DFM Aware CAD Libraries

- Designing for Manufacturability Upfront

Aug 8th, 2024

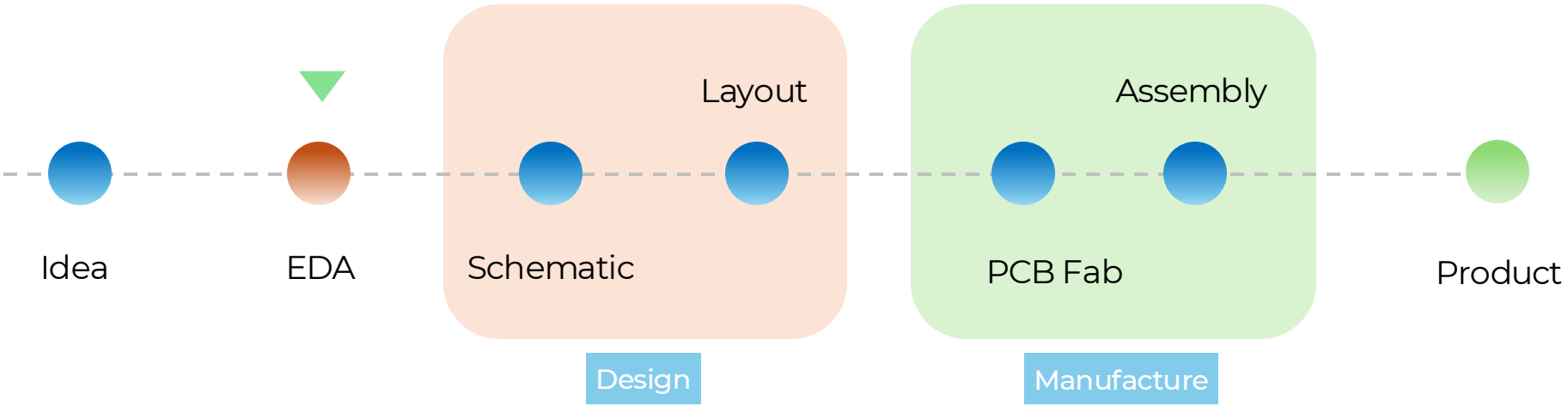
footprintku AI

Ultra Librarian

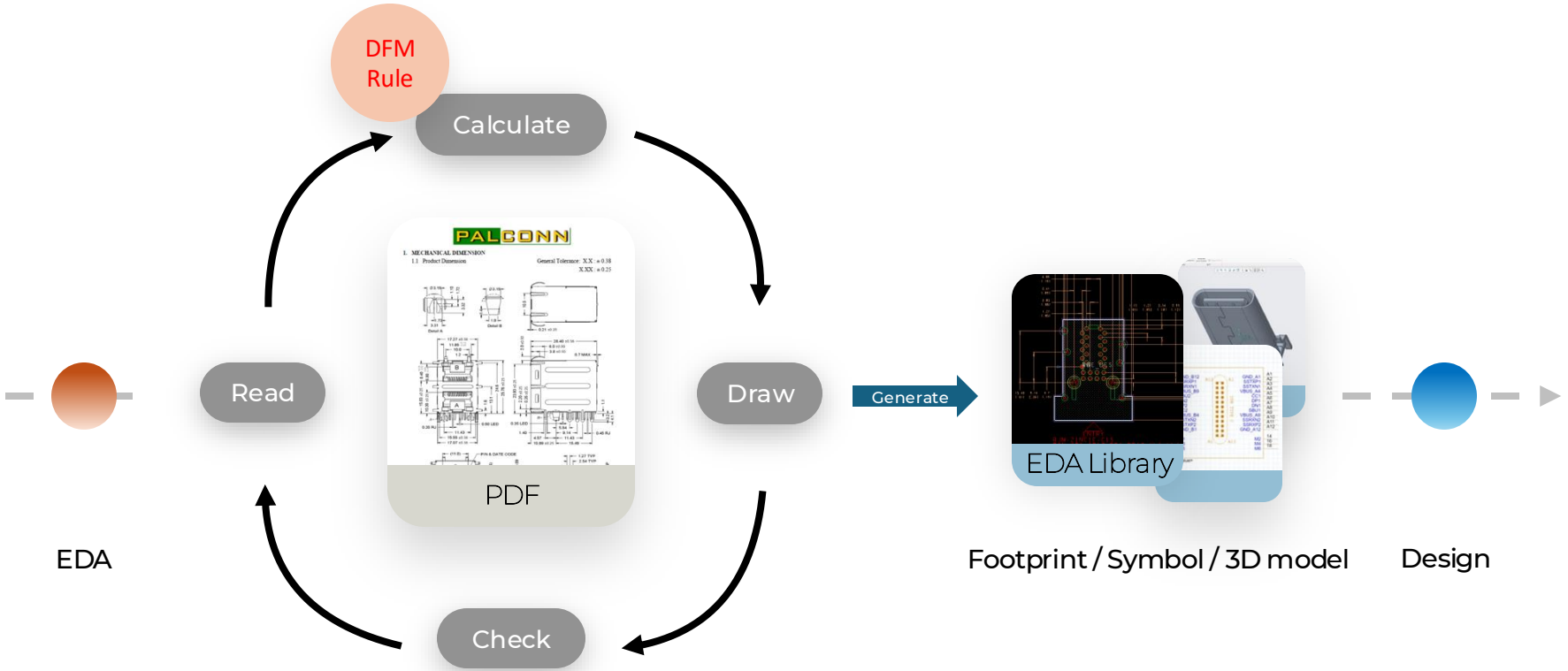
Agenda

- Importance of DFM-aware Library
- Case Studies: Impact of DFM Rules on Manufacturability
- Developing a DFM-aware Library
- Integrating to Virtual Librarian Service
- Q&A

EDA Library in Product Design

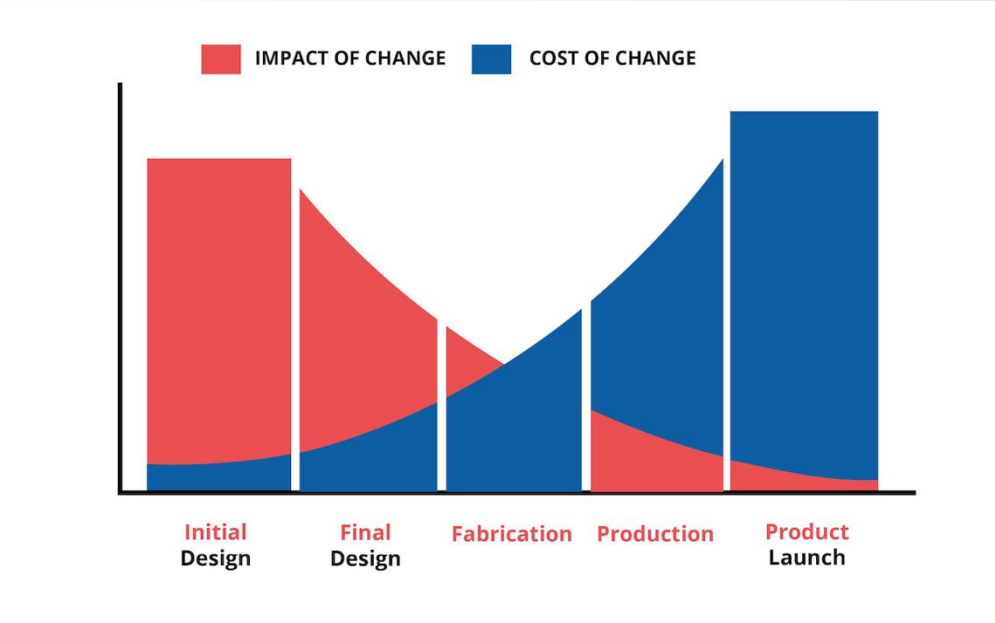


Process of Creating an EDA Library



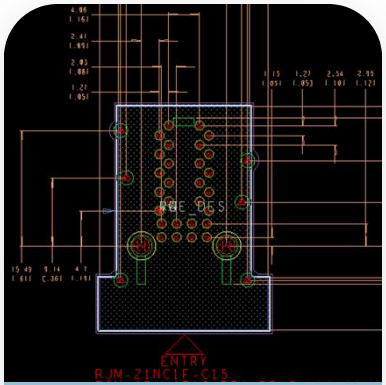
What Happens When DFM Rules are Overlooked in Early Design Cycles?

"The cost of having to re-work design at a post-design check or even after discovering initial product build is faulty, is much higher than making changes in the initial design to ensure it can be manufactured right-first-time."

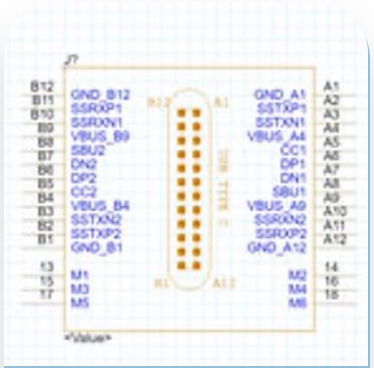


Libraries that are Ready-for-Manufacturing

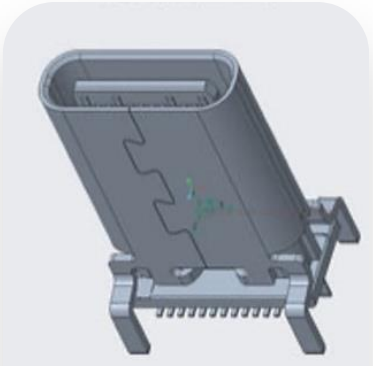
Creation | DFM Checking | Convert | Mapping



PCB Footprint



Schematic Symbol



3D Model

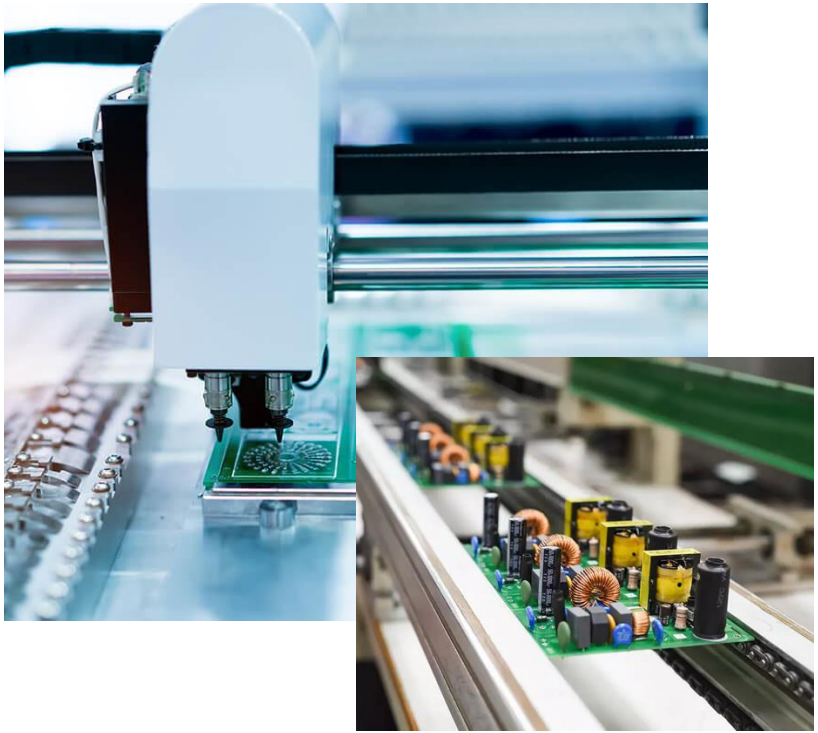
Cadence | Altium | Pads

Covering 100% DFM requirements from contract manufacturers.

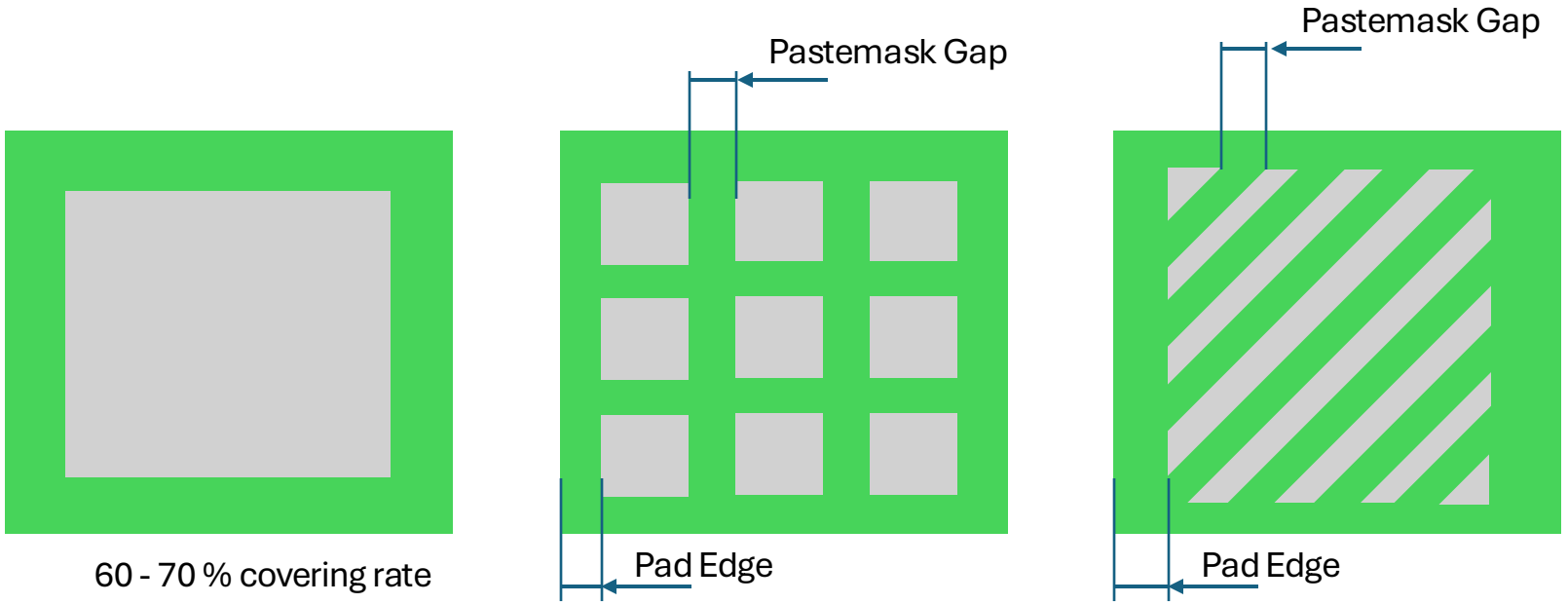
Meeting all requirements from ODM companies.

Impact of DFM Rules on Manufacturability

- Manufacturing condition and capabilities
- Increasing yield and minimize errors
- Engineer’s experience

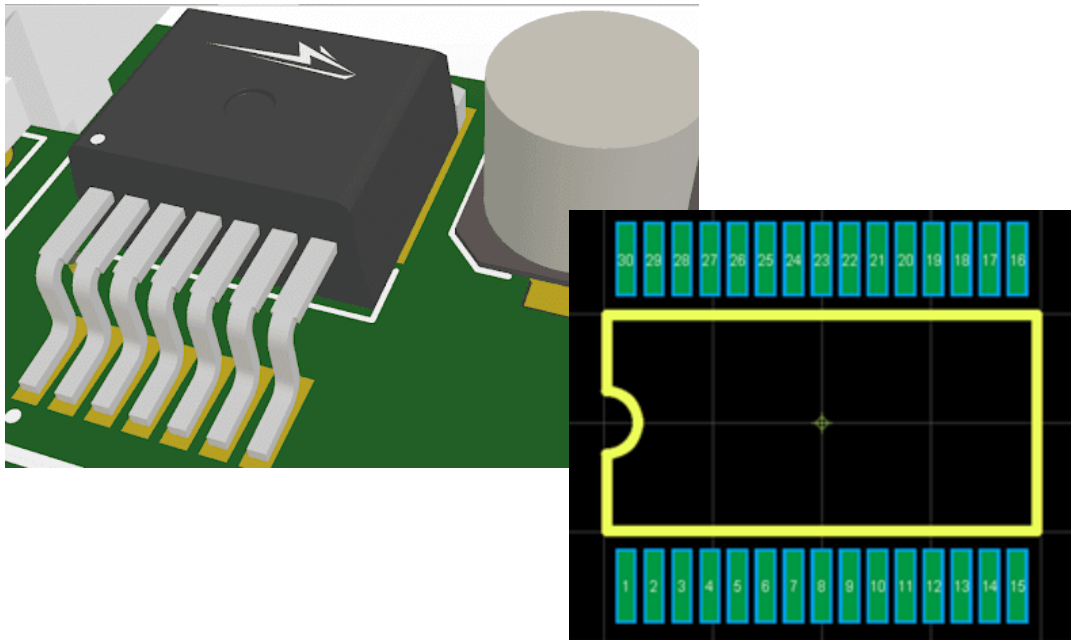


Case 1： Thermal Pad Pastemask Patterns



Case2：Land Pattern Design

- IPC 7351
- Vendor Land Pattern
- Lead types and extensions
- Package types



Case2：Land Pattern Design

IPC 7351

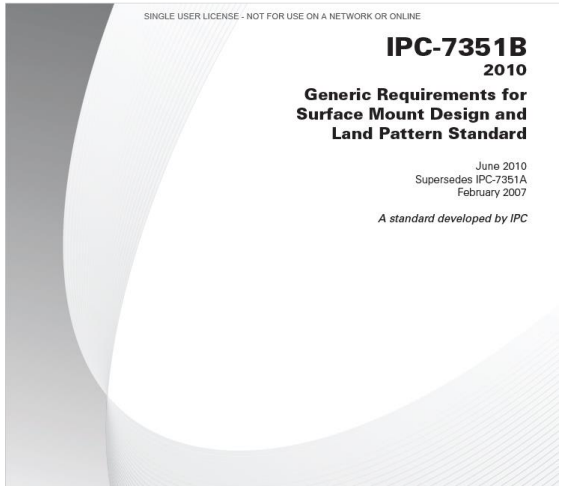


Table 3-23 IPC-7351 Land Pattern Naming Convention

Component, Category	Land Pattern Name
Ball Grid Array's	**BGA** + Pin Qty + **C** or **N** + Pitch **P** + Ball Columns **X** Ball Rows _ Body Length **X** Body Width **X** Height
BGA w/Dual Pitch	**BGA** + Pin Qty + **C** or **N** + Col Pitch **X** Row Pitch **P** + Ball Columns **X** Ball Rows _ Body Length **X** Body Width **X** Height
BGA w/Staggered Pins	**BGAS** + Pin Qty + **C** or **N** + Pitch **P** + Ball Columns **X** Ball Rows _ Body Length **X** Body Width **X** Height
BGA Note: The **C** or **N** = Collapsing or Non-collapsing Balls	
Capacitors, Chip, Array, Concave	**CAPCAV** + Pitch **P** + Body Length **X** Body Width **X** Height - Pin Qty
Capacitors, Chip, Array, Flat	**CAPCAF** + Pitch **P** + Body Length **X** Body Width **X** Height - Pin Qty
Capacitors, Chip, Non-polarized	**CAPC** + Body Length + Body Width **X** Height
Capacitors, Chip, Polarized	**CAPCP** + Body Length + Body Width **X** Height
Capacitors, Chip, Wire Rectangle	**CAPCWR** + Body Length + Body Width **X** Height
Capacitors, Molded, Non-polarized	**CAPM** + Body Length + Body Width **X** Height
Capacitors, Molded, Polarized	**CAPMP** + Body Length + Body Width **X** Height
Capacitors, Aluminum Electrolytic	**CAPAE** + Base Body Size **X** Height
Ceramic Flat Packages	**CFP127P** + Lead Span Nominal **X** Height - Pin Qty
Column Grid Array, Circular Lead	**CGA** + Pin Qty + **C** + Pitch **P** + Pin Columns **X** Pin Rows _ Body Length **X** Body Width **X** Height
Column Grid Array, Square Lead	**CGA** + Pin Qty + **S** + Pitch **P** + Pin Columns **X** Pin Rows _ Body Length **X** Body Width **X** Height
Crystals (2 leads)	**XTAL** + Body Length **X** Body Width **X** Height
Dual Flat No-lead	**DFN** + Body Length **X** Body Width **X** Height – Pin Qty
Diodes, Chip	**DIOC** + Body Length + Body Width **X** Height
Diodes, Molded	**DIOM** + Body Length + Body Width **X** Height
Diodes, MELF	**DIOMELF** + Body Length + Body Diameter
Diodes, Side Concave, 2 Pin	**DIOSC** + Body Length **X** Body Width **X** Height - Pin Qty
Diodes, Side Concave, 4 Pin	**DIOSC** + Pitch **P** + Body Length **X** Body Width **X** Height - Pin Qty
Dual-Inline Package (Butt Mounted)	**DIP** + Pitch **P** + Lead Span Nominal **X** Height – Pin Qty
Fuses, Molded	**FUSM** + Body Length + Body Width **X** Height

3.1.5.6 Padstack Naming Convention The padstack consists of combinations of letters and numbers that represent the shape, or dimensions, of lands on different layers of printed boards or documentation. The name of the padstack needs to represent all the various combinations. These are used in combination with the land pattern conventions defined herein according to the rules established in the IPC-2220 design series.

The first part of the padstack convention consists of a land shape. There are six basic land shape identifiers. See Figure 3-6 for an example of modifications to the land shape.

Note: All alphabetical characters are "lower case". This helps discriminate numeric values.

3.1.5.6.1 Basic Land Shape Letters

c = Circular
s = Square
r = Rectangle
b = Oblong
u = Contour (Irregular Shape)
d = D Shape (Square on one end and Circular on the other end)

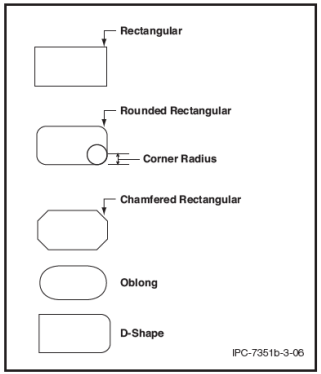
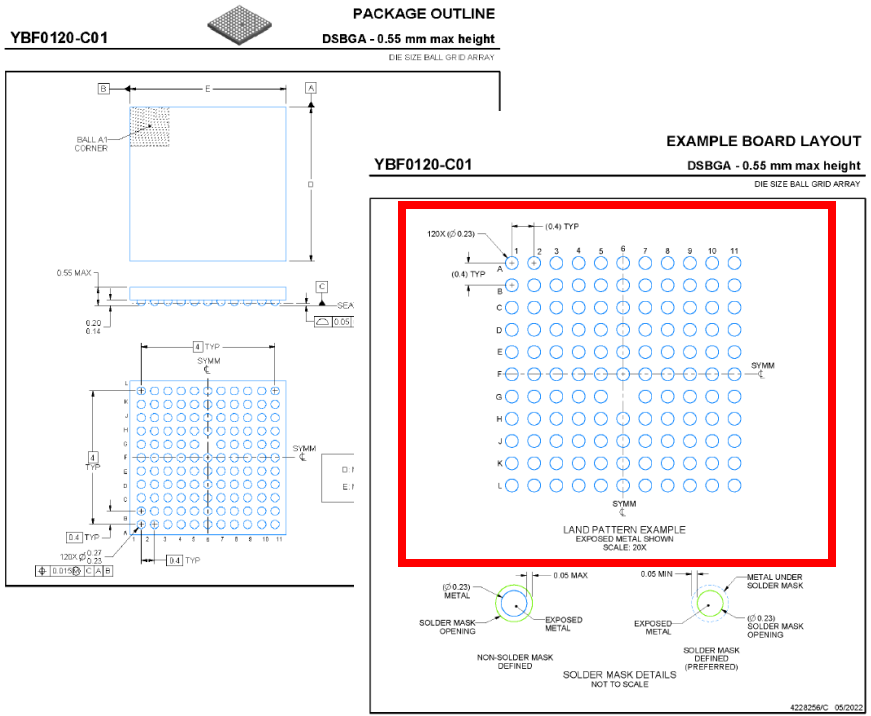
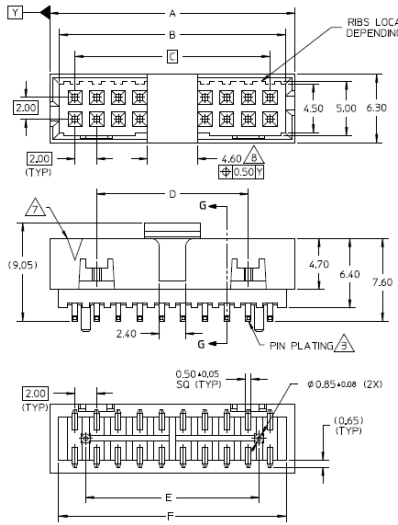


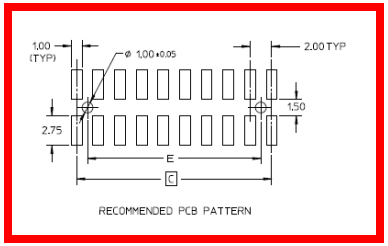
Figure 3-6 Examples of Land Shape Modifiers

Case2：Land Pattern Design

Vendor Land Pattern



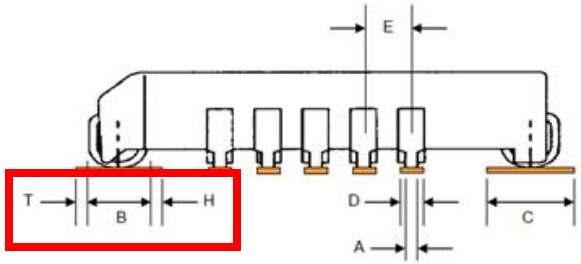




Case2：Land Pattern Design

Toe / Heel Calculation

J-LEAD TERMINATION



Copper Pad

Toe Extension (T) X.XX

Heel Extension (H) X.XX

Copper Pad Length (C) = Component Lead Length (B) + Toe Extension (T) + Heel Extension (H)

Copper Pad Width (D) = MAXIMUM Component Lead Width (A) + X.XX

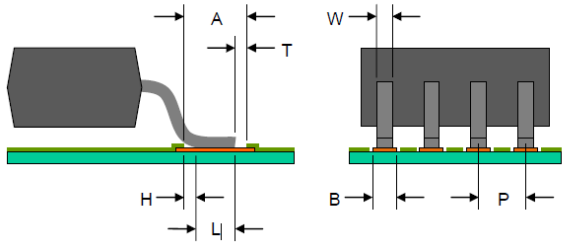
Soldermask Pad

The padstack shall be copper defined.

Pastemask Pad

The pastemask pad shall be 1:1 with copper pad.

GULL WING TERMINATION



Metal (Copper) Pad

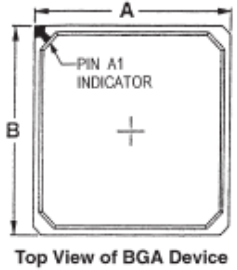
The metal pad width (B) shall be defined per the following table:

Pin Pitch (P)	Toe Extension (T)	Heel Extension (H)	Metal Pad Width (B)
P = 0.50			
0.50 < P <= 0.65			Nominal Lead Width (W) +
0.65 < P <= 0.80			Nominal Lead Width (W) +
0.80 < P <= 1.27			Nominal Lead Width (W) +
1.27 < P <= 1.71			Max. Lead Width (W) +
1.71 < P <= 2.54			Max. Lead Width (W) +
P > 2.54			Max. Lead Width (W) +

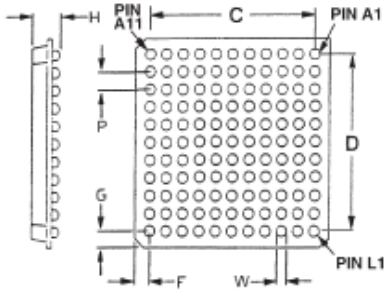
Effective Copper Length (A) = MAXIMUM Lead Length (L) + Toe extension (T) + Heel extension (H)

Case2：Land Pattern Design

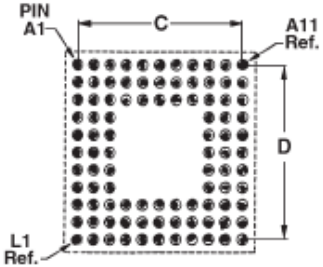
Standard Package



Top View of BGA Device



Bottom (contact side) View

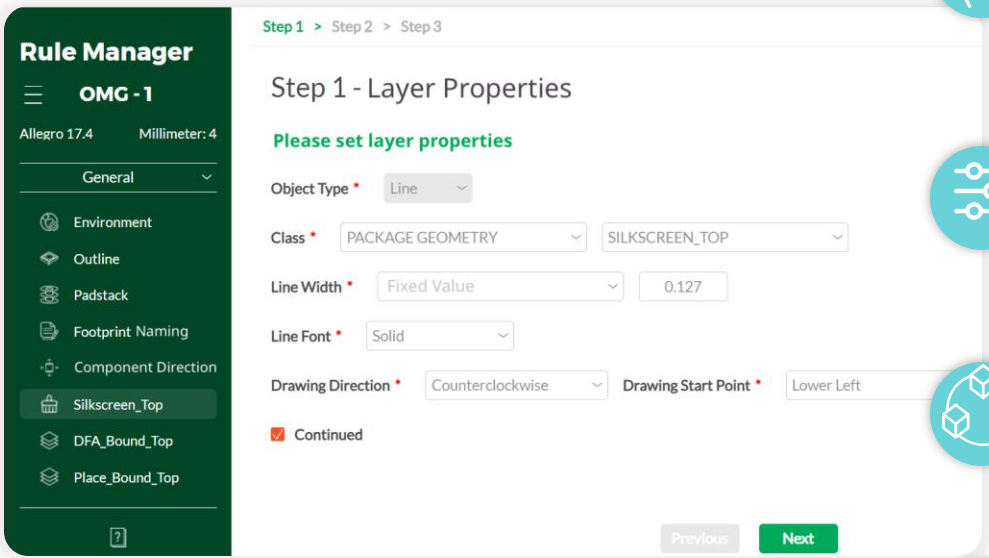


Land Pattern
(viewed on host substrate)

Land Approximation (mm) for Collapsible Solder Balls

Nominal Ball Diameter	Reduction	Nominal Land Diameter	Land Variation
0.75	25%	0.55	0.60 - 0.50
0.65	25%	0.50	0.55 -0.45
0.60	25%	0.45	0.50 - 0.40
0.55	25%	0.40	0.50 - 0.40
0.50	20%	0.40	0.45 - 0.35
0.45	20%	0.35	0.40 - 0.30
0.40	20%	0.30	0.35 - 0.25
0.35	20%	0.28	0.33 -0.23
0.30	20%	0.25	0.25 - 0.20
0.25	20%	0.20	0.20 - 0.17
0.20	15%	0.17	0.20 - 0.14
0.17	15%	0.15	0.18 - 0.12
0.15	15%	0.13	0.15 - 0.10

Developing a DFM-Aware Library



Digitalization

A digital DFM knowledge base linked to library creation process

Customization

Allow users to customize their DFM standards.

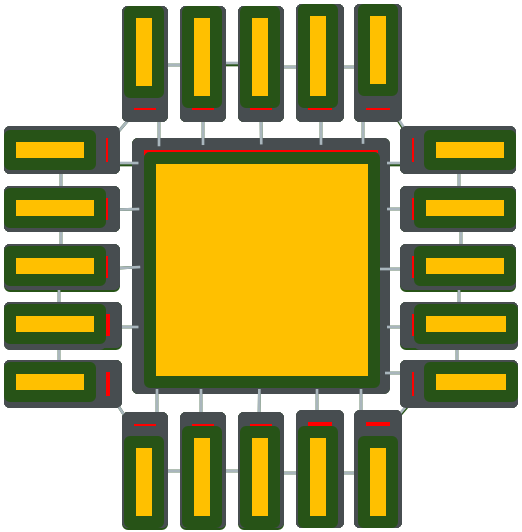
Transferability

Easy to share and transfer the experience.

Management

Trackable tolerance modifications to meet Design consistency.

Programable DFM – Automatically Embedding DFM rules during Library Creation



Rule Manager

Verify Condition +

Regular Pad Begin Layer	>=	8 mil
Regular Pad Soldermask Top	>=	4 mil

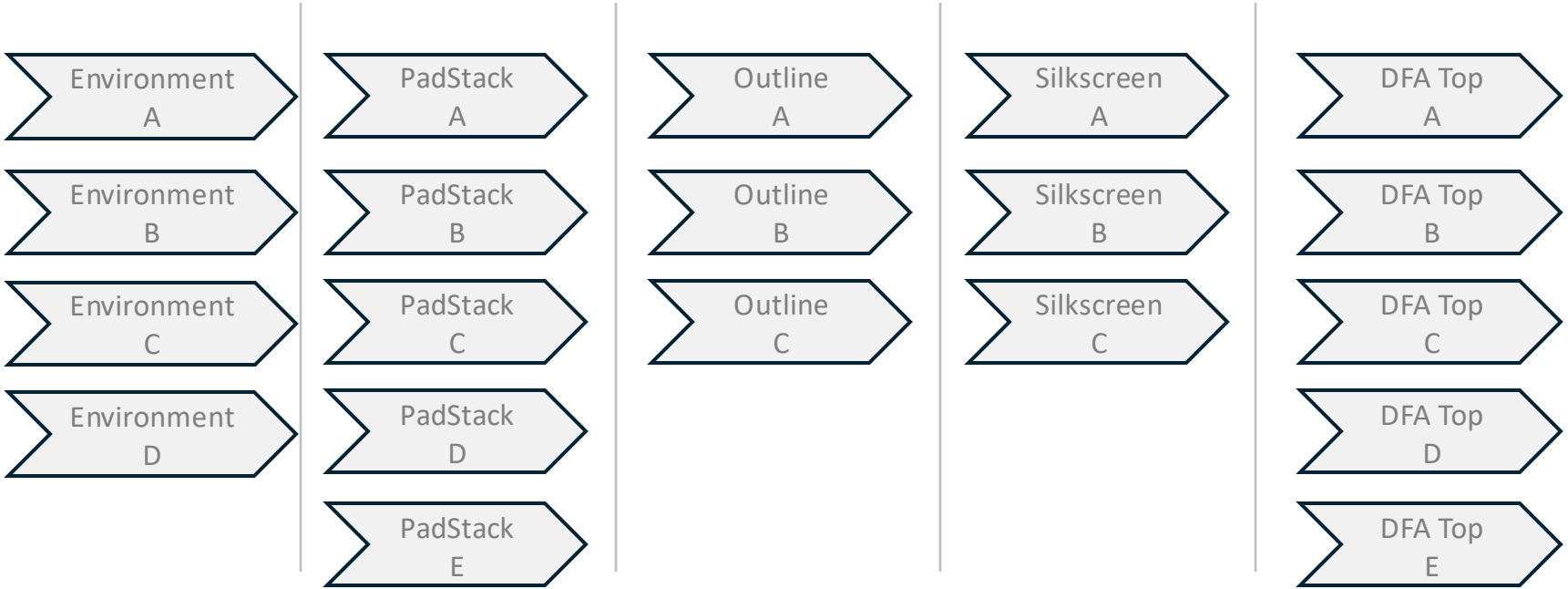
Pad minimum size

Lead Size (Avg.)

Priority

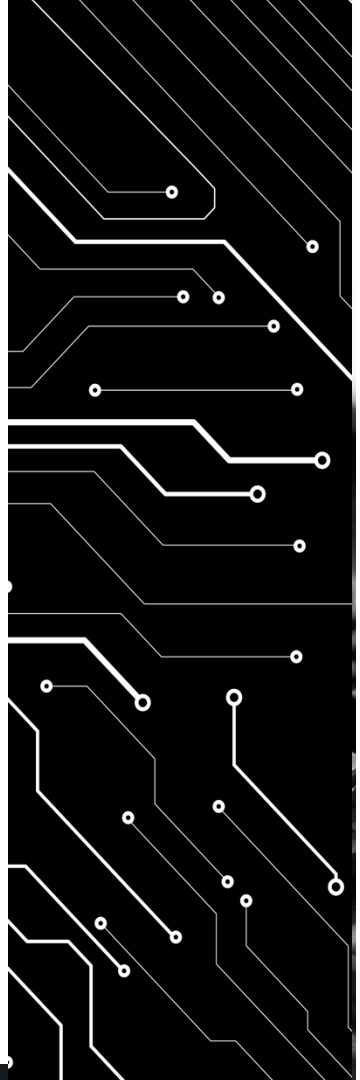
- Adjusting Epad using Avg.
- Reducing Signal Pin Heel by 1mil until it meets the requirements
- Reducing Signal pin Width by 1mil until it meets the requirements
- Reducing corner Signal pin Heel by 1mil until it meets the requirements

Modularized DFM Knowledge




RM
Rule Manager
Automated DFM Rules Management and Implementation Tool
footprintku AI

HOW DOES VLS WORK?



CUSTOM DASHBOARD

VLS provides a unique, custom dashboard for designers. Each user has a unique login to access both a personal and company-wide parts library.

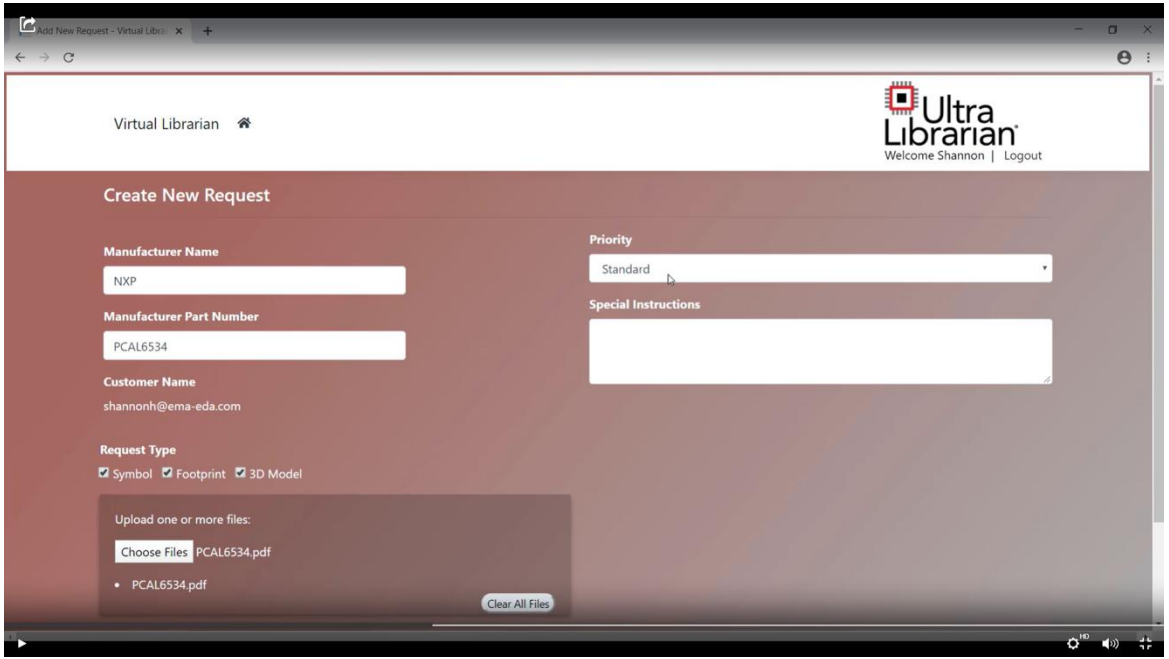
REQUEST PARTS

All requested parts are created to match your internal standards and requirements. Just provide the datasheets, drawings, or specs and any special requests for your part and we handle the rest.

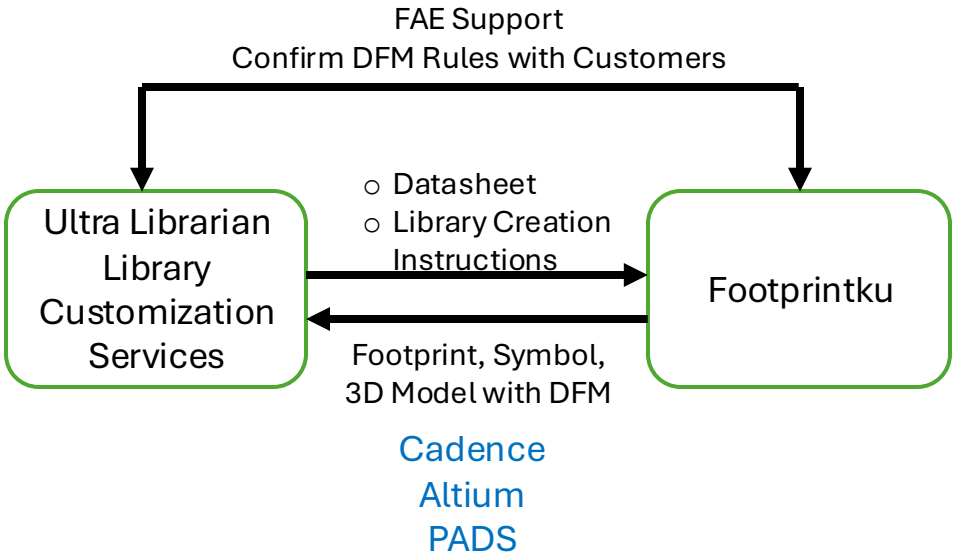
TURN AROUND TIME

All parts are created within two business days, and an email will be sent to alert the requester when it's

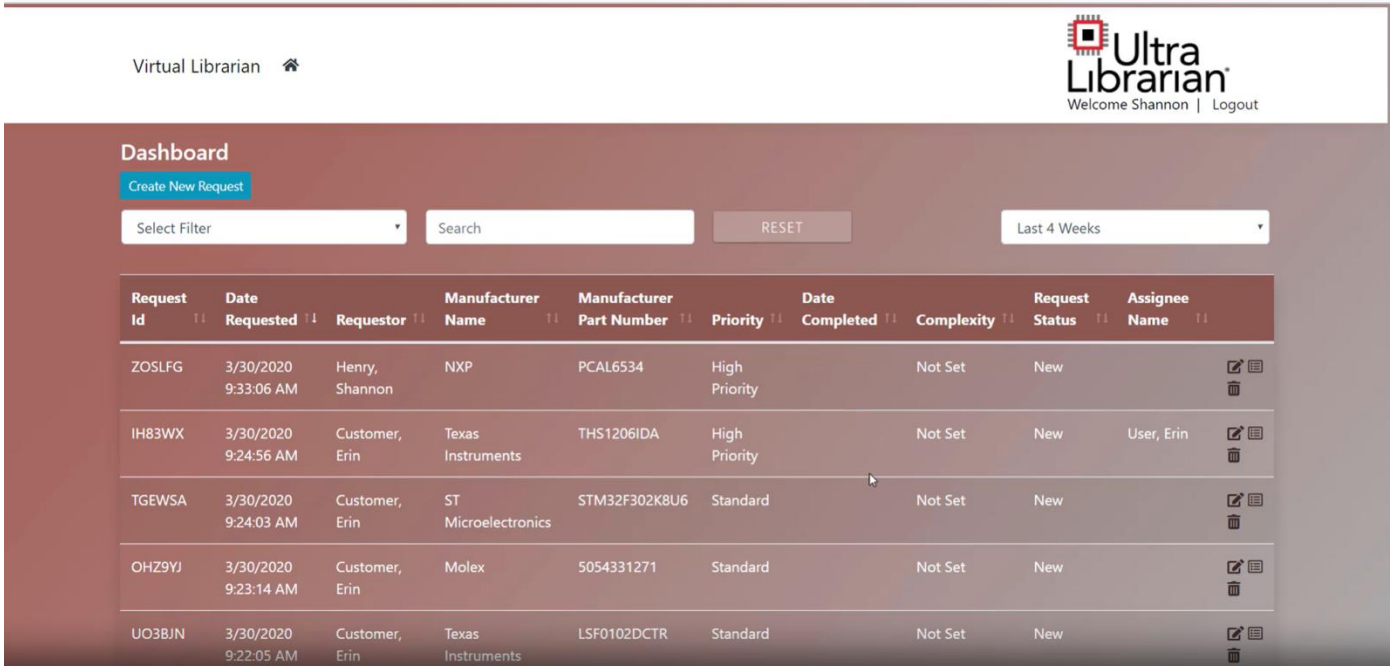
PARTS BUILT TO YOUR STANDARDS, ON YOUR TIMELINE



INTERNAL WORKFLOW

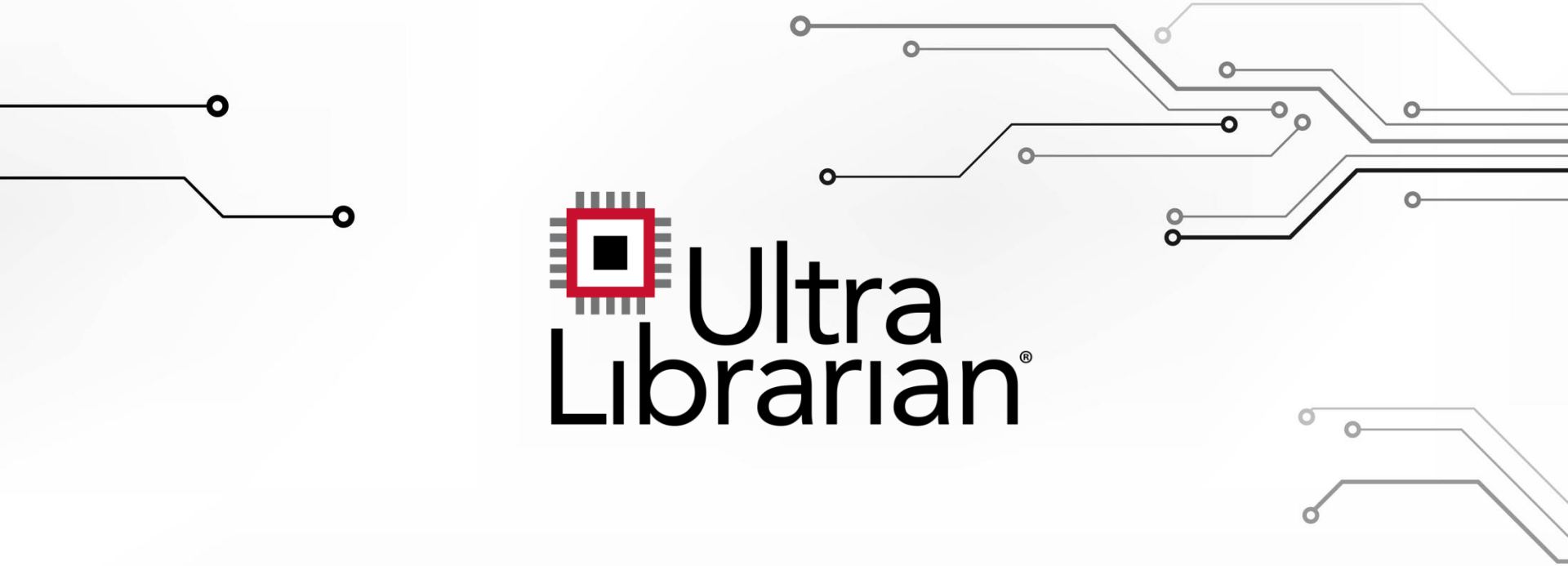


PARTS BUILT TO YOUR STANDARDS, ON YOUR TIMELINE



Librarian Service Onboarding

- Establish Symbol creation guidelines
- Agree on turn around time, Prioritization
- Setup part request and fulfillment process,
  - Virtual Librarian Service Portal (Recommended)
  - Email alias and file transfer area
- Monthly checkpoint
  - Dashboard review
  - Invoicing approval



Julie Liu, Sanjay Keswani