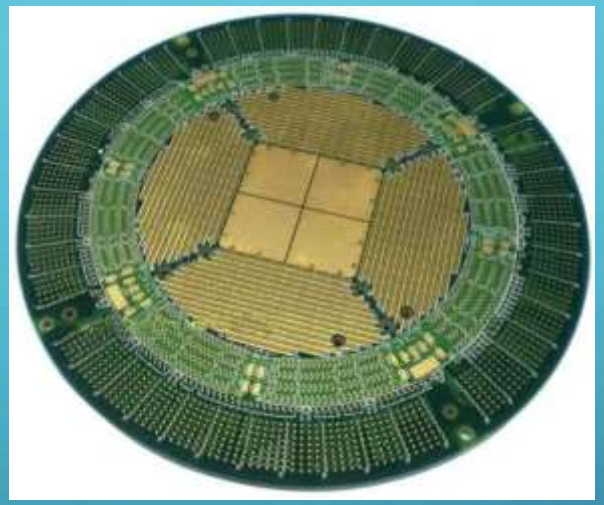
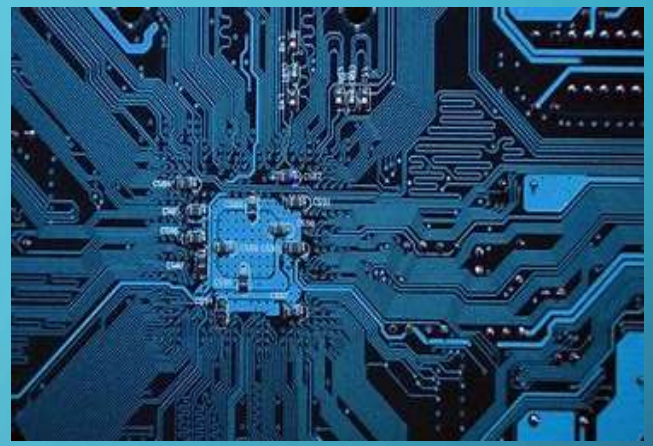
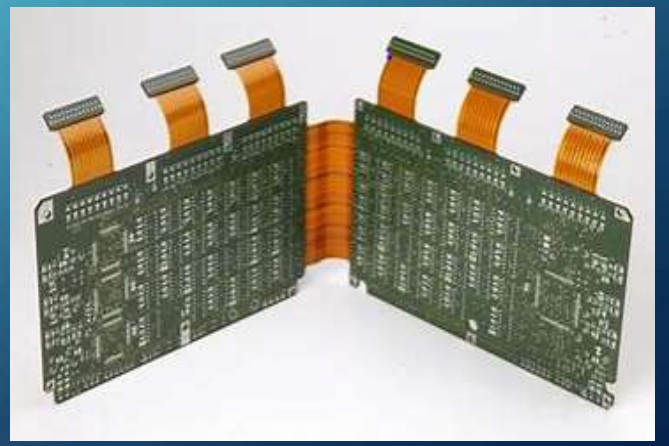
A BEGINNERS GUIDE TO BUILDING A PRINTED CIRCUIT BOARD

NETVIA GROUP, LLC
JANUARY 2019





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INTRODUCTION

NetVia Group LLC

MANUFACTURING A BASIC MULTILAYER PRINTED CIRCUIT BOARD CAN BE SUMMARIZED AS FOLLOWS:

- PLANNING & CAM: CREATION OF BUILD PLAN AND NECESSARY TOOLING
- IMAGING: INNER LAYER IMAGE APPLIED TO SUBSTRATES
- DEVELOP, ETCH, STRIP: ETCH COPPER FEATURES
- INNER LAYER AOI: COMPARE ETCHED PANEL TO CAM DATA
- LAMINATION: BONDING INNER LAYERS TOGETHER
- DRILL: DRILL HOLES IN THE BOARD PER DESIGN & HOLE SIZES DESIRED
- COPPER 1: INITIAL COPPER DEPOSIT INTO THE DRILLED HOLES
- IMAGING: OUTER LAYER IMAGE APPLIED TO THE PANELS
- COPPER 2: PLATE THE OUTER LAYERS WITH COPPER (IE. PATTERN PLATE)
- STRIP, ETCH, STRIP: ETCH COPPER FEATURES
- OUTER LAYER AOI: COMPARE ETCHED PANEL TO CAM DATA
- SOLDER MASK: PROTECTIVE COATING APPLIED TO THE OUTER LAYERS
- SCREEN PRINTING: PRINT A “LEGEND” ON TO THE BOARD (TEXT IDENTIFIERS)
- FINAL FINISH: APPLYING A FINAL FINISH TO EXPOSED COPPER
- ROUTE: CUTTING OF THE FINISHED BOARDS FROM THE PANEL
- FINAL QC: VISUAL & ELECTRICAL TESTING PRIOR TO SHIPMENT TO THE CUSTOMER

BASICS – A QUICK VIEW

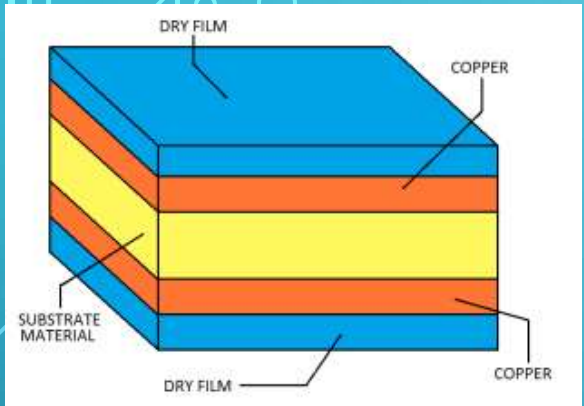
THE FOLLOWING 3 SLIDES WILL SHOW A BASIC VIEW OF THE STEPS PREVIOUSLY MENTIONED.

FOLLOWING THOSE THREE SLIDES WE WILL GO INTO GREATER DETAIL SHOWING AN ACTUAL REPRESENTATION OF PCB FABRICATION.

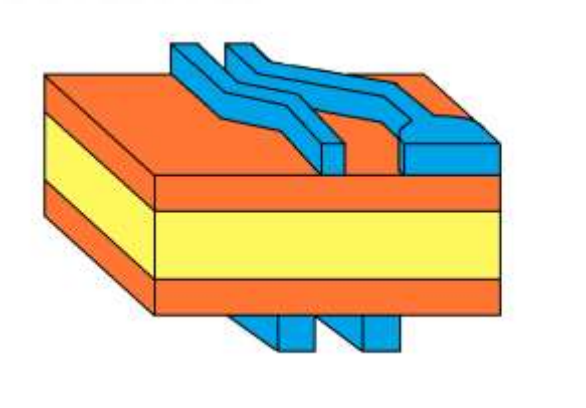
NOTE, THERE ARE MANY UNMENTIONED STEPS USED IN FABRICATION, THE PRESENTATION WILL FOCUS ON THE MAIN PROCESS STEPS.

BASICS QUICK VIEW

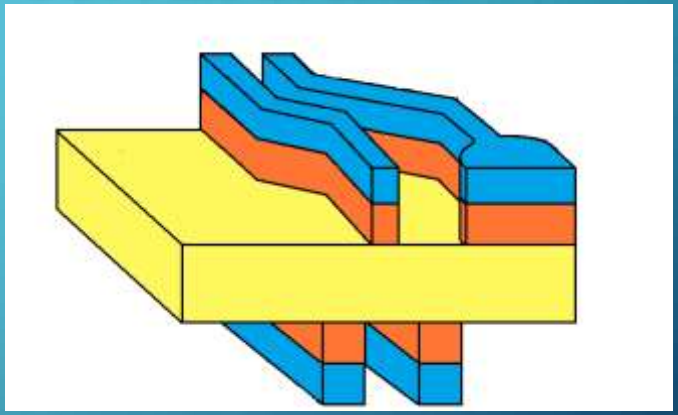
INNER LAYER DRY FILM APPLICATION



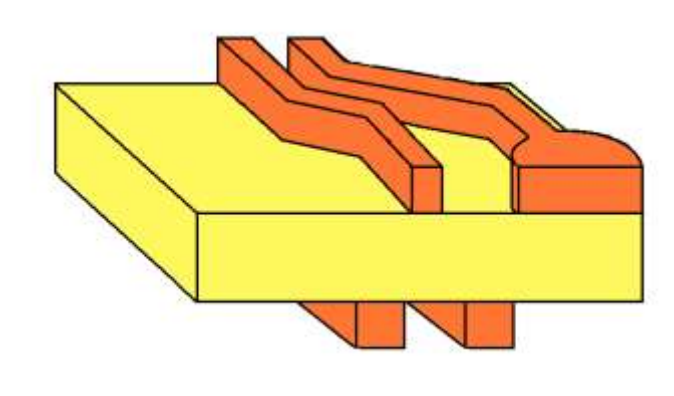
INNER LAYER DRY FILM EXPOSED / DEVELOPED



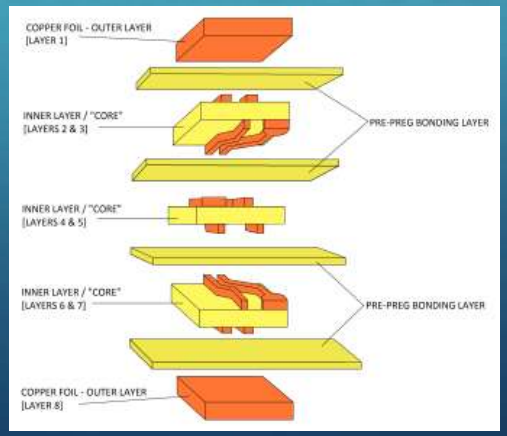
INNER LAYER COPPER ETCHED



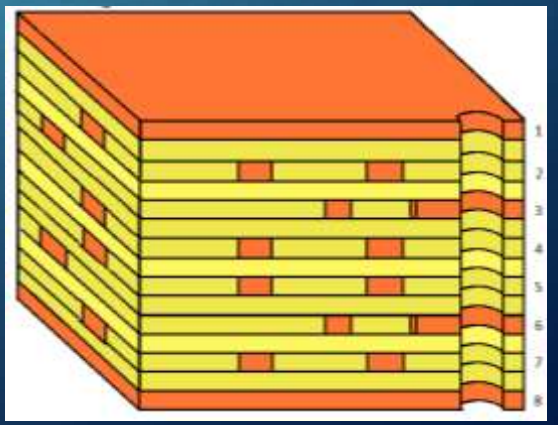
DRY FILM RESIST STRIPPED



ALL LAYERS ARE LAMINATED TOGETHER

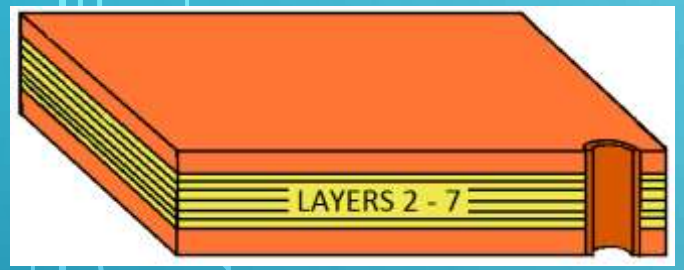


LAMINATED PANEL IS THEN DRILLED

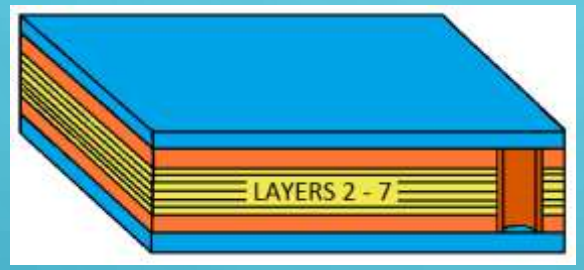


BASICS QUICK VIEW

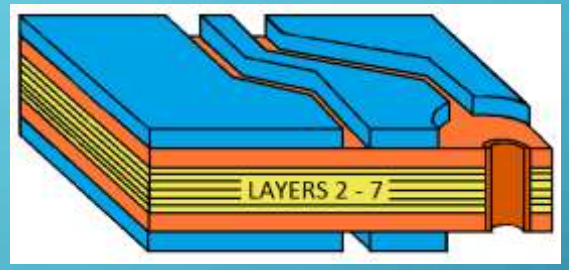
ELECTROLESS COPPER DEPOSITED INTO DRILLED HOLES



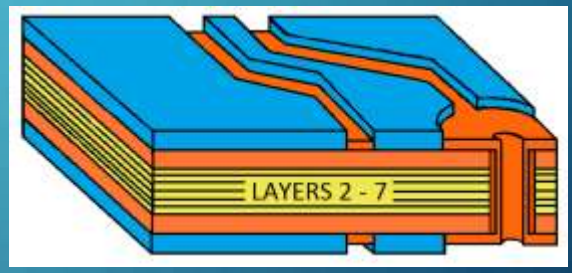
OUTER LAYER DRY FILM APPLIED



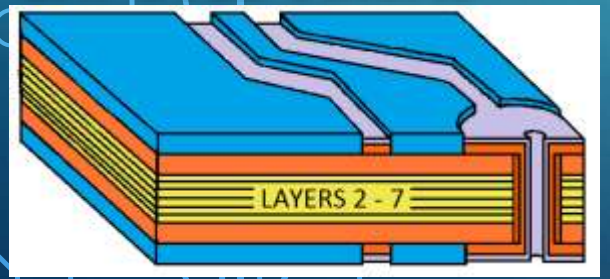
OUTER LAYER IMAGE EXPOSED / DEVELOPED



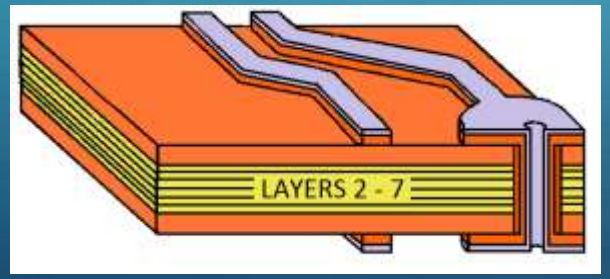
COPPER II OR PATTERN PLATE



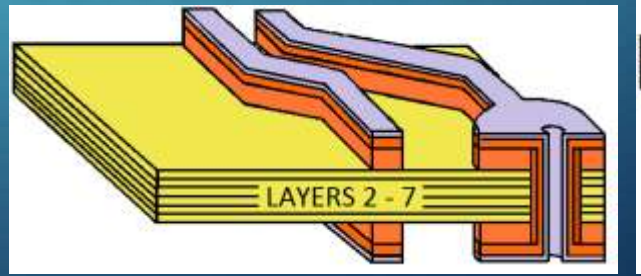
TIN IS PLATED TO EXPOSED AREAS



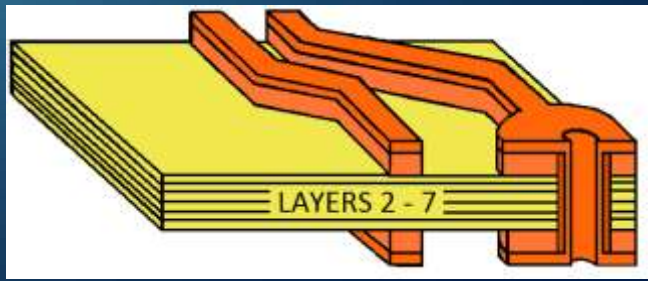
DRY FILM RESIST IS STRIPPED



ALL EXPOSED COPPER IS ETCHED

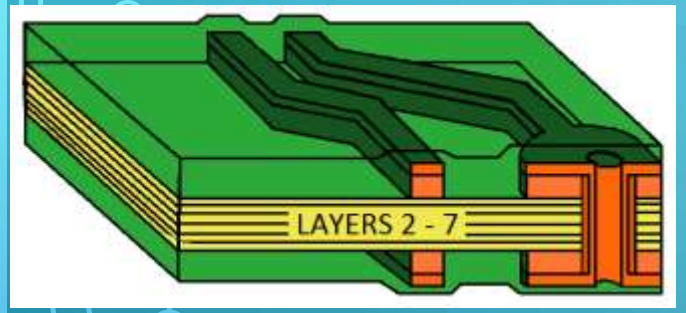


TIN IS STRIPPED

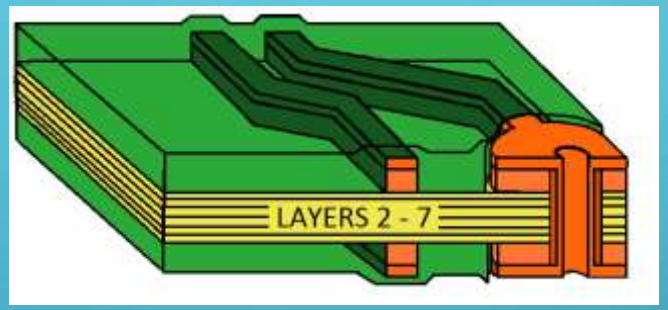


BASICS QUICK VIEW

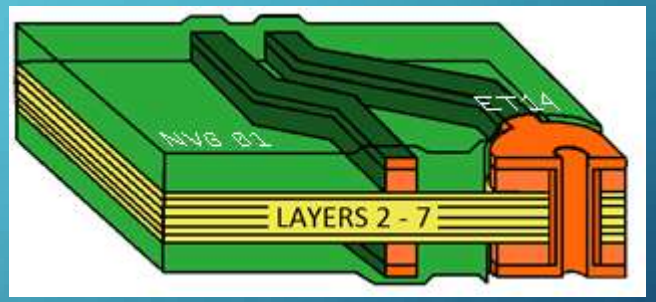
LIQUID PHOTO-IMAGEABLE SOLDER MASK IS APPLIED



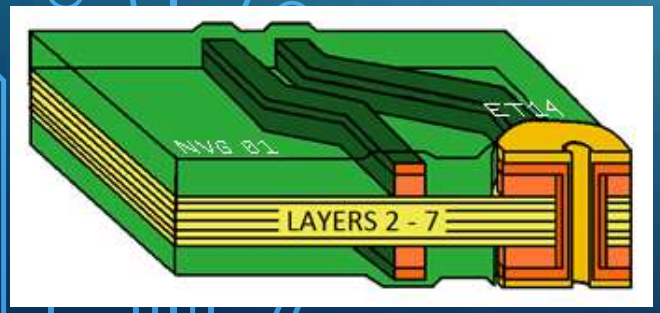
PANEL IS IMAGED AND UN-DESIRED SOLDER MASK IS DEVELOPED OFF



SILK SCREEN LEGEND IS PRINTED TO BOARD PER CUSTOMER DESIGN



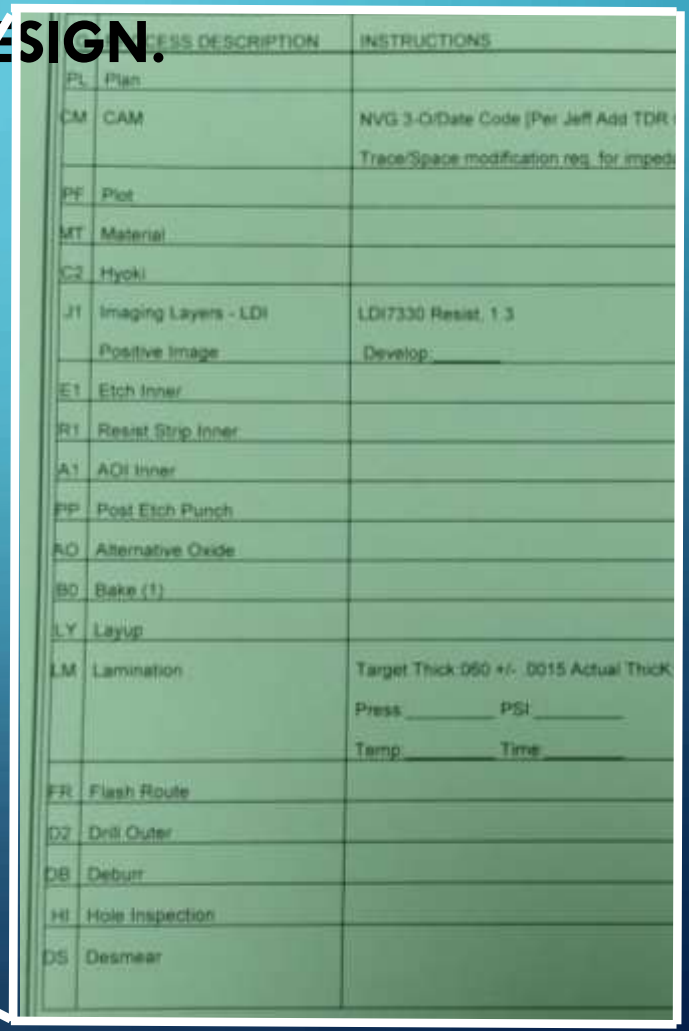
FINAL FINISH DEPOSITED TO EXPOSED AREAS



PLANNING

ONCE A CUSTOMER ORDER IS RECEIVED IT IS GIVEN TO "PLANNING" TO DETERMINE THE STEPS NEEDED TO FABRICATE THE CUSTOMER DESIGN. EACH ORDER IS ASSIGNED A "TRAVELER" WHICH FOLLOWS EACH PANEL THROUGH FABRICATION.

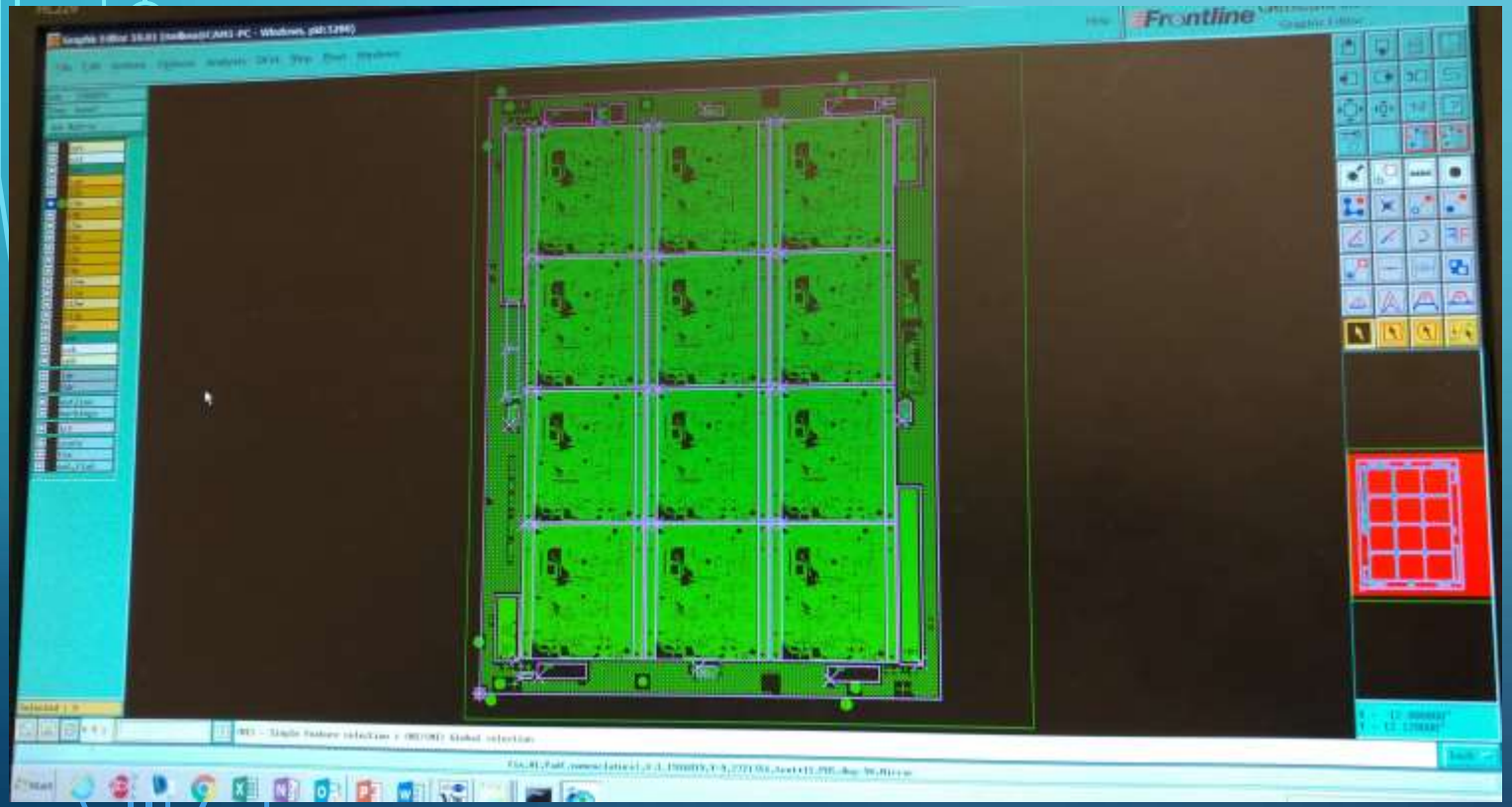
TRAVELER FOR FULLY PLANNED BOARD – ALL STEPS NEEDED FOR THE BUILD



	PROCESS DESCRIPTION	INSTRUCTIONS
PL	Plan	
CM	CAM	NVG 3-O/Date Code [Per Jeff Add TDR Trace/Space modification req. for imped
PF	Plot	
MT	Material	
C2	Hyoki	
J1	Imaging Layers - LDI Positive Image	LDI7330 Resist, 1.3 Develop:_____
E1	Etch Inner	
R1	Resist Strip Inner	
A1	AOI Inner	
PP	Post Etch Punch	
AO	Alternative Oxide	
B0	Bake (1)	
LY	Layup	
LM	Lamination	Target Thick 060 +/- 0015 Actual Thick Press _____ PSI _____ Temp _____ Time _____
FR	Flash Route	
D2	Drill Outer	
DB	Deburr	
HI	Hole Inspection	
DS	Desmear	

CAM

AFTER A TRAVELER IS CREATED THE JOB IS SENT TO “CAM” TO CREATE ALL NECESSARY PROGRAM FILES FOR BOARD FABRICATION.

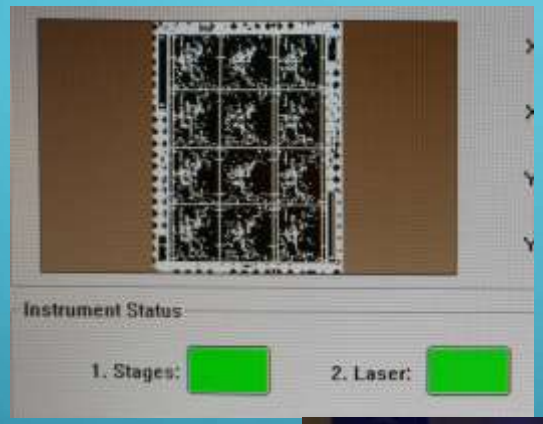


EXAMPLE OF CAM PLANNING BOARD DESIGN PER CUSTOMER SUPPLIED FILES

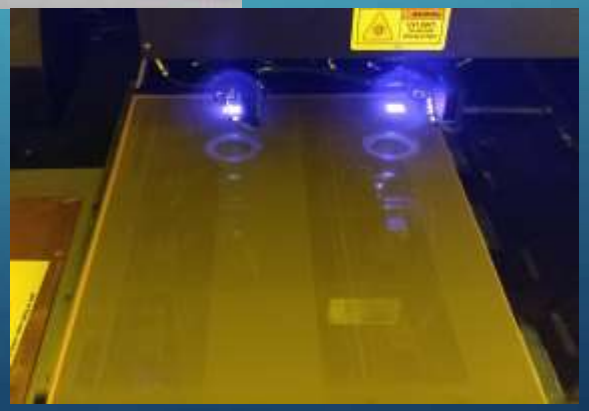
IMAGING (INNER LAYERS)

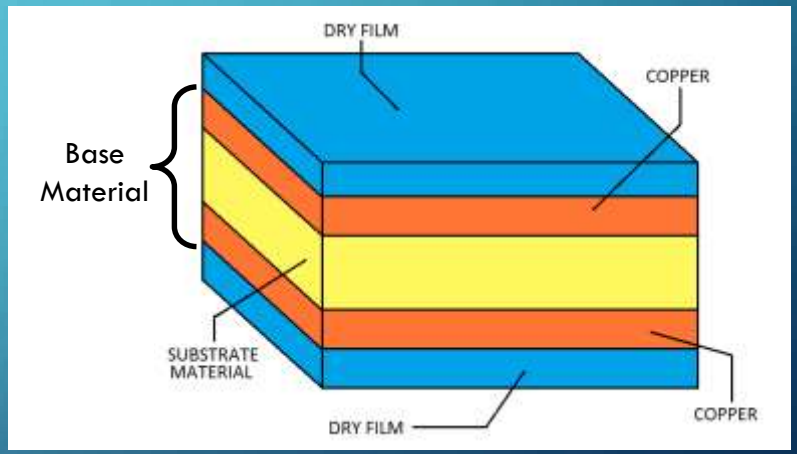
BASE MATERIAL FOR INNER LAYERS TYPICALLY CONSISTS OF A SUBSTRATE (COMMONLY WOVEN FIBERGLASS) WITH COPPER ON EACH SIDE. MATERIALS ARE SENT TO "IMAGING" & DRY FILM IS APPLIED ON BOTH SIDES. ON INNER LAYERS A "POSITIVE" IMAGE IS USED TO COVER / PROTECT ONLY COPPER WHICH IS TO REMAIN.

DRY FILM IS APPLIED TO THE PANEL



DESIGN IS LASER IMAGED TO THE FILMED PANEL(S)

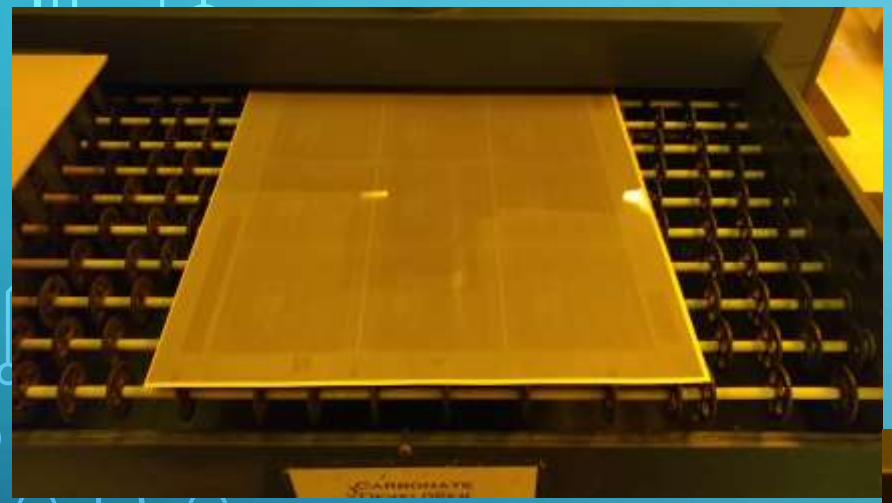




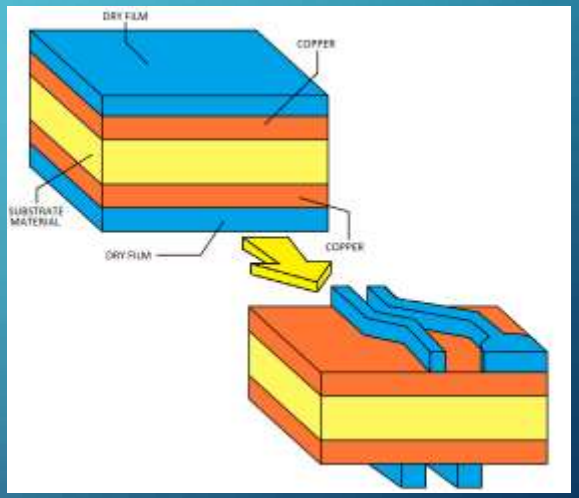
REPRESENTATION OF MATERIALS PRE-EXPOSURE

IMAGING (INNER LAYERS)

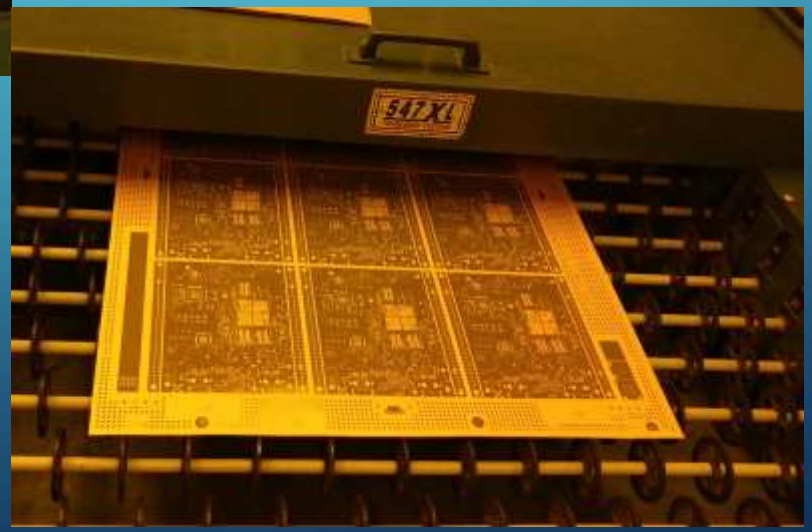
ONCE AN IMAGE IS EXPOSED ON TO THE PANEL IT IS THEN DEVELOPED. ANY AREAS EXPOSED TO U.V. LIGHT WILL HARDEN AND NOT DEVELOP OFF.



IMAGED PANEL ENTERING DEVELOPER



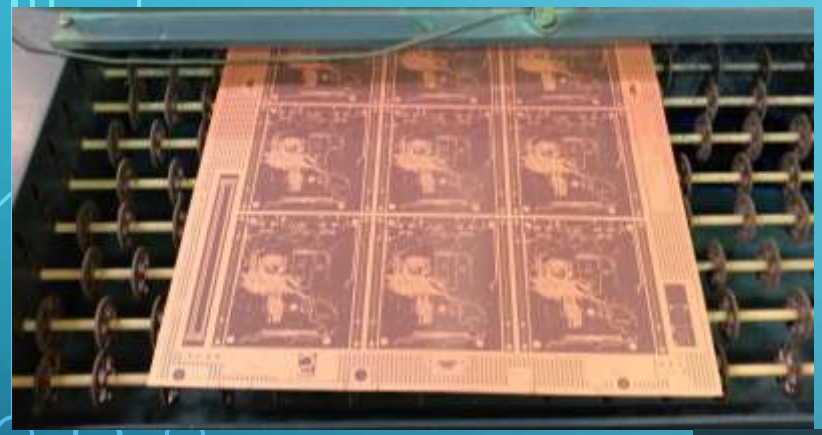
REPRESENTATION OF BEFORE / AFTER



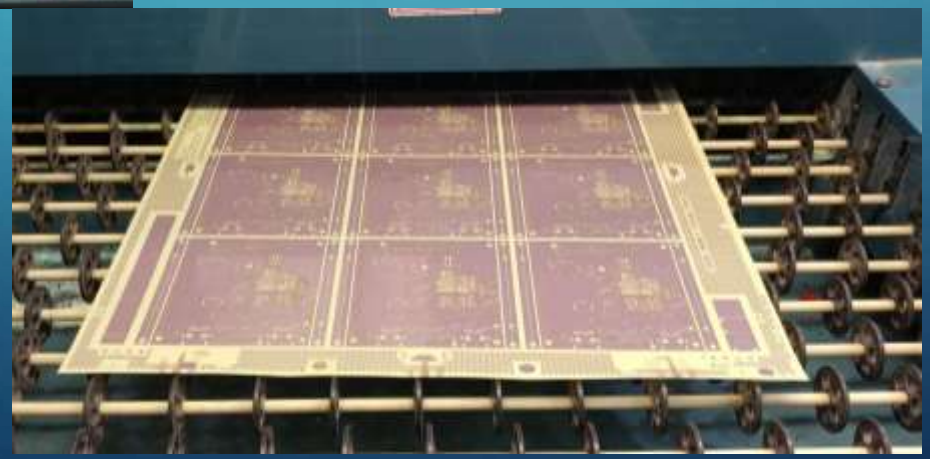
PANEL EXITING DEVELOPER – ALL UNEXPOSED / UN-HARDENED FILM REMOVED

ETCH (INNER LAYER)

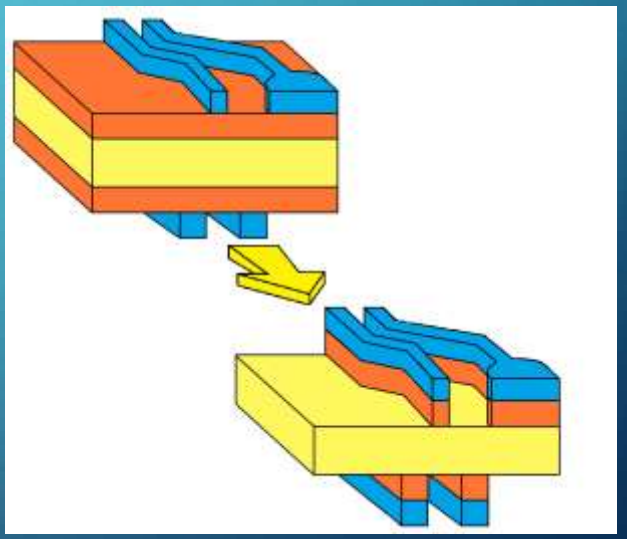
NOW THAT THE CIRCUITRY WHICH IS TO REMAIN ON THE PANEL IS DEFINED & PROTECTED WITH EXPOSED DRY FILM, WE ETCH AWAY UNDESIRED COPPER FROM THE PANELS.



PANEL ENTERING THE ETCH LINE



PANEL EXITING THE ETCH LINE – ALL UNPROTECTED COPPER ETCHED OFF

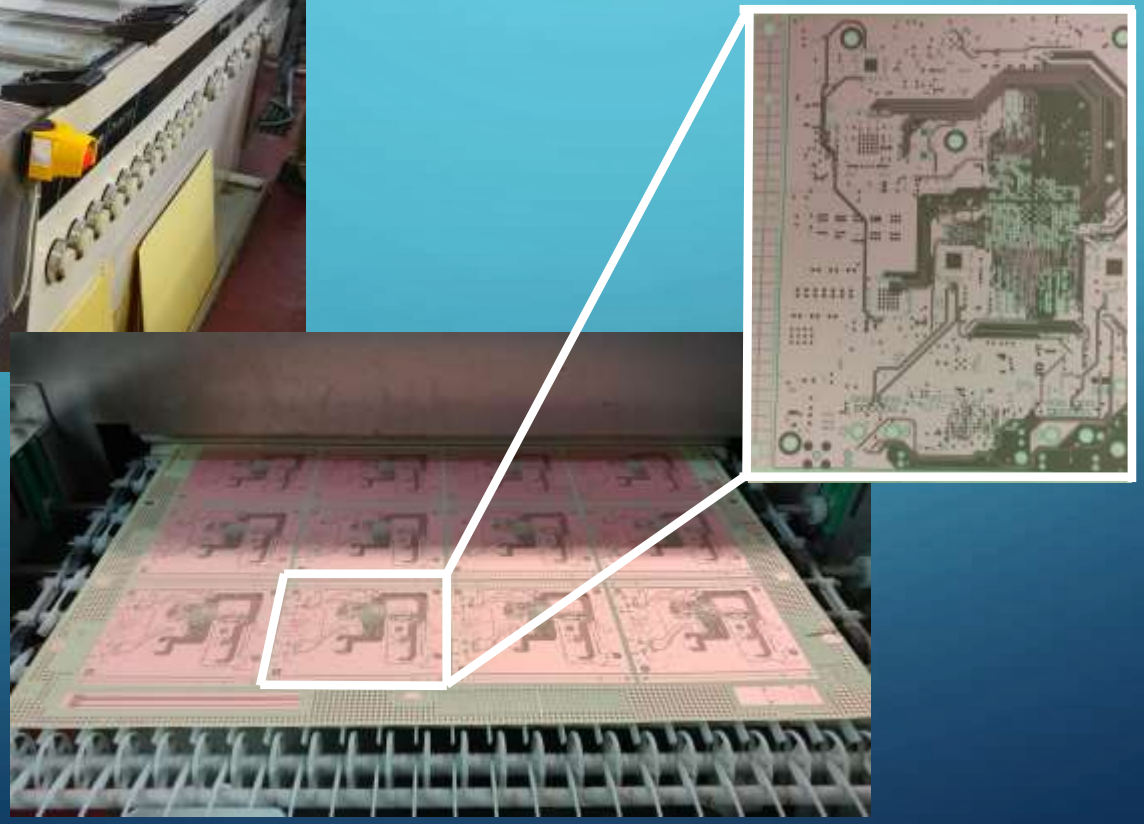


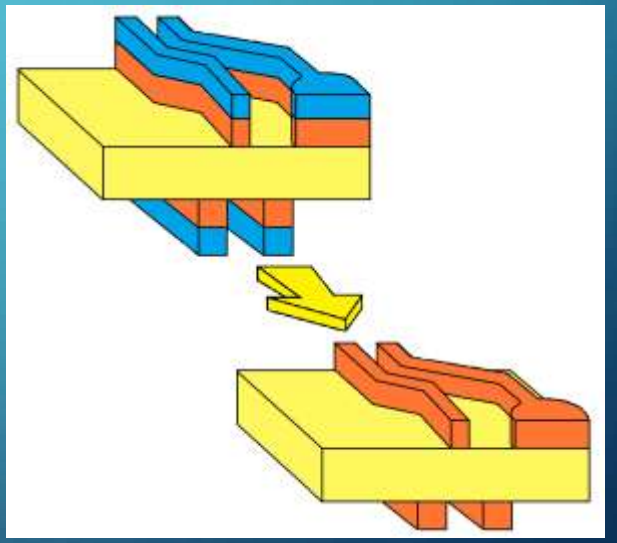
REPRESENTATION OF BEFORE / AFTER

ETCH (INNER LAYER)

THE FINAL STEP INVOLVED IN THE STRIP & ETCH OF INNER LAYERS IS REMOVING THE HARDENED DRY FILM FROM THE SUBSTRATE.

HARDENED DRY FILM REMOVED TO REVEAL COPPER DESIGN ON THE INNER LAYER





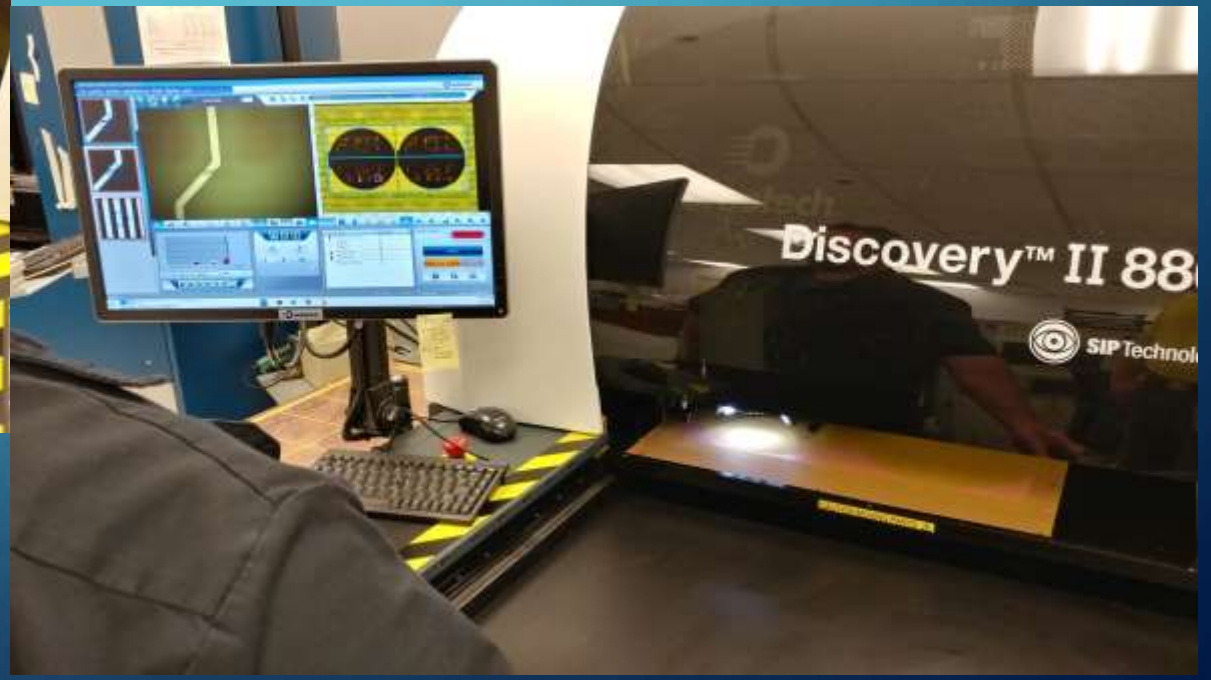
REPRESENTATION OF BEFORE / AFTER

QC - INNER LAYER

INNER LAYERS GO THROUGH AOI (AUTOMATED OPITICAL INSPECTION) WHICH COMPARES THE ETCHED PANEL TO CUSTOMER CAM FILES TO INSURE IT MATCHES THE DESIGN, INSURING THERE ARE NO SHORTS OR OPENS IN THE CIRCUITRY

AOI MACHINE INSPECTING PANEL, COMPARING TO LOADED CAM DATA

CAM DATA BEING LOADED IN TO AOI

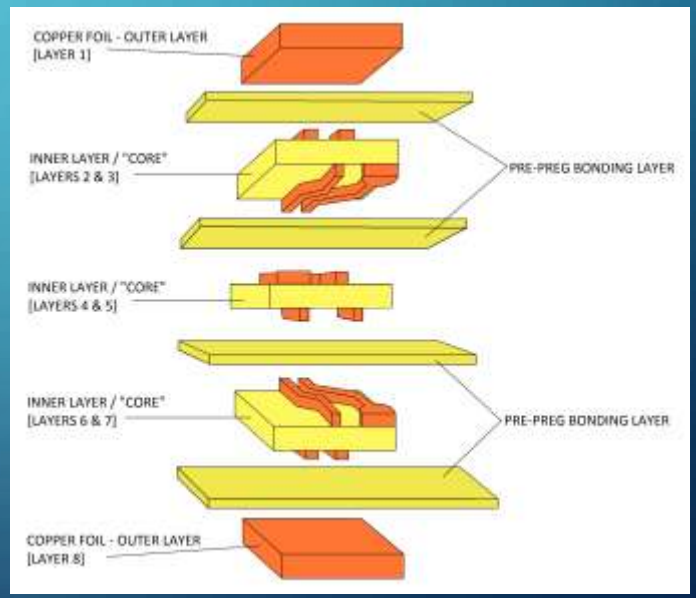


LAMINATION

INNER LAYERS ARE THEN "STACKED UP" IN THE PROPER ORDER, LAMINATED TOGETHER WITH ADHESIVE ("PRE-PREG"), AND A LAYER OF COPPER IS PLACED ON BOTH THE TOP & BOTTOM TO FORM THE OUTER LAYERS.

PANELS ARE "STACKED UP" IN ORDER

THEN PLACED IN A PRESS FOR LAMINATION



REPRESENTATION OF BEFORE / AFTER

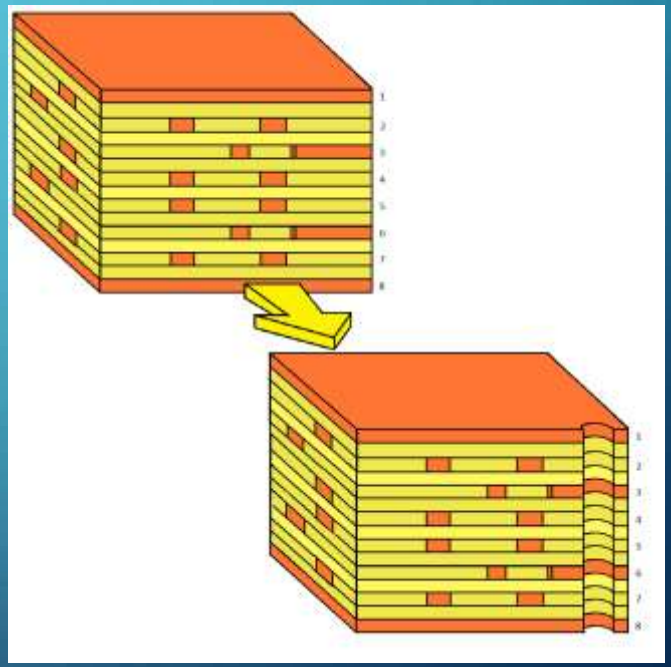
DRILL

ONCE LAMINATED, PANELS WILL BE DRILLED PER DESIGN.

LAMINATED PANEL PRIOR TO DRILL

DURING DRILL

PANEL AFTER DRILLING

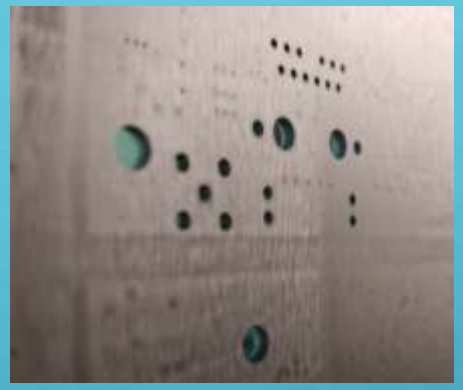


REPRESENTATION OF BEFORE / AFTER

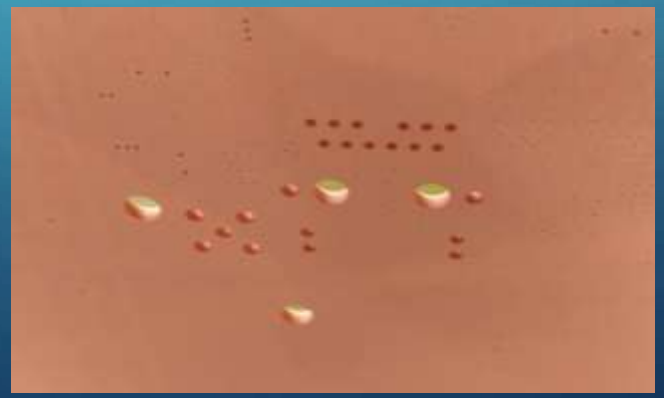
ELECTROLESS COPPER

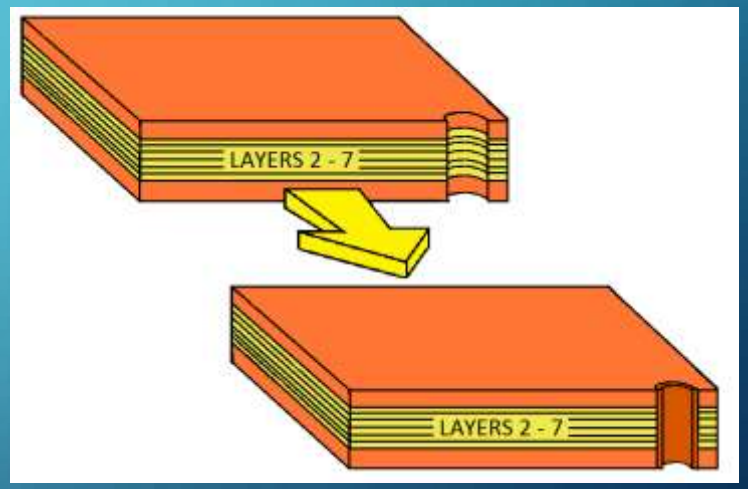
ONCE DRILLED, THE HOLES ARE PLATED IN AN "ELECTROLESS" PROCESS ("COPPER 1") TO DEPOSIT ALL HOLES WITH A LAYER OF COPPER WHICH WILL PROVIDE A METALIZED BASE WHICH ADDITIONAL COPPER CAN THEN BE PLATED ON TO.

ELECTROLESS COPPER BATH LINE



THROUGH HOLES BEFORE & AFTER ELECTROLESS





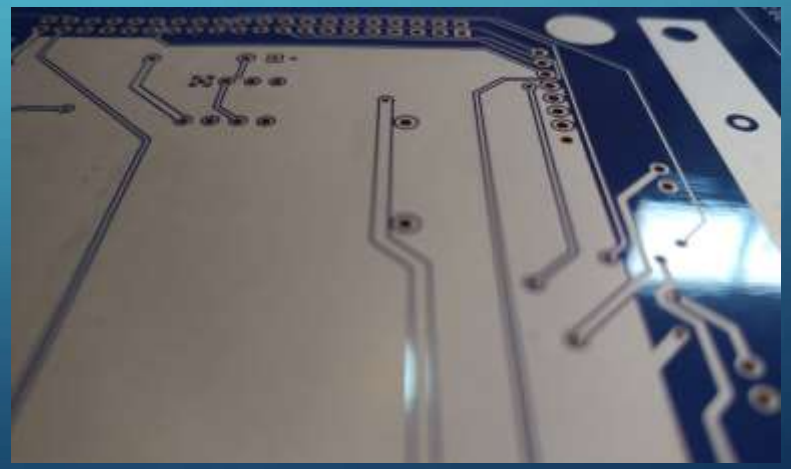
REPRESENTATION OF BEFORE / AFTER

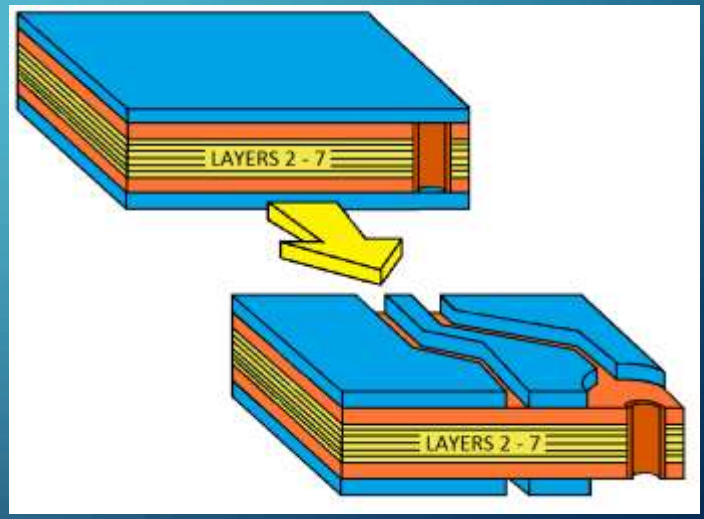
IMAGING (OUTER LAYERS)

AFTER ELECTROLESS PLATING, OUTER LAYERS ARE DRY FILM COATED FOR IMAGING. ON OUTER LAYERS A "NEGATIVE" IMAGE IS USED TO EXPOSE AREAS SO THEY MAY SELECTIVELY RECEIVE ADDITIONAL COPPER PLATING (IE. PATTERN PLATE)

PANEL IS DRY-FILMED, THEN LASER IMAGED

IMAGED PANEL AFTER DEVELOPER, SHOWING CIRCUITRY NOW EXPOSED





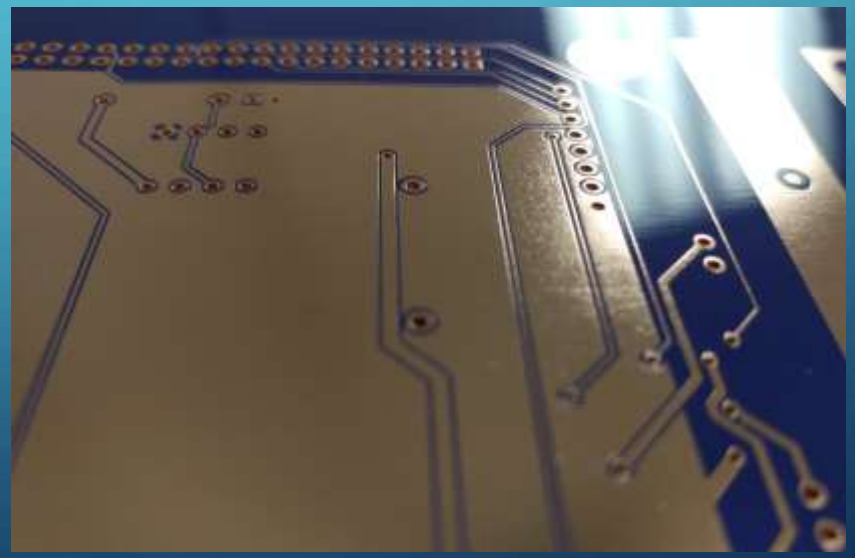
REPRESENTATION OF BEFORE / AFTER

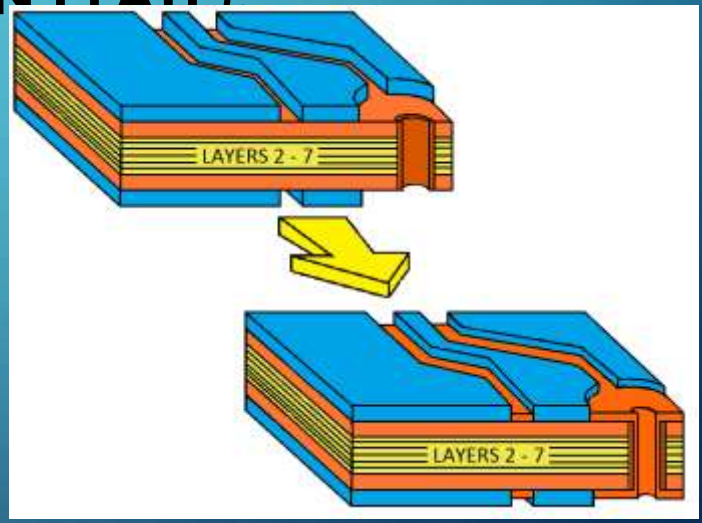
PLATING

WITH COPPER CIRCUITRY NOW EXPOSED, AN EXTRA LAYER OF COPPER IS APPLIED TO BUILD UP SURFACE LAYER COPPER THROUGH AN ELECTROLYTIC PROCESS (THIS STEP IS COMMONLY REFERRED TO AS "COPPER 2" OR PATTERN PLATE)

PANEL IN SECOND COPPER PLATING TANK

PANEL AFTER RECEIVING "2ND COPPER" PLATING

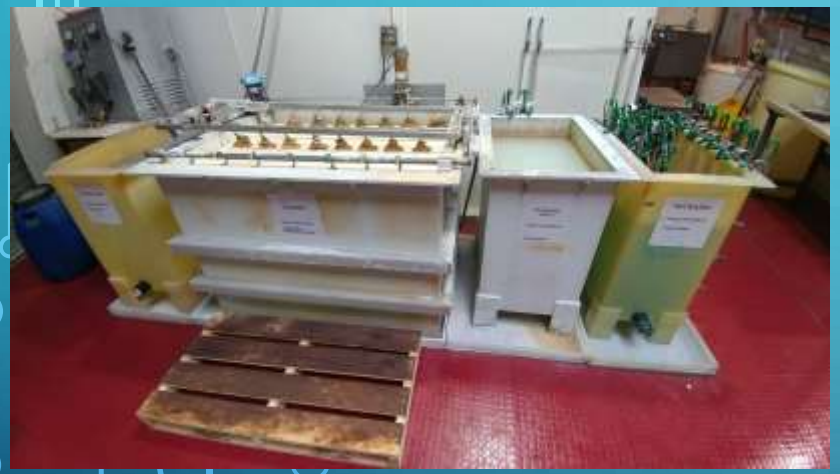




REPRESENTATION OF BEFORE / AFTER

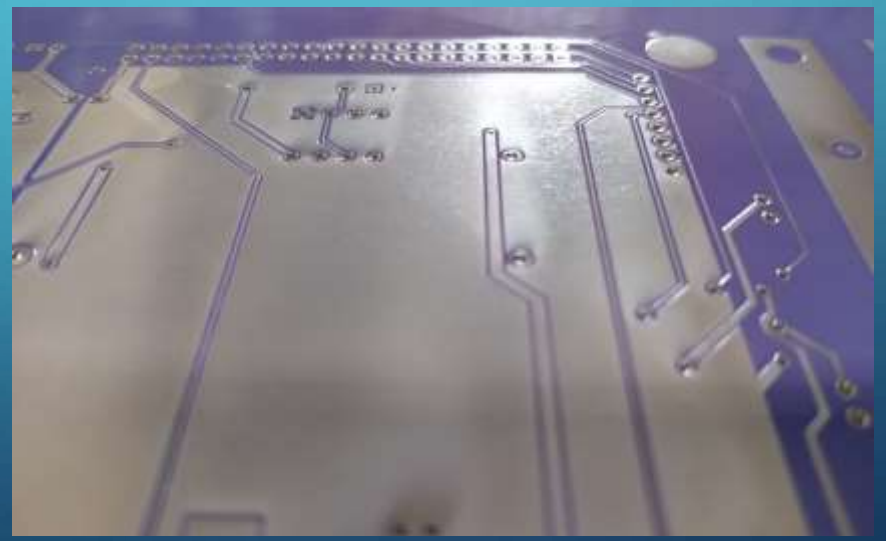
PLATING

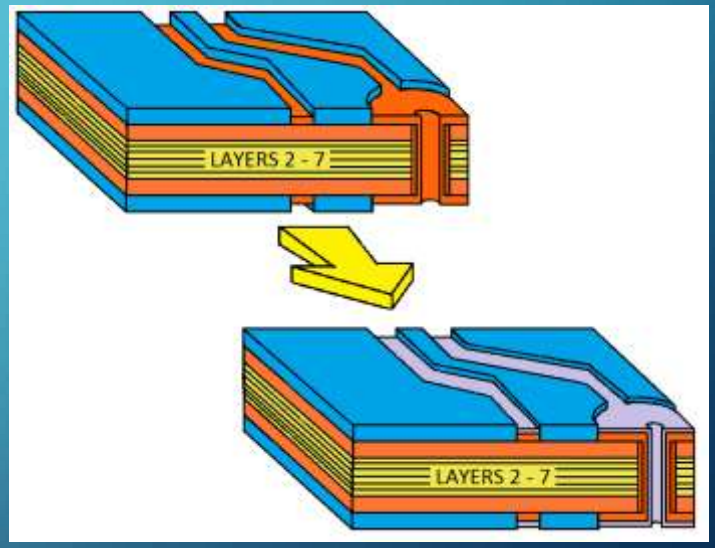
AS THE PANELS STILL HAVE THE ORIGINAL BASE COPPER ON THEM, BEFORE ETCHING OFF COPPER, THE PANELS ARE PLATED WITH A LAYER OF TIN ("TIN RESIST").



PANELS ARE PLACED INTO A TIN PLATING TANK

TIN IS PLATED OVER ALL EXPOSED COPPER





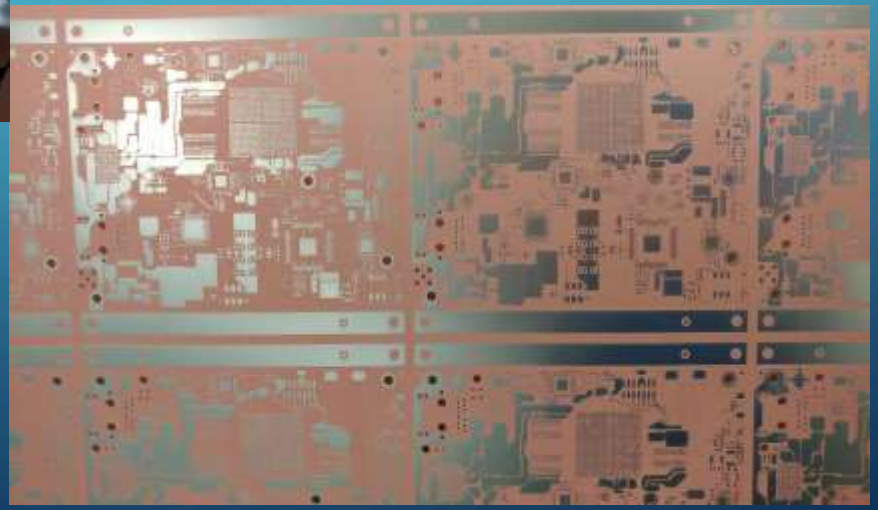
REPRESENTATION OF BEFORE / AFTER

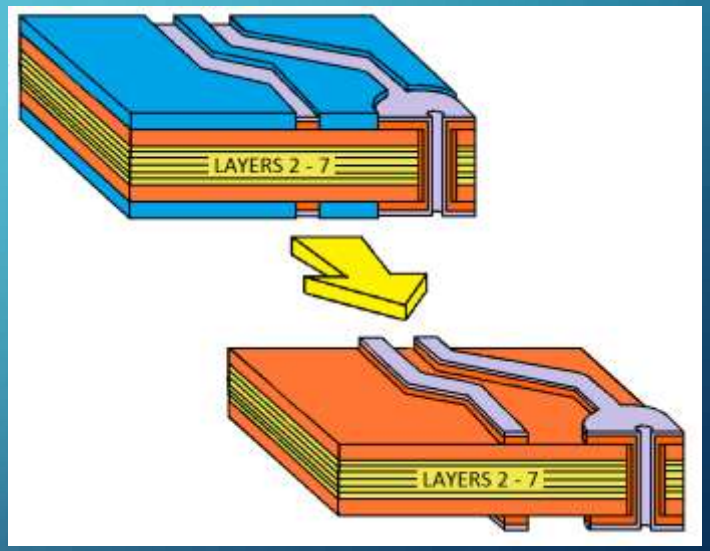
ETCH (OUTER LAYERS)

WITH TIN PROTECTING THE COPPER WE WANT TO KEEP, PANELS NOW HAVE THEIR PHOTO-RESIST (DRY FILM) STRIPPED OFF.

PANELS ARE STRIPPED OF ALL DRY FILM RESIST

PANELS EXITING RESIST STRIP LINE

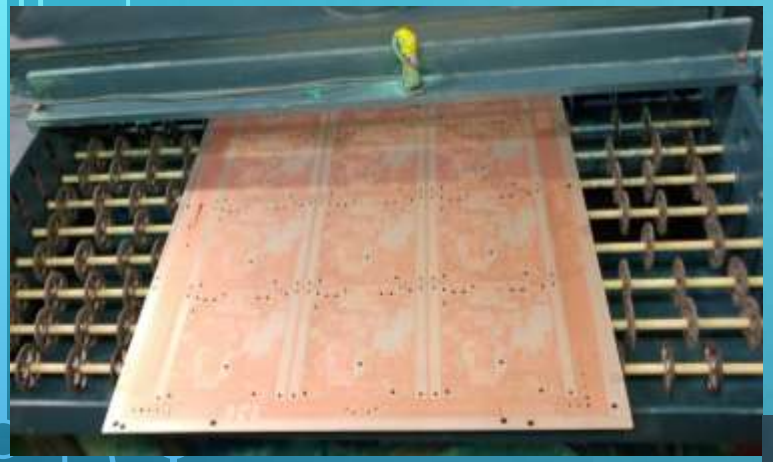




REPRESENTATION OF BEFORE / AFTER

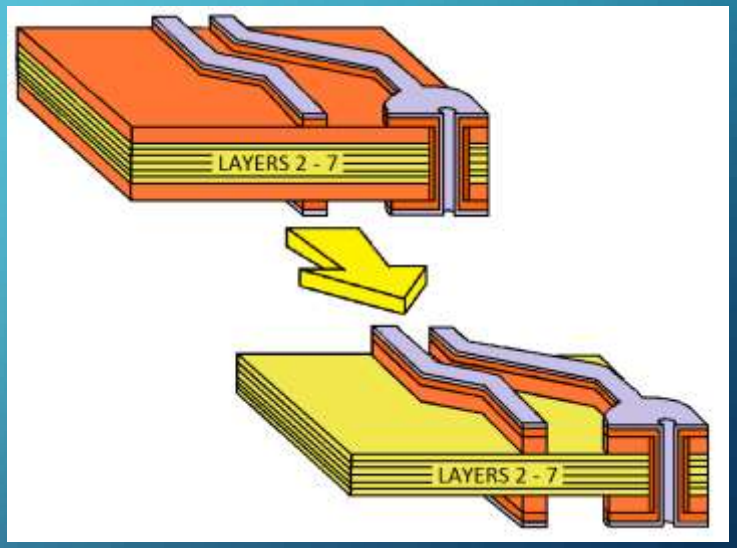
ETCH (OUTER LAYERS)

PANELS ARE PUT THROUGH THE ETCHER TO HAVE ALL NON-TIN COATED AREAS ETCHED OFF THE PANEL.



PANELS ENTERING ETCHER

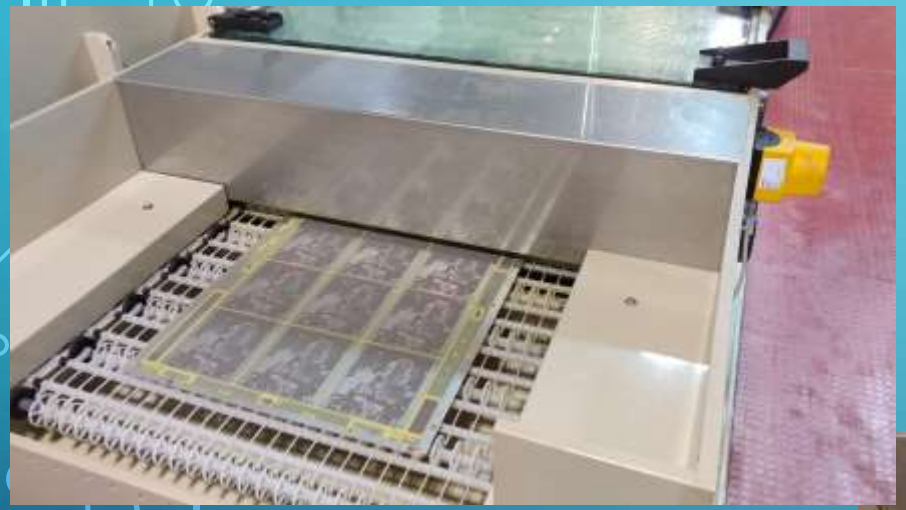
PANELS EXITING ETCHER – ALL UNPROTECTED COPPER ETCHED OFF



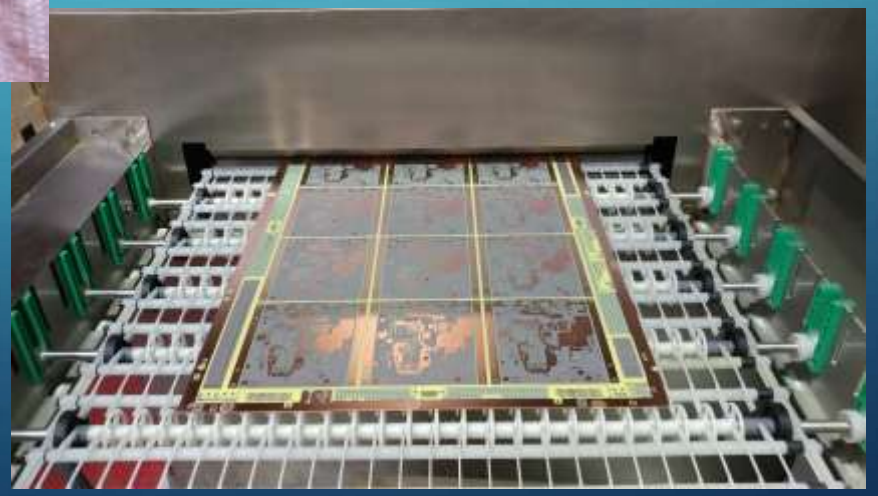
REPRESENTATION OF BEFORE / AFTER

ETCH (OUTER LAYERS)

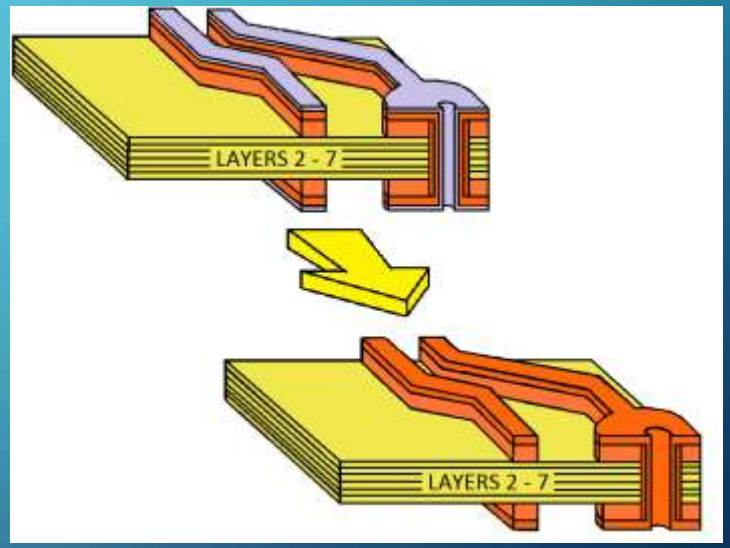
THE LAYER OF TIN PROTECTING DESIRED CIRCUIT AREAS IS STRIPPED FROM THE PANELS.



PANEL ENTERING TIN STRIPPER



PANELS EXITING WITH ALL TIN STRIPPED



REPRESENTATION OF BEFORE / AFTER

QC - OUTER LAYER

OUTER LAYERS GO THROUGH AOI TO COMPARE THE ETCHED PANEL TO CUSTOMER CAM DATA TO INSURE IT MATCHES THE DESIGN AND THERE ARE NO SHORTS OR OPENS IN THE CIRCUITRY

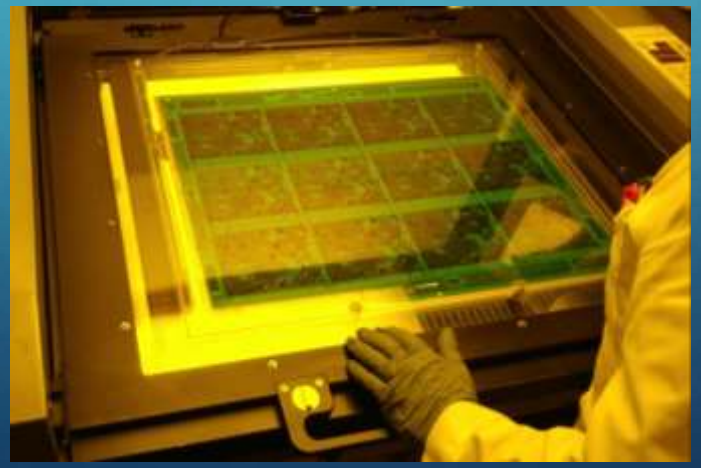
AOI MACHINE INSPECTING PANEL, COMPARING TO LOADED CAM DATA

PANEL CAM DATA BEING LOADED IN TO AOI

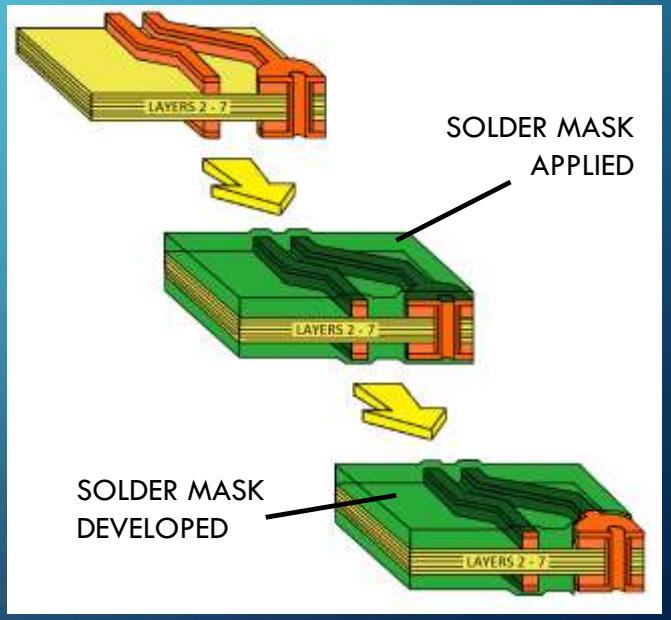
SOLDER MASK

WITH PANELS NOW FULLY RESEMBLING FINAL DESIGN, IT IS NECESSARY TO PROTECT THE BOARDS FROM SUBSEQUENT SOLDERING, EXTERNAL FORCES & ENVIRONMENT. TO DO SO, A LAYER OF SOLDER MASK IS APPLIED TO THE SURFACES USING SIMILAR IMAGING TO DRY FILM.

PANEL COATED WITH LIQUID PHOTO-IMAGEABLE SOLDER MASK (LPI)



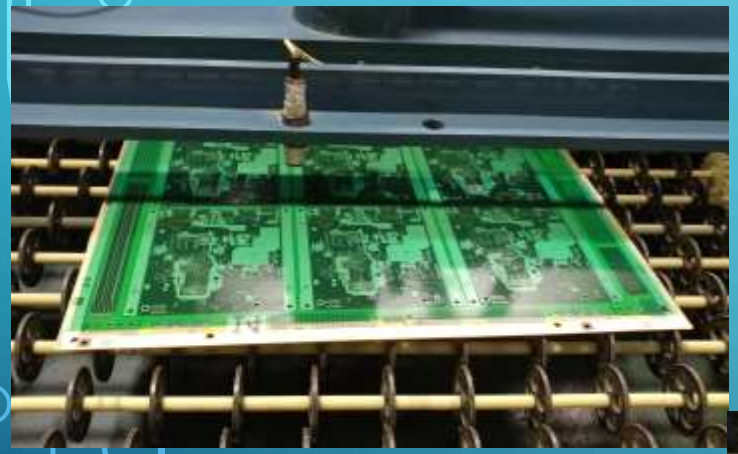
AND IS THEN IMAGED TO UV LIGHT IN SELECT AREAS TO HARDEN THE SOLDER MASK



REPRESENTATION OF BEFORE / AFTER

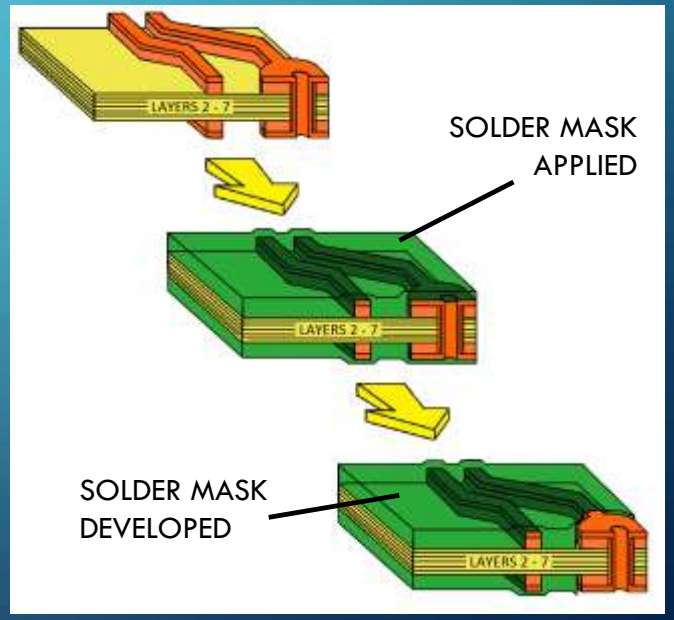
SOLDER MASK

ONCE THE IMAGE IS APPLIED TO THE PANELS, THE SOLDER MASK IS NOW HARDENED IN SPECIFIC AREAS WHERE IT IS DESIRED TO REMAIN. THOSE AREAS WHICH WERE NOT EXPOSED OR HARDENED, ARE REMOVED IN THE SOLDER MASK DEVELOPER.



PANEL AFTER EXPOSURE, ENTERING THE DEVELOPER

PANEL EXITING THE DEVELOPER, ONLY DESIRED SOLDER MASK LAYER REMAINING

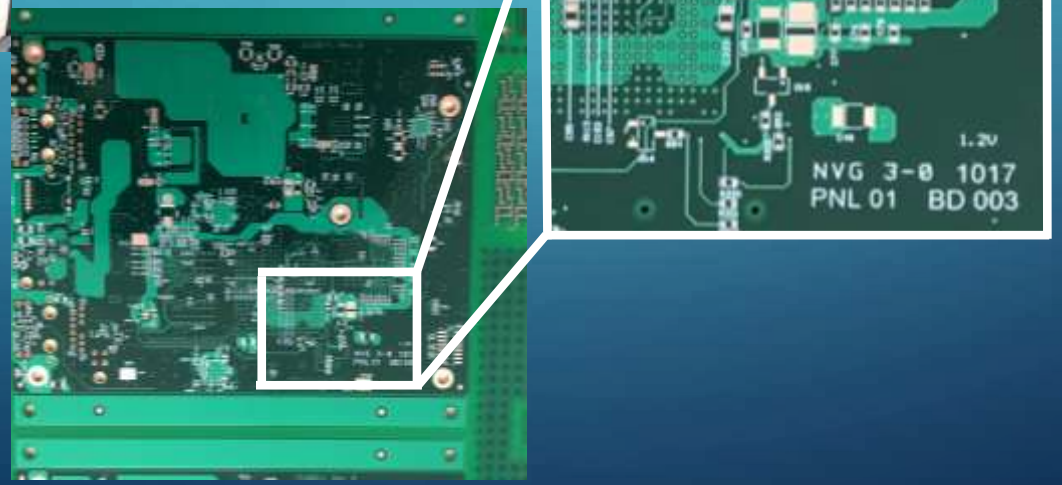


REPRESENTATION OF BEFORE / AFTER

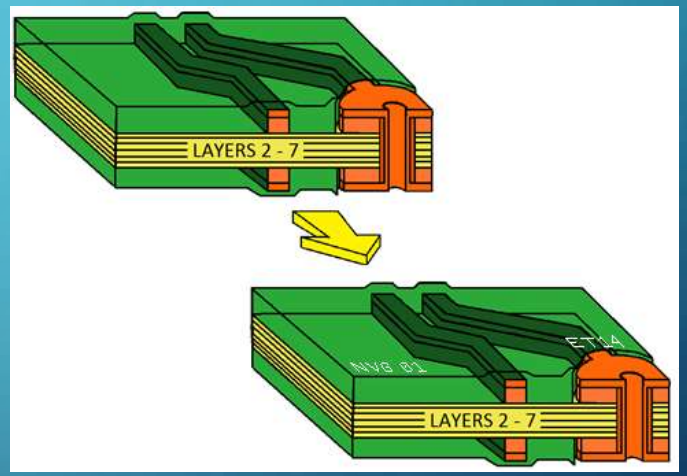
SILK SCREEN / LEGEND PRINT

WITH SOLDER MASK APPLIED, PANELS ARE NOW LEGEND PRINTED.

SOLDER MASKED PANEL PRIOR TO SILK SCREEN LEGEND APPLICATION



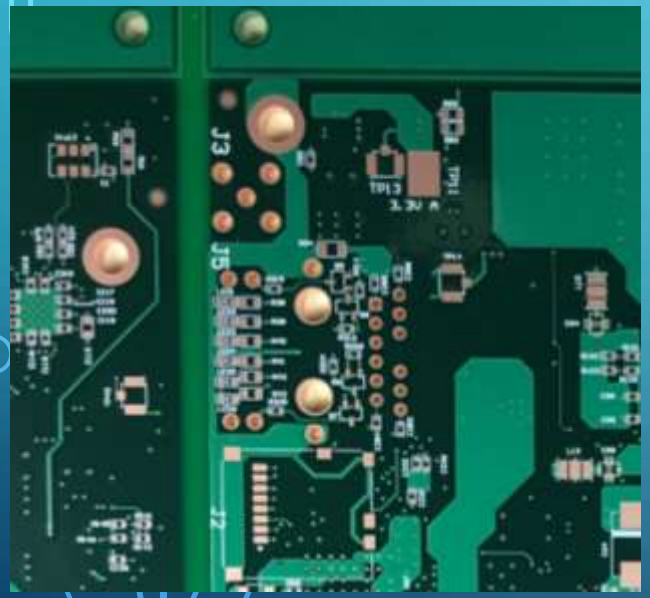
PANEL AFTER LEGEND HAS BEEN APPLIED



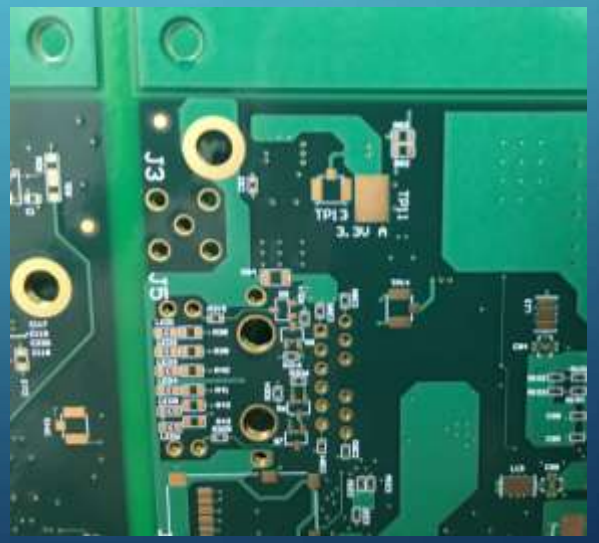
REPRESENTATION OF BEFORE / AFTER

FINAL FINISH

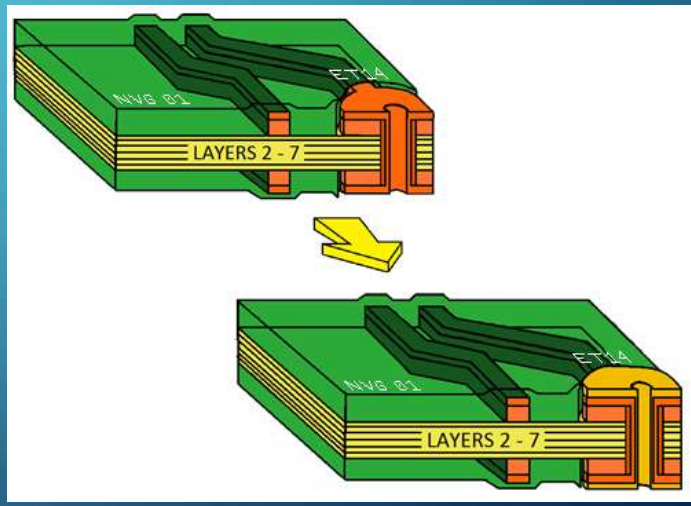
A FINAL PLATING OVER EXPOSED COPPER AREAS WITH THE CUSTOMERS CHOICE OF COATING (NICKEL/GOLD, HASL/TIN LEAD SOLDER, SILVER OR TIN – THERE ARE MANY OPTIONS AVAILABLE & SELECTION WILL BE BASED ON CUSTOMERS NEEDS).



PANEL PRIOR TO RECEIVING GOLD PLATING



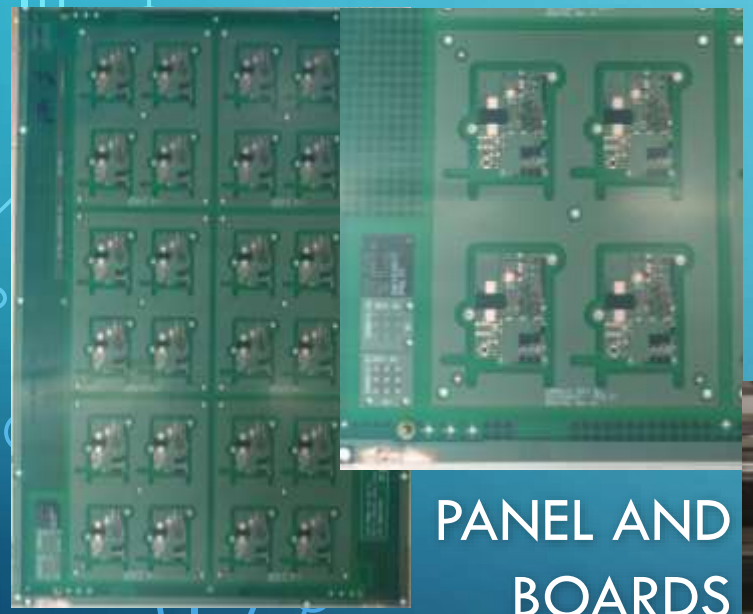
PANEL AFTER RECEIVING GOLD PLATING



REPRESENTATION OF BEFORE / AFTER

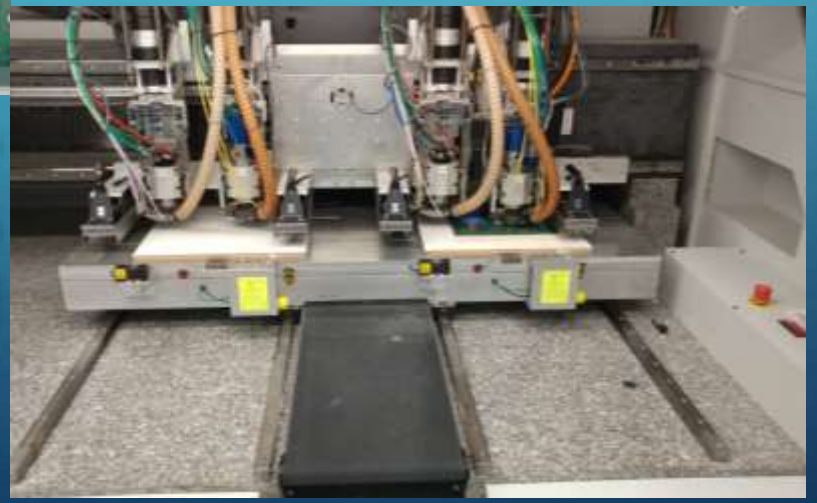
ROUTE

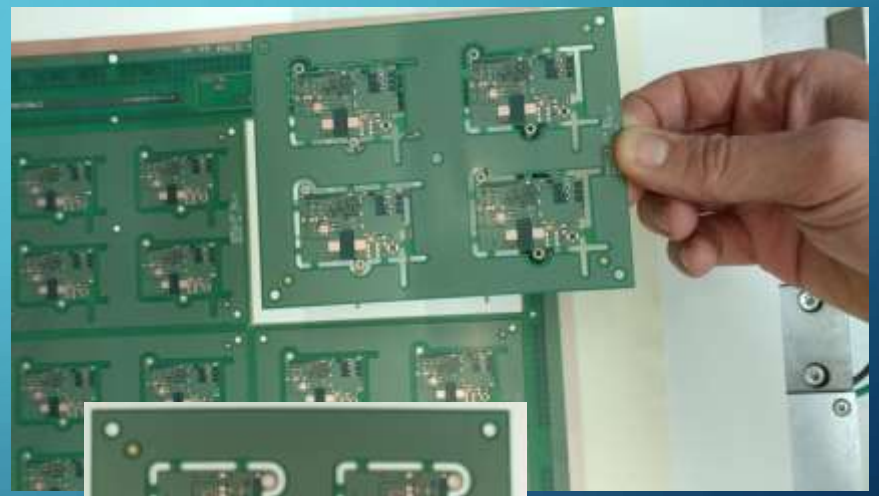
TYPICALLY MULTIPLE BOARDS ARE BUILT ON A PANEL FOR EFFICIENCY AND ONCE THE BUILD IS COMPLETE, THEY NEED TO BE CUT OUT OF THE PANEL, WHICH IS AT THE ROUTE STEP.

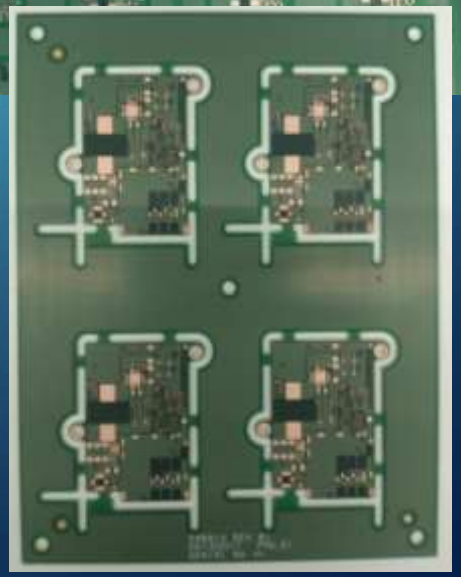


PANEL WITH MULTIPLE BOARDS PRIOR TO ROUTE

PANEL AND BOARDS DURING ROUTE



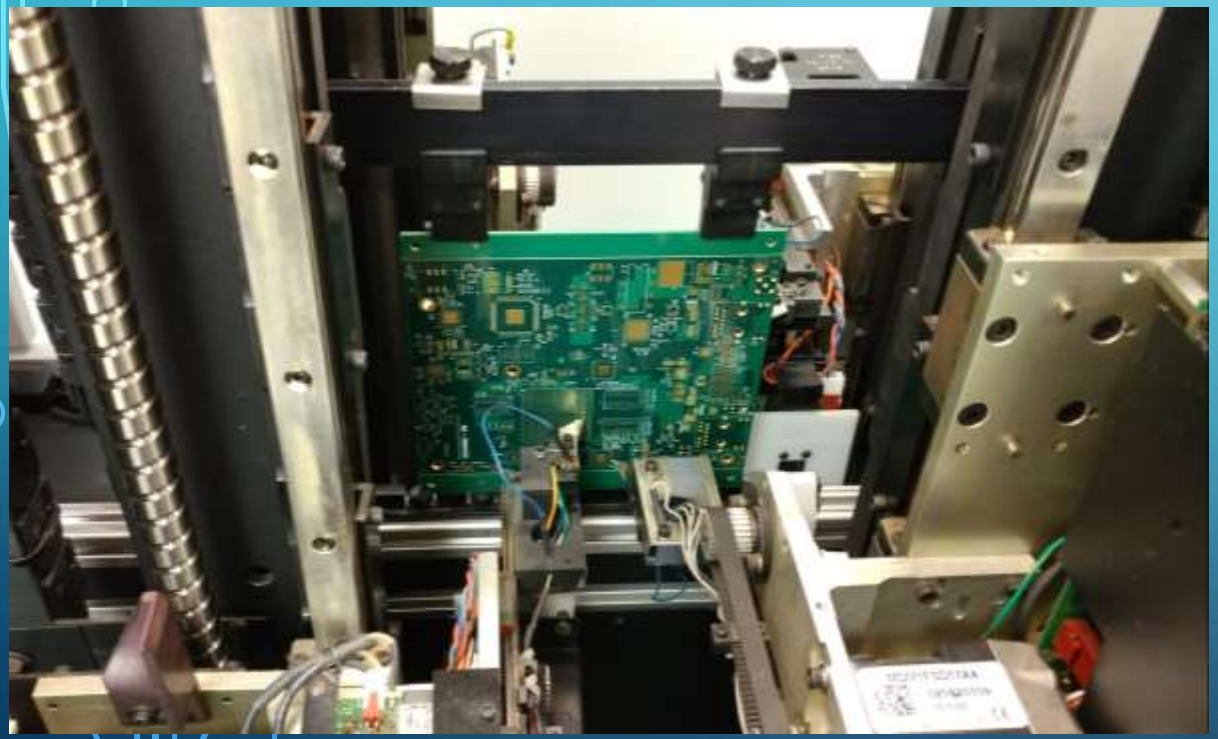




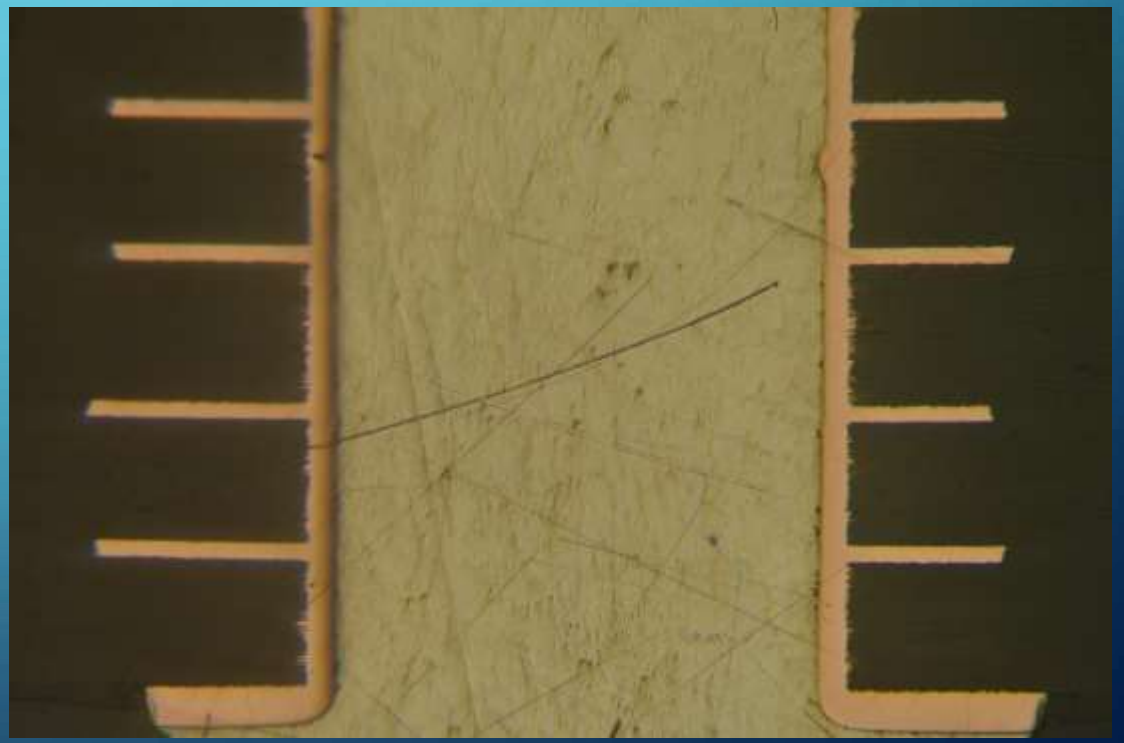
FULLY ROUTED BOARDS

FINAL TESTING

WITH THE FABRICATION PROCESS NOW COMPLETE, BOARDS ARE ELECTRICALLY TESTED TO CONFIRM FUNCTIONALITY. CROSS SECTIONS ARE PERFORMED TO CONFIRM INTEGRITY OF PLATED THROUGH HOLES, HOLE WALL PLATING & INNER LAYER "REGISTRATION".



"FLYING PROBE" ELECTRICAL TEST

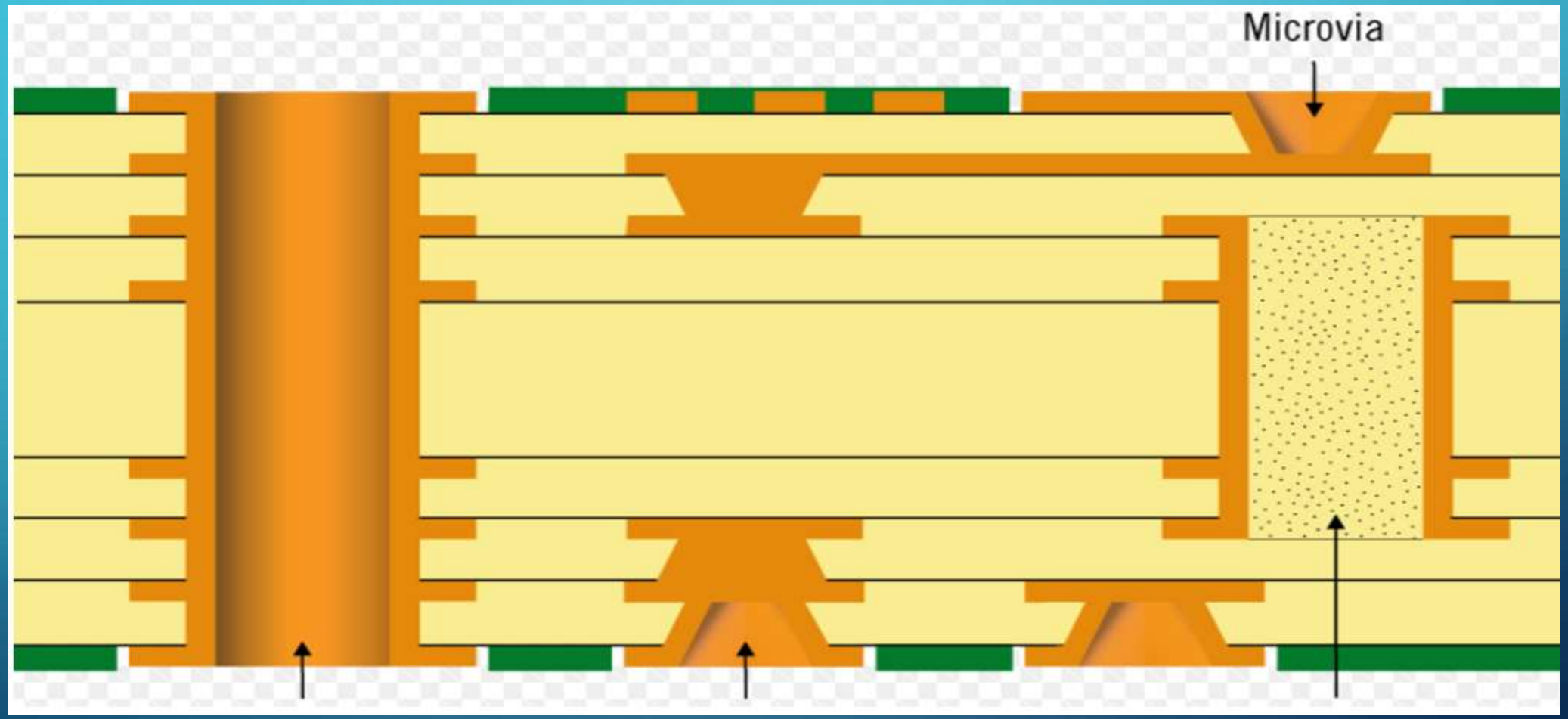


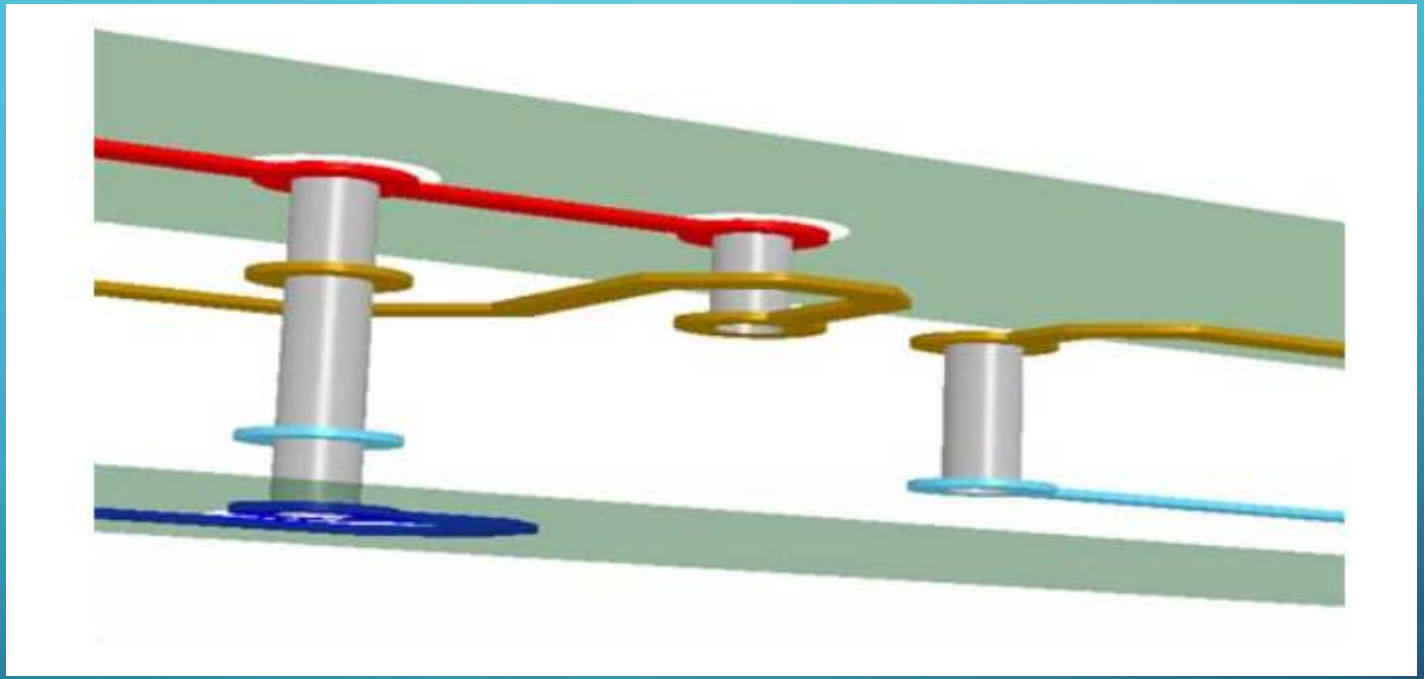
EXAMPLE OF A BOARD CROSS SECTION

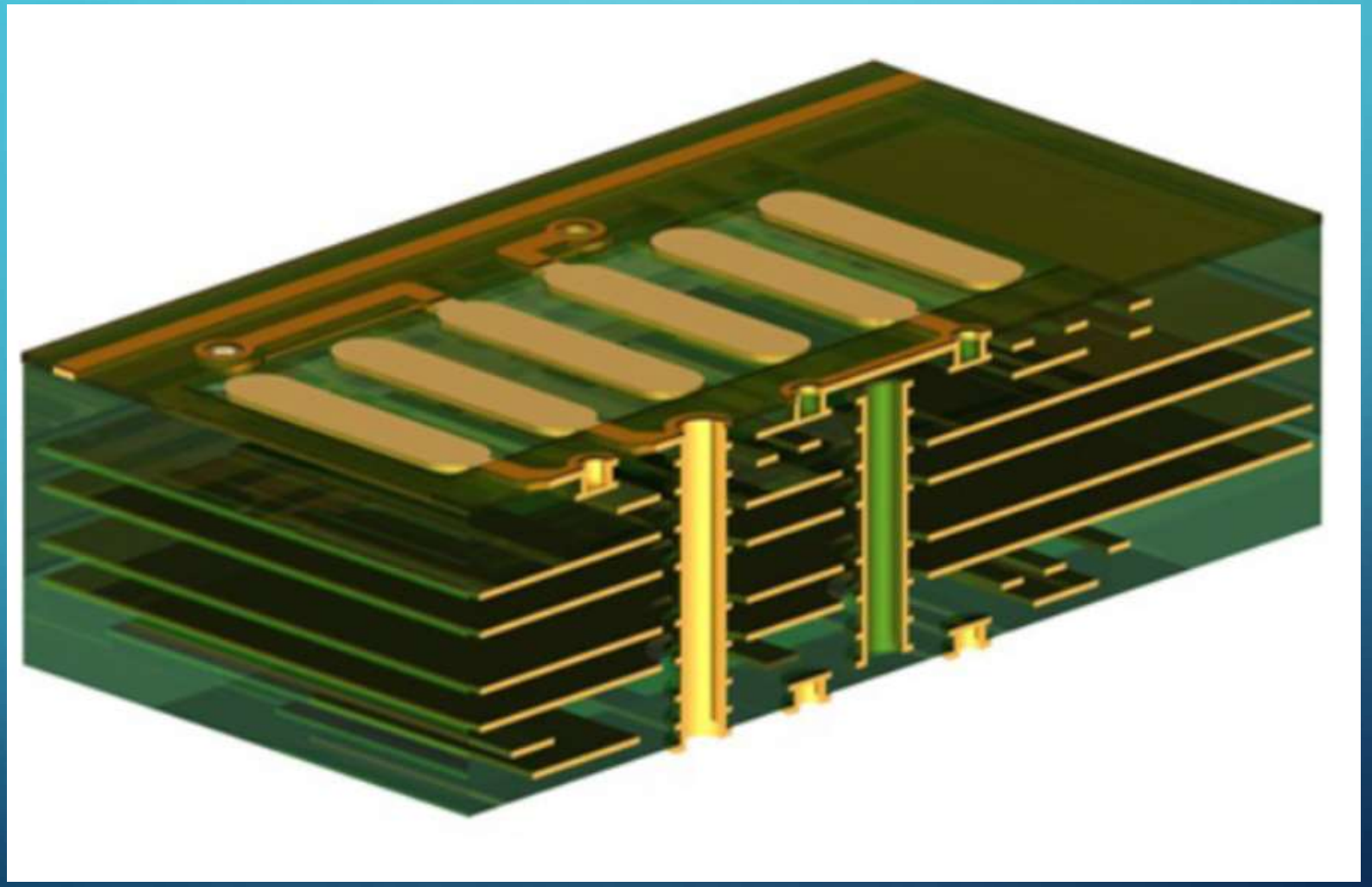
CURRENT TECHNOLOGIES

- BLIND/BURIED/STACKED VIAS
- ETCHED RESISTORS
- CASTELLATIONS

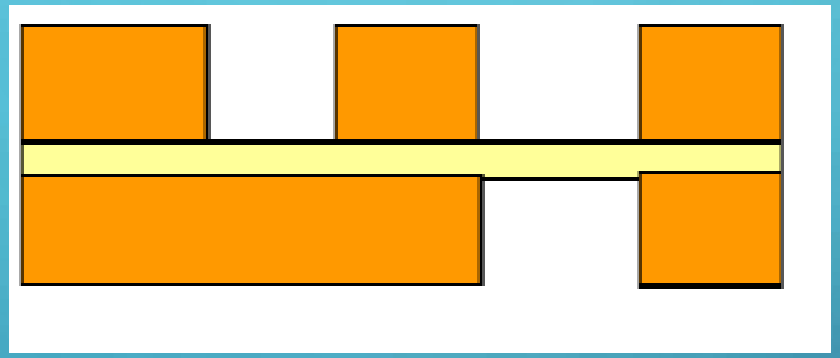
BLIND/BURIED/STACKED VIAS

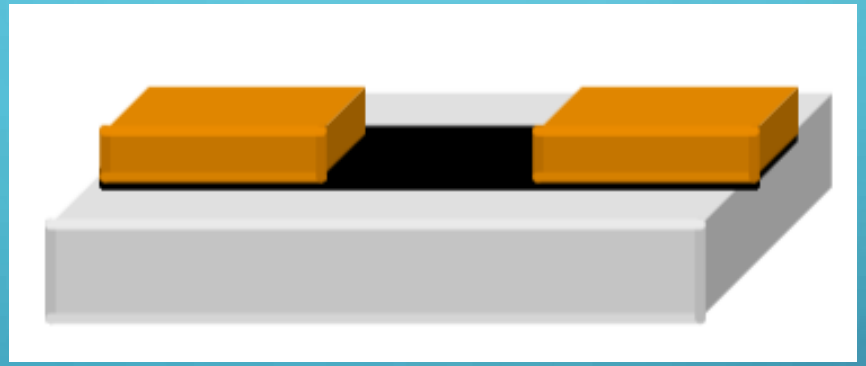

Microvia





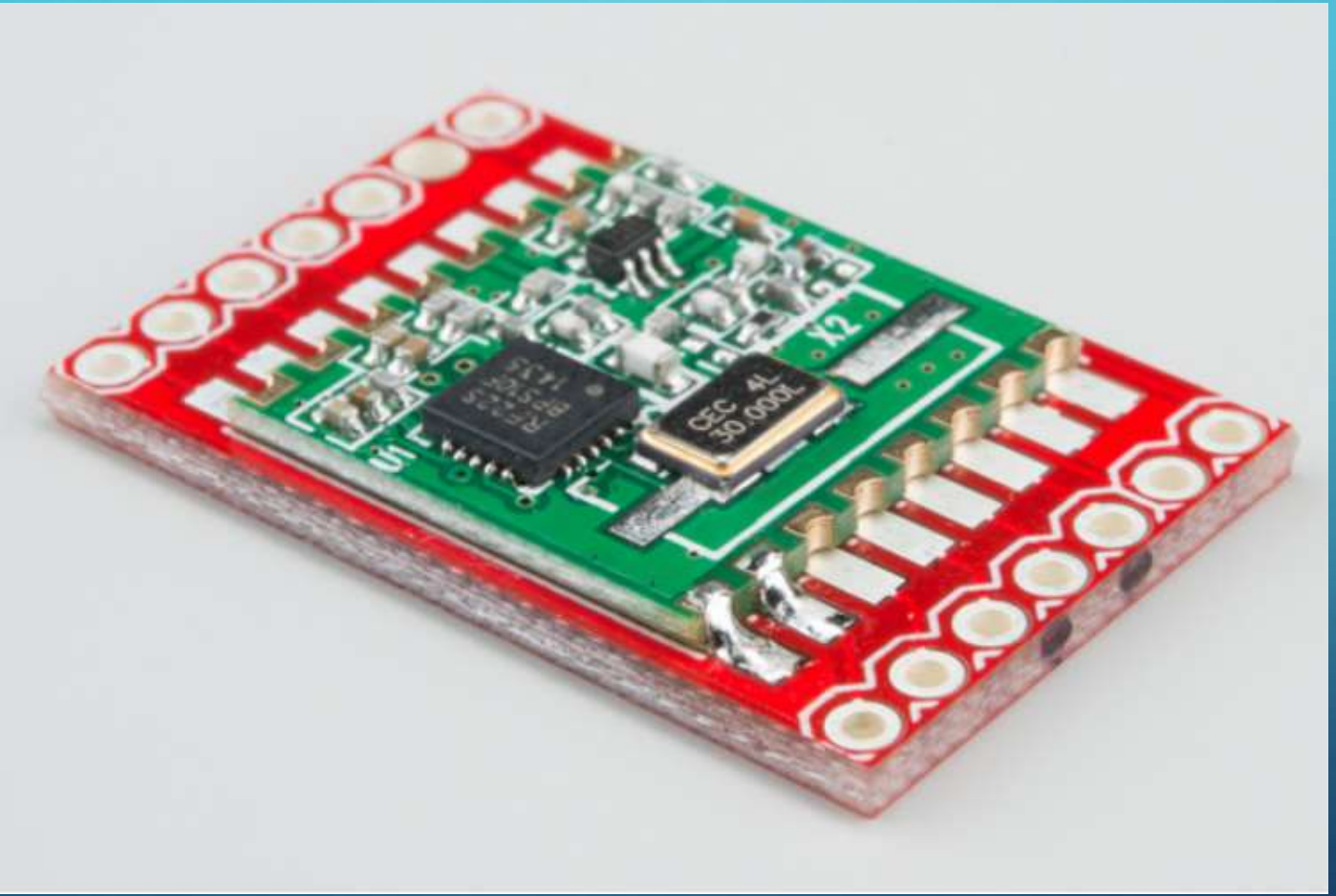
ETCHED RESISTORS





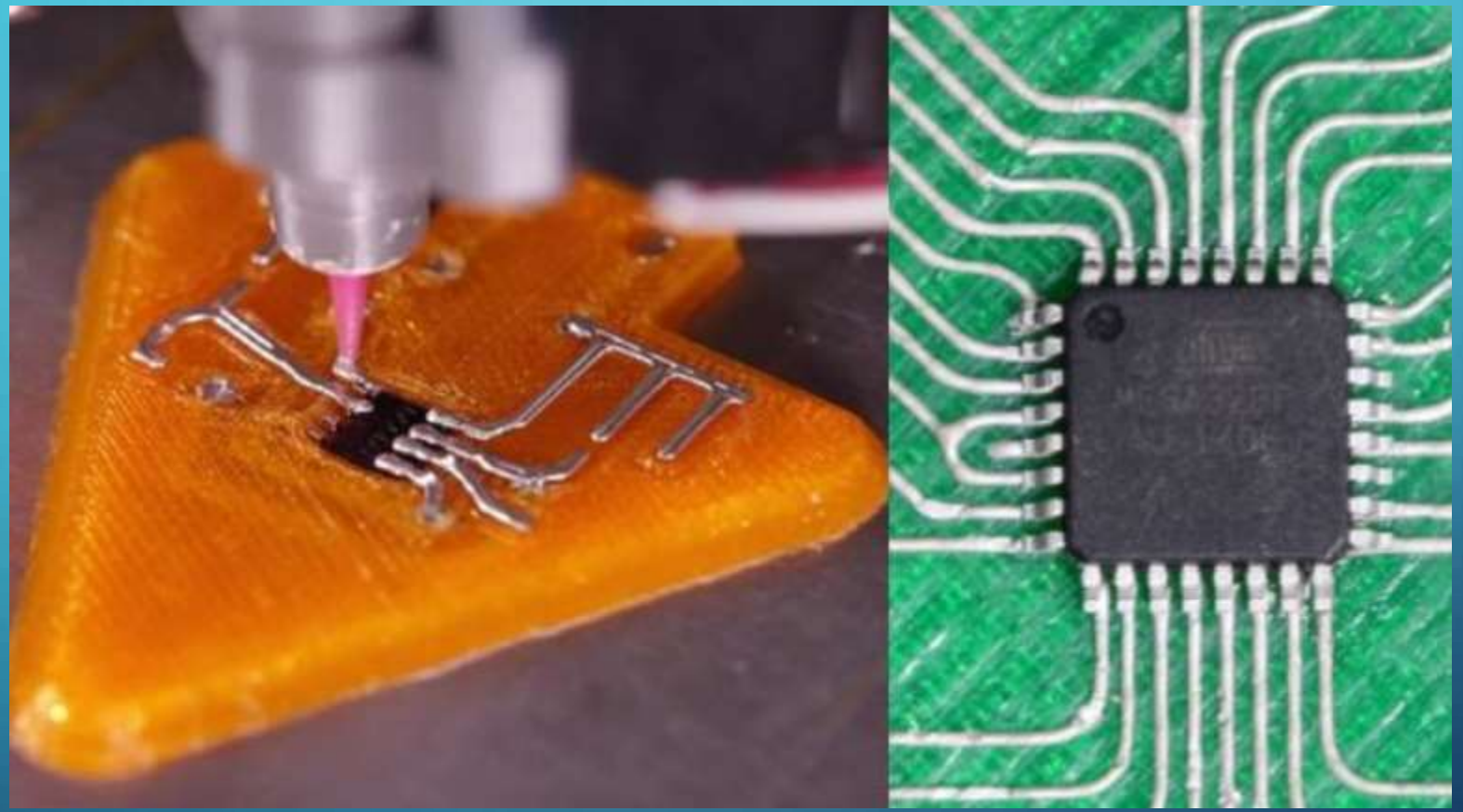
CASTELLATED HOLES

NetVia Group LLC

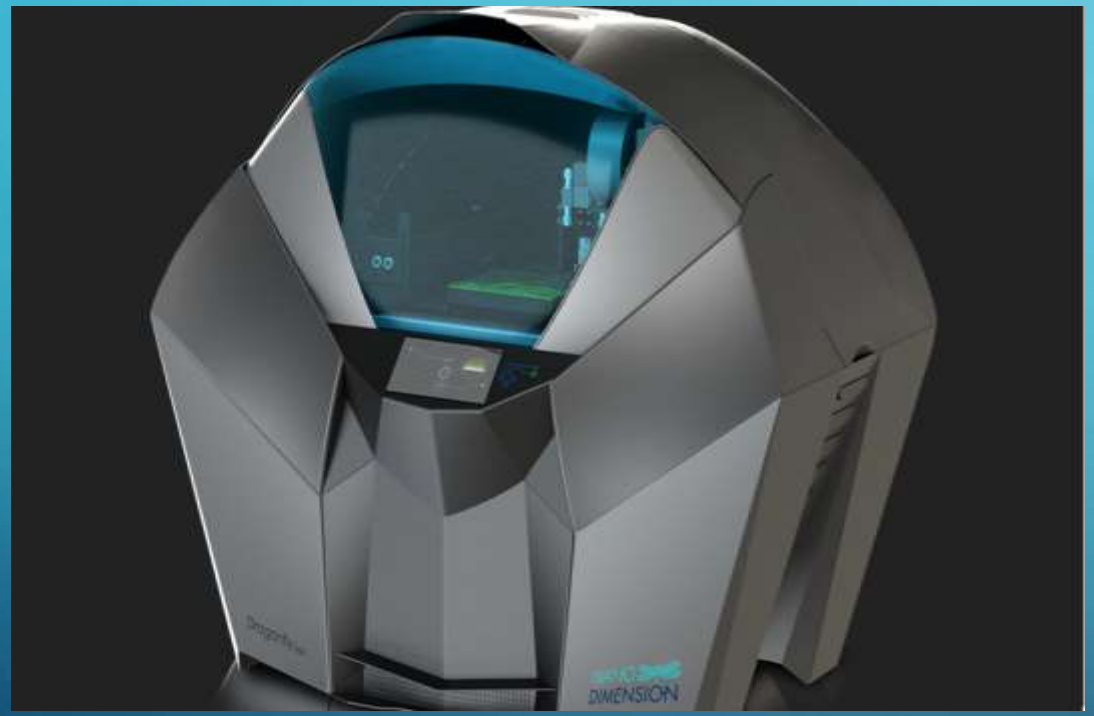


FUTURE TECHNOLOGIES

- 3D PRINTED PCBS



NetVia Group LLC



ADVANTAGES AND DISADVANTAGES

PROS

- MINIMAL EQUIPMENT REQUIRED
- ABILITY TO PRODUCE PROTOTYPES QUICKLY
- ABILITY TO PRINT CIRCUITRY ON 3D SURFACES

CONS (CURRENTLY)

- LOW PRODUCTION CAPABILITIES
- LIMITED MULTILAYER TECHNOLOGY
- LIMITED THRU HOLE PLATED TECHNOLOGY
- LIMITED RESOLUTION

NetVia Group is a manufacturer of **High-Rel, Advanced Circuit Technology.**

We specialize in Double Sided, Multilayer, Rigid, Flex and Rigid-Flex Printed Circuit Boards meeting IPC-6012/6013/6018 Class 2, Class 3 and Class 3/A qualifications.

Located in Irving, Texas

- Established in 1984
- ITAR Compliant
- 100% American Made!
- Quick Turn Prototypes, Pre-Production and Production
- 2–60 layers capability

Industries Served

- Defense & Aerospace
- Telecommunications
- Semiconductor
- Industrial
- Contract Manufacturing
- Medical
- Automotive
- Commercial

Materials

- Rogers RO4350, RO4003, RO6035HTC, RO6002, RO3006, TMM and 2929 bondply material fabrication for RF applications
- Taconic RF-35, TLX/TLY, TSM-DS3 and Eastrise for RF applications
- Arlon DiClad, CuClad and CLTE for RF applications
- Panasonic Megtron 6 & 7
- Isola 370HR, FR408 and FR408HR for enhanced FR4 applications, including RoHS compliant as well as lower loss
- Polyimide multilayers for military, aerospace and the oil and gas industries
- Arlon (substrates) / www.arlon-med.com
- Isola (substrates) / www.isola-group.com
- Ticer Technologies (resistive materials)
- Ohmega Technologies (resistive materials)

Technology

- Blind and/or buried vias which account for approximately 40% of our work
- Conductive and non-conductive filled vias (ie. VIP or via-in-pad technology), which accounts for better than 50% of the part numbers we build
- Controlled depth pockets, both plated and non-plated for various mechanical requirements
- Mixed package designs, where we bond and process different materials together
- Expertise in edge plating and castellation holes through a well developed process
- Etched resistors on 25, 50, 100 and 250 ohms per square
- Electroless Nickel / Electroless Palladium / Immersion Gold (ENEPIG), in house and regarded as the most superior surface finish available and is also compatible with wire bond applications
- Microvias down to 0.004", including 1+N+1, 2+N+2 and 3+N+3 stacked and/or staggered construction
- Copper and Aluminum bonded boards for heavy thermal dissipation

NetVia Group LLC

Investing in the Future
Our customers depend on it. Our ownership demands it.

As part of our never-ending pursuit of quality and capability, Netvia Group reinvests over 90% of our profits into capital improvements.

These investments have targeted new machinery and equipment to expand the boundaries of what we can produce and the quality and efficiency that we are able to achieve.

Acquisitions in just the last two years!

- Lenz 2+2 300K rpm smart drill & router with CCD capability
- Fabcon Microprint laser direct image (LDI)
- MicroVu Excel CMM for 1/10th mil accuracy measurements
- Sprint 100 inkjet screen printer – digital accuracy and legibility of silkscreen
- Pola Massa automated planarization equipment to speed process and enable tighter control of copper removal
- Microcraft EMMA Flying Probe tester
- Lenz 2+2 300K rpm smart drill & router with CCD capability
- ESI 5335 Laser Drill

Netvia Group
Here for the last 30 years
Here for the next 30 years
Investing in the Future

Contact us today and put our technology to work for you.
deanbutler@netviagroup.com
972-839-3457

Technology

Description	Standard	Advanced
LINE / SPACE		
Inner layer trace width / spacing (0.5, 0.33 and 0.25 oz)	4/4	2.5/2.5
Inner layer trace width / spacing (1 oz)	5/5	3/4
Outer layer trace width / spacing (1 oz)	5/5	3/4
Outer layer trace width / spacing (2 oz)	8/8	6/6
MECHANICAL / TOLERANCE		
Aspect ratio	20:1	30:1
Minimum drill size (mechanical)	0.012"	0.004"
Minimum drill size (laser)	0.005"	0.003"
Minimum pad size over drill (outer layer)	0.010"	0.006"
Minimum pad size over drill (inner layer)	0.020"	0.010"
Blind vias available	Yes	Yes
Buried vias available	Yes	Yes
Cavity / pocket mill	No	Yes
Plated through hole size tolerance (+/- mils)	3	2
Drill position accuracy (+/- mils)	3	1
Layer count	12	60
Layer to layer registration (+/- mils)	5	3
Minimum core thickness	0.004"	0.001"
Minimum finished PCB thickness	0.020"	0.008"
Maximum finished PCB thickness	0.125"	0.500"
FINISHES		
HASL (hot air solder level) / 63% Tin / 37% Lead	Yes	Yes
HASL (hot air solder level) / Lead free / SN100CL	No	Yes
Electroless Nickel - 120u" / Immersion Gold - 2u" (ENIG)	Yes	Yes
Electroless Nickel - 120u" / Immersion Gold - 5u" (ENIG)	No	Yes
Electroless Ni - 120u" / Electroless Pd - 5u" / Immersion Au - 2u" (ENEPIG)	Yes	Yes
Immersion Silver	Yes	Yes
Immersion Tin	No	Yes
OSP (Entek Cu106A)	No	Yes
Selective hard Gold and soft Gold	No	Yes
Carbon ink	No	Yes
Edge plating / Castellated holes	No	Yes
VIP / non-conductive via fill (PP-2795 and PHP-900)	Yes	Yes
Copper plated shut vias	No	Yes
Conductive via fill (Tatsuta AE-3030)	No	Yes
LAMINATES		
FR4 (185HR, 370HR)	Yes	Yes
FR408HR, N4000-13EP/Si	Yes	Yes
Megtron 6, 6N, 7, 7N	Yes	Yes
RO4003, RO4350, TMM	Yes	Yes
Ticer/OhmegaPly resistor foil - 25ops, 50ops, 100ops, 250ops	No	Yes
Polyimide	Yes	Yes
Teflon (RO3000, RO5000, RO6000, TLY, TLX, CLTE, DiClad, TC600)	Yes	Yes
Eastrise, 2929 bondply, 6700 bonding films	Yes	Yes
Flex	Yes	Yes
Rigid-Flex	Yes	Yes

Specialized capabilities (blue font)

IF YOU WOULD LIKE TO CONSIDER NETVIA GROUP FOR YOUR PCB FABRICATION OR SHOULD YOU HAVE ANY QUESTIONS, YOU CAN EMAIL US AT: SALES@NETVIAGROUP.COM

NETVIA GROUP, LLC
JANUARY 2019

MAIN: (972) 573-1400
FAX: (972) 573-1410
ADDRESS: 230 IRBY LN.
IRVING, TX 75061