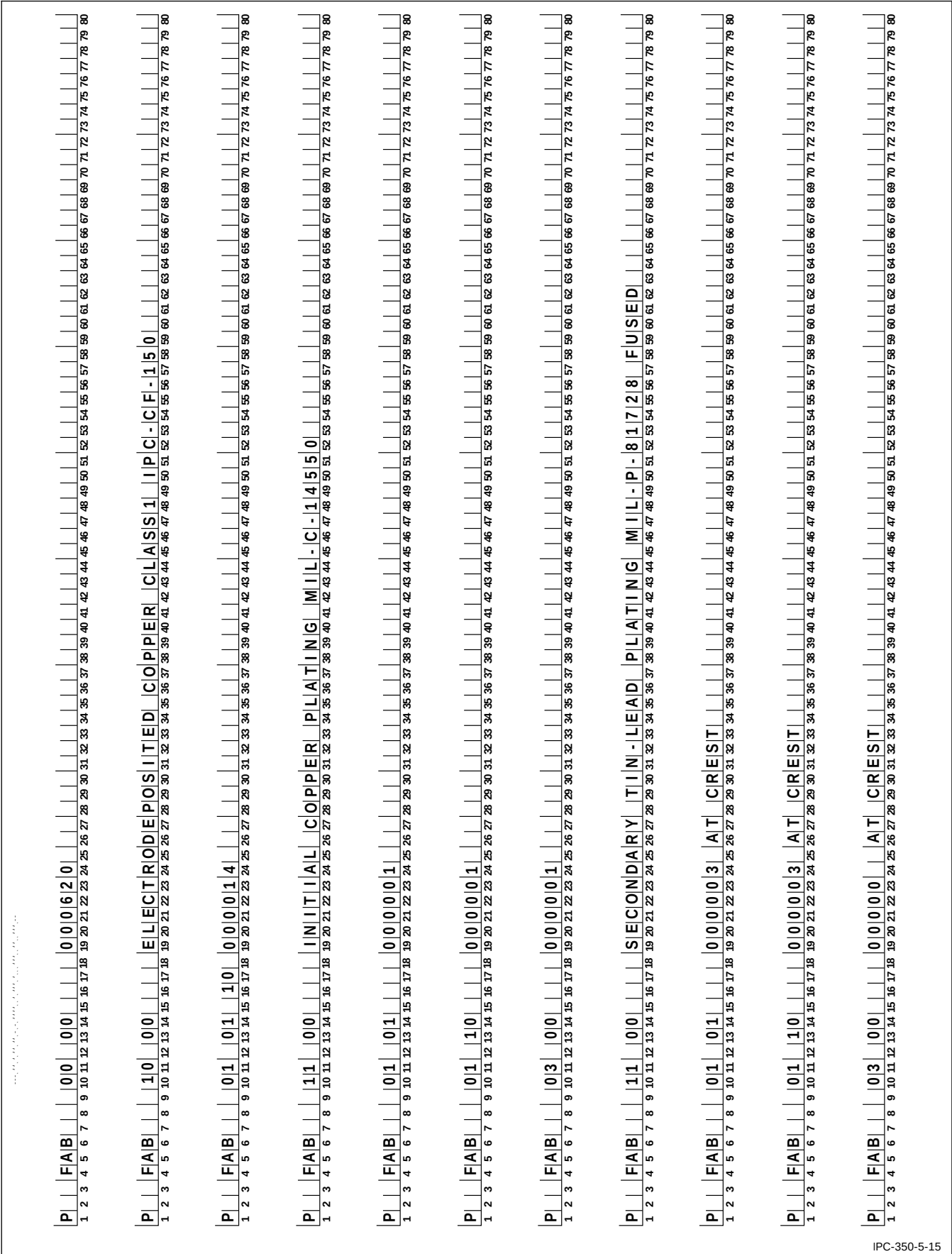


Figure 5-15 Parameter FAB

When TOL records are used to specify tolerances for the nominal thicknesses designated in FAB records, the TOL record shall contain a “2” in column 11 (see Table 5–5). Since the TOL parameter is modal, a TOL record with a “2” in column 11 will affect all subsequent FAB records until a new TOL record is invoked.

FAB records are specified in pairs. The first record in the pair, called the “material specification,” indicates a board material (e.g., “solder mask”) for which a thickness will be defined. The second record in the pair, called the “thickness specification,” indicates the specific board construction characteristic (e.g., “surface dielectric”) for which the thickness will be defined.

Thus, a pair of records made up of a FAB material specification record for solder mask followed by a FAB thickness specification record for surface dielectric thickness constitutes the pair of records necessary to describe thickness requirements for solder mask.

Note: There is one exception to the requirement of material specification preceding thickness specification. Thickness specification records for overall board thickness (Table 5–7 code “00”) need not be preceded by a FAB material specification.

The paragraphs under 5.14.1 detail how to construct the material specification record, which is the first record in any pair of FAB parameter records.

The paragraphs under 5.14.2 detail how to construct the thickness specification record, which is the second record in any pair of FAB parameter records.

5.14.1 FAB Material Specification Records The designation “FAB” in columns 4–6, preceded by a “P” and two spaces in columns 1–3, shall indicate a fabrication parameter record.

Columns 7–9 shall be blank.

Columns 10–11 shall contain a two-digit code from Table 5–7 to indicate the board material. Only Table 5–7 codes equal to or greater than “10” shall be used for FAB material specification records.

Column 12 shall be blank.

Columns 13–14 shall contain “00.”

Columns 15–18 shall be blank.

Columns 19–72 may contain special notes (comments). Special notes shall be used to make additional comments about the materials used in the board construction (such as specifying the standard and class that define the requirements for the material.) For special notes, the use of continuation records are not permitted. To continue a special note, begin a new FAB parameter record.

Columns 73–80 may contain alphanumeric identification used for sequencing, or are unassigned.

Table 5-7 Material and Thickness Codes

Columns 10–11 Code Number	Board Construction Characteristic (Thickness Specification)
00	Overall printed board thickness
01	Surface conductive material thickness (foil, plating, deposition)
02	Surface dielectric thickness
03	Hole conductive material thickness (plating)
04	Hole dielectric thickness (metal core isolation)
09	General Thicknesses
	Board Material (Material Specification)
10	Conductor type
11	Plating type
12	Rigid cured dielectric type
13	Flex dielectric type
14	Preimpregnated dielectric laminate
15	Cover coat (including adhesive)
16	Cast adhesive
17	Solder mask
18	Conformal coating
19	Legend material
20	Solder paste
21	Metal core material
22	Metal core dielectric for surface (porcelainized steel)
23	Metal Core dielectric material for hole isolation

5.14.2 FAB Thickness Specification Records The designation “FAB” in columns 4–6, preceded by a “P” and two spaces in columns 1–3, shall indicate a fabrication parameter record.

Columns 7–9 shall be blank.

Columns 10–11 shall contain a two-digit code from Table 5–7 to indicate the board construction characteristic to which a specified thickness applies. Only the Table 5–7 codes less than or equal to “09” shall be used for FAB thickness specification records.

Column 12 shall be blank.

The information contained in columns 13–14 shall be used to define the physical layer to which the fabrication parameter applies. Physical layer numbers are defined only in FAB thickness specification records. The two-digit number shall be defined according to the conventions for physical layer numbering given in paragraph 4.5 and Table 4–1, except for the number “00.” If the layer is “00,” then this specification applies to all layers that follow. If a layer number appears in columns 16 and 17, the number in columns

13–14 shall be the first in a range or set of layers (for example, layers 02–06).

Column 15 shall be blank.

The information contained in columns 16–17 shall define the second or last layer of a layer set (the first layer of the set is defined in columns 13–14). The two-digit number shall be defined according to the conventions for physical layer numbering given in paragraph 4.5 and Table 4–1. If the fabrication specification is used to describe only one physical layer, columns 16–17 shall be blank (see Figure 5–15).

Column 18 shall be blank.

The information in columns 19–24 shall contain one 6-digit value in accordance with the UNIT parameter of the job. The value in columns 19–24 shall represent the thickness of the specified board characteristic in ten-thousandths of an inch (smallest value is 0.0001 inches) or in one-thousandths of a millimeter (smallest value is 0.001 mm).

Column 25 shall be blank.

Columns 26–72 may contain special notes (comments). Special notes shall be used to determine thickness. For special notes, the use of continuation records are not permitted. To continue a special note, begin a new FAB parameter record.

Columns 73–80 may contain alphanumeric identification used for sequencing, or are unassigned.

5.14.3 Variable Format Records Variable format records for the FAB identical to fixed format records, except that the data may be left-justified starting after the FAB designation in columns 4–6. A minimum of a single space shall be maintained between adjacent numeric values. The data shall be terminated by an end-of-record.

5.15 Parameter AREA (See Figure 5–17.) The designation “AREA” in columns 4–7, preceded by a “P” and two spaces in columns 1–3, shall indicate a rectangular boundary for the area types defined in Table 5–8. Column 10 shall contain the AREA code according to Table 5–8.

The boundaries for the area shall be defined by minimum and maximum (x,y) coordinates that establish the end points of a diagonal of the rectangular zone. The coordinates shall be described in two 20-column fields (31–50 and 51–70). Columns 71–72 shall not be used.

5.15.1 Minimum (x,y) Coordinate (Columns 31–50)

Column 31 shall contain an “X.” Column 32 shall contain either a plus (“+”) or minus (“–”) sign. A blank may be substituted for the plus sign. Columns 33–40 shall contain an 8-digit number. The 8-digit number shall represent the minimum x-coordinate value (in accordance with the UNIT

parameter) in ten-thousandths of an inch (smallest value is 0.0001 in.) or in one-thousandths of a millimeter (smallest value is 0.001 mm). Blanks may be substituted for leading zeros.

Column 41 shall contain a “Y.” Column 42 shall contain either a plus (“+”) or minus (“–”) sign. A blank may be substituted for the plus sign. Columns 43–50 shall contain an 8-digit number. The 8-digit number shall represent the minimum y-coordinate value (in accordance with the UNIT parameter) in ten-thousandths of an inch (smallest value is 0.0001 in.) or in one-thousandths of a millimeter (smallest value is 0.001 mm). Blanks may be substituted for leading zeros.

5.15.2 Maximum (x,y) Coordinate (Columns 51–70)

Column 51 shall contain an “X.” Column 52 shall contain either a plus (“+”) or minus (“–”) sign. A blank may be substituted for the plus sign. Columns 53–60 shall contain an 8-digit number. The 8-digit number shall represent the maximum x-coordinate value (in accordance with the UNIT parameter) in ten-thousandths of an inch (smallest value is 0.0001 in.) or in one-thousandths of a millimeter (smallest value is 0.001 mm). Blanks may be substituted for leading zeros.

Column 61 shall contain a “Y.” Column 62 shall contain either a plus (“+”) or minus (“–”) sign. A blank may be substituted for the plus sign. Columns 63–70 shall contain an 8-digit number. The 8-digit number shall represent the maximum y-coordinate value (in accordance with the UNIT parameter) in ten-thousandths of an inch (smallest value is 0.001 in.) or in one-thousandths of a millimeter (smallest value is 0.001 mm). Blanks may be substituted for leading zeros.

5.15.3 Variable Format Records For variable format records, data may be left-justified starting after the designation “AREA” in columns 4–7. Leading and trailing zeros may be eliminated. Blanks are permitted. A minimum of one blank is required after the “AREA” designation. Precision shall be indicated by a decimal point. Indicating positive numbers with a plus (“+”) sign is optional. Indicating negative numbers with a minus sign (“–”) is mandatory. The data shall be terminated by an end-of-record.

6.0 COMMENT RECORDS

(See Figure 6–1.) The letter “C” in column 1 shall indicate a comment record for 1-byte characters. The letters “CC” in columns 1–2 shall indicate comment records that intermix 1- and 2-byte characters. Columns 4 through 72 are used for descriptive material. Comment Records support the design data by referencing pertinent descriptive information, specifications and documents.

6.1 Allowable Character Set The allowable character set for comment records includes the allowable characters

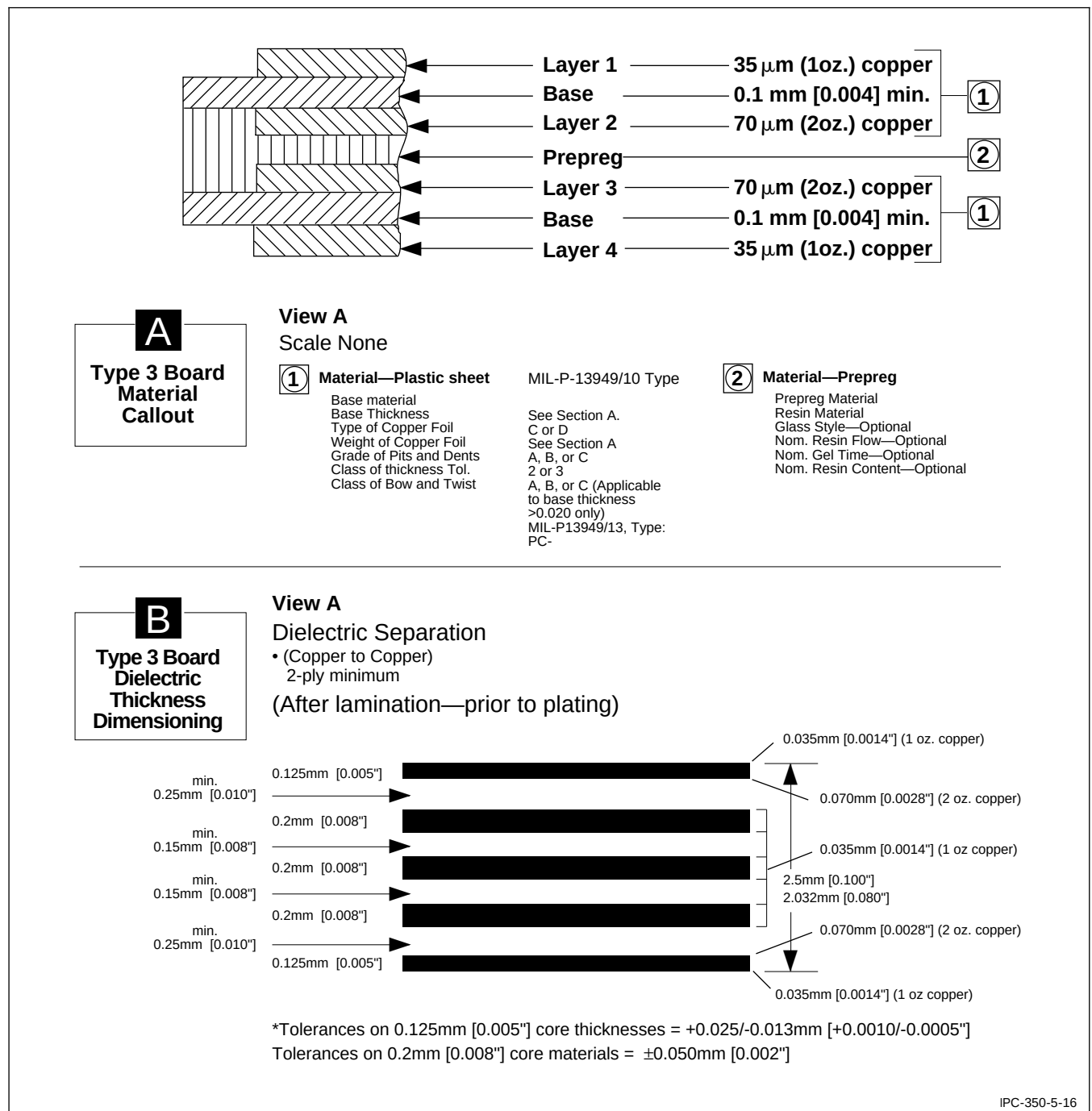


Figure 5-16 Dielectric cross section

Table 5-8 Area Parameter Codes

Area Code	Definition
1	Rectangular periphery of the physical location of all printed board features, including annotation.
2	Rectangular periphery of the printed board.

for non-comment records (see paragraph 4.6, and Table 10-4), and, in addition, comment records can include characters from any native language set identified by the CODE parameter (see paragraph 5.3). The rules for allowable

characters in comment records also apply to TITLE, NUM, and REV parameter records.

Native language comments are permitted only for comment records, and are not available for data, complex, or parameter records (other than the TITLE, NUM, and REV parameters).

The use of native language character sets shall be preceded by the appropriate CODE parameter (paragraph 5.3). If a parameter CODE record is not present, the standard ISO code shall be assumed.