

IPC-D-356 & NTD NETLIST FORMAT

The following are some of the basic guidelines used to enhance the IPC-D-356 netlist test specification. These are a suggestion which are in use today by several CAD/CAM software companies. Support of the IPC-D-356 standard with NTD format, provide the user with the ability for netlist compare , netlist test and fixturing and computer aided repair.

GENERAL GUIDELINES

1. For the Pad definition for a round feature , the pad size should be placed in the X field of the pad dimension. The Y field should be set to zero. Doing so allows the distinction between round and square features. (Square has both values set).
2. Non Plated Drill holes should be output as 367 records. These are typically used to tool the PCB to the test fixture.
3. The Midpoint flag should be included and Midpoint records should be output when test point elimination or Net End routines are performed. This information can be useful in reducing test points in fixturing while still being available during computer aided repair.
4. When Midpoint elimination is done and PTH endpoints can be identified as to a preferred side to test (testing for hole voids), the access side should be set to the layer number rather than A00.
5. When Soldermask is used, the soldermask information should be output. This is critical when building test fixtures and performing netlist test.
6. When possible , Trace/Track information should be output in the NTD specification. This will be used by computer aided repair systems (NTD = Net Trace Data)
7. When outputting pads for Rounded Rectangles , Ovals or Chamfered Rectangles , the pad dimension should be output as a rectangle. This information will allow for proper pin placement and staggering in test. The netlist has been created at this point and net compare or DRC should not be affected by this presentation.
8. When blind vias are used in the design , PTH records should be output as a 317 record with the access side set to the layer that the PTH can be tested from.

IPC-D-356 ELECTRICAL TEST SPECIFICATION

NETLIST RECORDS

Every record consists of a line of 80 characters , referred to as columns.

Operation Code Definition (columns 1-3)	
Column 1	3 = Start of test point record C = Comment Information
Column 2	1 = Feature & Through hole 2 = Feature Only (SMD , etc...) 5 = Tooling Feature (defined as such in the original data source) 6 = Tooling hole (defined as Non Plated Holes)
Column 3	7 = This file is using the standard electrical TEST record format

Signal Identification Field (columns 4-20)	
Columns 4-17	= Net Name / Node Number N/C (in columns 4-6) = single point net / Isolated point

Component Identifier Field (columns 21-32)	
Columns 21-26	= Reference Designator (Device nomenclature)
Column 27	= “-” A Dash to separate the reference designator from pin identifier
Columns 28-31	= The pin identifier. (Pin Number)
Column 32	May contain M to indicate a Mid Net point. Other wise left blank.

Hole Definition Field (columns 33-38)	
Column 33	= “D” Drilled Hole Identifier . Left blank if not drilled
Columns 34-37	= The Hole diameter in 0.0001 Inch or 0.001 mm.
Column 38	= “P” Indicates Plated Through hole = “U” Indicates Unplated Through hole

Test Point Access Field (columns 39-41)	
Column 39	= “A” Access Code
Columns 40-41	= “00” Test point is accessible from both sides (PTH) = “01” Test point is accessible from side 1 (Primary side) = “0n” Test pont is accesible from side “n” where “n” is usually the last outer layer

Test Point Location Field (columns 42-57)	
Column 42	= Shall contain “X” to specify X location
Column 43	= “+” or “-” or blank to specify the sign (blank = “+”)
Columns 44-49	= Shall contain six digits representing the X coordinate in 0.0001 Inch or 0.001mm. Leading zeroes may be blank.
Column 50	= Shall contain “Y” to specify the Y location
Column 51	= “+” or “-” or blank to specify the sign (blank = “+”)
Columns 52-57	= Shall contain six digits representing the Y coordinate in 0.0001 Inch or 0.001mm. Leading zeroes may be blank.

Feature Size Field (columns 58-71)	
Column 58	shall contain an "X"
Columns 59-62	X - dimension in 0.0001 Inch or 0.001 mm
Column 63	shall contain "Y"
Columns 64-67	Y - dimension in 0.0001 Inch or 0.001 mm
Column 68	shall contain R to signify Counter Clockwise Rotation of feature
Columns 69-71	shall contain 3 digits to represent rotation (000-360)
Column 72	Is unassigned and should be left blank

Soldermask Field (columns 73-74)	
Column 73	Shall contain "S" to signify soldermask information
Column 74	= 0 specifies no solder mask = 1 specified primary side soldermask = 2 specifies secondary side soldermask = 3 specifies both sides soldermasked

Alternate Test Point Record (Columns 75-80)	
Column 75	"A" indicates an alternate test record exists
Columns 76-80	A five digit alphanumeric identification representing the alternate test record

HEADER INFORMATION

The header information always starts with a "P" in column 1 and two blanks in columns 2-3 , followed by the parameter designation in columns 4-7 , two blanks in columns 8-9 and the value of the parameter in column 10-72.

Parameter	Description
JOB	the name of the job
FORM	specify if the format of the IPC-D-356 data is FIXED or VARIABLE (Note : in this document , only the Fixed format is described)
CODE	Indicate a switch to native language character set for comment records
DIM	Data Information Module - for netlist data , always "N"
UNITS	Units of measurement : CUST 0 or CUST Inches and degrees CUST 1 Millimeters and degrees CUST 2 Inches and radians
TITLE	title of the data defined in this file
NUM	part number of the data
REV	revision number of the data
LANG	data exchange format , usually always "SDEF"
SCALE	scale factor of the data
TOL	Tolerance specification
LAYER	Layer specification
AREA	Description of the board's rectangular boundaries. The coordinates are specified in columns 32-50 (xmin,ymin) and columns 51-70 (xmax,ymax).

IPC-D-356 Sample File

P JOB forw_1
P FORM FIXED
P CODE 01
P DIM N
P UNITS CUST 0
P TITLE standard
P NUM 1000
P REV 1.00
P LANG SDEF
P SCALE 00010000 0

367	-	D1250UA00X+008660Y+032725X1250Y0000	S0
367	-	D1250UA00X+008660Y+098725X1250Y0000	S0
367	-	D1250UA00X+011680Y+060885X1250Y0000	S0
367	-	D1250UA00X+011840Y+087275X1250Y0000	S0
367	-	D1250UA00X+017000Y+030995X1250Y0000	S0
317NET1	-	MD0079PA00X+013960Y+072575X Y	S3
317NET1	-	M 0079PA01X+013960Y+072575X0220Y0000	S3
317NET1	-	M 0079PA08X+013960Y+072575X0220Y0000	S3
317NET1	-	MD0079PA00X+017160Y+071225X Y	S3
317NET1	-	M 0079PA01X+017160Y+071225X0220Y0000	S3
317NET1	-	M 0079PA08X+017160Y+071225X0220Y0000	S3
317NET1	-	MD0079PA00X+018210Y+076375X Y	S3
317NET1	-	M 0079PA01X+018210Y+076375X0220Y0000	S3
317NET1	-	M 0079PA08X+018210Y+076375X0220Y0000	S3
327NET1	-	A01X+027907Y+077727X0500Y0260	S0
327NET1	-	A01X+030607Y+078977X0500Y0260	S0
317NET2	-	MD0079PA00X+011310Y+070775X Y	S3
317NET2	-	M 0079PA01X+011310Y+070775X0220Y0000	S3
317NET2	-	M 0079PA08X+011310Y+070775X0220Y0000	S3
327NET2	-	A08X+012660Y+065725X0300Y0000	S3
327NET3	-	A08X+013660Y+063725X0300Y0000	S3
327NET3	-	A01X+014157Y+063977X0500Y0260	S3
327NET3	-	A01X+026260Y+082225X0200Y0340	S3
327NET3	-	A01X+027407Y+084727X0500Y0260	S3
327NET8	-	M A01X+012050Y+064477X0400Y0700	S0

NETLIST TRACE DATA FILE (.NTD)

The following is the specification of the Netlist Trace Data format (NTD). This data file format was created to accompany an IPC-D-356 data file , and to supply the trace data that the IPC-D-356 file format does not supply.

File Description:

The .NTD file is in ASCII format , comma (,) delimited. The data is in standard ASCII and there is a comma (,) separating each field in the record. The fields are of variable length , and each record in the data file must end with a newline character (either carriage return , or a carriage return/linefeed pair).

Note : due to the fact that the comma (,) is used as the field delimiter , it may not be used in any of the record data.

Basic Data Format :

The data in the .NTD file is stored in the following format :

Data , Type Indicator , Data

The format of the data section is determined by the **Data Type Indicator (DTI)**.

The DTI codes presently defined are as follows :

Units	-	Units of measurement
Comment	-	Comment or remarks (Not Processed)
Signal	-	Signal data
Extension	-	Extension of previous signal data record
Layer	-	Layer type identification
Sorted	-	Indicate if the data is sorted (see below)

Please note that the DTI code appears as the whole word. This is done to allow maximum flexibility and readability of the data file. To reduce the size of the resulting .NTD file , the following DTI codes can be abbreviated as follows :

Comment	-	C
Signal	-	S
Extension	-	E
Layer	-	L

Since **Units** only appears once per file , as does the **Sorted** DTI code , they have no need for abbreviation.

Data Record Order:

In the .NTD file the DTI codes **Units** , **Layer** and **Sorted** have limited appearances , and effect the translation of the **Signal** records. For this reason , they should be placed in the beginning of the .NTD file , before any **Signal** records. **Comment** records are ignored , and therefor can be placed anywhere within the file.

Units Record Format:

The format of a **Units** record is as follows :

DTI,Unit Code

The Unit Codes presently defined are as follows :

English	-	Units of 0.0001 inch (i.e.: 1000 = 0.1 inch)
Metric	-	Units of 0.001 Millimeter (i.e.: 1000 = 1 mm)
English Mils	-	Units of 0.001 inch (i.e. : 100 = 0.1 inch)

Presently there are only 3 possible **Units** records :

Units,English

Units,Metric

Units,English Mils

There must be 1 and only 1 **Units** record per file , and all measurements in the .NTD file shall be given in the units indicated but the **Units** record.

Sorted record format:

The format of a **Sorted** record is as follows :

DTI,Flag

The Flags presently defined are as follows:

Yes	-	The file is sorted
No	-	The file is not sorted

Presently , there are 2 possible **Sorted** records :

Sorted,Yes

Sorted,No

There shall be only 1 **Sorted** record per file. The **Sorted** record must appear before all **Signal** records. If the **Sorted** flag is set to Yes , the file must be **Sorted** first by signal name , then by layer number within the sorted signal name (see example data below). If the **Sorted** flag is No , or not present , then no assumption should be made on the order of the **Signal** records.

Layer Record Format:

The format of a Layer record is as follows :

DTI,Layer Number or Layer Indicator , Layer Type

The **Layer Number** must correspond with the **Layer** used in the **Signal** record.

The **Layer Type** codes presently defined are as follows :

Component	-	Component Layer
Solder	-	Solder Layer
Signal	-	Signal Layer
Plane	-	Any Plane Layer
Power	-	Power Plane Layer
Ground	-	Ground Plane Layer

An example of a **Layer** record is as follows :

Layer,1,Component

This record indicates that layer 1 is the component layer. As the **Layer** records effect the translation of the **Signal** records , they must appear before any **Signal** records in the file.

Another example , using the layer indicator , is as follows :

Layer,\TEMP\LAYER1.GRB,Component

This record indicates that the layer identified eith “\TEMP\LAYER1.GRB” is the component layer.

Comment Record Format

The format of a Comment record is as follows :

DTI,Comment Text

An example of a **Comment** record is as follows :

Comment,This is a sample comment record.

Please Note : The **Comment** record is the only place that a comma (,) may be used in the data , as the **Comment** record is ignored , it will cause no conflict with the interpretation of the record data.

Signal Record format:

The format of a **Signal** record is as follows :

DTI,Signal Name,X1,Y1,X2,Y2,Layer,trace Width

The fields of this record are described below.

- Signal Name** - The name of the net or signal. Note , this should be the actual signal name , regardless length.
- X1** - X location (in units specified in **Units** record) of the start of the trace.
- Y1** - Y location (in units specified in **Units** record) of the start of the trace.
- X2** - X location (in units specified in **Units** record) of the end of the trace.
- Y2** - Y location (in units specified in **Units** record) of the end of the trace.
- Trace Width** - Width of the trace (in units specified in the **Units** record)

Extension Record Format :

The Extension record is a continuation of the previous **Signal** record. It allows the elimination of shared endpoints between consecutive traces.

NOTE: The Extension Record Format may only be used if the data is SORTED.

The format of a **Extended** record is as follows:

DTI,X2,Y2,Layer,Trace width

The fields of this record are described below :

X2 - Xlocation (in units specified in **Units** record) of end of trace
Y2 - Ylocation (in units specified in **Units** record) of end of trace
Layer - Layer number of circuit board that the trace appears on.
Trace Width - Width of the trace (in units specified in **Units** record)

The X2 and Y2 data from the previous **Signal** record is used as the X1 and Y1 data for the trace being described in the **Extended** record. A pair of traces , on layer 1 , with the coordinats (5000,5000,5000,6000) and (5000,6000,6000,6000) could be written as follows :

Signal,Net_1,5000,5000,5000,6000,\TMPLAYER1.GRB,40
Extension,Net_1,6000,6000,\TMPLAYER1.GRB,40

Sample Data :

The following is a sample .NTD file

```
Comment,Part Number 72-65-80-80-89
Units,English
Sorted,Yes
Layer,1,Component
Layer,2,Solder
Layer,3,Signal
Layer,4,Signal
Signal,Control,2000,18000,18000,18000,1,250
Extension,18000,2000,1,250
Extension,2000,2000,2,250
Extension,2000,18000,2,250
Signal,NTSC Left,7000,15000,8000,14000,1,150
Extension,7000,13000,1,150
Extension,6000,14000,2,150
Extension,7000,15000,2,150
Signal,NTSC Right,13000,15000,14000,14000,1,150
Extension,13000,13000,2,150
Extension,12000,14000,3,150
Extension,13000,15000,3,150
Signal,Output,3000,8000,5000,10000,1,200
Signal,Output,4000,9000,6000,6000,2,200
Extension,8000,5000,2,200
Extension,12000,5000,2,200
Extension,16000,9000,3,200
Signal,Output,15000,10000,17000,8000,4,200
```

The following is a sample .NTD file with the DTI abbreviations

```
C,Part Number 72-65-80-80-89
Units,English
Sorted,Yes
L,1,Component
L,2,Solder
L,3,Signal
L,4,Signal
S,Control,2000,18000,18000,18000,1,250
E,18000,2000,1,250
E,2000,2000,2,250
E,2000,18000,2,250
S,NTSC Left,7000,15000,8000,14000,1,150
E,7000,13000,1,150
E,6000,14000,2,150
E,7000,15000,2,150
S,NTSC Right,13000,15000,14000,14000,1,150
E,13000,13000,2,150
E,12000,14000,3,150
E,13000,15000,3,150
S,Output,3000,8000,5000,10000,1,200
S,Output,4000,9000,6000,6000,2,200
E,8000,5000,2,200
E,12000,5000,2,200
E,16000,9000,3,200
S,Output,15000,10000,17000,8000,4,200
```