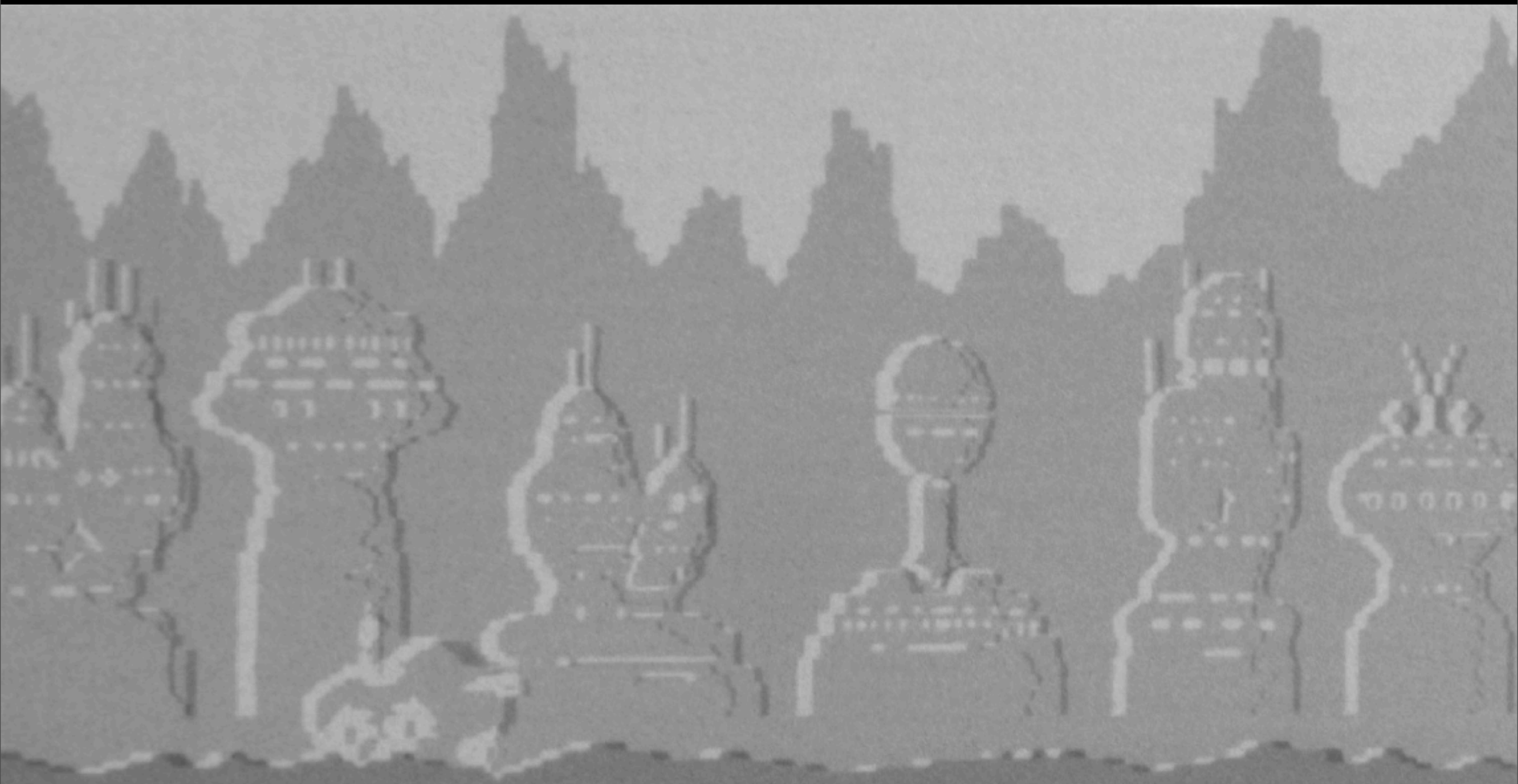
Printed Circuit Board Deconstruction Techniques



Joe Grand
Grand Idea Studio, Inc.
USENIX WOOT '14

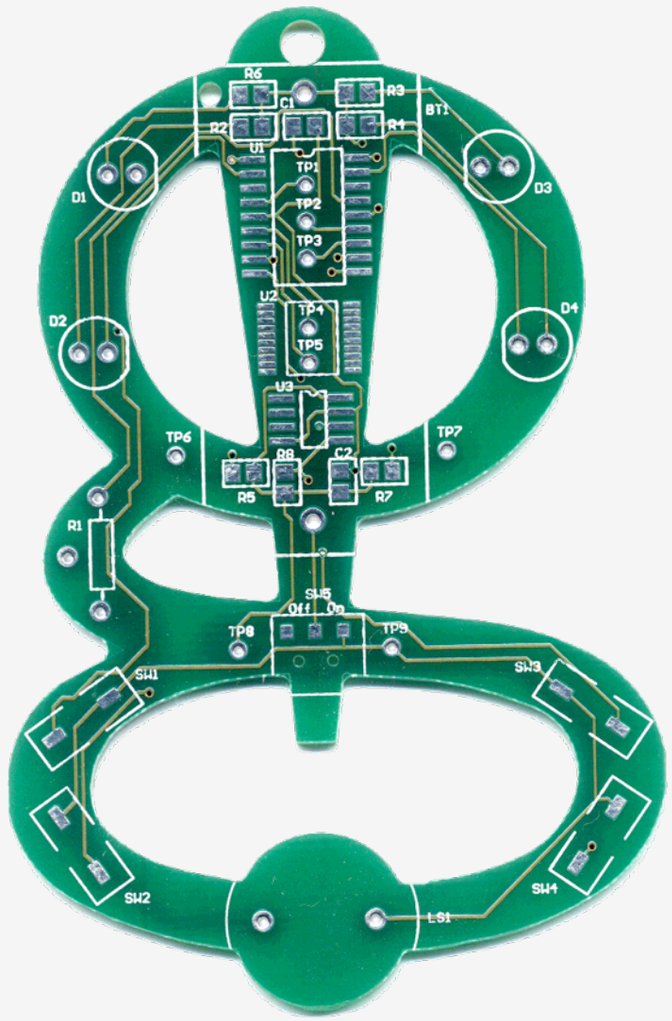
GRAND IDEA STUDIO

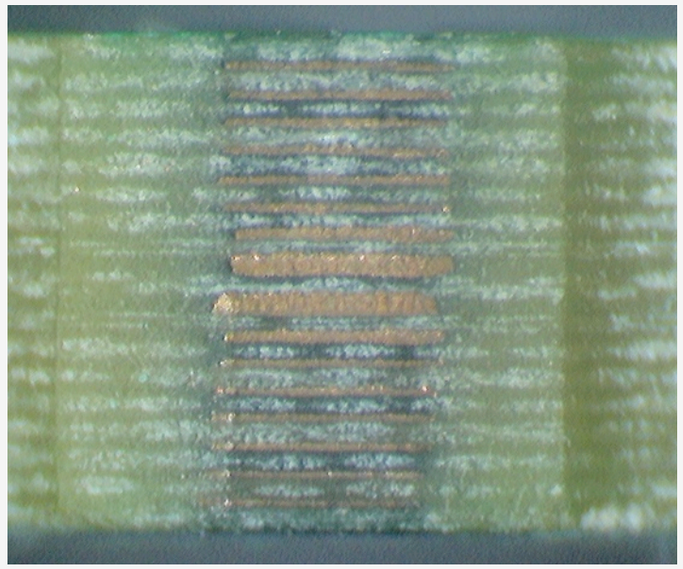
PCB Reverse Engineering

- The art of "undesigning" an existing system
- Destructive and non-destructive methods
- Why?
  - Determine system or subsystem functionality
  - Security research/verification
  - Forensic analysis/intelligence
  - Clone a design
  - Inject new (malicious) behavior
- How?
  - Access to copper layers
  - Analyze layout rules/features
  - Trace component interconnections

PCB Construction & Layer Stack

- Silkscreen (Component Legend)
  - Epoxy or printable ink
  - Part designators, symbols/logos, manufacturing/test markings
- Soldermask
  - Protects PCB from dust/moisture
  - Provides access to desired copper areas
- Copper
  - Thickness = weight of copper/sq. ft.
  - Surface finish provides better solderability
- Substrate
  - Insulating layer
  - Rigid and/or flex, fiberglass/epoxy weave or specialized composite





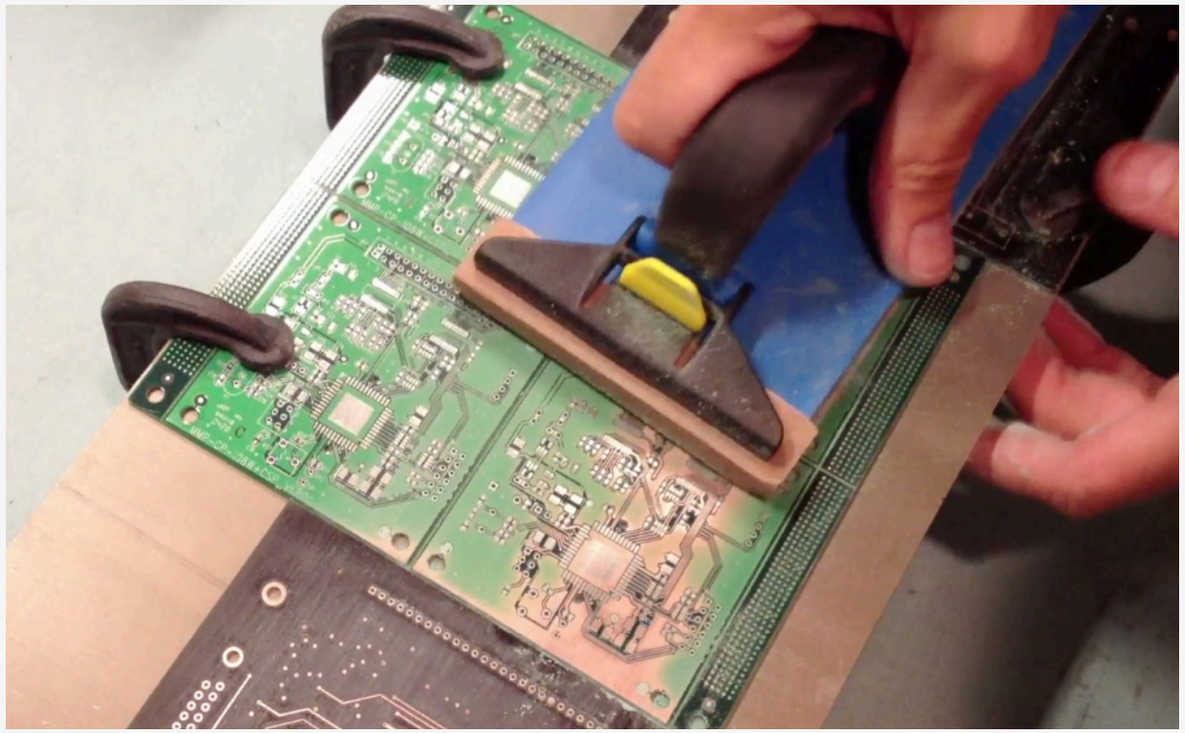
Deconstruction Techniques

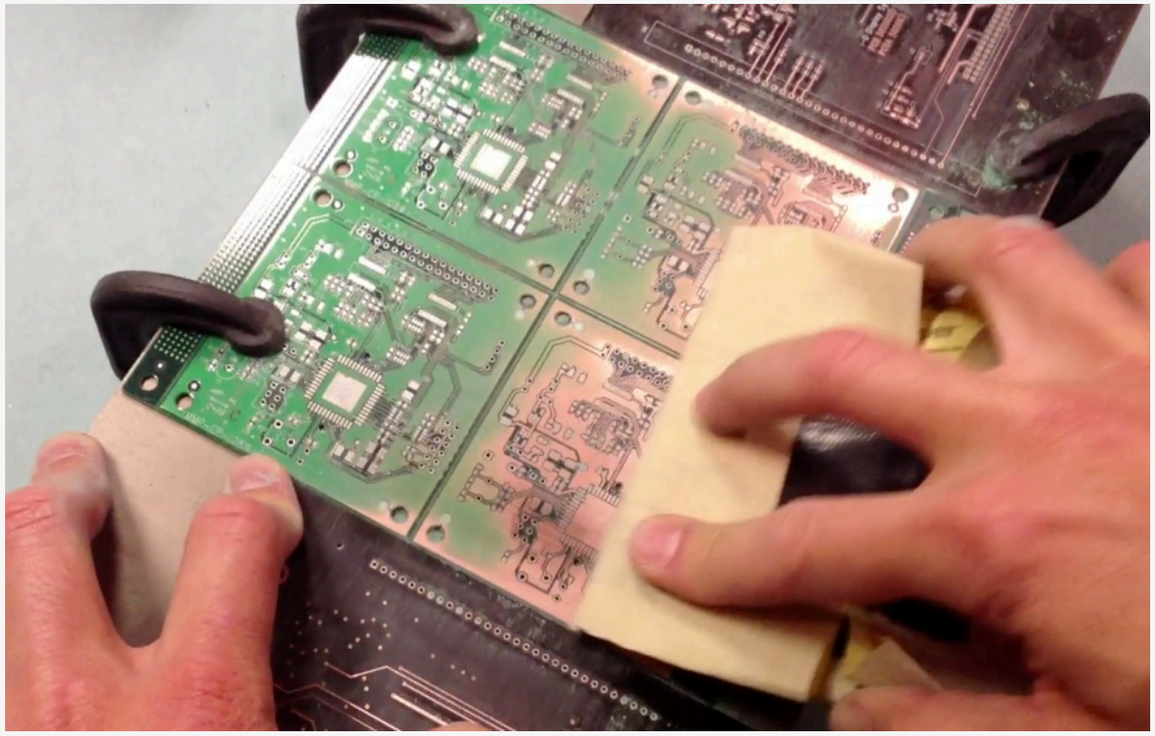
- Solder Mask Removal
- Delayering
- Imaging

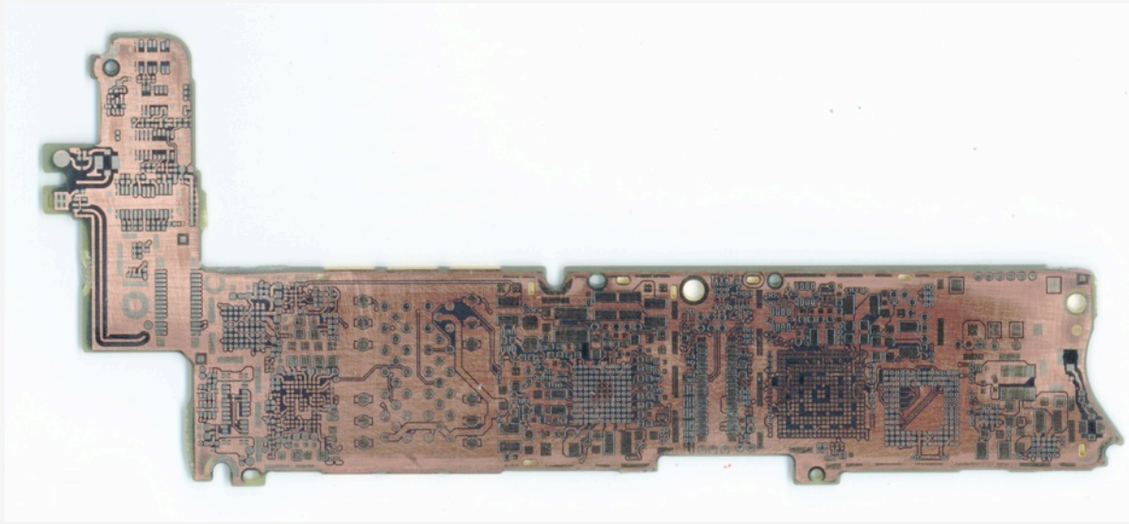
* Results of my DARPA CFT *Research and Analysis of PCB Deconstruction Techniques* project

GRAND IDEA STUDIO

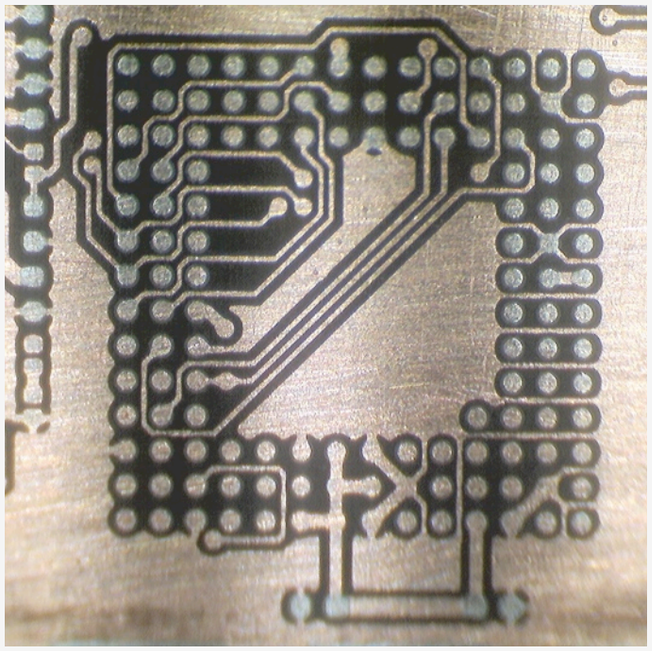
Solder Mask Removal: Sandpaper/Rubbing Stone





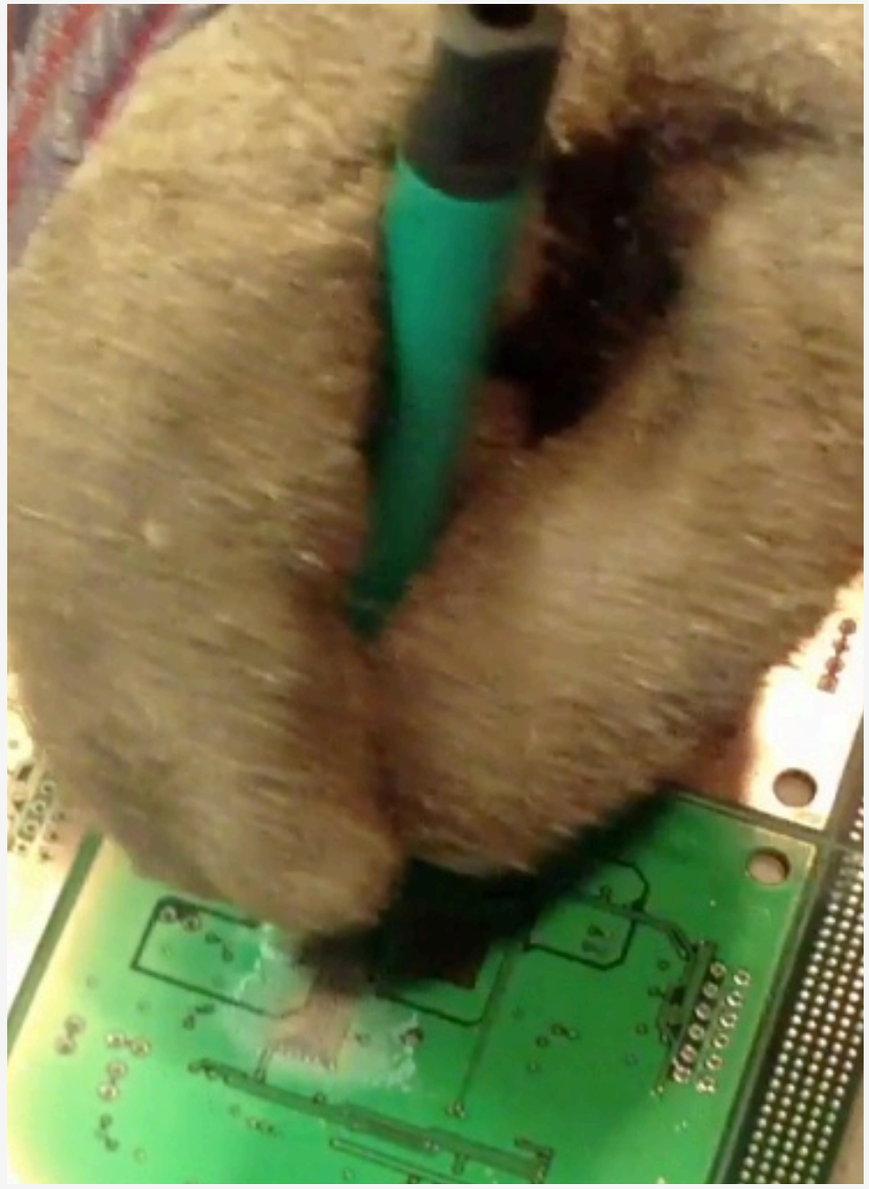


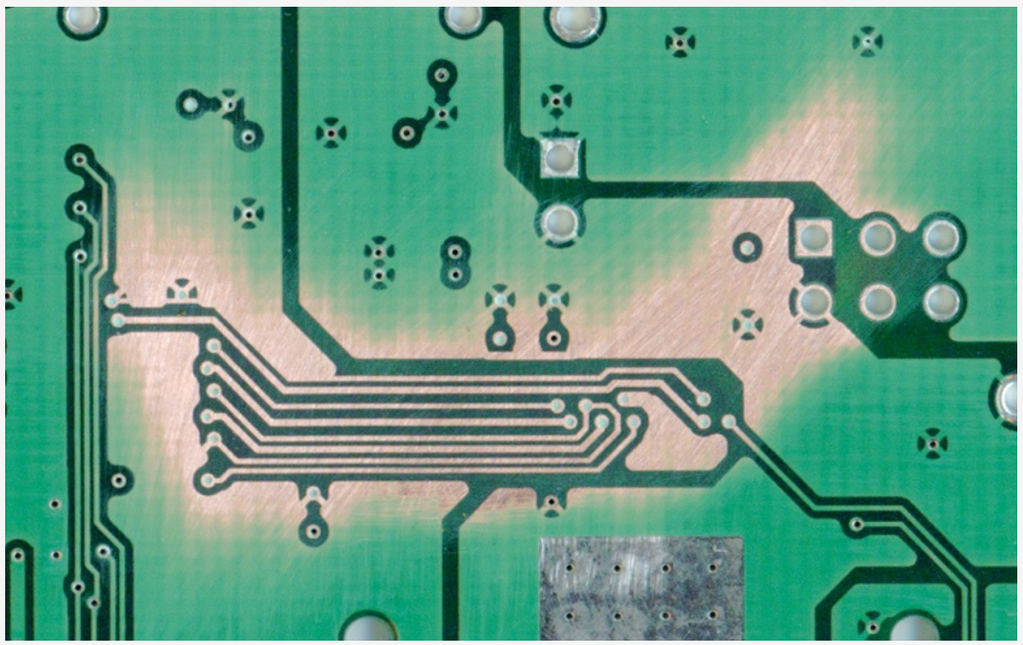
iPhone 4 16GB w/ 400 grit sandpaper

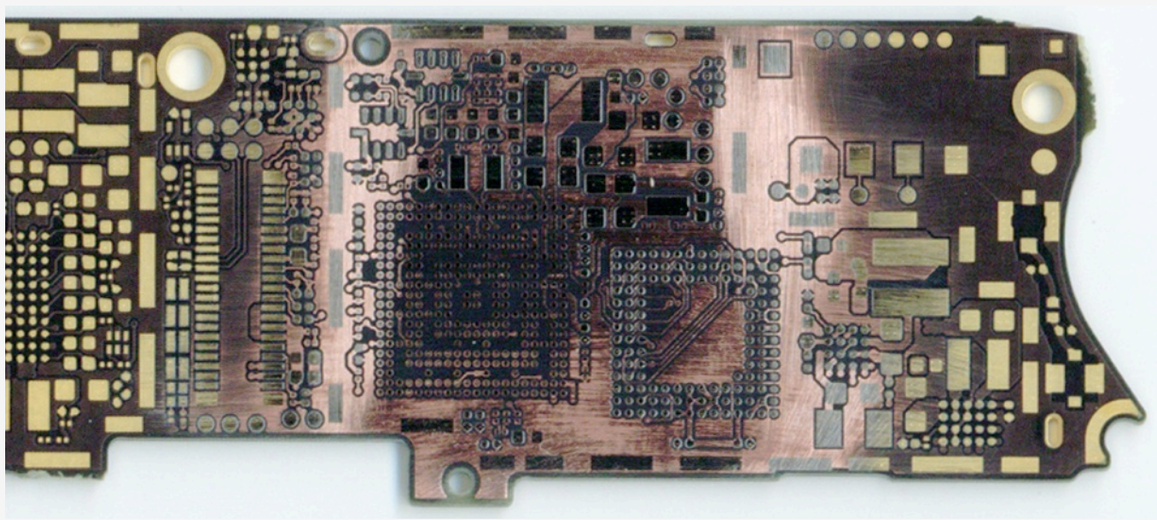


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Solder Mask Removal: Fiberglass Scratch Brush



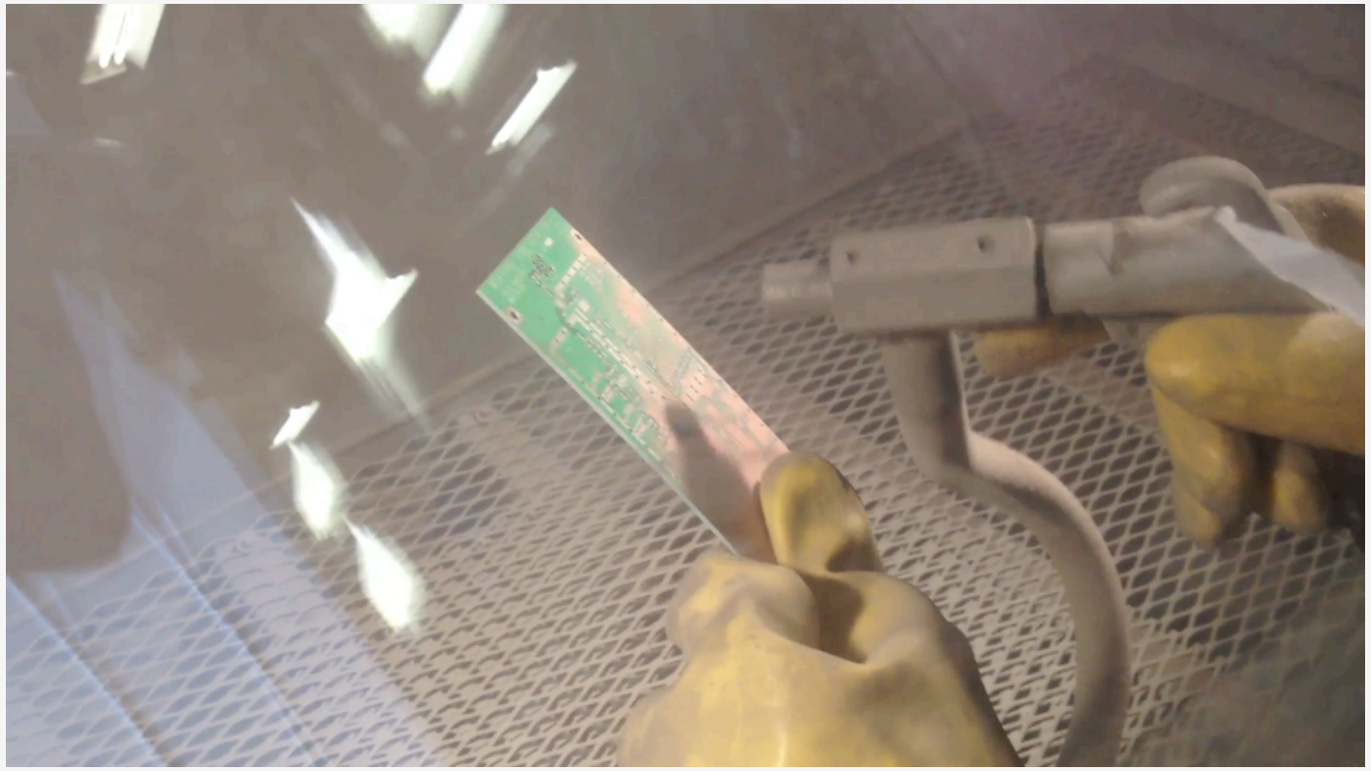


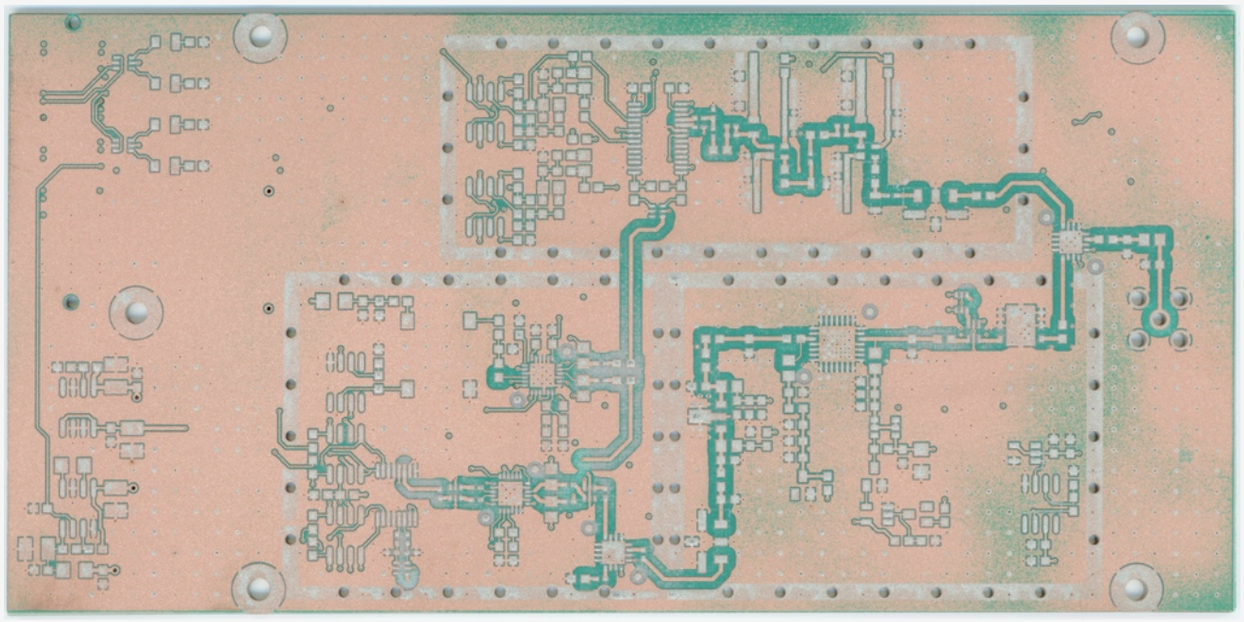


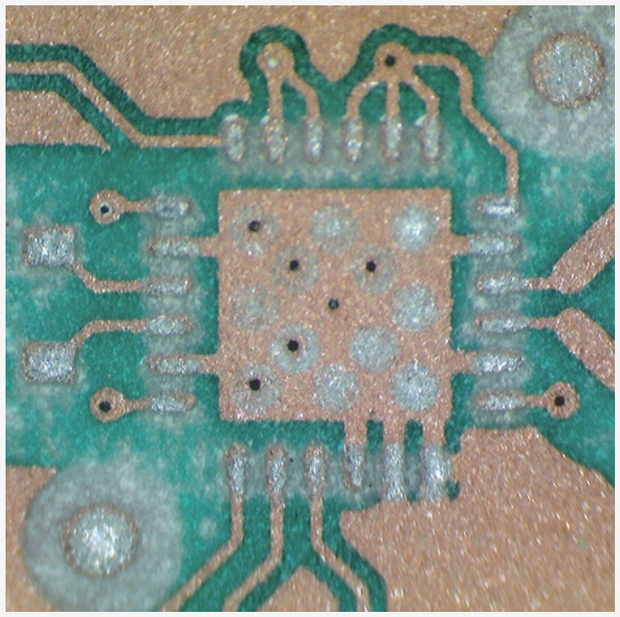
GRAND IDEA STUDIO

Solder Mask Removal: Abrasive Sand Blasting





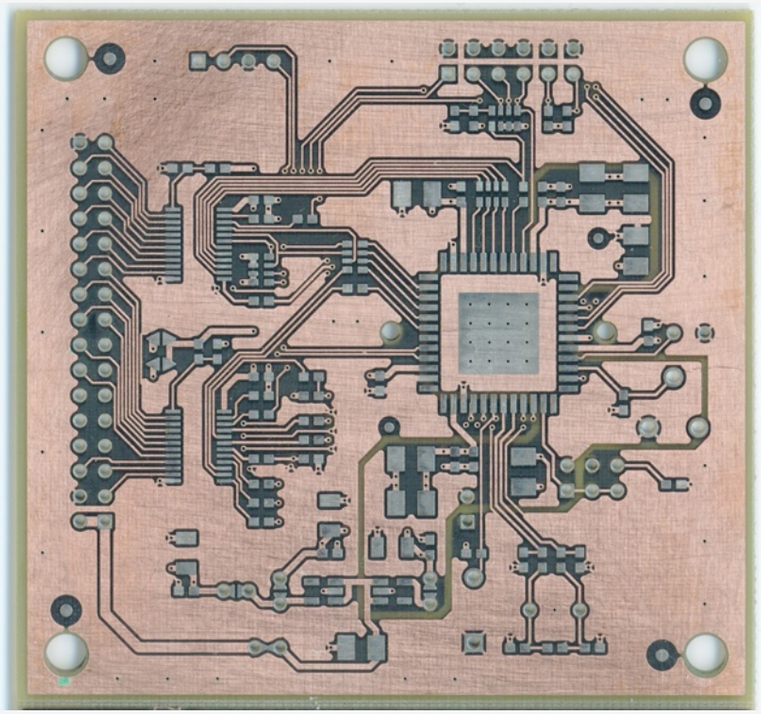




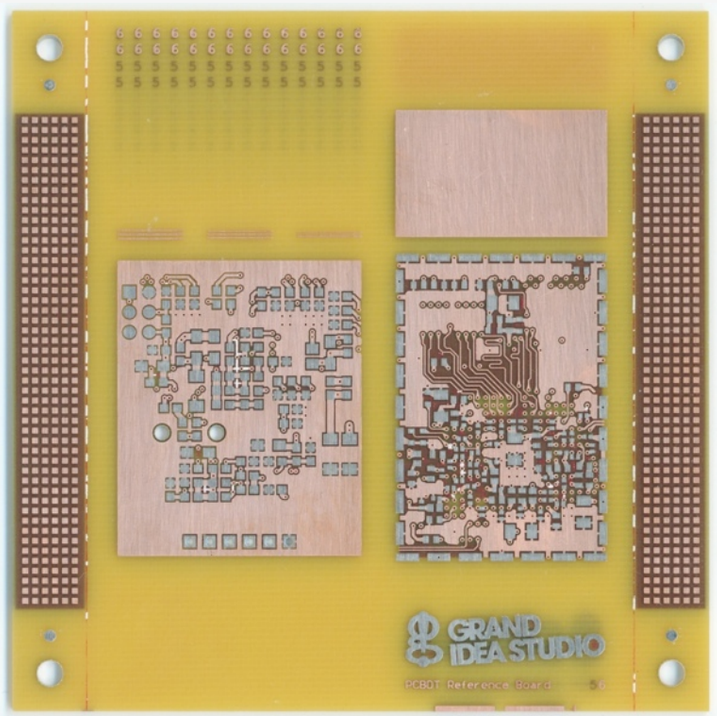
Solder Mask Removal: Chemical







Ristoff C-8 @ 90 min., 130°F

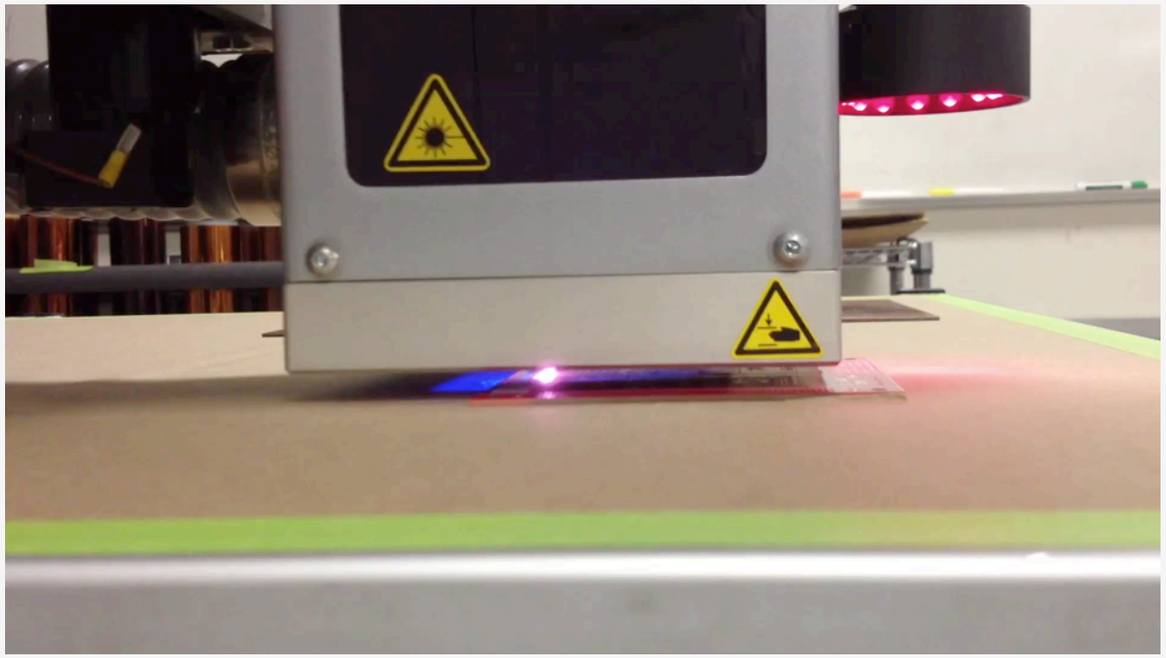


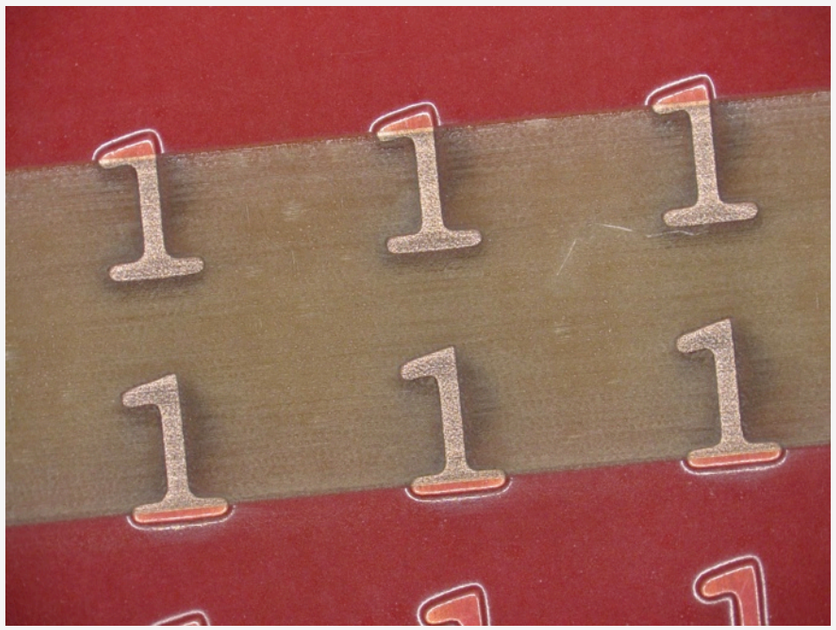
Magnastrip 500 @ 75 min., 150°F

GRAND IDEA STUDIO

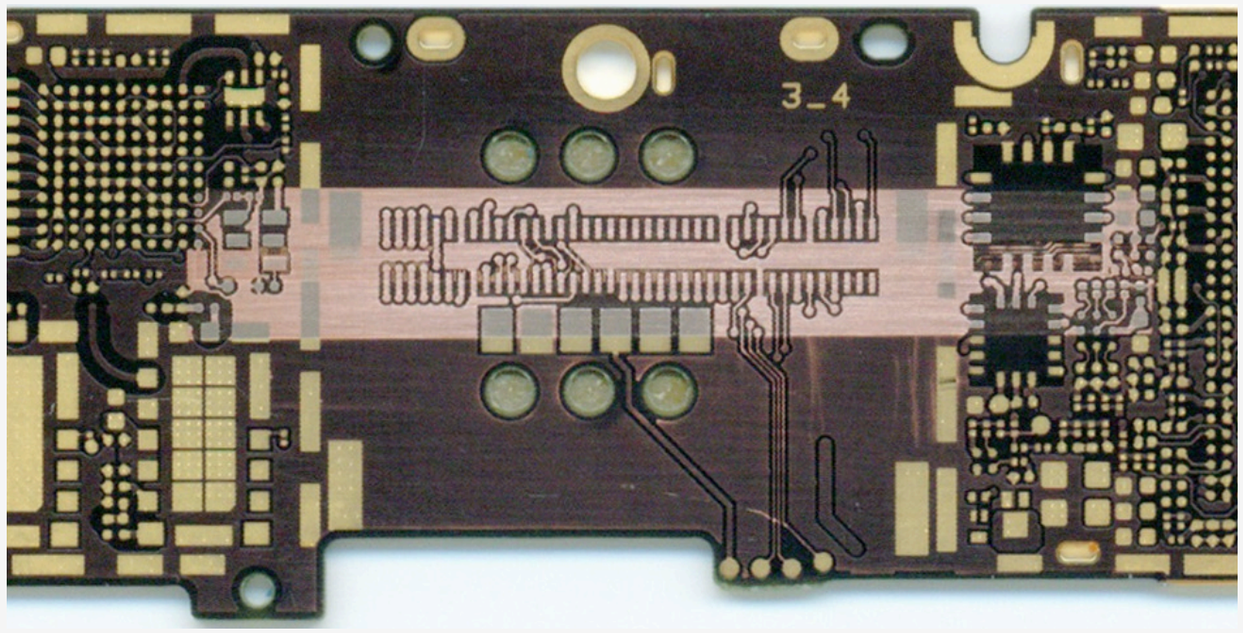
Solder Mask Removal: Laser







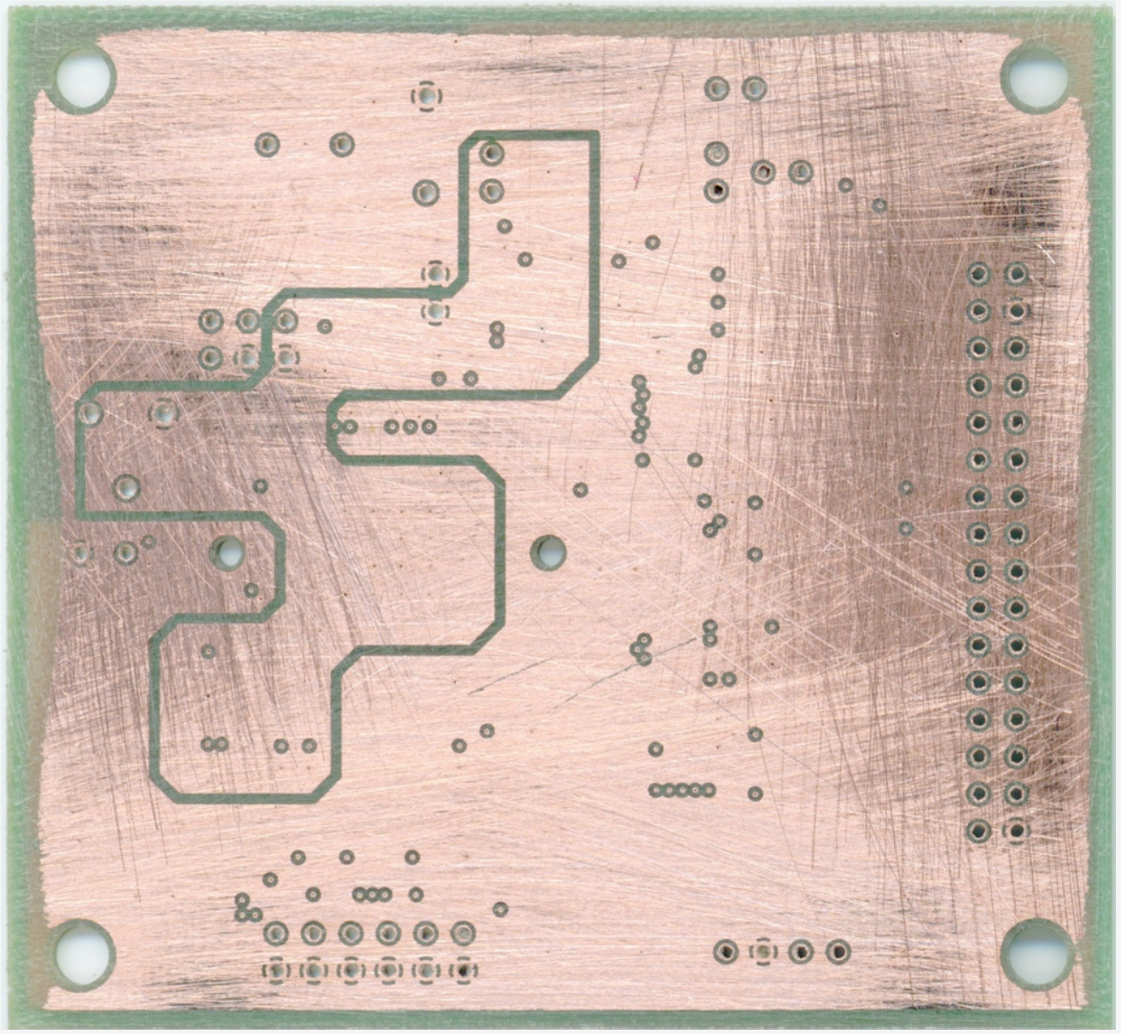
PCBDT Reference Board



iPhone 4 16GB Logic Board

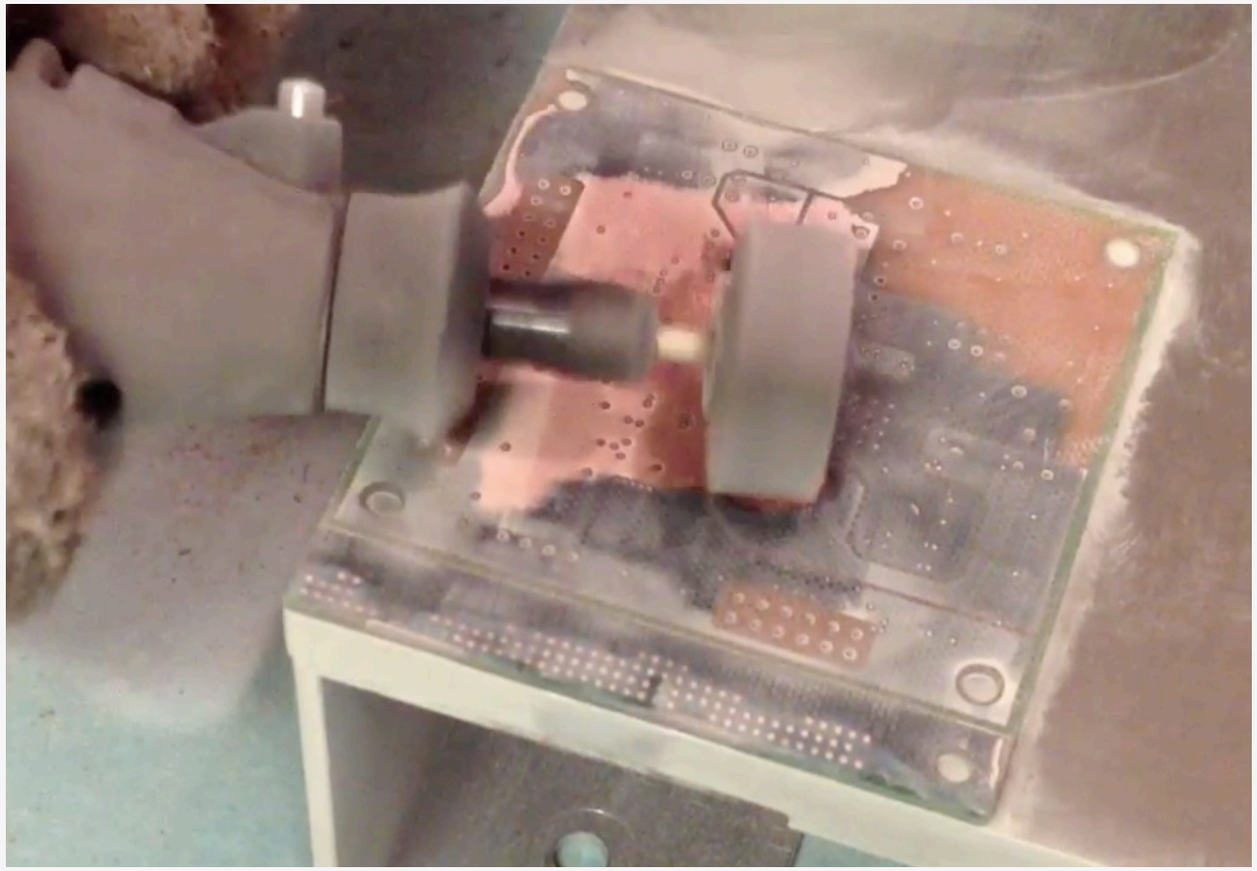
Delayering: Sandpaper/Rubbing Stone

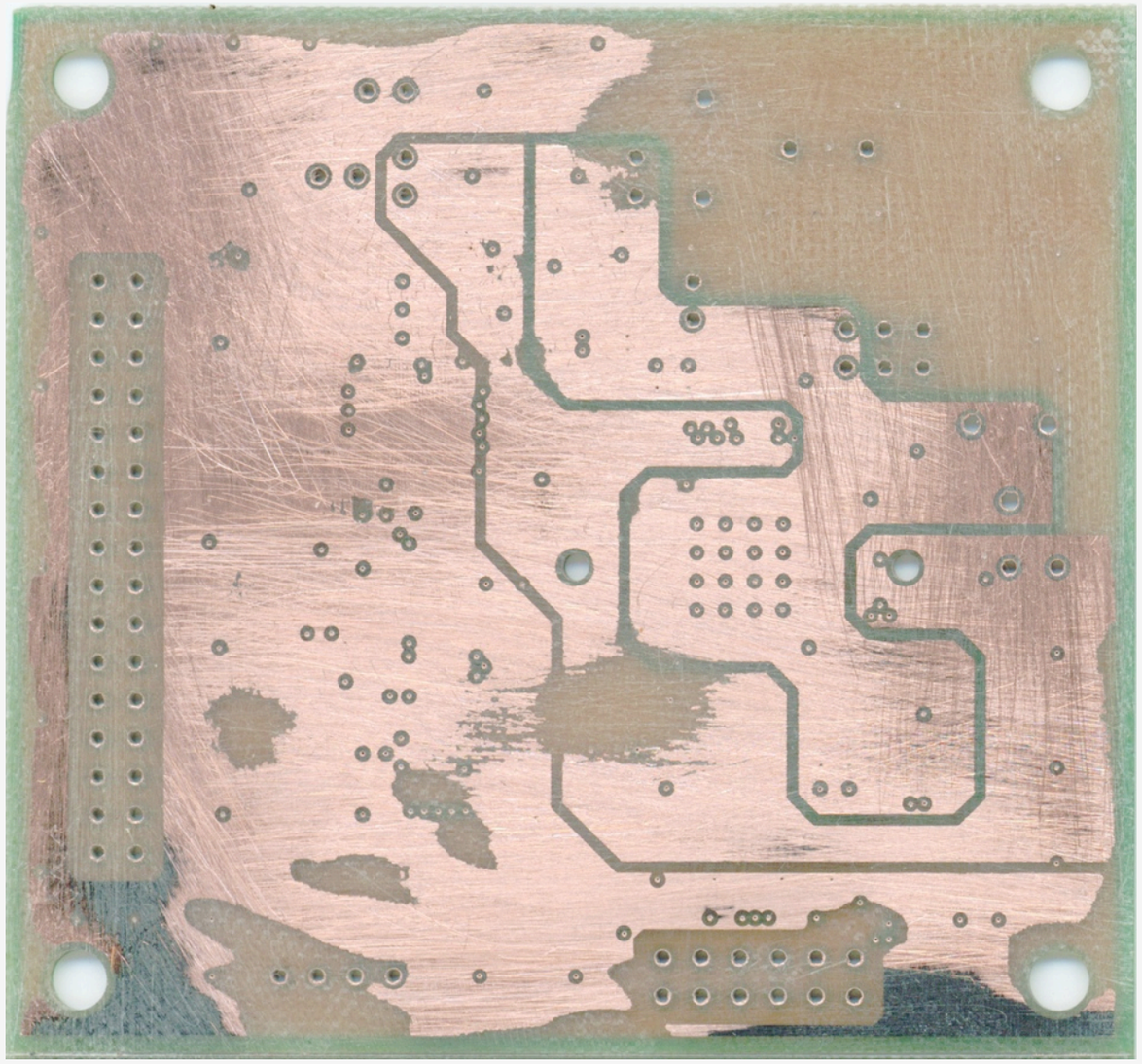




60/80 grit rubbing stone + 220 grit sandpaper

Delayering: Dremel Tool

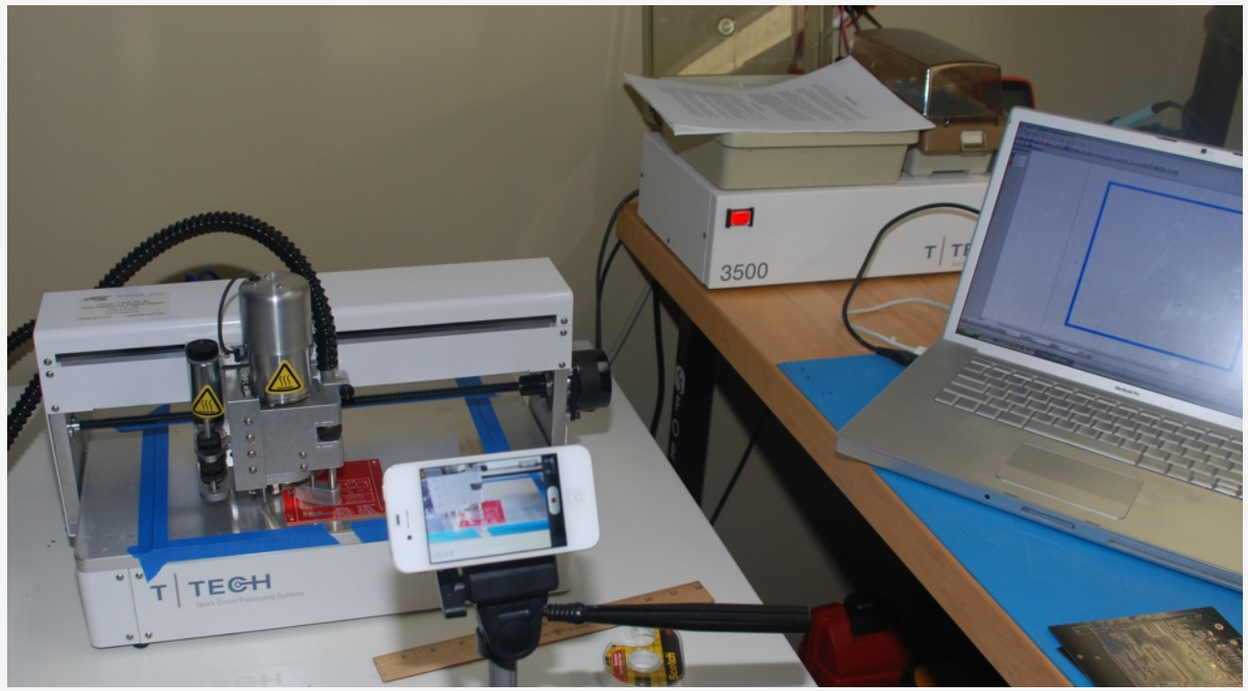


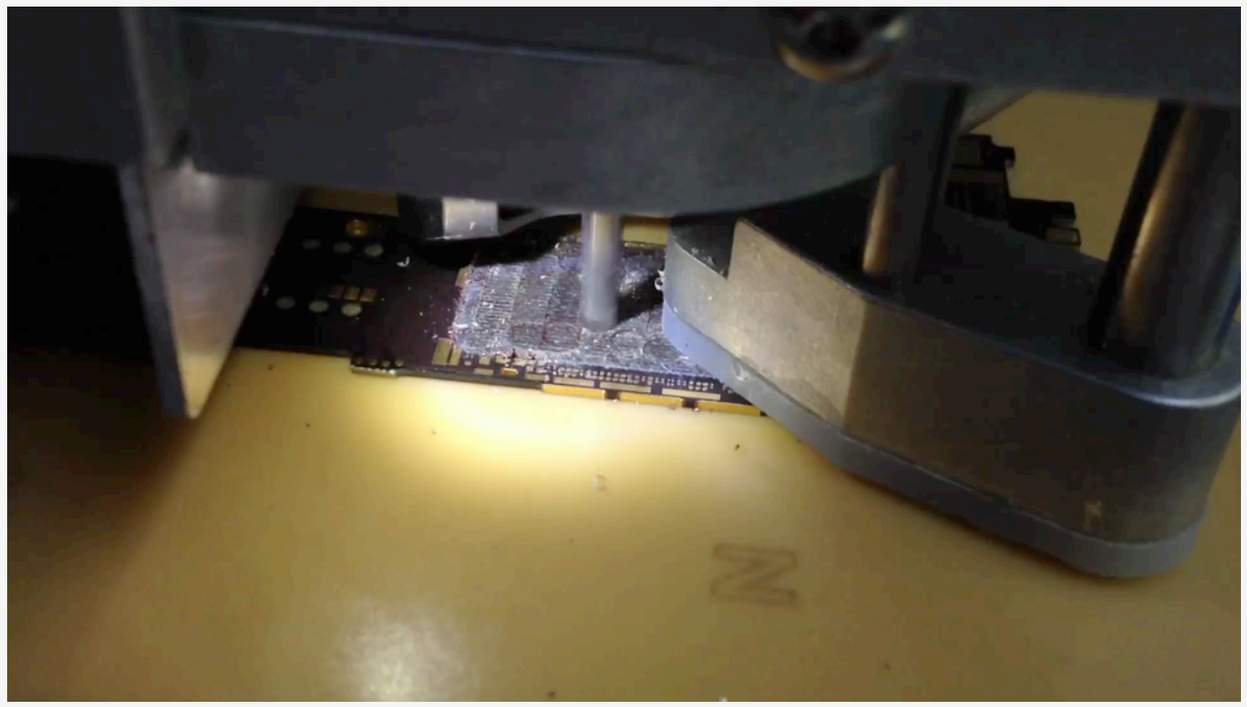


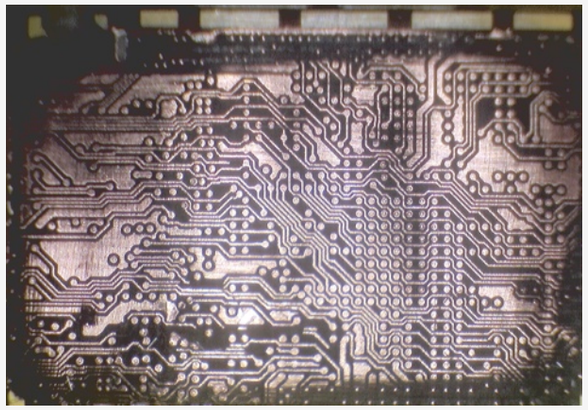
MultiPro 395 w/ 503 Flapwheel (120 grit, 3/8")

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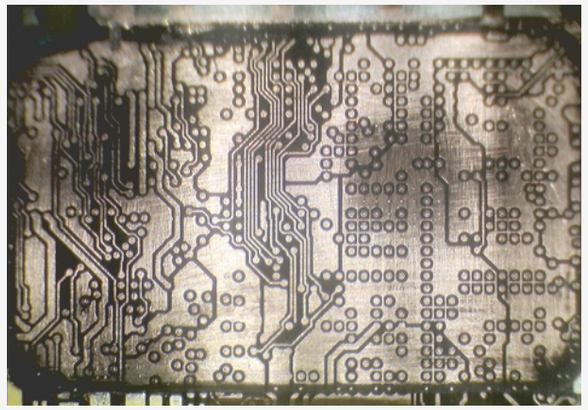
Delayering: CNC Milling



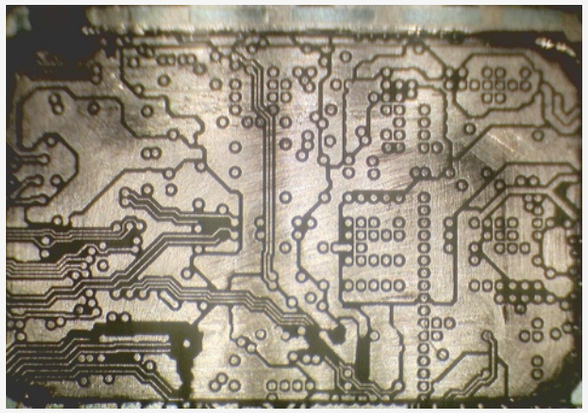




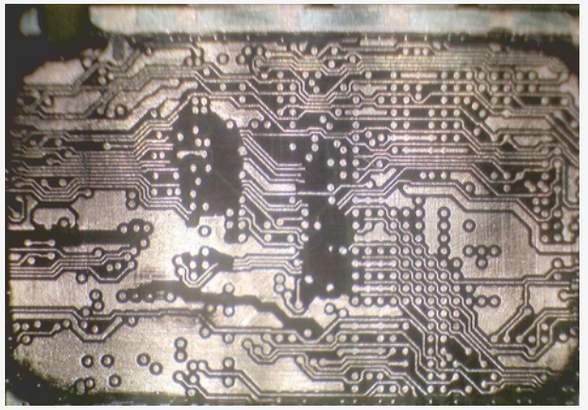
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3



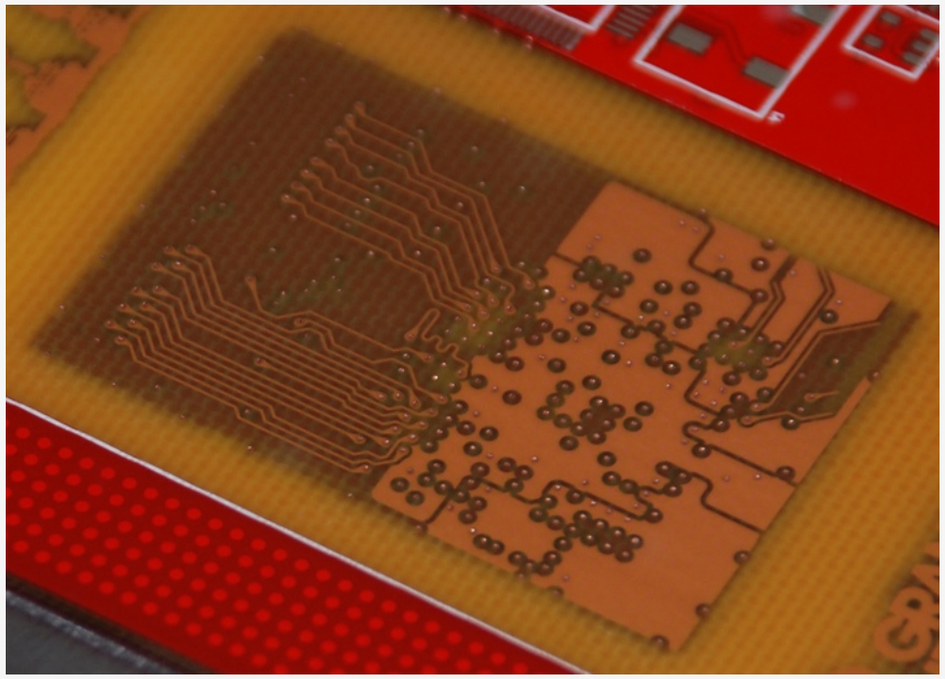
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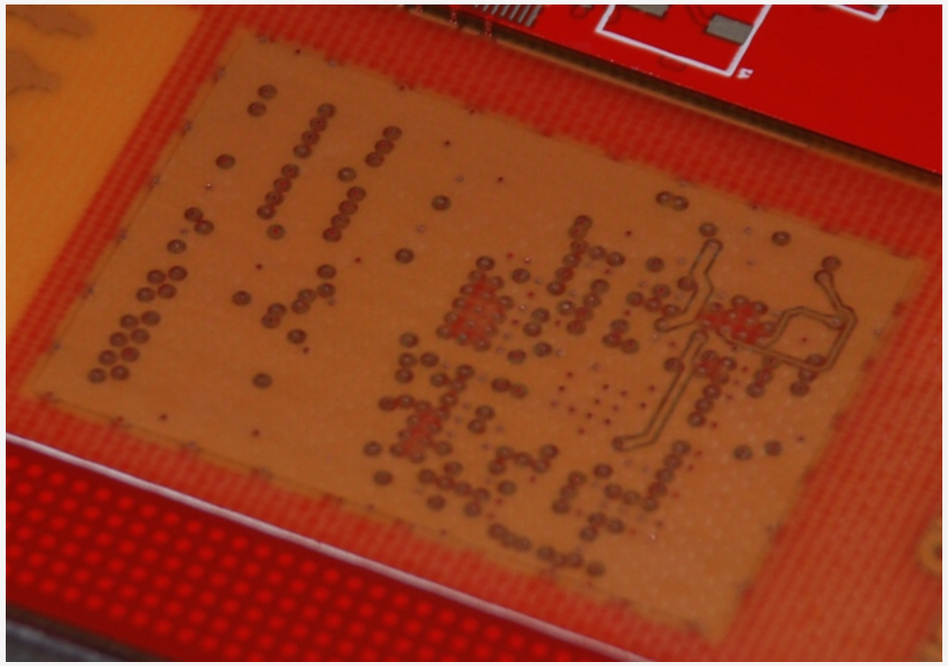
Delayering: Surface Grinding





3



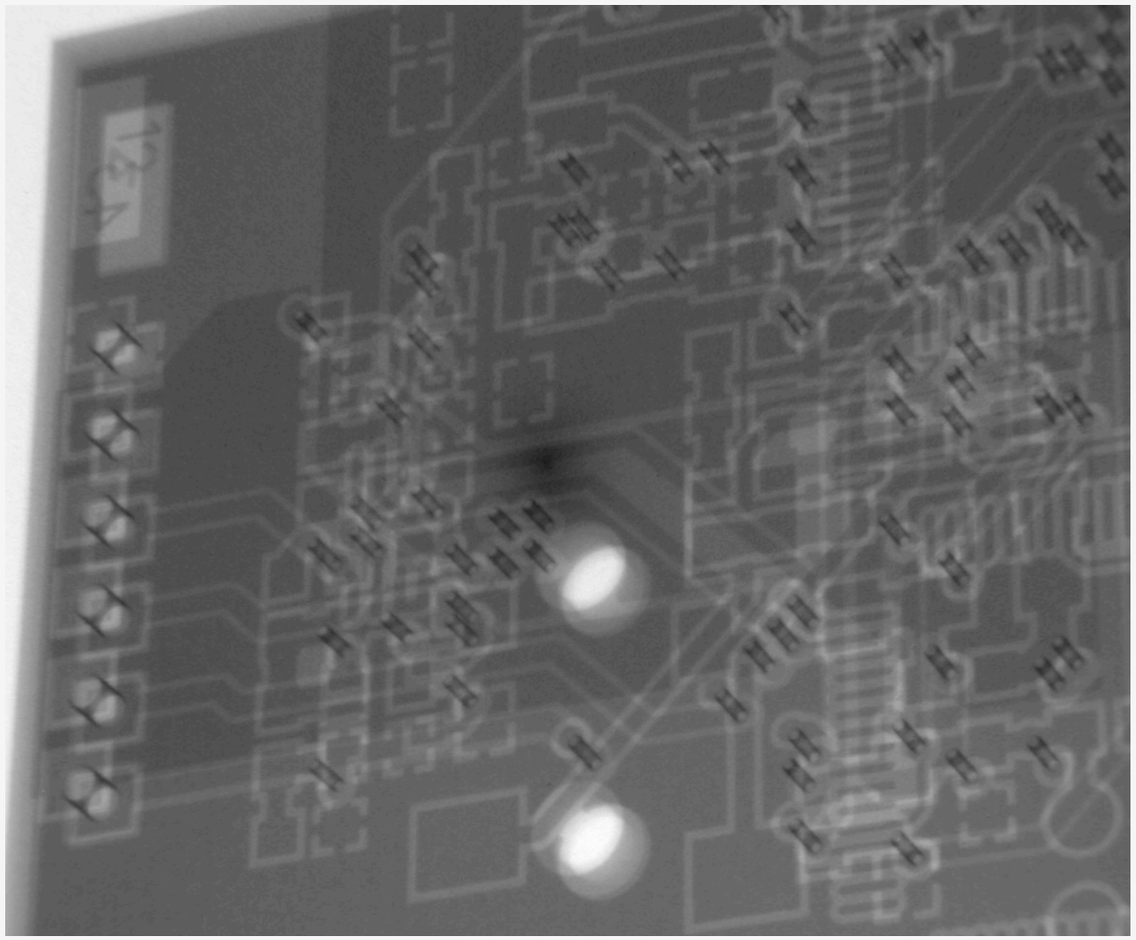


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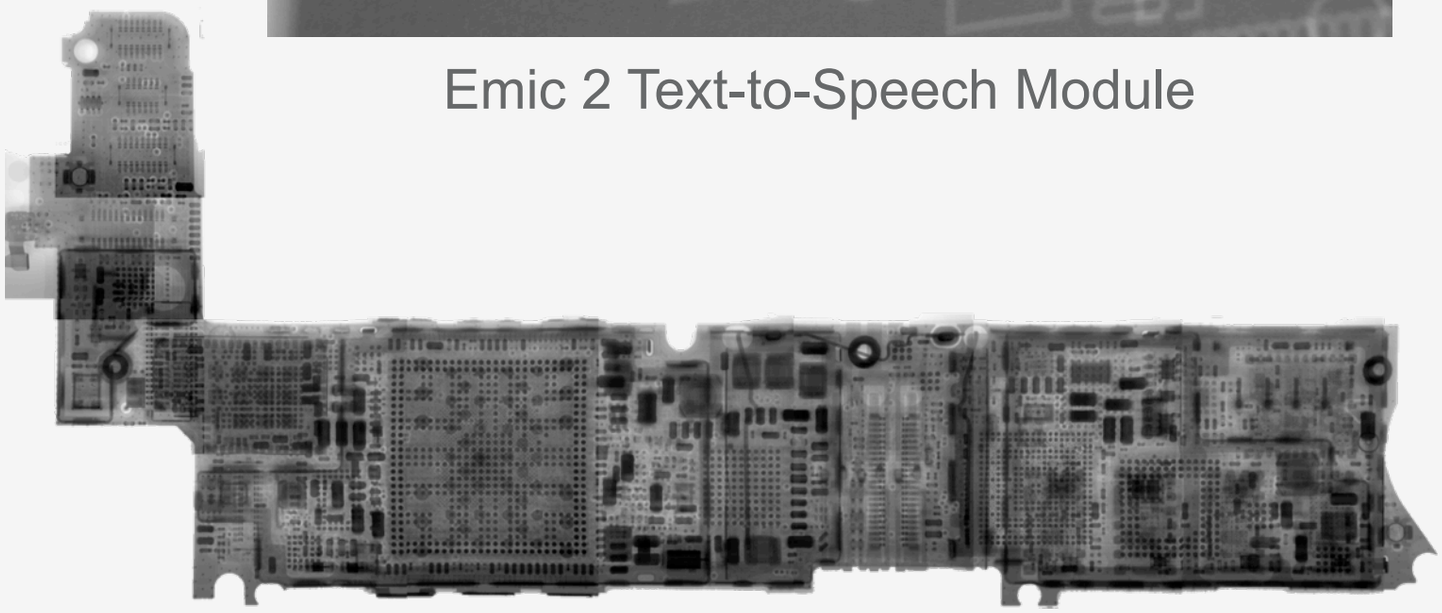
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Imaging: X-Ray (2D)





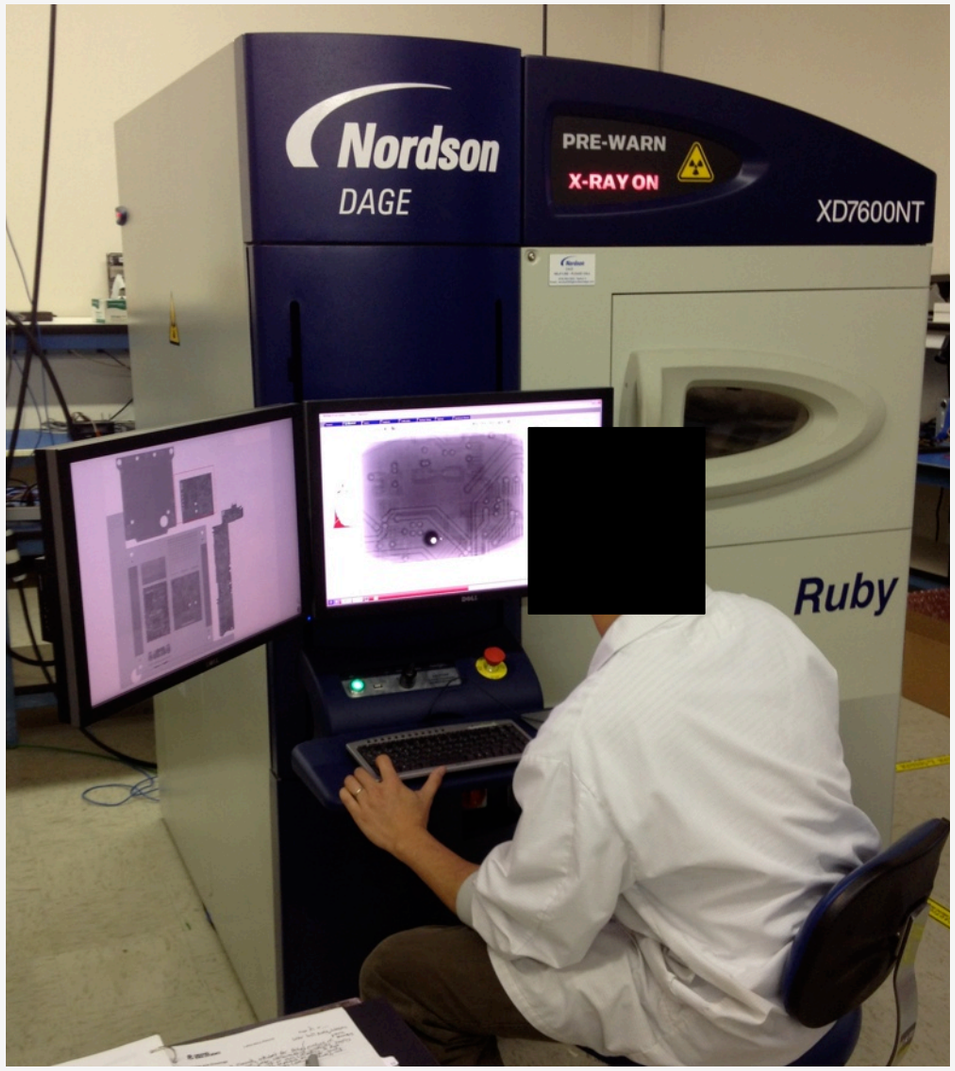
Emic 2 Text-to-Speech Module

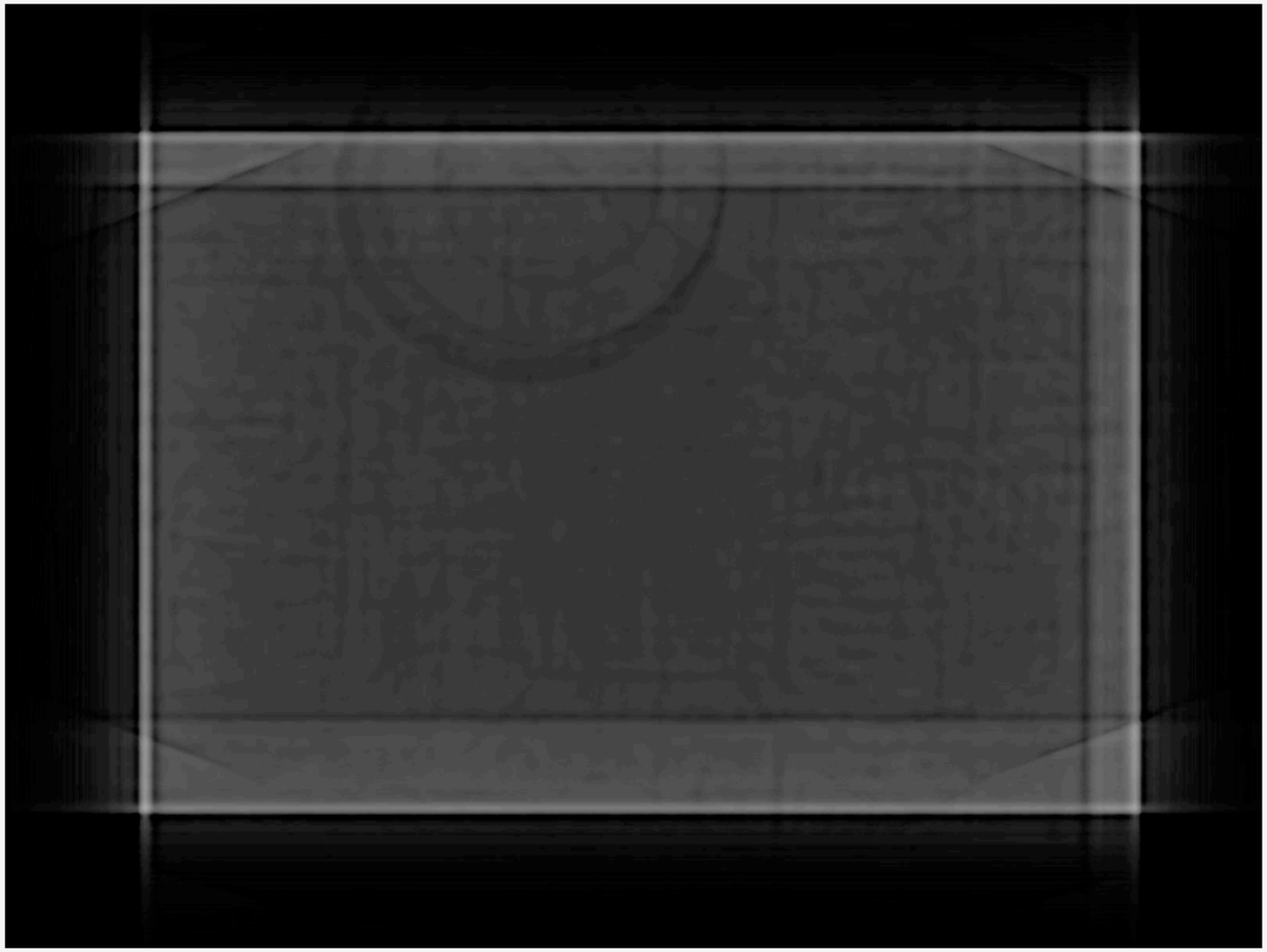


iPhone 4 16GB Assembled

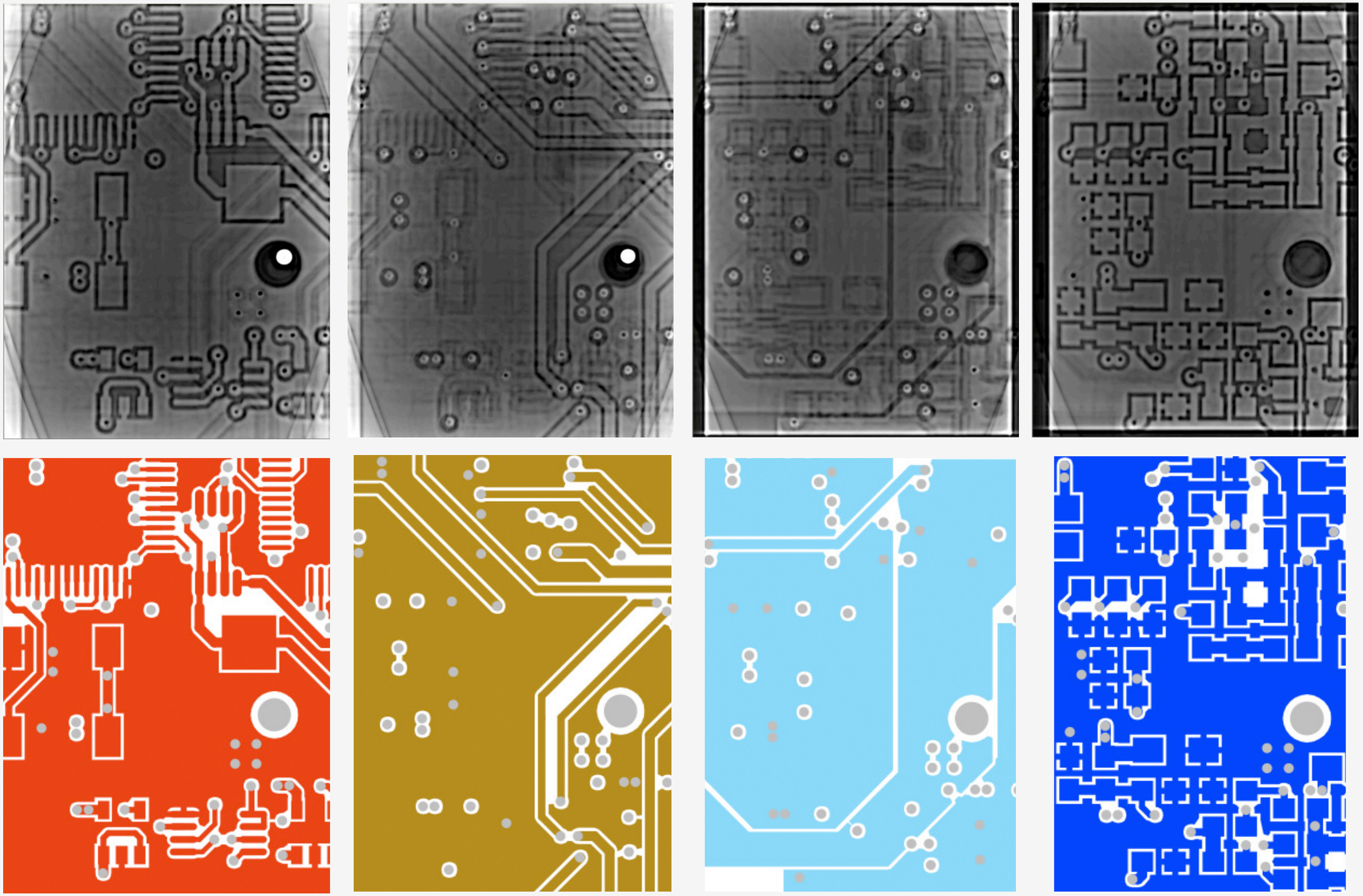
GRAND IDEA STUDIO

Imaging: X-Ray (3D/CT)





Imaging: X-Ray (3D/CT) 2



Emic 2 Text-to-Speech Module (5/8" x 7/8" area)

Characterization Matrix

Technique	Time Required	Cost	Access to Equipment	Ease of Use	Likelihood of Success	Quality of Result
Solder Mask Removal						
Sandpaper	< 1 hour	$	Easy	Easy	Fair	Good
Fiberglass scratch brush	< 1 hour	$	Easy	Easy	Excellent	Excellent
Abrasive sand blasting	< 1 hour	$$	Moderate	Medium	Fair	Good
Ristoff C-8	3-4 hours	$$	Difficult	Hard	Excellent	Excellent
Magnastrip 500	3-4 hours	$	Difficult	Hard	Excellent	Excellent
Laser	2-3 hours	$$$	Moderate	Hard	Varies	Excellent
Delayering						
Sandpaper	2-3 hours	$	Easy	Easy	Fair	Excellent
Dremel tool	< 1 hour	$	Easy	Medium	Poor	Varies
CNC milling	3-4 hours	$$	Moderate	Hard	Excellent	Excellent
Surface grinding	3-4 hours	$$$	Moderate	Hard	Excellent	Excellent
Imaging						
X-ray (2D)	Many	$$$	Moderate	Medium	Poor	Varies
Computerized Tomography	1-2 hours	$$$	Moderate	Medium	Fair	Excellent

The End.

