PCB Library Considerations

PCB Libraries, Inc.

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PCB Libraries

Introduction
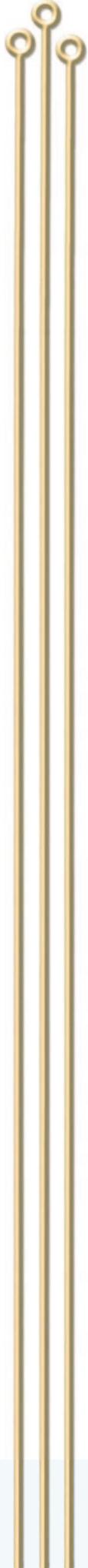
- Library parts are the fundamental part of all PCB layout

  - A PCB designer cannot complete a PCB design layout until all footprint library parts are created

- Libraries carry intelligence right through the design cycle

  - The schematic symbol contains the logical properties and the properties to create the BOM and the Net List w/footprint name

  - The footprint libraries are mechanically created to produce the highest yield in fabrication and assembly manufacturing and are used to create the assembly drawing

- Every company must create a clear well defined process and structure for library development, maintenance and guidelines

  - The library construction guidelines or "rules" must be documented to insure consistent quality regardless of who creates the library and to prevent productivity downtime when employees leave

PCB Libraries

What Happens With Poor Library Control?

- Schematic Symbols are not consistent quality
  - Inconsistent symbol quality makes the schematic look terrible
- Versions get out of control
  - An unorganized PCB library is every company's worst nightmare
- Multiple symbols are generated for the same part
  - Duplication of effort wastes time and money
- Incorrect footprints get assigned in the symbol
  - This will cause assembly failure and lead to revision spins and the PCB's turn into scrap (door stops)
- Bill of Materials are incorrect – data missing
  - This causes project delays which lead to higher costs
- "On the fly" (undocumented) fixes lead to errors elsewhere

What Does a CAD Librarian Do?

- Plans and implements library structures, process and standards

  - Collaborate with management to define the rules

- Creates complete, correct and consistent symbols and footprints

  - Consistent library construction produces the highest quality PCB design layouts for aesthetics and makes it easier to locate errors

- Groups parts and symbols in sensible libraries for easier search

  - Finding existing library parts eliminates duplication & saves time

- Maintains version control

- Controls release of interim and approved parts

  - Library parts should not go into the main library until after they pass through the assembly process with 100% successful results

- May need to document changes for QC tracking

  - Good documentation will track changes for CYA

Types of Libraries

- Three types of libraries
  - Local, Network and Global
  - Local Library
    - Backups are problematic
    - Not universally available but flexible and fast
  - Network library
    - Routine backups, available to all but slower, difficulties in revision control and creation of new part numbers and only one library should exist because multiple libraries are hard to synchronize
  - Global library
   - Corporate development of part numbers globally
    - Corporate parts release
    - Global standards are hard to change

Library Structure
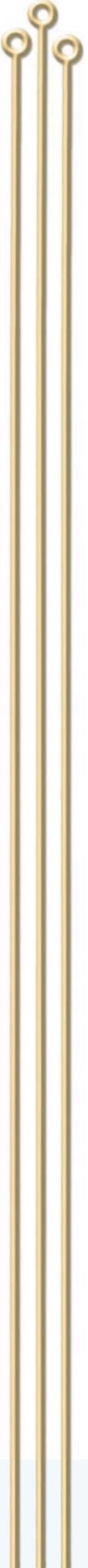
- Approved / Interim libraries

  - Interim for fast development

  - Approved for proven performance

- Sub-directory structure – Breakdown for intuitive searching

Ideal Directory Structure

  - Examples of Schematic Symbols

    - Analog – amplifiers, converters, filters, oscillators
    - Digital – gates, CPU, RAM, ROM
    - Optical – LED

  - Examples of physical footprints:

    - Active – IC's typically 8-pins or more
    - Passive – discrete parts typically less than 8-pins
    - Connectors

- Access to datasheets

 - Logical and physical, web-based or network archive
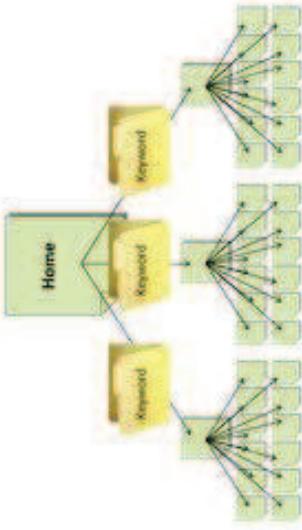
Library Standards

- Symbols
  - IPC-2612 Sectional Requirements for Electronic Diagramming Documentation
  - ANSI/IEEE STD 91A-1991
  - ANSI Y32.14
    - http://infostore.saiglobal.com/store/details.aspx?ProductID=779731
  - ANSI Y14.2
  - Component manufacturer recommended symbol
- Footprints
  - IPC-7251 for Through-hole
    - Not released yet
  - IPC-7351B for Surface Mount
    - Currently working on Revision C
  - Component manufacturer recommended pattern

Naming Convention

Schematic Symbols

- Hierarchical names – major category first
- Generic parts preferred
- Specific when very specialized
- Example: Manufacturer Name _ Manufacturer Logical Part Number
- Large corporations assign a corporate part number for each device
  - This introduces a high level of bureaucracy that can have benefits for standardization for all components, but it has drawbacks as it slows productivity and needs to be highly organized and maintained by database entry personnel who do not create libraries, just manage a database

PCB Footprints

- IPC-7351C for standard component packages
  - The C revision has extended names to include Thermal Tab, Lead Length, Ball Size
- Non-standard Active and Passive Packages
  - Manufacturer Name _ Manufacturer Logical Part Number (this may be the future for all libraries)
- Connectors
  - Manufacturer Name _ Manufacturer Part Number
- Large corporations assign a corporate part number for each device

+VIN	+VOUT	12
	+VOUT	13
	0V	10
	0V	15
	-VOUT	8
-VIN	-VOUT	17
1		
2		

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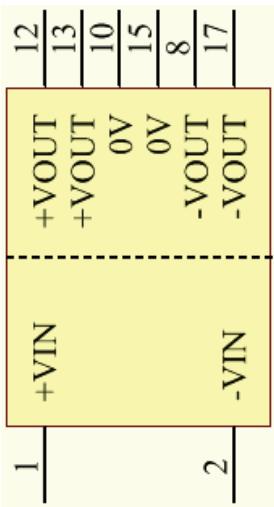
Schematic Symbol Links
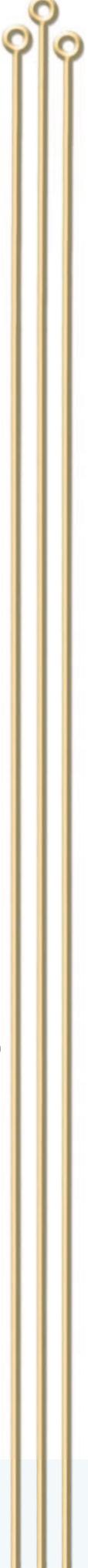
- Link logical with physical
  - A master database should be created to organize library attributes
- Database linking symbol these attributes
  - Footprint name
  - Physical description
  - Mfr. package case code
  - Manufacturer's name
  - Logical part number
  - Logical description
  - Datasheet link
- Symbol pin assignments linked to footprint pin numbers
  - There are not many software tools that can verify this prior to integration on the PCB design layout.

Pin	Name
1	VCCA
23	VCCB
24	VCCB
22	OE
2	DIR
3	A1
4	A2
5	A3
6	A4
7	A5
8	A6
9	A7
10	A8
21	B1
20	B2
19	B3
18	B4
17	B5
16	B6
15	B7
14	B8
11	GND
12	GND
13	GND

Library Standard for Symbols

- Symbols
  - Generic Symbols Reduce Duplication
  - How to Add VCC and GND
    - Shown in the schematic on the IC, Hidden, Group on last page
  - ANSI, IEEE, CAD Vendor, Component Manufacturer, Own
- Properties
  - CAD tool, Assembly System, Purchasing System, Company MRP
- Simulation Models
  - Hardware, IBIS, VHDL, Behavioral Language, Built from Primitives
- Text
  - Height, Justification, Thickness, Font
- Symbol Pins
  - Spacing, Inputs Left, Outputs Right, VCC Top, GND Bottom, Line Thickness

PCB Libraries

Padstack and Footprint Generation
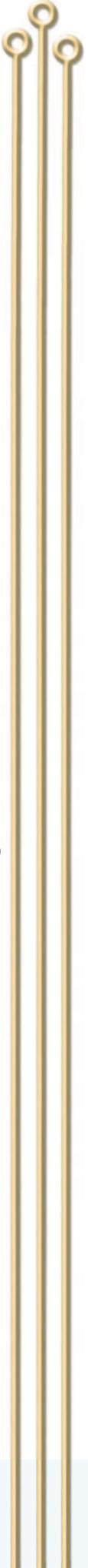
- Padstack Generation
  - Naming Convention – see IPC-7351B
  - Inch or Metric units
  - Metric Unit Example: c150h90
    - Circular pad 1.50 mm with hole size 0.90 mm
- Footprint Generation
  - Naming Convention –
    - IPC-7351B for standard parts
  - Non-standard parts
    - Component Family _ Manufacturer Name _ Manufacturer Part Number
  - Layer Conventions
    - Active electrical layers, Documentation layers, Assist layers
  - Text Conventions
    - Ref Des, Pin text, Font

PCB Libraries

Part Number Generation

- Parametric library generation
  - Controls part number documentation and maybe generation
- Documentation required
- Documentation storage
- Vendor data
  - Electrical spec
    - Model, Timing, Pin assignment
  - Physical spec
- Corporate data
  - Part number, Price, Availability
- Delivery spec
 - Tape, Reel, Tube, Tray, Stick, Orientation

New Symbol Generation & Sheet Size

- New Symbol Generation
  - Observe naming convention
  - Observe symbol graphical standards
  - Observe symbol data standards
  - Release to Interim library
- New schematic sheet generation
  - Size of plotter / printer
  - Size of storage
 - Size of service manuals
  - PDF format

Schematic and PCB Drawing Standard Sheets

ANSI – Inch

- A Size – 8 ½" X 11" (215.9 mm X 279.4 mm)
- B Size – 11" X 17" (279.4 mm X 431.8" mm)
- C Size – 17" X 22" (431.8" mm X 558.8 mm)
- D Size – 22" X 34" (558.8 mm X 863.6 mm)
- E Size – 34" X 44" (863.6 mm X 1117.6 mm)
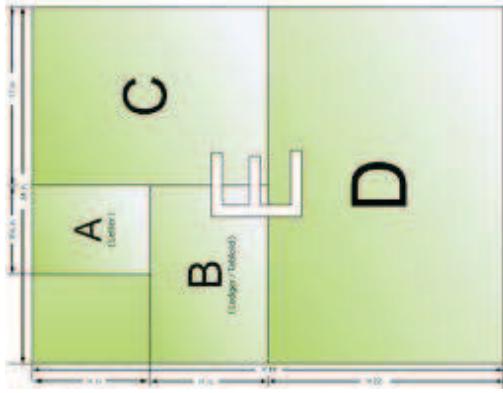
ISO – Metric

- A5 Size – 148 mm X 210 mm (5.827" X 8.268")
- A4 Size – 210 mm X 297 mm (8.268" X 11.693")
- A3 Size – 297 mm X 420 mm (11.693" X 16.535")
- A2 Size – 420 mm X 594 mm (16.535" X 23.386")
- A1 Size – 594 mm X 841 mm (23.386" X 33.110")
- A0 Size – 841 mm X 1,189 mm (33.110" X 46.811)
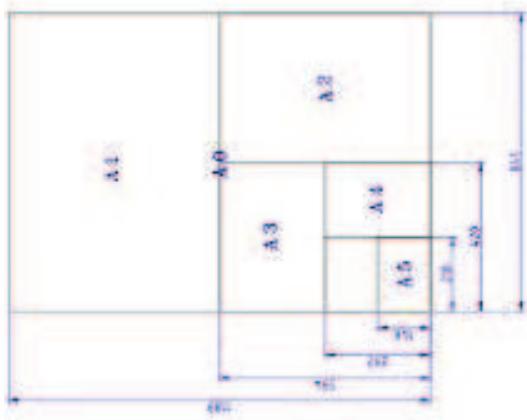
New Padstack & Footprint Generation

- Top Assembly Pad
- Top Solder Mask
- Top Pad (Land)
- Inner Layer Pad (Land)
- Plane Thermal
- Plane Anti-pad
- Bottom Pad (Land)
- Bottom Solder Mask
- Bottom Assembly Pad
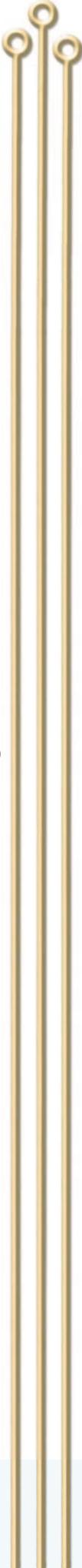
- New Padstack
  - Observe naming convention
  - Board fabrication issues
    - Through-hole annular ring (IPC Class 1, 2 and 3)
  - Board assembly issues
    - Solder paste deposition
    - Solder mask type / clearances / minimum web

- New Footprint
  - Observe naming convention
  - Board fabrication issues
    - Solder mask clearance
  - Board assembly issues
    - Placement tolerances for outline
    - Component Height
    - Special keep-outs for vias, traces

Diagram labels:
- 0.25mm Silk to Land Gap Automatic DRC Checked
- 2mm Thermal to Land Gap DRC Checked
- 2mm Land to Land Gap DRC Checked
- Perfect IPC Land Sizes
- 2 Ref Des – Silkscreen & Assembly Drawing
- Silkscreen Outline Line Width 0.2mm
- Assembly Outline Nom or Max Body w/0.1mm Line Width
- 3D Model Outline Maximum Body Size
- Thermal Pad
- Silkscreen Pin 1 Polarity
- Assembly Pin 1 Polarity
- Post Assembly Dot Located by Pin 1 Visible After Assembly
- 1:1 Scale Paste Mask on all Terminal Lands
- Center of Gravity Origin
- 75um Solder Mask Swell on all Lands
- 40% Paste Reduction on Thermal Pad Broken Into Squares
- IPC Placement Courtyard 0.25mm External Boundary

Quality Control Checks

- Parametric generation more foolproof

- Check Symbols
  - CAD checks
  - Property checks
  - Modeling checks
  - Standards checks

- Check Padstacks
  - Assembly and fabrication for through-hole annular rings

- Check Footprints
  - Assembly
  - Fillets after soldering
  - Component outline on silkscreen and silkscreen off pads
  - Electrical function ok (special keep-outs)
  - Clearance to adjacent components – placement courtyard

Releasing New Part Numbers & Version Control
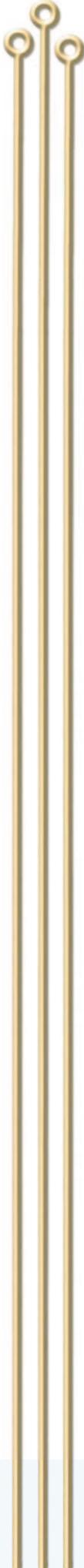
- Releasing part numbers
  - When to release
  - How to release
  - How to update existing drawings
- Version control
  - History
  - Versions versus variations
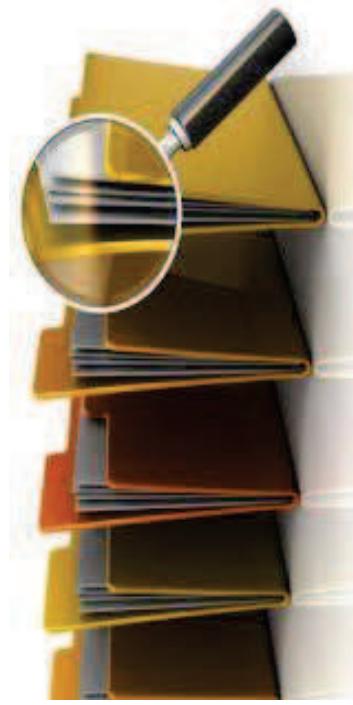
Conclusion

- Creating library parts requires special people
- Library creation needs time, effort, care
- If the library is not right, nothing works

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