Prototyping with Surface Mount Technology

Take your Design to the Market

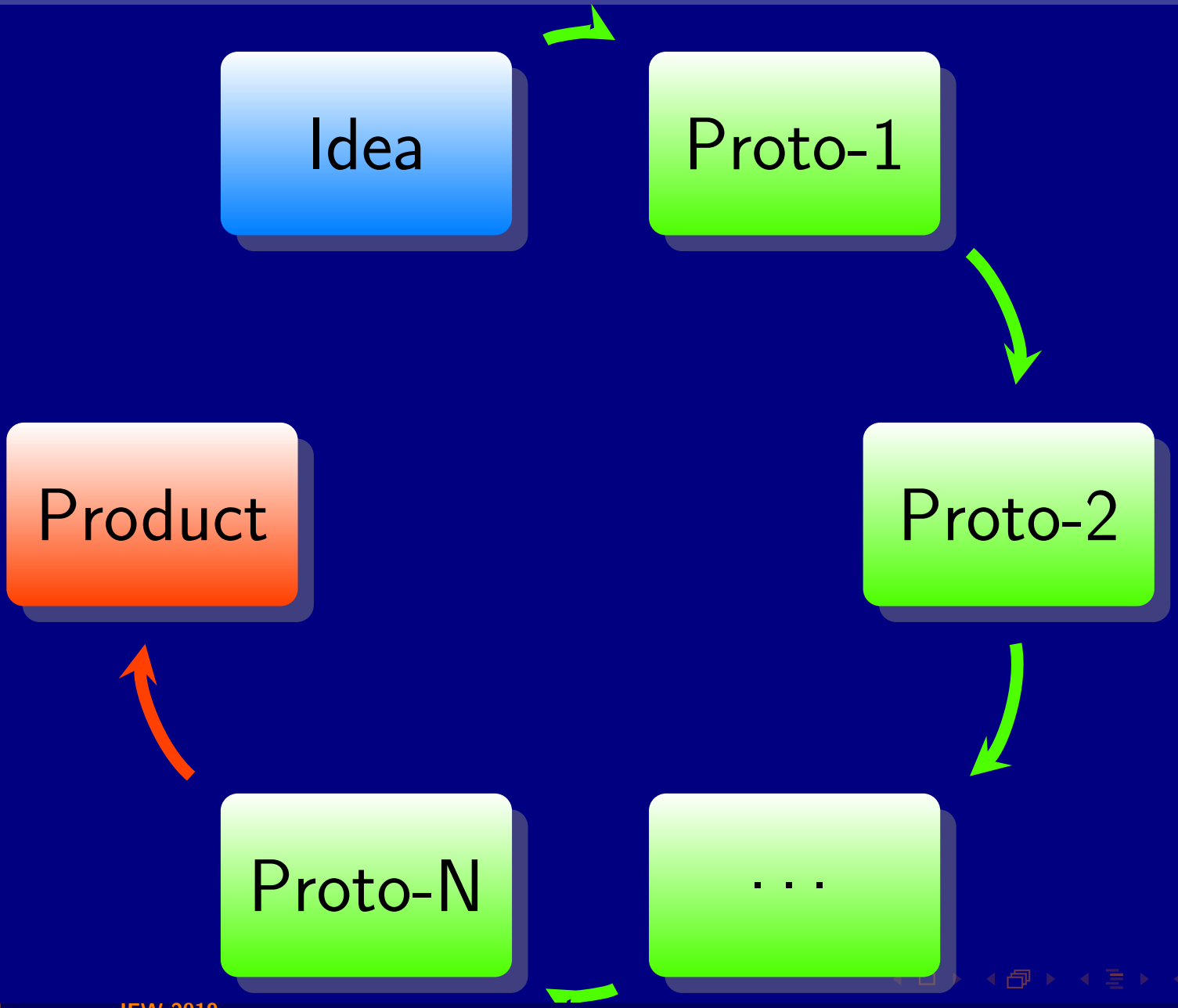
Well before Sunset

Ajith Narayanan

Zoid Labs

28 Feb 2019

From Idea to Product



Context:

- Limited Resources
- Budgetary constraints
- Desire to in-source
  - e.g to protect IP
  - e.g to build technology base
- Non-trivial level of complexity
- Time to Market

Overview

Overview

Overview

Overview

Overview

Overview

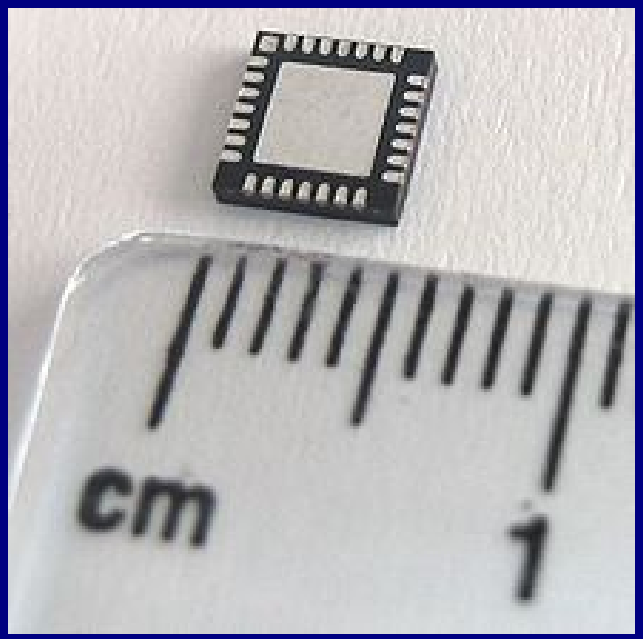
Overview

1. Introduction
2. Prototyping – Strategies, Activities, Bottlenecks
3. SMT PCB Assembly process & Tips
4. Challenges in prototyping with SMT
5. Reducing cycle time with in-house assembly
6. Streamlining with DFP (Design for Prototyping)
7. Equipment and Process
8. Conclusion

Overview

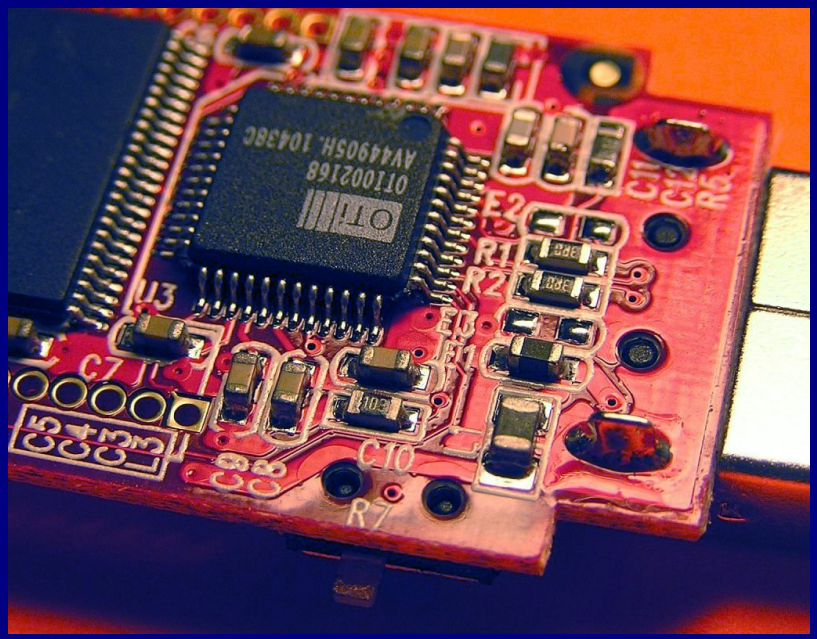
1. Introduction
2. Prototyping – Strategies, Activities, Bottlenecks
3. SMT PCB Assembly process & Tips
4. Challenges in prototyping with SMT
5. Reducing cycle time with in-house assembly
6. Streamlining with DFP (Design for Prototyping)
7. Equipment and Process
8. Conclusion

SMT chip



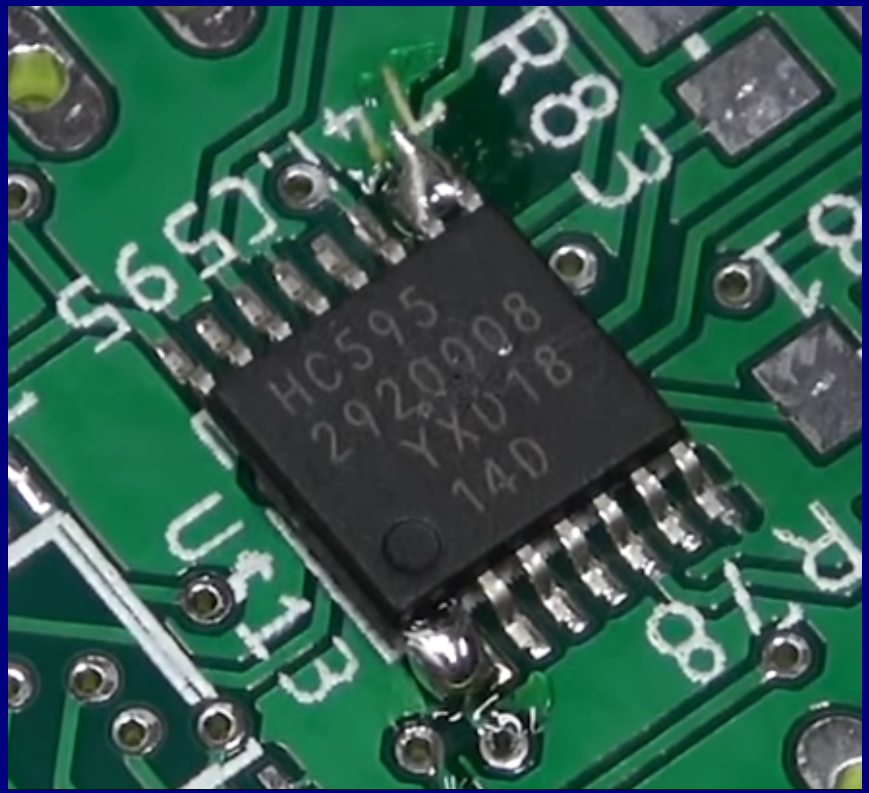
Introduction: SMT Basics

SMT board

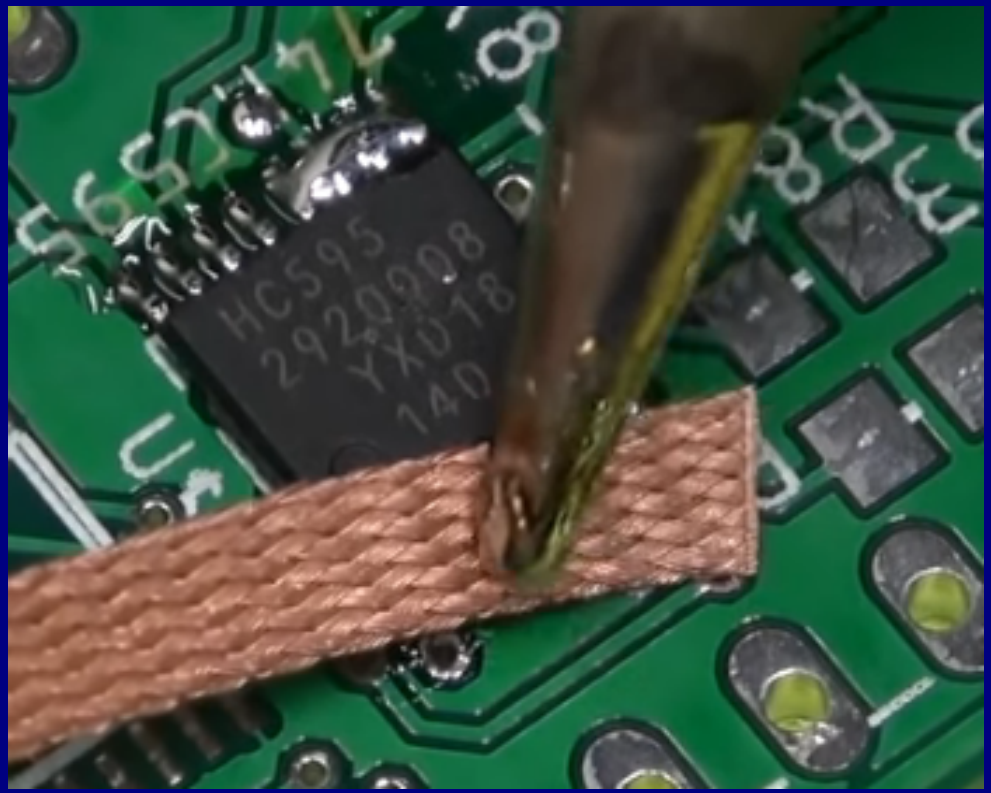


Introduction: SMT Basics

SMT
Mayhem

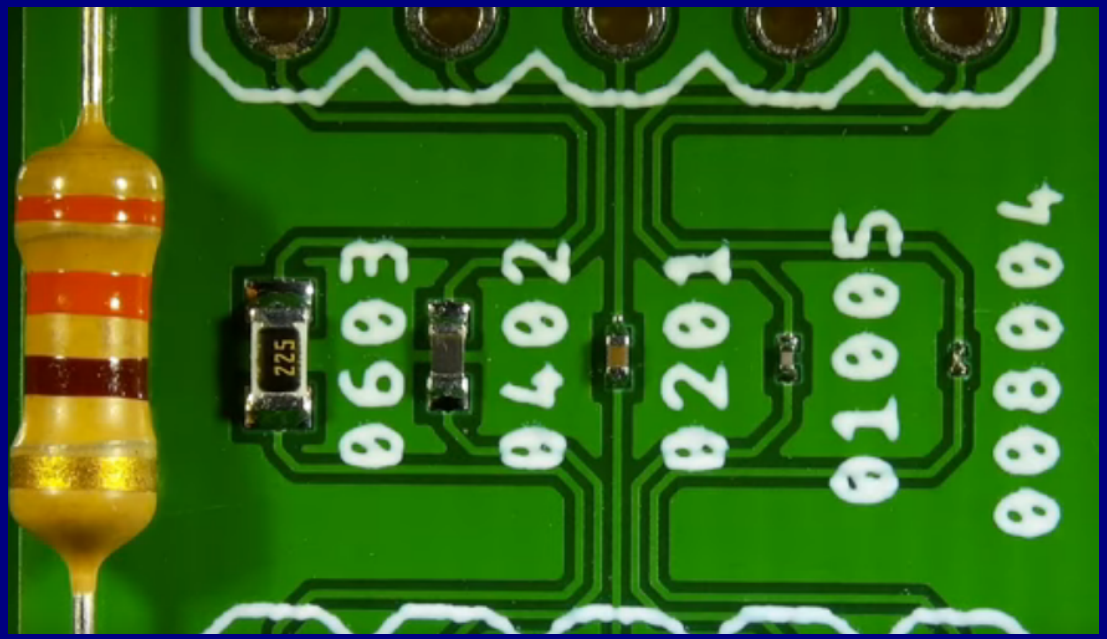


More
Mayhem



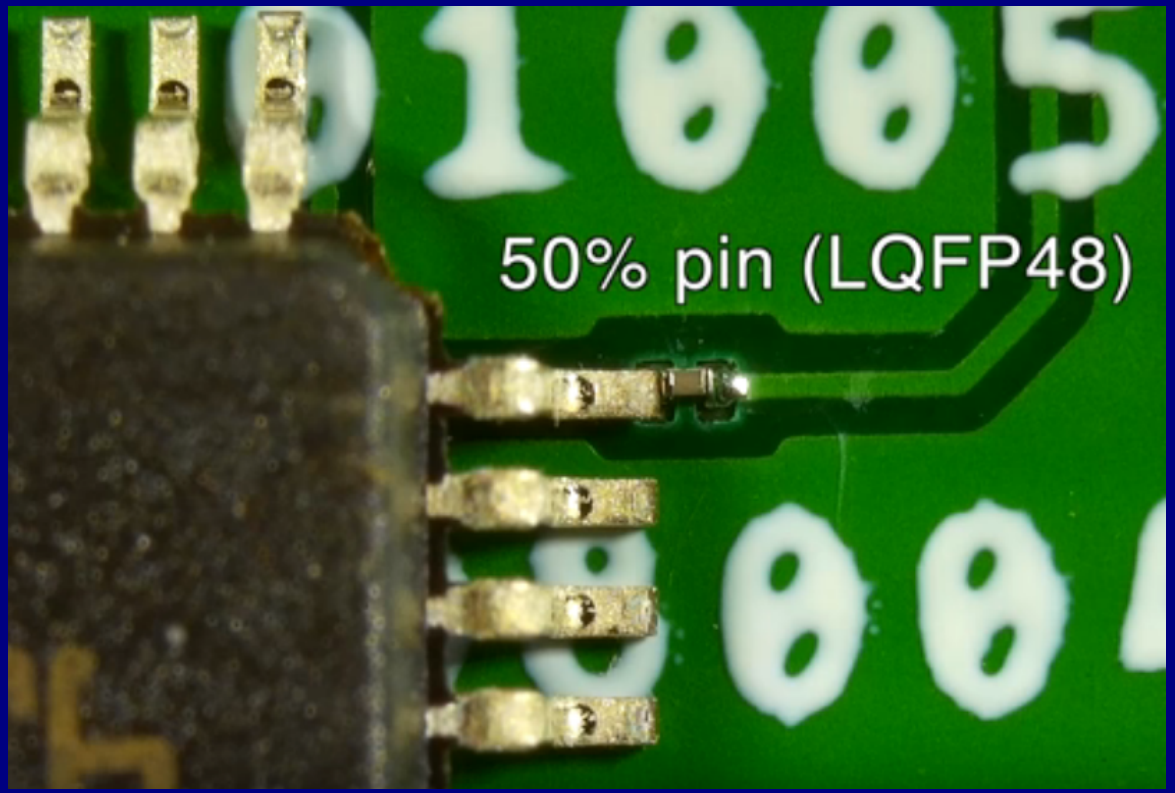
Introduction: SMT Basics

0201=
0.6 x
0.3
mm,
20 x
10
mil,
0.02 x
0.01”



Introduction: SMT Basics

008004
8x4
mil
=
0.2 x
0.1
mm



Prototyping: Strategies, Activities, Bottlenecks

Prototyping Strategies

- Divide and Conquer approach
  - E.g. Build and test a sub-circuit
  - More common towards early stages of prototyping
  - Partial assembly $\rightarrow$ Full assembly
- Big Bang approach

  Build and test completely assembled PCB
  Typically for product-intent PCBs
  More common towards later stages of prototyping

Prototyping Strategies

- Divide and Conquer approach
  - E.g. Build and test a sub-circuit
  - More common towards early stages of prototyping
  - Partial assembly $\rightarrow$ Full assembly
- Big Bang approach

  Build and test completely assembled PCB
  Typically for product-intent PCBs
  More common towards later stages of prototyping

Prototyping Strategies

- Divide and Conquer approach
  - E.g. Build and test a sub-circuit
  - More common towards early stages of prototyping
  - Partial assembly $\rightarrow$ Full assembly
- Big Bang approach

  Build and test completely assembled PCB
  Typically for product-intent PCBs
  More common towards later stages of prototyping

Prototyping Strategies

- Divide and Conquer approach
  - E.g. Build and test a sub-circuit
  - More common towards early stages of prototyping
  - Partial assembly $\rightarrow$ Full assembly
- Big Bang approach

  Build and test completely assembled PCB
  Typically for product-intent PCBs
  More common towards later stages of prototyping

Prototyping Strategies

- Divide and Conquer approach
  - E.g. Build and test a sub-circuit
  - More common towards early stages of prototyping
  - Partial assembly $\rightarrow$ Full assembly
- Big Bang approach
  - Build and test completely assembled PCB
  - Typically for product-intent PCBs
  - More common towards later stages of prototyping

Prototyping Strategies

- Divide and Conquer approach
  - E.g. Build and test a sub-circuit
  - More common towards early stages of prototyping
  - Partial assembly $\rightarrow$ Full assembly
- Big Bang approach
  - Build and test completely assembled PCB
  - Typically for product-intent PCBs
  - More common towards later stages of prototyping

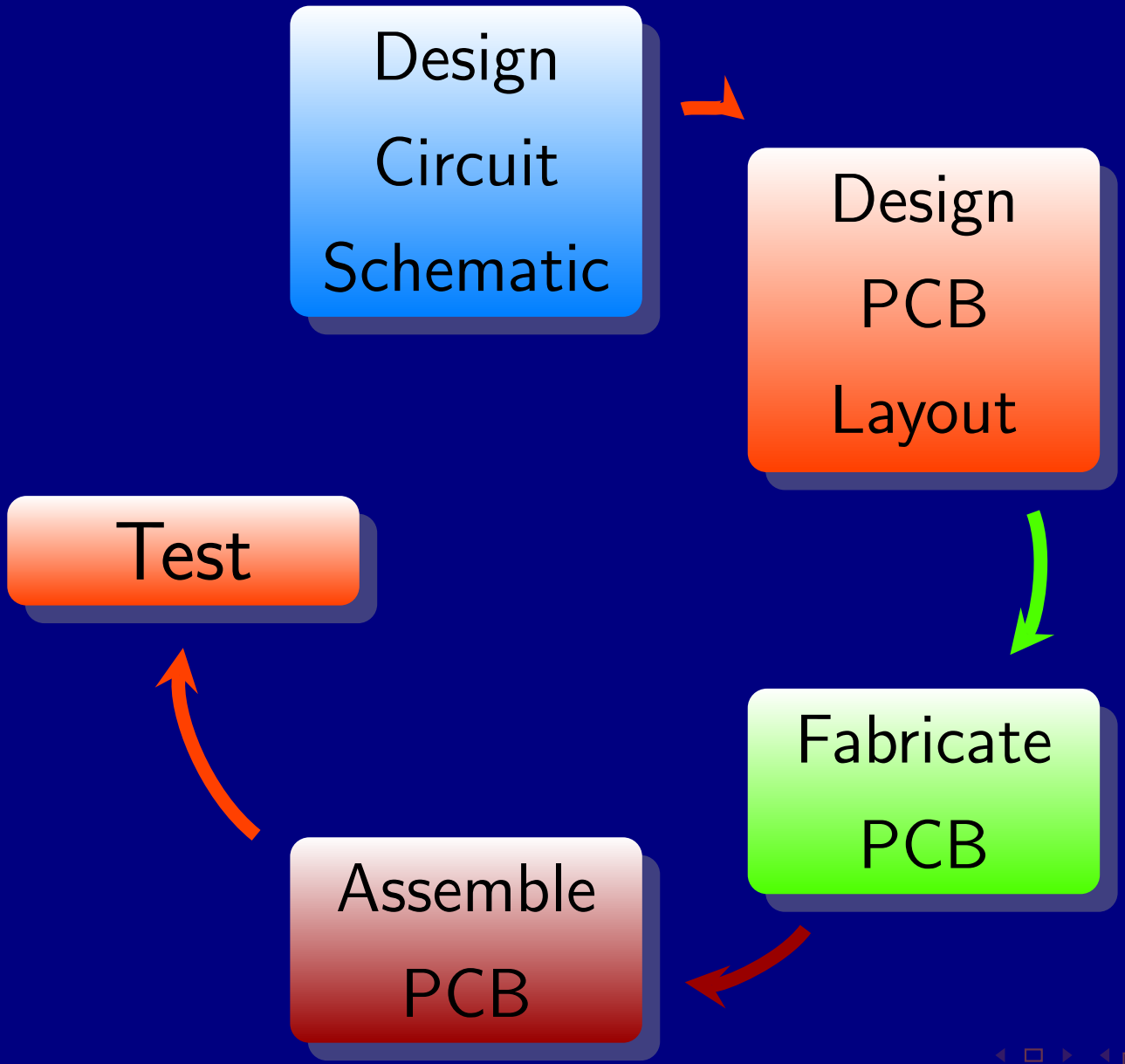
Prototyping Strategies

- Divide and Conquer approach
  - E.g. Build and test a sub-circuit
  - More common towards early stages of prototyping
  - Partial assembly $\rightarrow$ Full assembly
- Big Bang approach
  - Build and test completely assembled PCB
  - Typically for product-intent PCBs
  - More common towards later stages of prototyping

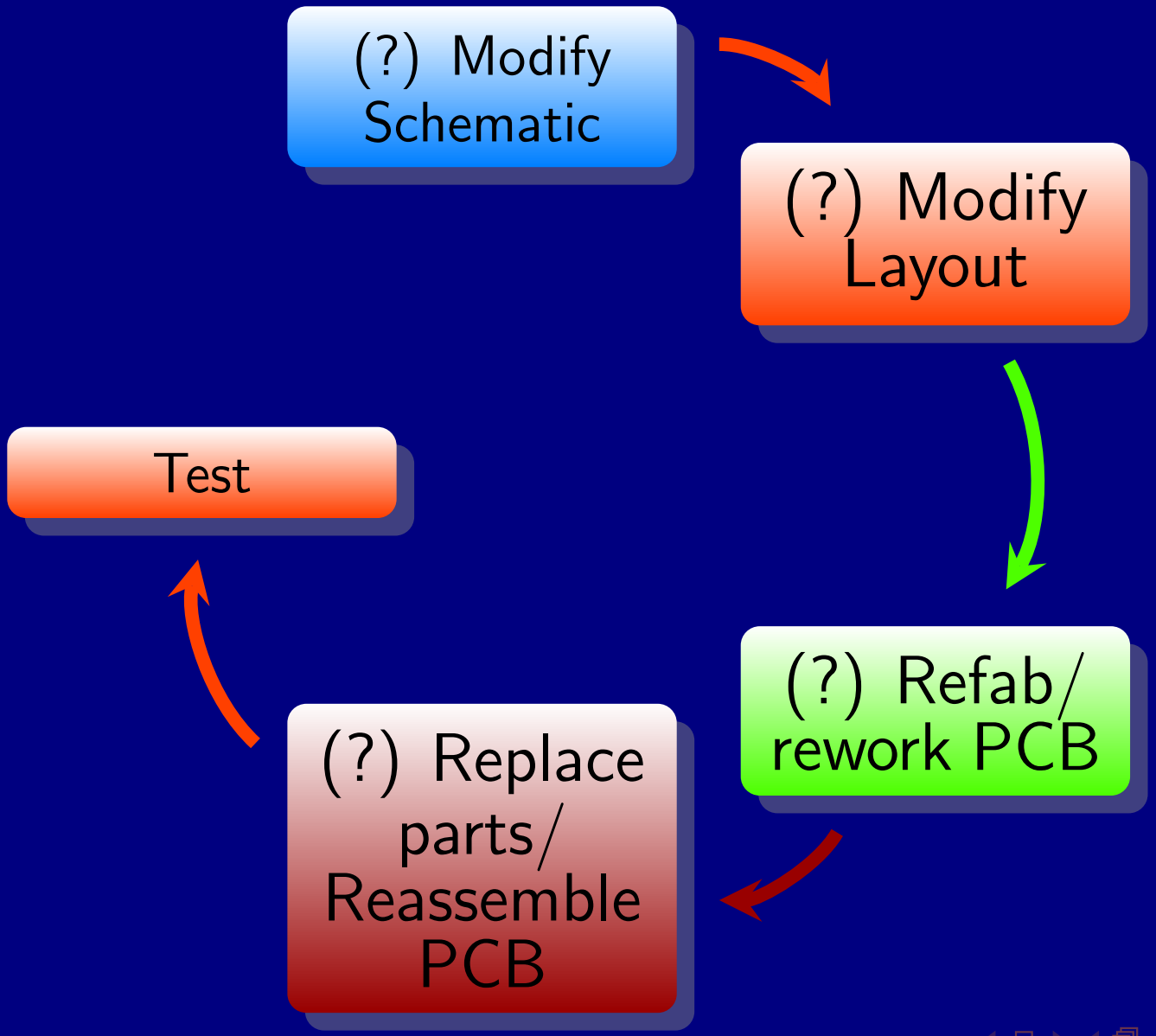
Prototyping Strategies

- Divide and Conquer approach
  - E.g. Build and test a sub-circuit
  - More common towards early stages of prototyping
  - Partial assembly $\rightarrow$ Full assembly
- Big Bang approach
  - Build and test completely assembled PCB
  - Typically for product-intent PCBs
  - More common towards later stages of prototyping

Activities in Prototyping



Activities (in successive steps)



Iterative process

- Say 5 iterations
- If a typ. iteration takes 1 day $\Rightarrow$ 5 days
- If it takes 4 weeks $\Rightarrow$ 5 months!
- $\Rightarrow$ Critical to have fast turn-around
- $\Rightarrow$ Cycle time can make it or break it!

Iterative process

- Say 5 iterations
- If a typ. iteration takes 1 day $\Rightarrow$ 5 days
- If it takes 4 weeks $\Rightarrow$ 5 months!
- $\Rightarrow$ Critical to have fast turn-around
- $\Rightarrow$ Cycle time can make it or break it!

Iterative process

- Say 5 iterations
- If a typ. iteration takes 1 day $\Rightarrow$ 5 days
- If it takes 4 weeks $\Rightarrow$ 5 months!
- $\Rightarrow$ Critical to have fast turn-around
- $\Rightarrow$ Cycle time can make it or break it!

Iterative process

- Say 5 iterations
- If a typ. iteration takes 1 day $\Rightarrow$ 5 days
- If it takes 4 weeks $\Rightarrow$ 5 months!
- $\Rightarrow$ Critical to have fast turn-around
- $\Rightarrow$ Cycle time can make it or break it!

Iterative process

- Say 5 iterations
- If a typ. iteration takes 1 day $\Rightarrow$ 5 days
- If it takes 4 weeks $\Rightarrow$ 5 months!
- $\Rightarrow$ Critical to have fast turn-around
- $\Rightarrow$ Cycle time can make it or break it!

Bottlenecks

- Modify schematic design 🕒
- Modify the PCB Layout 🕒
- Re-fab PCB 🕒🕒
- Rework (modify/hack) PCB 🕒
- Replace part(s) 🕒... 🕒🕒
- Assemble new PCB 🕒... 🕒🕒
- Test 🕒

Bottlenecks

- Modify schematic design
- Modify the PCB Layout
- Re-fab PCB
- Rework (modify/hack) PCB
- Replace part(s) . . .
- Assemble new PCB . . .
- Test

Bottlenecks

- Modify schematic design
- Modify the PCB Layout
- Re-fab PCB
- Rework (modify/hack) PCB
- Replace part(s) . . .
- Assemble new PCB . . .
- Test

Bottlenecks

- Modify schematic design
- Modify the PCB Layout
- Re-fab PCB
- Rework (modify/hack) PCB
- Replace part(s) . . .
- Assemble new PCB . . .
- Test

Bottlenecks

- Modify schematic design
- Modify the PCB Layout
- Re-fab PCB
- Rework (modify/hack) PCB
- Replace part(s) . . .
- Assemble new PCB . . .
- Test

Bottlenecks

- Modify schematic design
- Modify the PCB Layout
- Re-fab PCB
- Rework (modify/hack) PCB
- Replace part(s)
- Assemble new PCB
- Test

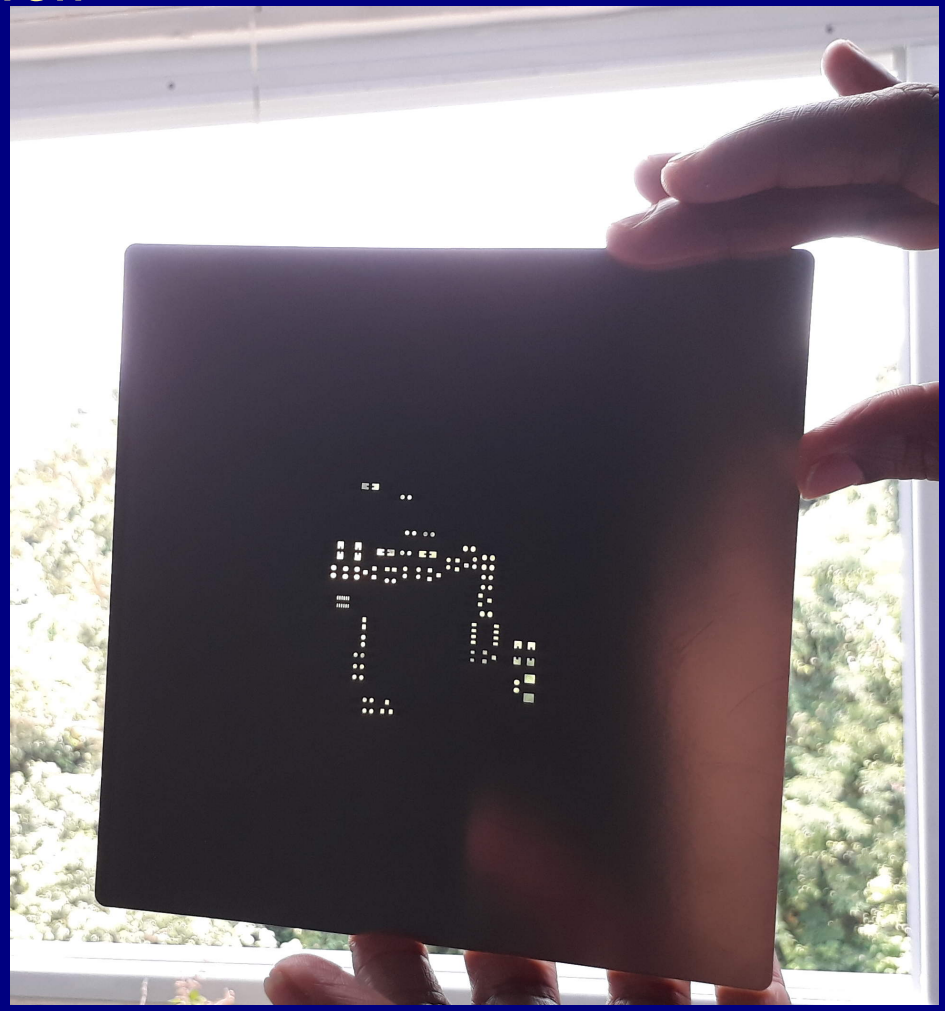
Bottlenecks

- Modify schematic design 🕒
- Modify the PCB Layout 🕒
- Re-fab PCB 🕒🕒
- Rework (modify/hack) PCB 🕒
- Replace part(s) 🕒... 🕒🕒
- Assemble new PCB 🕒... 🕒🕒
- Test 🕒

SMT Assembly Process & Process Tips

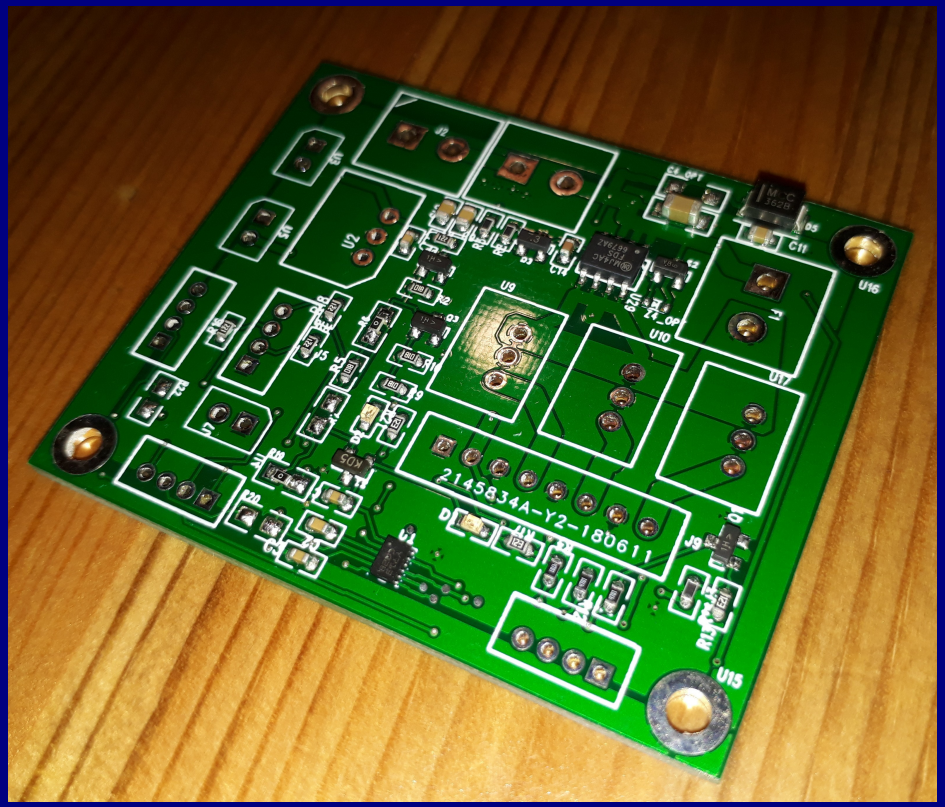
SMT PCB Assembly – PCBs, Stencils

Unframed or "cut" stencil



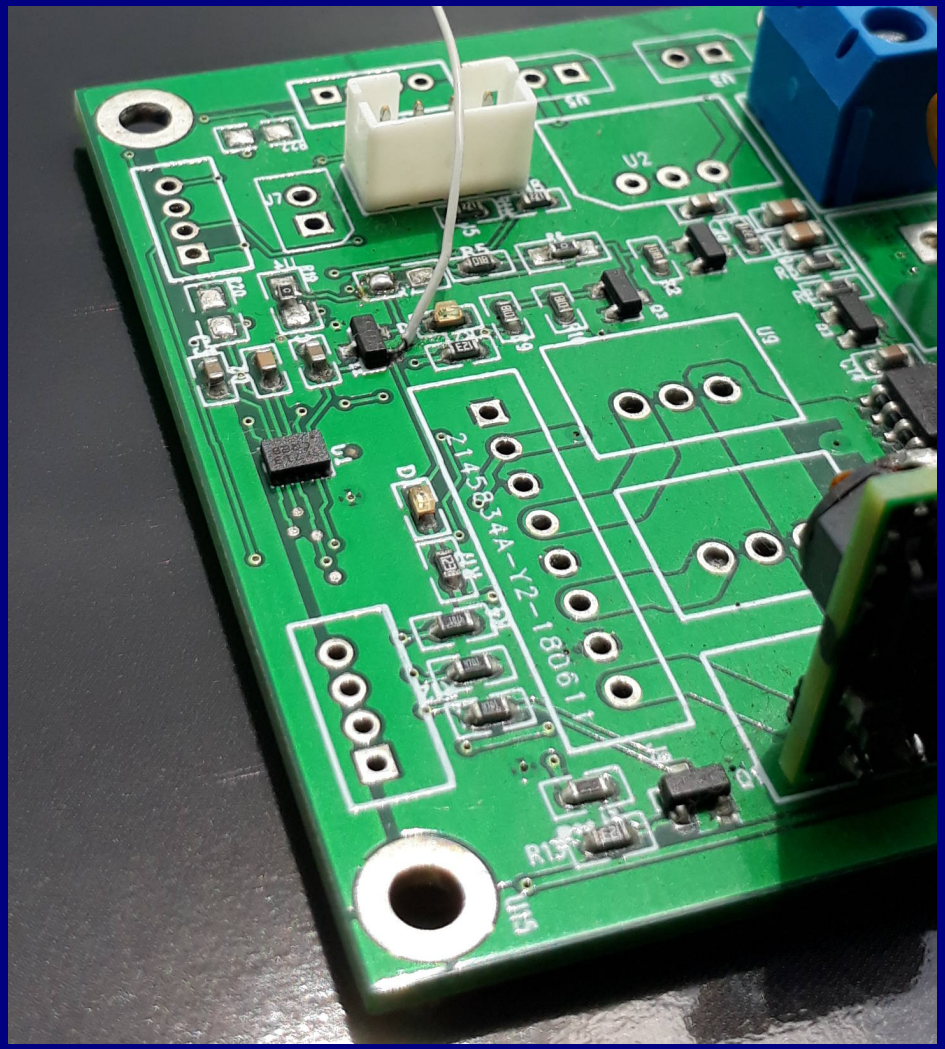
SMT PCB Assembly – PCBs, Stencils

PCB after placing and reflow



SMT PCB Assembly – PCBs, Stencils

Assembled PCB, with minor rework



SMT PCB Assembly Process (1/3)

PCB, Stencil, Paste . . . Action!

- Lay the PCB right side up, for stencilling
- Overlay with stencil, adjust until registration is good
- Apply solder paste, squeegee through
- Examine solder paste coverage
- Remove stencil without smudging

SMT PCB Assembly Process (1/3)

PCB, Stencil, Paste . . . Action!

- Lay the PCB right side up, for stencilling
- Overlay with stencil, adjust until registration is good
- Apply solder paste, squeegee through
- Examine solder paste coverage
- Remove stencil without smudging

SMT PCB Assembly Process (1/3)

PCB, Stencil, Paste . . . Action!

- Lay the PCB right side up, for stencilling
- Overlay with stencil, adjust until registration is good
- Apply solder paste, squeegee through
- Examine solder paste coverage
- Remove stencil without smudging

SMT PCB Assembly Process (1/3)

PCB, Stencil, Paste . . . Action!

- Lay the PCB right side up, for stencilling
- Overlay with stencil, adjust until registration is good
- Apply solder paste, squeegee through
- Examine solder paste coverage
- Remove stencil without smudging

SMT PCB Assembly Process (1/3)

PCB, Stencil, Paste . . . Action!

- Lay the PCB right side up, for stencilling
- Overlay with stencil, adjust until registration is good
- Apply solder paste, squeegee through
- Examine solder paste coverage
- Remove stencil without smudging

SMT PCB Assembly Process (2/3)

On their pads, get set... Go!

- Pick and place components on wet PCB
  - Ensure parts are correct
  - Ensure polarity/orientation
  - Don't let solder paste dry up
  - If doing manually with tweezers, don't let parts fly!
- Put loaded PCB into oven

  Run appropriate cooking profile
- Remove, Inspect, Re-heat if necessary

SMT PCB Assembly Process (2/3)

On their pads, get set... Go!

- Pick and place components on wet PCB
  - Ensure parts are correct
  - Ensure polarity/orientation
  - Don't let solder paste dry up
  - If doing manually with tweezers, don't let parts fly!
- Put loaded PCB into oven

  Run appropriate cooking profile
- Remove, Inspect, Re-heat if necessary

SMT PCB Assembly Process (2/3)

On their pads, get set... Go!

- Pick and place components on wet PCB
  - Ensure parts are correct
  - Ensure polarity/orientation
  - Don't let solder paste dry up
  - If doing manually with tweezers, don't let parts fly!
- Put loaded PCB into oven
  Run appropriate cooking profile
- Remove, Inspect, Re-heat if necessary

SMT PCB Assembly Process (2/3)

On their pads, get set... Go!

- Pick and place components on wet PCB
  - Ensure parts are correct
  - Ensure polarity/orientation
  - Don't let solder paste dry up
  - If doing manually with tweezers, don't let parts fly!
- Put loaded PCB into oven
  Run appropriate cooking profile
- Remove, Inspect, Re-heat if necessary

SMT PCB Assembly Process (2/3)

On their pads, get set... Go!

- Pick and place components on wet PCB
  - Ensure parts are correct
  - Ensure polarity/orientation
  - Don't let solder paste dry up
  - If doing manually with tweezers, don't let parts fly!
- Put loaded PCB into oven

  Run appropriate cooking profile
- Remove, Inspect, Re-heat if necessary

SMT PCB Assembly Process (2/3)

On their pads, get set... Go!

- Pick and place components on wet PCB
  - Ensure parts are correct
  - Ensure polarity/orientation
  - Don't let solder paste dry up
  - If doing manually with tweezers, don't let parts fly!
- Put loaded PCB into oven
  Run appropriate cooking profile
- Remove, Inspect, Re-heat if necessary

SMT PCB Assembly Process (2/3)

On their pads, get set... Go!

- Pick and place components on wet PCB
  - Ensure parts are correct
  - Ensure polarity/orientation
  - Don't let solder paste dry up
  - If doing manually with tweezers, don't let parts fly!
- Put loaded PCB into oven

  Run appropriate cooking profile
- Remove, Inspect, Re-heat if necessary

SMT PCB Assembly Process (3/3)

Finishing up!

- Brush & clean with Iso-Propyl Alcohol (IPA)
- Test for power shorts
- . . . Go on to power up test

SMT PCB Assembly Process (3/3)

Finishing up!

- Brush & clean with Iso-Propyl Alcohol (IPA)
- Test for power shorts
- . . . Go on to power up test

SMT PCB Assembly Process (3/3)

Finishing up!

- Brush & clean with Iso-Propyl Alcohol (IPA)
- Test for power shorts
- . . . Go on to power up test

PCB & Stencil Fabrication

- Usually outsourcing is good.
  - \$ and 🕒 encourage outsourcing
  - Standard materials and spec, specialized job, chemical hazards, equipment/skills.
- But inspect results carefully.
- "100% tested" may not be so! ☹
- "Cut stencils" are cheap and good ✓

PCB & Stencil Fabrication

- Usually outsourcing is good.
  - \$ and 🕒 encourage outsourcing
  - Standard materials and spec, specialized job, chemical hazards, equipment/skills.
- But inspect results carefully.
- "100% tested" may not be so! ☹
- "Cut stencils" are cheap and good ✓

PCB & Stencil Fabrication

- Usually outsourcing is good.
  - \$ and 🕒 encourage outsourcing
  - Standard materials and spec, specialized job, chemical hazards, equipment/skills.
- But inspect results carefully.
- "100% tested" may not be so! ☹
- "Cut stencils" are cheap and good ✓

PCB & Stencil Fabrication

- Usually outsourcing is good.
  - \$ and 🕒 encourage outsourcing
  - Standard materials and spec, specialized job, chemical hazards, equipment/skills.
- But inspect results carefully.
- "100% tested" may not be so! ☹
- "Cut stencils" are cheap and good ✓

Pasta!

- Use good "Lead Free" paste.
  Right Type (grain size - e.g. Type 3, Type 4)
- Store paste in fridge
  Let it warm up before applying

Pasta!

- Use good “Lead Free” paste.
  Right Type (grain size - e.g. Type 3, Type 4)
- Store paste in fridge
  Let it warm up before applying

Challenges in Prototyping

Typical Challenges/Errors/Mistakes

- Design/Layout issues: ϟϟ☹$$$
- Sufficient test access?
- Sufficient rework/repair access?
- Components used as per design?
- Correct placement done? (C12 in place of R12?)
- Correct polarity / orientation?
- Correctly rated part used?

Typical Challenges/Errors/Mistakes

- Design/Layout issues: ϟϟ☹$$$
- Sufficient test access?
- Sufficient rework/repair access?
- Components used as per design?
- Correct placement done? (C12 in place of R12?)
- Correct polarity / orientation?
- Correctly rated part used?

Typical Challenges/Errors/Mistakes

- Design/Layout issues: ϟϟϟ☹$$$
- Sufficient test access?
- Sufficient rework/repair access?
- Components used as per design?
- Correct placement done? (C12 in place of R12?)
- Correct polarity / orientation?
- Correctly rated part used?

Typical Challenges/Errors/Mistakes

- Design/Layout issues: ϟϟ☹$$$
- Sufficient test access?
- Sufficient rework/repair access?
- Components used as per design?
- Correct placement done? (C12 in place of R12?)
- Correct polarity / orientation?
- Correctly rated part used?

Typical Challenges/Errors/Mistakes

- Design/Layout issues: ϟϟ☹$$$
- Sufficient test access?
- Sufficient rework/repair access?
- Components used as per design?
- Correct placement done? (C12 in place of R12?)
- Correct polarity / orientation?
- Correctly rated part used?

Typical Challenges/Errors/Mistakes

- Design/Layout issues: ϟϟ☹$$$
- Sufficient test access?
- Sufficient rework/repair access?
- Components used as per design?
- Correct placement done? (C12 in place of R12?)
- Correct polarity / orientation?
- Correctly rated part used?

Typical Challenges/Errors/Mistakes

- Design/Layout issues: ϟϟ☹$$$
- Sufficient test access?
- Sufficient rework/repair access?
- Components used as per design?
- Correct placement done? (C12 in place of R12?)
- Correct polarity / orientation?
- Correctly rated part used?

Some actual errors (mistakes)

Problem: Board worked for 3 days, then stopped.

Some actual errors (mistakes)

Problem: Board worked for 3 days, then stopped.

Culprit: Rating!

PCB with many decoupler caps (0.1 μF 10V)

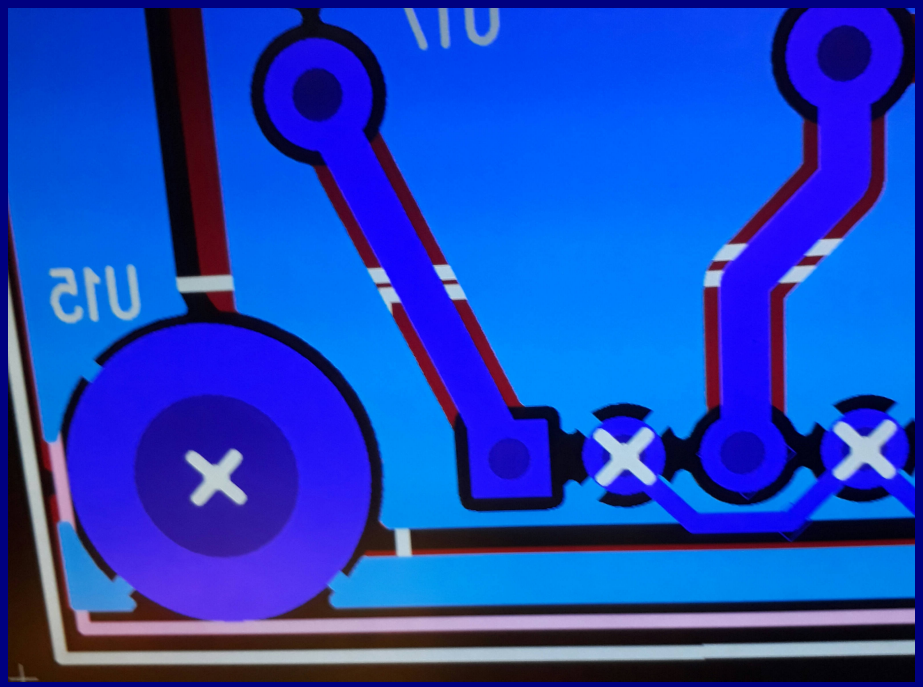
Had a charge pump using one 0.1 μF 50V.

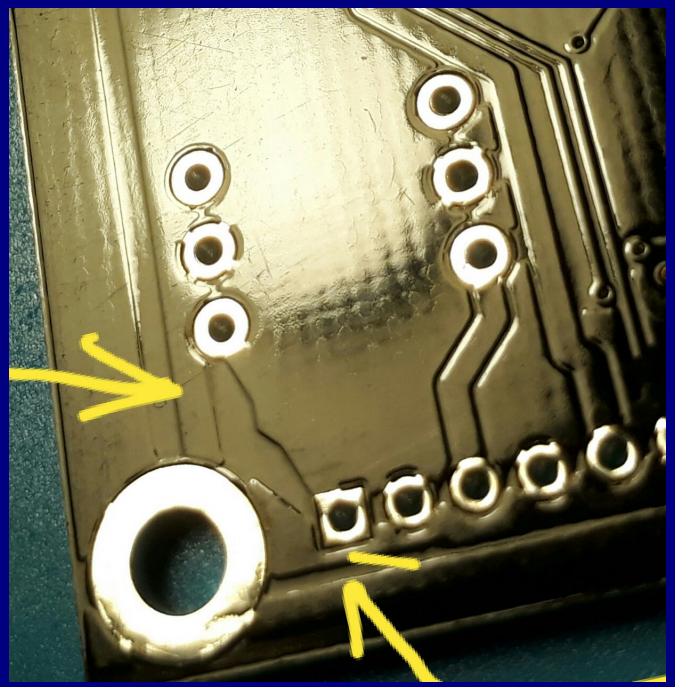
Assembly used the same capacitor for all.

Cap failed (dielectric punch through).

A fab error

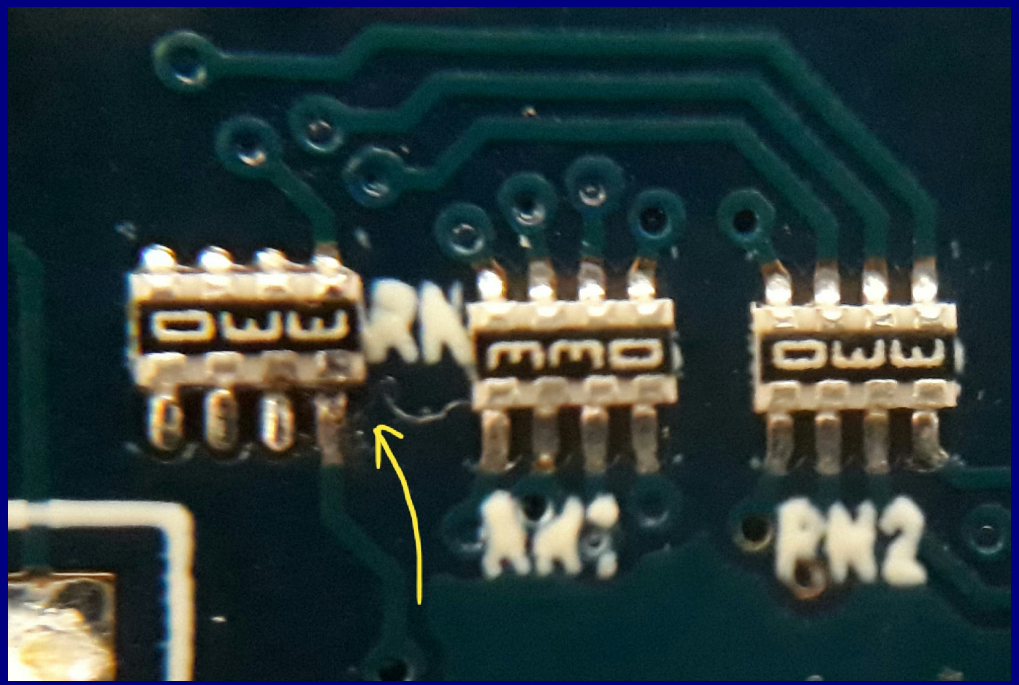
Power board with fab error, a V_{out} shorted to GND





A Reflow soldering slip-up

Soldering defect revealed by careful inspection



Reducing Cycle Time with In-house Assembly

Impact of errors

- Assembly error: rework 1 or entire batch
- PCB fabrication error: re-fab PCB, ...
- Schematic error: Re layout, re-fab, ...
- Fix and repeat tests

Impact of errors

- Assembly error: rework 1 or entire batch
- PCB fabrication error: re-fab PCB, ...
- Schematic error: Re layout, re-fab, ...
- Fix and repeat tests

Impact of errors

- Assembly error: rework 1 or entire batch
- PCB fabrication error: re-fab PCB, ...
- Schematic error: Re layout, re-fab, ...
- Fix and repeat tests

Impact of errors

- Assembly error: rework 1 or entire batch
- PCB fabrication error: re-fab PCB, ...
- Schematic error: Re layout, re-fab, ...
- Fix and repeat tests

Hardware-Software Co-Design

Hardware/Software Co-Design

GIOVANNI DE MICHELI, FELLOW, IEEE, AND RAJESH K. GUPTA, MEMBER, IEEE

Invited Paper

Most electronic systems, whether self-contained or embedded, have a predominant digital component consisting of a hardware platform which executes software application programs. Hardware/software co-design means meeting system-level objectives by exploiting the synergism of hardware and software through their concurrent design. Co-design problems have different flavors according to the application domain, implementation technology and design methodology.

Digital hardware design has increasingly more similarities to software design. Hardware circuits are often described using modeling or programming languages, and they are validated and implemented by executing software programs, which are sometimes

Moreover, the implementation of electronic systems and subsystems shows often a predominant digital component.

We focus in this paper on the digital component of electronic systems, and refer to them as (digital) systems for brevity. The majority of such systems are programmable, and thus consist of hardware and software components. The value of a system can be measured by some objectives that are specific to its application domain (e.g., performance, design, and manufacturing cost, and ease of programmability) and it depends on both the hardware and the software

(Micheli & Gupta, Proc. IEEE, Vol.85, No.3, March 1997)

Partial Assembly & Incremental prototyping (1/2)

Examples:

- to test 1-channel in a 6-channel board
- for sub-circuit level prototyping
- for minimum h/w to get s/w dev started
- to skip some expensive parts (when not immediately needed), e.g. connectors, some peripherals

Partial Assembly & Incremental prototyping (1/2)

Examples:

- to test 1-channel in a 6-channel board
- for sub-circuit level prototyping
- for minimum h/w to get s/w dev started
- to skip some expensive parts (when not immediately needed), e.g. connectors, some peripherals

Partial Assembly & Incremental prototyping (1/2)

Examples:

- to test 1-channel in a 6-channel board
- for sub-circuit level prototyping
- for minimum h/w to get s/w dev started
- to skip some expensive parts (when not immediately needed), e.g. connectors, some peripherals

Partial Assembly & Incremental prototyping (1/2)

Examples:

- to test 1-channel in a 6-channel board
- for sub-circuit level prototyping
- for minimum h/w to get s/w dev started
- to skip some expensive parts (when not immediately needed), e.g. connectors, some peripherals

Partial Assembly & Incremental prototyping (2/2)

- Speeds up initial bring-up of proto and test boards
- Allows Hw/Sw Co-Design during proto
- Reduces unpredictability arising from external factors
- Reduces overall product development time & cost

Have some in-house capability for h/w assembly!

Partial Assembly & Incremental prototyping (2/2)

- Speeds up initial bring-up of proto and test boards
- Allows Hw/Sw Co-Design during proto
- Reduces unpredictability arising from external factors
- Reduces overall product development time & cost

Have some in-house capability for h/w assembly!

Partial Assembly & Incremental prototyping (2/2)

- Speeds up initial bring-up of proto and test boards
- Allows Hw/Sw Co-Design during proto
- Reduces unpredictability arising from external factors
- Reduces overall product development time & cost

Have some in-house capability for h/w assembly!

Partial Assembly & Incremental prototyping (2/2)

- Speeds up initial bring-up of proto and test boards
- Allows Hw/Sw Co-Design during proto
- Reduces unpredictability arising from external factors
- Reduces overall product development time & cost

Have some in-house capability for h/w assembly!

Partial Assembly & Incremental prototyping (2/2)

- Speeds up initial bring-up of proto and test boards
- Allows Hw/Sw Co-Design during proto
- Reduces unpredictability arising from external factors
- Reduces overall product development time & cost

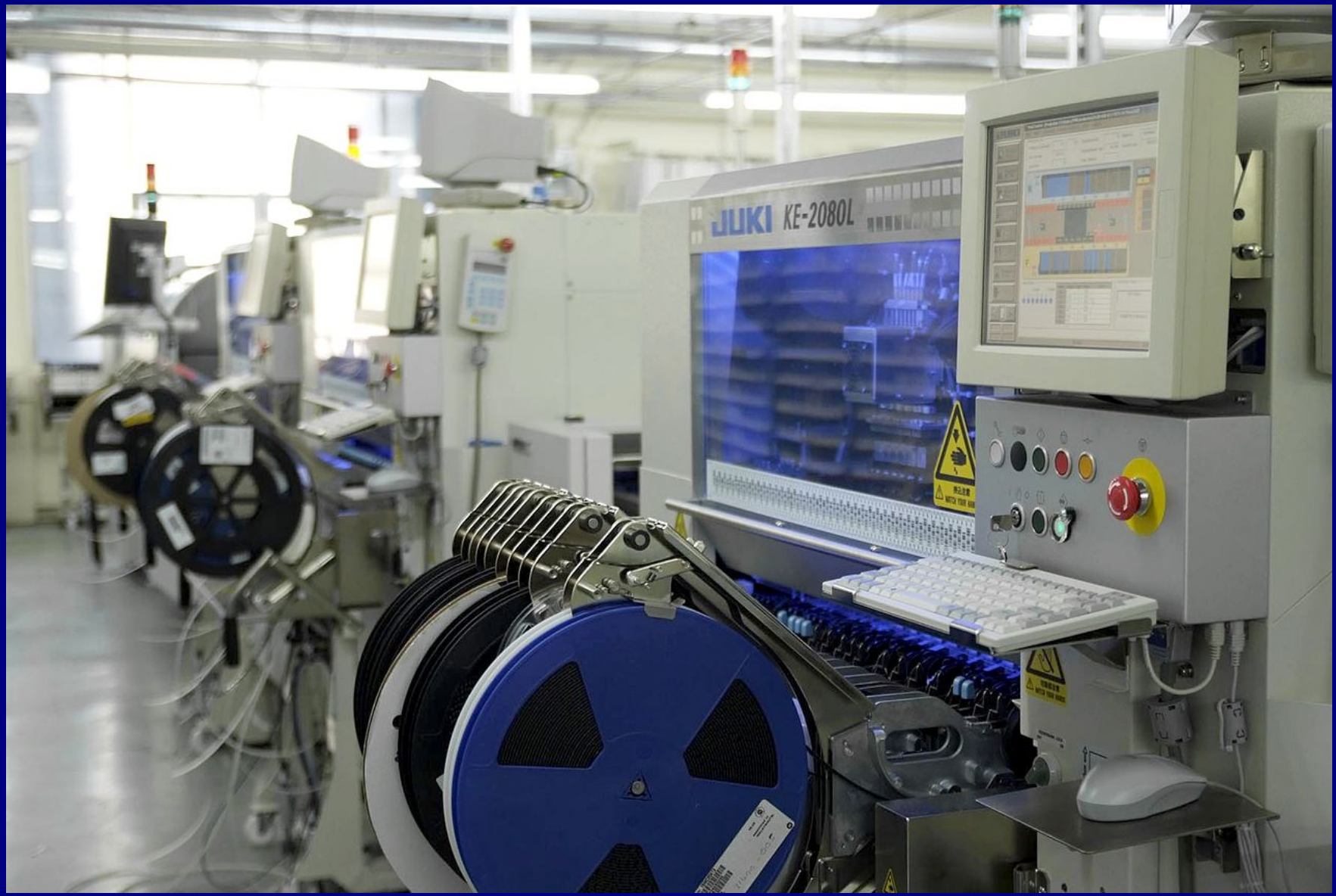
Have some in-house capability for h/w assembly!

Partial Assembly & Incremental prototyping (2/2)

- Speeds up initial bring-up of proto and test boards
- Allows Hw/Sw Co-Design during proto
- Reduces unpredictability arising from external factors
- Reduces overall product development time & cost

Have some in-house capability for h/w assembly!

Assembly – Pick & Place



Goals *set for Zoid Labs' Placerbot:*

- ✓To fit desktop
- ✓Be portable
- ✓Handle typical parts
- ✓Accuracy
- ✓Repeatability
- ✓Handle cut tapes
- ✓Also feed from tray
- ✓Be flexible
- ✓Easy to use

Placerbot

Why have SMT proto capability in-house?

- To leverage Partial Assembly
- To reduce cycle time per iteration
- To reduce overall dev time and cost
- To reduce errors (e.g. below)

Why have SMT proto capability in-house?

- To leverage Partial Assembly
- To reduce cycle time per iteration
- To reduce overall dev time and cost
- To reduce errors (e.g. below)

Why have SMT proto capability in-house?

- To leverage Partial Assembly
- To reduce cycle time per iteration
- To reduce overall dev time and cost
- To reduce errors (e.g. below)

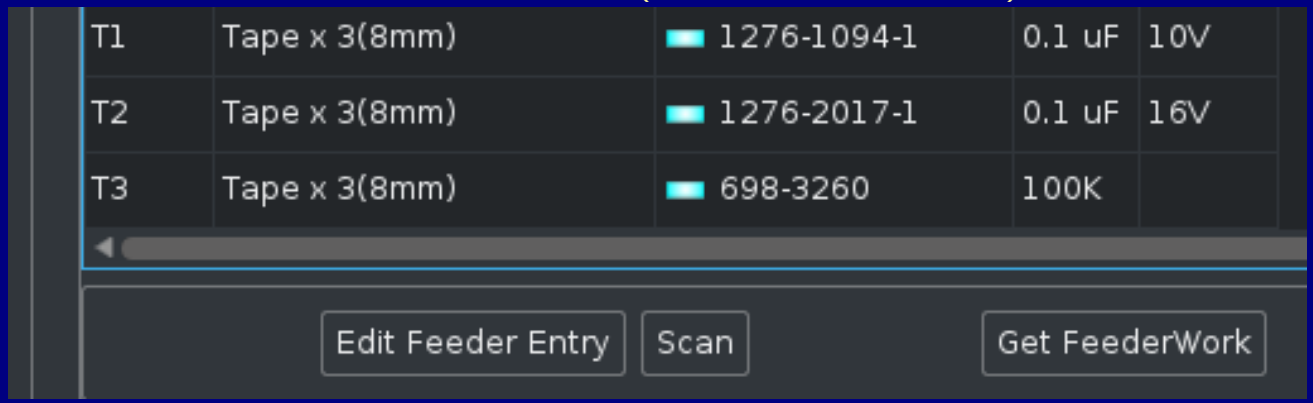
Why have SMT proto capability in-house?

- To leverage Partial Assembly
- To reduce cycle time per iteration
- To reduce overall dev time and cost
- To reduce errors (e.g. below)

Why have SMT proto capability in-house?

- To leverage Partial Assembly
- To reduce cycle time per iteration
- To reduce overall dev time and cost
- To reduce errors (e.g. below)

(from Placerbot UI)



Other benefits of in-house SMT prototyping

- Increased visibility / Early visibility into all aspects of design
  e.g. Mechanical issues, Thermal design
- Prepares for DFM and productization
- Total Control over **Intellectual Property**
- Design and BOM optimization

Other benefits of in-house SMT prototyping

- Increased visibility / Early visibility into all aspects of design
  e.g. Mechanical issues, Thermal design
- Prepares for DFM and productization
- Total Control over **Intellectual Property**
- Design and BOM optimization

Other benefits of in-house SMT prototyping

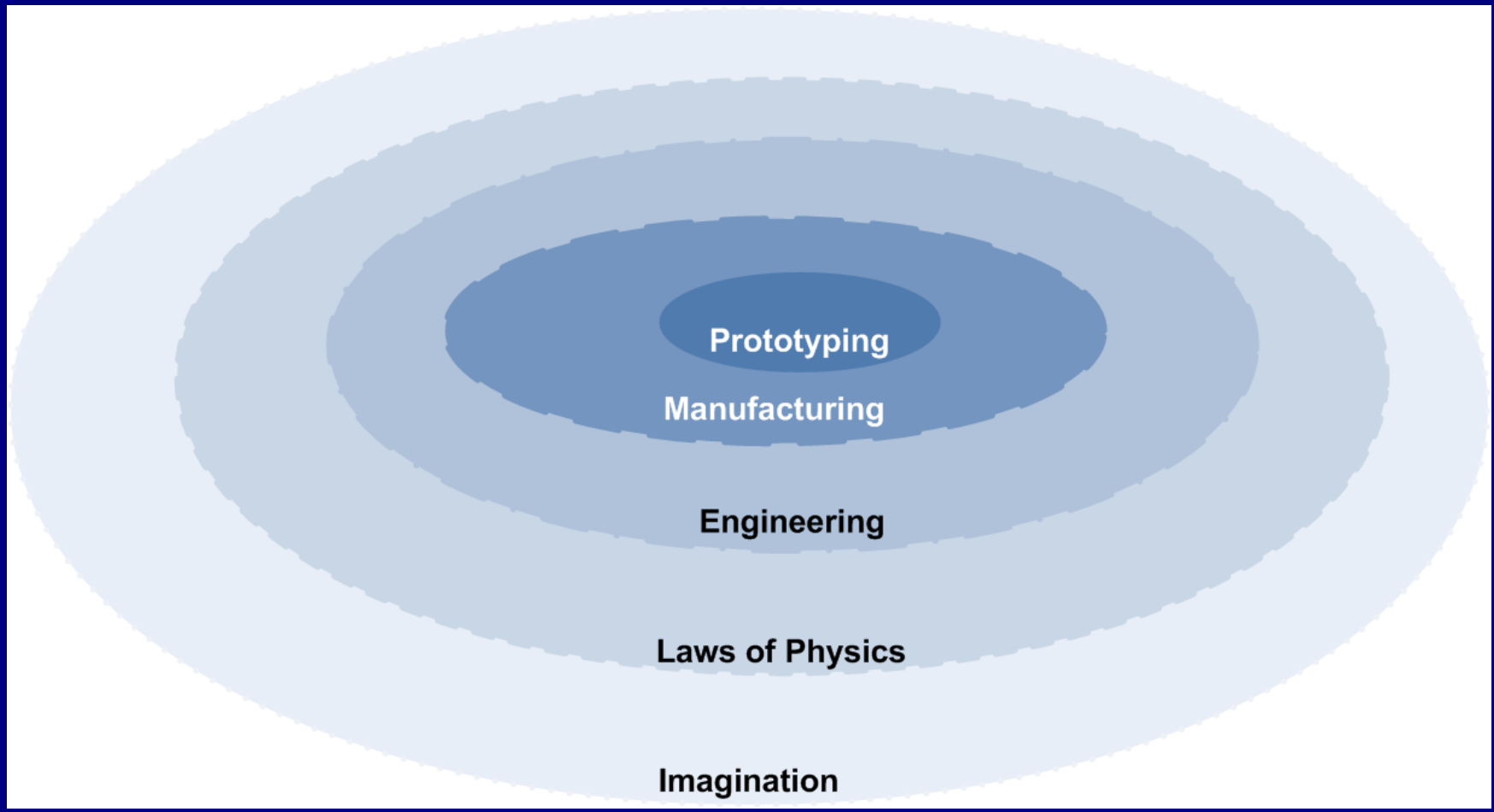
- Increased visibility / Early visibility into all aspects of design
  e.g. Mechanical issues, Thermal design
- Prepares for DFM and productization
- Total Control over **Intellectual Property**
- Design and BOM optimization

Other benefits of in-house SMT prototyping

- Increased visibility / Early visibility into all aspects of design
  e.g. Mechanical issues, Thermal design
- Prepares for DFM and productization
- Total Control over **Intellectual Property**
- Design and BOM optimization

Streamlining with DFP (Design for Prototyping)

Basic Approach



DFM (Design for Manufacture) – Design Rules

DFP (Design for Prototyping) – Stricter Rules

Some DFP Tips (1/3)
(As practised at Zoid Labs)

General

- Provision fuses.
  (Final product may or may not include these)
- Use 0R's (0Ω) or fuses to isolate power paths.
- Have all DFP additions (0Ω etc) with 0805 footprints
  (smaller size ⇒ ☹ ☹ for tweezers)

Some DFP Tips (1/3)
(As practised at Zoid Labs)

General

- Provision fuses.
  (Final product may or may not include these)
- Use 0R's (0Ω) or fuses to isolate power paths.
- Have all DFP additions (0Ω etc) with 0805 footprints
  (smaller size ⇒ ☹ ☹ for tweezers)

Some DFP Tips (1/3)
(As practised at Zoid Labs)

General

- Provision fuses.
  (Final product may or may not include these)
- Use 0R's (0Ω) or fuses to isolate power paths.
- Have all DFP additions (0Ω etc) with 0805 footprints
  (smaller size ⇒ ☹ ☹ for tweezers)

Testability

- Add testpoints liberally
  - say 0.5 x 0.5mm pad for occasional probing
  - Where needed to hook up a probe often, add a thru-hole pin pad.
- Provision configuration 0R's
  - For intercepting signals
  - To provide alternate paths (mux/demuxing)
  - Strapping options (e.g. mode inputs, I2C addresses)
- Allow space for test/probe access

Testability

- Add testpoints liberally
  - say 0.5 x 0.5mm pad for occasional probing
  - Where needed to hook up a probe often, add a thru-hole pin pad.
- Provision configuration 0R's
  - For intercepting signals
  - To provide alternate paths (mux/demuxing)
  - Strapping options (e.g. mode inputs, I2C addresses)
- Allow space for test/probe access

Testability

- Add testpoints liberally
  - say 0.5 x 0.5mm pad for occasional probing
  - Where needed to hook up a probe often, add a thru-hole pin pad.
- Provision configuration 0R's
  - For intercepting signals
  - To provide alternate paths (mux/demuxing)
  - Strapping options
    (e.g. mode inputs, I2C addresses)
- Allow space for test/probe access

Footprints, Layout, Stencil

- Use rounded pads in footprints
  - For small passives
  - Less likely to 'tombstone'
  - Better for IC's too
- Careful with big thermal pads (belly pads)!
- Prefer non-BGA packages if possible
  - More leeway with solder reflow profile
- Include fiducial marks (local,global)
- Include fiducial marks in Stencil for easy registration visually
- Undersize stencil openings slightly

Footprints, Layout, Stencil

- Use rounded pads in footprints
  - For small passives
  - Less likely to 'tombstone'
  - Better for IC's too
- Careful with big thermal pads (belly pads)!
- Prefer non-BGA packages if possible
  - More leeway with solder reflow profile
- Include fiducial marks (local,global)
- Include fiducial marks in Stencil for easy registration visually
- Undersize stencil openings slightly

Footprints, Layout, Stencil

- Use rounded pads in footprints
  - For small passives
  - Less likely to 'tombstone'
  - Better for IC's too
- Careful with big thermal pads (belly pads)!
- Prefer non-BGA packages if possible
  - More leeway with solder reflow profile
- Include fiducial marks (local,global)
- Include fiducial marks in Stencil for easy registration visually
- Undersize stencil openings slightly

Footprints, Layout, Stencil

- Use rounded pads in footprints
  - For small passives
  - Less likely to 'tombstone'
  - Better for IC's too
- Careful with big thermal pads (belly pads)!
- Prefer non-BGA packages if possible
  - More leeway with solder reflow profile
- Include fiducial marks (local,global)
- Include fiducial marks in Stencil for easy registration visually
- Undersize stencil openings slightly

Footprints, Layout, Stencil

- Use rounded pads in footprints
  - For small passives
  - Less likely to 'tombstone'
  - Better for IC's too
- Careful with big thermal pads (belly pads)!
- Prefer non-BGA packages if possible
  - More leeway with solder reflow profile
- Include fiducial marks (local,global)
- Include fiducial marks in Stencil for easy registration visually
- Undersize stencil openings slightly

Footprints, Layout, Stencil

- Use rounded pads in footprints
  - For small passives
  - Less likely to 'tombstone'
  - Better for IC's too
- Careful with big thermal pads (belly pads)!
- Prefer non-BGA packages if possible
  - More leeway with solder reflow profile
- Include fiducial marks (local,global)
- Include fiducial marks in Stencil for easy registration visually
- Undersize stencil openings slightly

What Equipment?
Process support
etc

Equipment

- PCB mill? Evaluate use vs. $
- Stencilling machines??
- Inspection capability ✓
- Auto Pick and Place: ✓

  Ensures correct parts, polarity, orientation. Faster than manual process; else paste may dry up
  Easier to repeat the run (than manual)
  Should do 0402, cut tape, fine pitch ICs
- PCB Oven: ✓

  Verify temp. profiles for Pb & Pb-free
  Verify heat distribution

Equipment

- PCB mill? Evaluate use vs. $
- Stencilling machines??
- Inspection capability ✓
- Auto Pick and Place: ✓

  Ensures correct parts, polarity, orientation. Faster than manual process; else paste may dry up
  Easier to repeat the run (than manual)
  Should do 0402, cut tape, fine pitch ICs
- PCB Oven: ✓

  Verify temp. profiles for Pb & Pb-free
  Verify heat distribution

Equipment

- PCB mill? Evaluate use vs. $
- Stencilling machines??
- Inspection capability ✓
- Auto Pick and Place: ✓

  Ensures correct parts, polarity, orientation. Faster than manual process; else paste may dry up
  Easier to repeat the run (than manual)
  Should do 0402, cut tape, fine pitch ICs
- PCB Oven: ✓

  Verify temp. profiles for Pb & Pb-free
  Verify heat distribution

Equipment

- PCB mill? Evaluate use vs. $
- Stencilling machines??
- Inspection capability ✓
- Auto Pick and Place: ✓
  - Ensures correct parts, polarity, orientation. Faster than manual process; else paste may dry up
  - Easier to repeat the run (than manual)
  - Should do 0402, cut tape, fine pitch ICs
- PCB Oven: ✓

  Verify temp. profiles for Pb & Pb-free

  Verify heat distribution

Equipment

- PCB mill? Evaluate use vs. $
- Stencilling machines??
- Inspection capability ✓
- Auto Pick and Place: ✓
  - Ensures correct parts, polarity, orientation. Faster than manual process; else paste may dry up
  - Easier to repeat the run (than manual)
  - Should do 0402, cut tape, fine pitch ICs
- PCB Oven: ✓

  Verify temp. profiles for Pb & Pb-free

  Verify heat distribution

Equipment

- PCB mill? Evaluate use vs. $
- Stencilling machines??
- Inspection capability ✓
- Auto Pick and Place: ✓
  - Ensures correct parts, polarity, orientation. Faster than manual process; else paste may dry up
  - Easier to repeat the run (than manual)
  - Should do 0402, cut tape, fine pitch ICs
- PCB Oven: ✓

  Verify temp. profiles for Pb & Pb-free

  Verify heat distribution

Equipment

- PCB mill? Evaluate use vs. $
- Stencilling machines??
- Inspection capability ✓
- Auto Pick and Place: ✓
  - Ensures correct parts, polarity, orientation. Faster than manual process; else paste may dry up
  - Easier to repeat the run (than manual)
  - Should do 0402, cut tape, fine pitch ICs
- PCB Oven: ✓

  Verify temp. profiles for Pb & Pb-free

  Verify heat distribution

Equipment

- PCB mill? Evaluate use vs. $
- Stencilling machines??
- Inspection capability ✓
- Auto Pick and Place: ✓
  - Ensures correct parts, polarity, orientation. Faster than manual process; else paste may dry up
  - Easier to repeat the run (than manual)
  - Should do 0402, cut tape, fine pitch ICs
- PCB Oven: ✓
  - Verify temp. profiles for Pb & Pb-free
  - Verify heat distribution

Equipment

- PCB mill? Evaluate use vs. $
- Stencilling machines??
- Inspection capability ✓
- Auto Pick and Place: ✓
  - Ensures correct parts, polarity, orientation. Faster than manual process; else paste may dry up
  - Easier to repeat the run (than manual)
  - Should do 0402, cut tape, fine pitch ICs
- PCB Oven: ✓
  - Verify temp. profiles for Pb & Pb-free
  - Verify heat distribution

Equipment

- PCB mill? Evaluate use vs. $
- Stencilling machines??
- Inspection capability ✓
- Auto Pick and Place: ✓
  - Ensures correct parts, polarity, orientation. Faster than manual process; else paste may dry up
  - Easier to repeat the run (than manual)
  - Should do 0402, cut tape, fine pitch ICs
- PCB Oven: ✓
  - Verify temp. profiles for Pb & Pb-free
  - Verify heat distribution

Process Support

- Managing components: e.g. cut tapes
- Managing part numbers
- HPN – House Part No, MPN – Mfr Part No, DPN – Distributor Part No, DPN2 –Alternate Distributer Part No. . . . etc and equivalences between these part numbers.

Conclusions

1. SMT Prototyping can be challenging
2. To cut cycle-time/cost, have in-house assembling capability
3. Use DFP (Design For Prototyping) guidelines
4. Appropriate Equipment and Process

Thank You!

ajith@zoidlabs.com

Conclusions

1. SMT Prototyping can be challenging
2. To cut cycle-time/cost, have in-house assembling capability
3. Use DFP (Design For Prototyping) guidelines
4. Appropriate Equipment and Process

Thank You!

ajith@zoidlabs.com

Conclusions

1. SMT Prototyping can be challenging
2. To cut cycle-time/cost, have in-house assembling capability
3. Use DFP (Design For Prototyping) guidelines
4. Appropriate Equipment and Process

Thank You!

ajith@zoidlabs.com

Conclusions

1. SMT Prototyping can be challenging
2. To cut cycle-time/cost, have in-house assembling capability
3. Use DFP (Design For Prototyping) guidelines
4. Appropriate Equipment and Process

Thank You!

ajith@zoidlabs.com

Conclusions

1. SMT Prototyping can be challenging
2. To cut cycle-time/cost, have in-house assembling capability
3. Use DFP (Design For Prototyping) guidelines
4. Appropriate Equipment and Process

Thank You!

ajith@zoidlabs.com

Conclusions

1. SMT Prototyping can be challenging
2. To cut cycle-time/cost, have in-house assembling capability
3. Use DFP (Design For Prototyping) guidelines
4. Appropriate Equipment and Process

Thank You!

ajith@zoidlabs.com