



IPC-9121A

# Troubleshooting for Printed Board Fabrication Processes

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Users of this publication are encouraged to participate in the  
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# Table of Contents

<b>1</b>	<b>SCOPE</b> .....	1-1	4.3.1	Over-Sized Exposed Features Across Entire Copy .....	4-5
1.1	Purpose .....	1-1	4.3.2	Over-Sized Exposed Features on Center of Copy .....	4-5
1.2	Classification .....	1-1	4.3.3	Poor Edge Sharpness (Blurred Images).....	4-5
1.3	Use of “Lead” .....	1-1	4.3.4	Image Gain: Background Discoloration in Clear Area – Uniform High Background (Clear Area) Density .....	4-6
1.4	Abbreviations and Acronyms .....	1-1	4.3.5	Low $D_{MAX}$ (Inadequate Image Density) All the Time .....	4-6
1.5	Terms and Definitions .....	1-1	4.3.6	Low $D_{MAX}$ Some of the Time .....	4-6
1.6	IPC-9121 Format Example .....	1-1	4.3.7	Pinholes or Voids in Image .....	4-7
1.7	Guidelines for Effective Troubleshooting and Process Control .....	1-2	4.3.8	Specks in Clear Area of Film .....	4-7
1.8	Parameter Analysis .....	1-3	4.3.9	Image Distortion .....	4-7
1.8.1	Brainstorming .....	1-3	4.3.10	Straight Lines (Not Part of CAD Data) Showing on Processed Film .....	4-7
1.8.2	Process Audit .....	1-3	4.3.11	Random Yellow Spots in Image Area .....	4-7
1.8.3	Initial Capability Study .....	1-3	4.3.12	Ammonia Processor Not Developing Properly, Even with Correct Heating/Temperature .....	4-7
1.8.4	Optimization .....	1-3	4.3.13	Film Sticking in Processor .....	4-8
1.8.5	Confirmation and Final Capability Assessment .....	1-4	4.4	Ag Halide Film (Master and Working Phototools, Laser Raster Plotted) .....	4-8
1.8.6	Parameter Control .....	1-4	4.4.1	Black Lines Too Wide (Clear Lines Too Narrow) .....	4-8
1.8.7	Corrective Action Plan .....	1-4	4.4.2	Clear Lines Too Wide (Black Lines Too Narrow) .....	4-8
<b>2</b>	<b>APPLICABLE DOCUMENTS</b> .....	2-1	4.4.3	Low image density ( $D_{MAX}$ too low) .....	4-9
2.1	IPC .....	2-1	4.4.4	Clear Areas Not Clear Enough ( $D_{MIN}$ Too High) .....	4-9
<b>3</b>	<b>DESIGN AND DOCUMENTATION</b> .....	3-1	4.4.5	Milky White Color in Clear Area .....	4-9
3.1	Design .....	3-1	4.4.6	Pinholes .....	4-9
3.2	Layout Problems .....	3-2	4.4.7	Poor Line Edge Quality .....	4-9
3.2.1	Location of Holes and Terminations .....	3-2	4.4.8	Black Speck Redeposit in Clear Area – Irregular Shape .....	4-9
3.2.2	Electrical Description Inconsistency .....	3-4	4.4.9	Ag Pepper Spots in Clear Area – Round Shape .....	4-10
3.2.3	Tooling Hole Location .....	3-5	4.4.10	Yellow, Orange/Yellow or Brown Deposits in Clear Areas of Film .....	4-10
3.3	Electrical .....	3-5	4.4.11	Powder Deposits on Film (Yellow or White) .....	4-10
3.3.1	Electrical Arcing Between Adjacent Conductors .....	3-5	4.4.12	Black line abrasion .....	4-10
3.3.2	Unable to Achieve Functionality/ Reliability Using Signal Integrity Devices .....	3-6	4.4.13	Streaking .....	4-10
3.3.3	Conductor Crosstalk and Board Radiation .....	3-6	4.4.14	Image Not Sharp .....	4-10
<b>4</b>	<b>ARTWORK AND IMAGING</b> .....	4-1	4.4.15	Lines Not Straight .....	4-10
4.1	Phototools .....	4-1			
4.2	General Process Effects (Common with Ag and Diazo Phototools) .....	4-4			
4.2.1	Feature Size Dimensions Too Large (Larger than CAD Data) .....	4-4			
4.2.2	Feature Size Dimensions Too Small (Smaller Than CAD Data) .....	4-4			
4.3	Diazo Phototools .....	4-5			

4.4.16	Pinholes in Phototool	4-11	6.1.3	Metal Foils	6-1
4.4.17	CAD Database Incompatible	4-11	6.1.4	Prepreg/B-stage	6-2
4.4.18	Long or Slow CAD Database Conversion	4-11	6.1.5	Laminate	6-2
4.4.19	Phototool Not Producing Clear Image	4-11	6.2	Problems Associated with Base Materials	6-2
4.5	Ag Halide Films – Protective Coatings	4-11	6.2.1	Material Identification	6-2
4.5.1	Finished, Laminated (Protective Coating) Artwork Film Curved or Bent	4-11	6.2.2	Dimensional Stability	6-3
4.5.2	Protective Coating Film Wrinkled or Shrunken	4-11	6.2.3	Mechanical Stability	6-3
4.6	Glass – Ag Halide	4-12	6.2.4	Foreign Material/Inclusions	6-4
4.6.1	Line Width Incorrect (Over-Sized or Under-Sized)	4-12	6.2.5	Metal Surface Defects	6-6
4.6.2	Low Image Density	4-12	6.2.6	Chemical and Thermal Resistance	6-8
4.6.3	Pinholes	4-12	6.2.7	Electrical	6-10
4.6.4	Poor-Quality Line Edge	4-13	<b>7</b>	<b>MECHANICAL OPERATIONS</b>	7-1
4.6.5	Uneven Density, Mottle or Streaks	4-13	7.1	Drilling	7-1
4.6.6	Specks or Deposits on Processed Glass Plate	4-13	7.1.1	Dimensional	7-2
4.7	Glass – Hard-Surface Image on Glass	4-13	7.1.2	Hole Quality	7-3
4.7.1	Ragged Lines	4-13	7.1.3	Processing	7-11
4.7.2	Pinholes or Voids	4-14	7.2	Punching (Pierce and Blank) (Dimensional)	7-12
4.8	LDI and Other Digital Imaging Technologies	4-14	7.2.1	Undersized holes/features	7-12
4.8.1	Resist Image Has Irregular (Distorted) Areas	4-14	7.2.2	Improperly Located Hole or Feature	7-12
4.8.2	Evidence of Skipped Image Pixels, Rows	4-14	7.2.3	External Dimensions Out of Spec	7-13
4.8.3	Problems with Front-to-Back Image Registration on Top and Bottom of Board	4-15	7.2.4	Missing Holes or Features	7-13
4.8.4	Incomplete Polymerization of Resist in Exposed Areas	4-15	7.2.5	Edge Delamination	7-13
4.8.5	Resist Image Has Pinholes/Voids	4-15	7.2.6	Fibers and/or Roughness Along Edges	7-13
4.8.6	Image Lines Have Scalloped (Step-Pattern) Appearance (Especially on Angled Lines)	4-15	7.2.7	Surface Dents and Scratches	7-14
4.8.7	Blurred image	4-15	7.3	Routing	7-14
<b>5</b>	<b>HANDLING AND STORAGE</b>	5-1	7.3.1	Feature out of tolerance	7-14
5.1	Fractured Corner/Edge	5-1	7.3.2	Crazing	7-14
5.2	Dent in Cu Foil	5-2	7.3.3	Rough Edges of Punched Holes	7-15
5.3	Fracturing of Thin Material or Delicate Designs	5-3	7.3.4	Cusp Forms on Edge Where Pin-Less Routing Pressure Foot Clamps	7-15
5.4	Blow Holes in Lamination Stack Due to Entrapped Moisture	5-3	7.3.5	Caking Dust	7-16
<b>6</b>	<b>BASE MATERIALS</b>	<b>6-1</b>	7.3.6	Router bit discoloration	7-16
6.1	General	6-1	7.3.7	Breaking Bits	7-16
6.1.1	Resins	6-1	7.4	Shearing	7-16
6.1.2	Reinforcements	6-1	7.4.1	Panel Not Square	7-16
			7.4.2	Panel Lift	7-17
			7.5	Beveling	7-17
			7.5.1	Cu Foil Lifting	7-17
			7.5.2	Rough Bevel	7-17
			7.5.3	Uneven bevel	7-17
			7.5.4	Processing	7-18
			7.6	Scoring	7-18
			7.6.1	Score Lines Misplaced	7-18

7.6.2	Improper Setup	7-19	8.5	Hole Metallization (Cu Deposition) (Includes Electroless Cu Bath and Rinses)	8-22
7.6.3	Score Depth Fluctuates from Line to Line	7-19	8.5.1	Bath Control	8-23
7.6.4	Web Thickness Varies Across One Line	7-19	8.5.2	Hole Conditions	8-26
7.6.5	Improper Score Angle	7-19	8.5.3	Surface Problems	8-30
7.6.6	Cutter Wheels Marked Panel Surface	7-19	8.6	Hole Metallization (Rework)	8-31
7.7	Laser Drilling	7-19	8.6.1	Poor Interconnect Conductivity During Final Testing	8-31
7.7.1	Hole Not Properly Located	7-19	8.7	Direct Metallization Processes	8-32
7.7.2	Improper Hole Size	7-20	8.7.1	Pd-Based Direct Metallization Processes	8-32
7.7.3	Holes Not Drilled	7-20	8.7.2	Carbon Black and Graphite Dispersion Processes	8-33
7.7.4	Holes Not Drilled Through	7-20	8.8	Conductive Polymers	8-36
7.7.5	Blind Via or Microvias Drilled Through	7-20	8.9	Full-Build Electroless Cu	8-36
7.7.6	Burrs	7-20	8.9.1	Additive Processing	8-36
7.7.7	Capture Pad Penetration	7-21	8.9.2	Semi-Additive Processing	8-37
7.7.8	Delamination of Target Pad	7-21	8.10	Electroplating	8-39
7.7.9	Insufficient Contact Area (As-Received Samples)	7-22	8.10.1	Electrolytic Cu Peels from Base Metal	8-39
7.7.10	Microvias Separation (Thermal Stressed)	7-22	8.10.2	Partial Plating of Circuit Pattern (Skip Plating / Step Plating)	8-40
7.8	Water-Jet Cutting/Profiling	7-23	8.10.3	Nonuniform Plating Distribution Across Surface of Panel	8-40
7.8.1	Finished Board Dimension Out of Tolerance	7-23	8.10.4	Voids in Holes (Not Seen After Electroless Cu)	8-41
7.8.2	Incomplete Cut Through Substrate	7-23	8.10.5	Nodular Cu Plating	8-42
7.8.3	Haloing, Cracking, Delamination or Rough Edges	7-23	8.10.6	Plating Fold in PTH	8-43
7.8.4	Excessive Nozzle Wear	7-23	8.10.7	Barrel Plating Issues Due to Insufficient Resistance to Thermal Stresses	8-44
<b>8</b>	<b>HOLE PREPARATION AND METALLIZATION</b>	<b>8-1</b>	8.10.8	Electroplated Cu, Corner or "Knee" Issues	8-45
8.1	Desmear	8-1	8.10.9	Burrs or Nodules in PTH	8-46
8.1.1	Chemical Desmear Using Alkaline Permanganate	8-1	8.10.10	Incomplete Microvia Cu Fill	8-47
8.1.2	Plasma Desmear	8-2	8.10.11	Failure to Meet Cu Mechanical Requirements	8-47
8.2	Electroless Processes	8-13	8.10.12	Columnar Cu Grain Structure	8-48
8.2.1	Electroless Void	8-13	8.10.13	Nodules or Bumps in Critical Contact Area	8-49
8.2.2	Voiding in the Via / Lack of Cu Plating Coverage	8-14	8.10.14	Excessive Foam in Plating Solution	8-50
8.2.3	Voids in Glass and Resin	8-15	8.10.15	Pits in Plated Metal	8-50
8.3	Hole Metallization (Conditioning)	8-16	8.11	Via Fill	8-51
8.3.1	Hole Wall Pullaway	8-16	8.11.1	Material and Properties for Nonconductive Plugging Paste	8-52
8.3.2	Bath Control (Includes Cleaner/Conditioner, Microetch Solutions and Rinses)	8-17	8.11.2	The Relationship Between Coefficient of Thermal Expansion (CTE) and Glass Transition Temperature (T <sub>g</sub> )	8-53
8.3.3	Hole Conditions	8-18	<b>9</b>	<b>SURFACE PREPARATION (CLEANING STRUCTURING)</b>	<b>9-1</b>
8.3.4	Surface Conditions	8-19	9.1	Mechanical Cleaning Surface Preparation	9-1
8.4	Hole Catalyzation (Sensitizing) (Includes Predip, Catalyst, and Accelerator Baths and Rinses)	8-20			
8.4.1	Bath Control	8-20			
8.4.2	Hole Conditions	8-21			

9.1.1	General	9-2	10.4.1	Drilling	10-24
9.1.2	Drilling and Deburring	9-5	10.4.2	Plating	10-24
9.1.3	Scrubbing Electroless Cu Surface Before Pattern or Panel Plating	9-5	10.4.3	Etching	10-24
9.1.4	Denoduling Panel-Plated Electroplated Cu Before Tent and Etch	9-6	10.5	Cu Treatment to Improve Laminate Adhesion	10-25
9.1.5	Surface Preparation of Panel-Plated Electroplated Cu Before Tent and Etch (After Denoduling)	9-7	10.5.1	Double-Treated Cu/Laminator's Oxide	10-25
9.1.6	Surface Preparation Before Fusing	9-8	10.5.2	Black or Red/Brown Oxide Coatings	10-25
9.2	Chemical Surface Preparation	9-8	10.5.3	Oxide Bath Control	10-27
9.2.1	General	9-8	10.5.4	Oxide Post-treatment	10-28
9.2.2	Innerlayer Surface Preparation Before Resist Application	9-10	10.5.5	Conveyorized Oxide Systems	10-29
9.2.3	Surface Preparation of Imaged Innerlayers Before Multilayer Bonder Application	9-10	10.5.6	Delamination Relating to Application of Oxide Coating	10-29
9.2.4	Through-Hole Hole Wall Preparation (Desmear) Before Electroless Cu Plating	9-11	10.5.7	Alternative Oxide Coatings (Surface Etch-Organic-Metallic)	10-30
9.2.5	Electroless Cu Surface Preparation Before Pattern or Panel Plating	9-12	<b>11 ETCHING</b>		11-1
9.2.6	Solder Conditioning Before Fusing	9-12	11.1	Equipment-Related Effects and Effects from Other Processes	11-1
9.2.7	Cleaning After Fusing or Hot-Air Solder Leveling (HASL)	9-12	11.1.1	Nonuniform Etch from Side-to-Side of Panel	11-1
9.3	Electrocleaning	9-13	11.1.2	Nonuniform Etch (Cu Left on Some Areas Of Panel While Other Areas are Etched Properly)	11-1
9.3.1	Cu-to-Cu Peelers After Pattern Plating	9-13	11.1.3	Excessive Undercut (Over-Etching Conductor)	11-2
9.3.2	Resist Breakdown, Edge-Lifting, and Under-Plating During Pattern Plating	9-13	11.1.4	Panels Skewing on Conveyor	11-2
9.3.3	Resist Image Stripped in the Electrocleaner	9-13	11.1.5	Cu Left Around Circuit Patterns	11-3
9.3.4	Step Plating	9-14	11.1.6	Etch Rate Slows	11-3
9.4	Section Notes	9-14	11.1.7	Etchant Attacks Resist (Print-and-Etch Work)	11-3
<b>10 INTERCONNECT FORMATION</b>		10-1	11.1.8	Front of Panel Etches Differently From Back of Panel	11-4
10.1	Imaging	10-1	11.2	Cupric Chloride	11-4
10.1.1	Dry-Film Photoresist	10-1	11.2.1	Bath Control	11-4
10.1.2	Liquid Photoresist	10-12	11.2.2	Improper Etching	11-6
10.1.3	Screen-Printed Resist	10-15	11.3	Alkaline (Ammonial) Etchants	11-7
10.1.4	Laser Direct Imaging (LDI) of Photoresist	10-22	11.3.1	Bath Control	11-7
10.1.5	Electrophoretically Deposited Photoresist	10-22	11.3.2	Improper Etching	11-9
10.2	Inner Layer Fabrication	10-23	11.4	Peroxide-Sulfuric Etchants	11-10
10.2.1	Handling	10-23	11.4.1	Bath Control	11-10
10.2.2	Inner Layer Problems	10-23	11.4.2	Improper Etching	11-12
10.3	Print-and-Etch Inner Layers	10-24	11.5	Ferric Chloride	11-13
10.3.1	Cleaning	10-24	11.5.1	Bath Control	11-13
10.3.2	Resist Residue on Inner Layers	10-24	11.5.2	Improper Etching	11-14
10.3.3	Imaging	10-24	11.6	Ammonium or Sodium Persulfate	11-15
10.4	Inner Layers with Blind and/or Buried Vias	10-24	11.6.1	Slow Etch Rate	11-15

<b>12 LAYERING AND LAMINATION</b> . . . . .	12-1	12.9.2 Surface Imperfections . . . . .	12-26
12.1 General . . . . .	12-3	12.10 Lay-Up . . . . .	12-26
12.1.1 Misregistration . . . . .	12-3	12.10.1 Blisters/Delamination . . . . .	12-26
12.1.2 Blisters/Delamination and Interlaminar Adhesion . . . . .	12-4	12.10.2 Bow and Twist (Warped) . . . . .	12-26
12.1.3 Bow/Twist . . . . .	12-5	12.10.3 Panel Thickness . . . . .	12-26
12.1.4 Laminate Voids . . . . .	12-6	12.10.4 Surface Imperfections . . . . .	12-27
12.1.5 Resin Starvation . . . . .	12-7	12.11 Pressing . . . . .	12-27
12.1.6 Panel/Board Thickness . . . . .	12-7	12.11.1 Misregistration . . . . .	12-27
12.1.7 Surface Imperfections . . . . .	12-8	12.11.2 Blisters/Delamination . . . . .	12-28
12.1.8 Pits . . . . .	12-8	12.11.3 Bow and Twist (Warped) . . . . .	12-29
12.1.9 Measling . . . . .	12-9	12.11.4 Laminate Voids . . . . .	12-30
12.2 Handling . . . . .	12-10	12.11.5 Resin Starvation . . . . .	12-32
12.2.1 Misregistration . . . . .	12-10	12.11.6 Panel Thickness . . . . .	12-33
12.2.2 Blisters/Delamination . . . . .	12-11	12.12 Bake After Lamination . . . . .	12-34
12.2.3 Laminate Voids . . . . .	12-13	12.12.1 Blisters/Delamination . . . . .	12-34
12.2.4 Surface Imperfections . . . . .	12-13	12.12.2 Bow and Twist (Warped) . . . . .	12-34
12.3 Equipment . . . . .	12-14	12.12.3 Surface Imperfections . . . . .	12-34
12.3.1 Blisters/Delamination . . . . .	12-14	12.13 Subsequent Processing . . . . .	12-35
12.3.2 Laminate Voids . . . . .	12-14	12.13.1 Voids in PTHs . . . . .	12-35
12.4 Material . . . . .	12-15	12.14 Electrical . . . . .	12-35
12.4.1 Misregistration . . . . .	12-15	<b>13 FINAL FINISHES</b> . . . . .	13-1
12.4.2 Blisters/Delamination . . . . .	12-16	13.1 Immersion Coatings . . . . .	13-1
12.4.3 Laminate Voids . . . . .	12-16	13.1.1 Immersion Sn . . . . .	13-1
12.4.4 Resin Starvation . . . . .	12-17	13.1.2 Immersion Ag . . . . .	13-3
12.4.5 Surface Imperfections . . . . .	12-17	13.2 Electroless Coatings . . . . .	13-4
12.5 Tooling . . . . .	12-18	13.2.1 Electroless Ni . . . . .	13-4
12.5.1 Misregistration . . . . .	12-18	13.2.2 Electroless Sn . . . . .	13-11
12.5.2 Surface Imperfections . . . . .	12-19	13.3 Organic Solderability Preservative (OSP) . . . . .	13-12
12.6 Multilayer Design . . . . .	12-19	13.3.1 OSP Coating Has Nonuniform Appearance Over Cu . . . . .	13-12
12.6.1 Misregistration . . . . .	12-19	13.3.2 White Precipitate on Printed Boards or in the OSP Process Tank . . . . .	13-13
12.6.2 Blisters/Delamination . . . . .	12-20	13.3.3 Poor Solderability with OSP (Dewetting, Incomplete Solder Flow-Up) . . . . .	13-13
12.6.3 Laminate Voids . . . . .	12-20	13.4 Metallic Protective Coatings . . . . .	13-14
12.6.4 Resin Starvation . . . . .	12-20	13.4.1 Sn/Pb Fusing . . . . .	13-14
12.7 Innerlayer Preparation . . . . .	12-21	13.4.2 Infrared Fusing . . . . .	13-16
12.7.1 Misregistration . . . . .	12-21	13.4.3 Hot-Oil Reflow . . . . .	13-16
12.7.2 Blisters/Delamination . . . . .	12-21	13.4.4 Vapor-Phase Fusing . . . . .	13-17
12.8 Prepreg (B-Stage) Preparation . . . . .	12-24	13.5 Solder Leveling . . . . .	13-17
12.8.1 Blisters/Delamination . . . . .	12-24	13.5.1 Hot-Air Leveling . . . . .	13-17
12.8.2 Laminate Voids . . . . .	12-25	13.5.2 Machine/Material Problems . . . . .	13-19
12.8.3 Panel Thickness . . . . .	12-25	13.6 Immersion Coatings . . . . .	13-20
12.9 Cu Foil Preparation . . . . .	12-26		
12.9.1 Blisters/Delamination . . . . .	12-26		

13.6.1	Immersion Sn . . . . .	13-20	14.2.4	Cu Oxidation . . . . .	14-22
13.6.2	Immersion Au . . . . .	13-21	14.3	Temporary Solder Resists . . . . .	14-23
13.6.3	Immersion Sn/Pb . . . . .	13-22	14.3.1	Tape . . . . .	14-23
13.7	Electroless Coatings . . . . .	13-23	14.4	Nomenclature (Legend) – Nonmetallic Materials . . . . .	14-24
13.7.1	Electroless Ni . . . . .	13-23	14.4.1	Screen-Printed . . . . .	14-24
13.7.2	Electroless Sn . . . . .	13-25			
13.8	Microvias . . . . .	13-26	<b>15 FLEXIBLE AND RIGID-FLEX PRINTED BOARDS . . . . .</b>		15-1
13.8.1	Etch Artifacts Observed after Microsectioning of Microvias . . . . .	13-26	15.1	Flexible Printed Board Anomalies . . . . .	15-1
13.8.2	Plating Artifacts in Microvia . . . . .	13-26	15.1.1	Coverlay Coverage (Surface Preparation) . . . . .	15-1
13.8.3	Missing Surface Cu Plating . . . . .	13-27	15.1.2	Coverlay Coverage (Mechanical Preparation) . . . . .	15-2
13.8.4	Deformation-Induced Voiding in Flex Observed after Microsectioning . . . . .	13-27	15.1.3	Adhesive Squeeze-Out – Land Area . . . . .	15-2
13.8.5	Cap Plating Pulled Off . . . . .	13-28	15.1.4	Adhesive Squeeze-Out – Foil Surface . . . . .	15-3
13.8.6	Design Issues with Stacked or Staggered Vias Misregistration . . . . .	13-28	15.1.5	Access Hole Registration . . . . .	15-3
13.8.7	Cu-Filled Microvia Voids . . . . .	13-29	15.1.6	Plating Defects . . . . .	15-4
13.9	Pattern Plating Rim Voids . . . . .	13-30	15.1.7	Transitional Zone Squeeze-Out . . . . .	15-5
13.9.1	Rim Void – Example 1 . . . . .	13-30	15.1.8	Solder Wicking/Plating Under Coverlay . . . . .	15-6
13.9.2	Rim Void – Example 2 . . . . .	13-30	15.1.9	Voids . . . . .	15-7
13.9.3	Rim Void – Example 3 . . . . .	13-31	15.1.10	Etchback . . . . .	15-8
13.9.4	Rim Void – Example 4 . . . . .	13-31	15.1.11	Smear Removal . . . . .	15-9
<b>14 NONMETALLIC COATINGS . . . . .</b>		14-1	15.1.12	Trimmed Edges . . . . .	15-10
14.1	Permanent Solder Resist . . . . .	14-1	15.1.13	Ag Film . . . . .	15-10
14.1.1	Screen-Printable Solder Resists (Thermal and UV Cure) . . . . .	14-1	15.2	Rigid-Flex . . . . .	15-11
14.1.2	Misregistration . . . . .	14-2	15.2.1	Delamination or Insufficient Squeeze-Out . . . . .	15-11
14.1.3	Incomplete Cure (Thermal-Cure Inks) . . . . .	14-3	15.2.2	Incorrect Radius . . . . .	15-11
14.1.4	Incomplete Cure (UV-Cure Inks) . . . . .	14-3	15.2.3	Delamination of Stiffener . . . . .	15-12
14.1.5	Adhesion Failure . . . . .	14-4	15.2.4	Flex Edge Damage . . . . .	15-12
14.1.6	Solder Resist on Lands or in Holes . . . . .	14-4	15.2.5	Open . . . . .	15-13
14.1.7	Solder Mask Adhesion Failure after Hot-Air Leveling . . . . .	14-5	15.2.6	Delamination . . . . .	15-13
14.1.8	Over-Cure of Solder Mask . . . . .	14-5	15.2.7	Foreign Material . . . . .	15-14
14.1.9	Insufficient Moisture/Insulation Resistance . . . . .	14-5	15.2.8	Holes in Flex Area . . . . .	15-14
14.1.10	Skipping . . . . .	14-6	15.2.9	Holes Too Close to Transition Area . . . . .	15-15
14.1.11	Boards Sticking to Screen . . . . .	14-6	15.2.10	Delamination . . . . .	15-15
14.1.12	Dry-Film Solder Resist . . . . .	14-7	15.2.11	Cu Nesting and Stacking (Telegraphing) . . . . .	15-16
14.1.13	Liquid Photoimageable (LPI) Solder Resist . . . . .	14-14	15.2.12	Insufficient Bend Radius . . . . .	15-17
14.2	Temporary Protective Coatings . . . . .	14-20	15.2.13	Wrinkles in Flex Circuit Coverlay . . . . .	15-17
14.2.1	Inhibitor Coatings . . . . .	14-20	15.2.14	Wrinkling During Flexing of Material . . . . .	15-18
14.2.2	Rosin- and Resin-Based Coatings (Prefluxes) . . . . .	14-21	15.2.15	Too Rigid for Depanelization . . . . .	15-19
14.2.3	Chromate-Inhibitor Coatings . . . . .	14-22			
				<b>Tables</b>	
			Table 7-1	Drilling Variables and Effects . . . . .	7-1
			Table 7-2	Provides a correlation between punching process variables and punching process effects . . . . .	7-12
			Table 7-3	Scoring Variables and Effects . . . . .	7-18

Table 8-1	Electroless Cu Process—Problem Sources and Subsequent Effects . . . . .	8-13	Figure 7-11	Residual Barrel Plating . . . . .	7-11
Table 8-2	Critical Contaminants for Electroless Cu Working Bath and Their Symptoms . . . . .	8-22	Figure 7-12	Rough Punched-Hole Edge . . . . .	7-15
Table 9-1	Surface Preparation Method by Laminate Thickness . . . . .	9-18	Figure 7-13	Lifted Foil . . . . .	7-17
Table 12-1	Laminate Process – Problem Sources and Subsequent Effects . . . . .	12-3	Figure 7-14	Laser Drill through Microvia Target Pad . . . . .	7-20
<b>Figures</b>					
Figure 1-1	Photo Resist Under-Exposure . . . . .	1-2	Figure 7-15	Penetrated Capture Pad . . . . .	7-21
Figure 3-1	Grid Outline . . . . .	3-2	Figure 7-16	Target Pad Delamination . . . . .	7-21
Figure 3-2	Grid Outline . . . . .	3-3	Figure 7-17	Insufficient Contact Area . . . . .	7-22
Figure 3-3	Fiducials . . . . .	3-3	Figure 7-18	Microvia Plating Separation . . . . .	7-22
Figure 3-4	Datum Lines Outside of Board . . . . .	3-4	Figure 8-1	Drill Smear . . . . .	8-2
Figure 3-5	Non-matching Layout . . . . .	3-4	Figure 8-2	Before Smear Removal (Left) and After Desmear (Right) . . . . .	8-3
Figure 3-6	Tooling Holes . . . . .	3-5	Figure 8-3	Uneven Smear/Resin Removal . . . . .	8-3
Figure 3-7	Signal Integrity Test. . . . .	3-6	Figure 8-4	Excessive Resin Removal . . . . .	8-4
Figure 4-1	Raster Scanning vs. Vector Plotting . . . . .	4-1	Figure 8-5	Recessed Fibers . . . . .	8-5
Figure 4-2	Negative vs. Positive Working Phototools . . . . .	4-3	Figure 8-6	Wicking Along Glass Fibers . . . . .	8-6
Figure 4-3	Dimension Change in Polyester Phototools (Size Change During Drying) . . . . .	4-3	Figure 8-7	Wedge Void . . . . .	8-7
Figure 5-1	Edge Fracture. . . . .	5-1	Figure 8-8	Excessive Negative Etchback . . . . .	8-8
Figure 5-2	Dent in Foil . . . . .	5-2	Figure 8-9	Drill Smear . . . . .	8-9
Figure 5-3	Thin Material Fracture. . . . .	5-3	Figure 8-10	Poor Drill Quality . . . . .	8-10
Figure 6-1	Cu Embedded in Resin . . . . .	6-4	Figure 8-11	Glass Gouge . . . . .	8-10
Figure 6-2	Etch Pit . . . . .	6-5	Figure 8-12	Resin Between Microvia and Target Pad . . . . .	8-11
Figure 6-3	Dark Spots within Laminate or Prepreg Caused by Embedded Fibers . . . . .	6-6	Figure 8-13	Plating Void on Resin-Rich Area of PTH . . . . .	8-11
Figure 6-4	Metal Scratch. . . . .	6-7	Figure 8-14	Insufficient Cu Plating Coverage on Glass Fibers . . . . .	8-12
Figure 6-5	Shiny Spot on Cu Laminate. . . . .	6-8	Figure 8-15	Electroless Voids . . . . .	8-13
Figure 6-6	Void in Laminate . . . . .	6-9	Figure 8-16	PTH Plating Voiding . . . . .	8-14
Figure 6-7	Cu Foil Crack Near Plated Cu. . . . .	6-10	Figure 8-17	Resin Voids . . . . .	8-15
Figure 7-1	Hole Misregistration . . . . .	7-2	Figure 8-18	PTH Cu Plating Pull-Away from Hole Wall. . . . .	8-16
Figure 7-2	Resin Smear on Exposed Internal Cu Layer in Hole . . . . .	7-3	Figure 8-19	Excessive Foam. . . . .	8-17
Figure 7-3	Fiber Protrusion from Surrounding Resin. . . . .	7-4	Figure 8-20	Epoxy Voids . . . . .	8-18
Figure 7-4	Nailheading . . . . .	7-5	Figure 8-21	Blistered Cu . . . . .	8-19
Figure 7-5	Haloing . . . . .	7-6	Figure 8-22	Fingerprint . . . . .	8-19
Figure 7-6	Plating Over Rough Hole Wall . . . . .	7-7	Figure 8-23	Electroless Cu Voids Caused by Ineffective Catalyst Bath . . . . .	8-21
Figure 7-7	Burrs on Cu Surface . . . . .	7-8	Figure 8-24	Voids Caused by Improper Acceleration . . . . .	8-22
Figure 7-8	Debris in Hole . . . . .	7-9	Figure 8-25	Electroless Cu Deposits. . . . .	8-23
Figure 7-9	Curl Chip . . . . .	7-10	Figure 8-26	PTH Plating Void on/Glass Area . . . . .	8-26
Figure 7-10	Excess Cu in Back-Drilled hole . . . . .	7-10	Figure 8-27	Plating Void on Resin Area Only . . . . .	8-27
			Figure 8-28	Cu Blister / Hole Wall Pull-Away . . . . .	8-28
			Figure 8-29	Deposits in PTH . . . . .	8-29



Figure 8-30	Rough Plating on Surface . . . . .	8-29	Figure 9-10	Comparison of Aluminum Oxide Particles . . . . .	9-18
Figure 8-31	Rough Deposit . . . . .	8-31	Figure 10-1	Photo Resist Under-Exposure . . . . .	10-2
Figure 8-32	Partial Plating . . . . .	8-40	Figure 10-2	Resist Scum/Residue . . . . .	10-3
Figure 8-33	PTH Plating Voids Due to Air Bubble Entrapment . . . . .	8-41	Figure 10-3	Insufficient Resist Bridging . . . . .	10-4
Figure 8-34	PTH Plating Void Due to Partial Etch-Out of Electroless Cu . . . . .	8-41	Figure 10-4	Underdeveloped Resist Areas . . . . .	10-5
Figure 8-35	Nodular Plating with Particulate Matter . . . . .	8-42	Figure 10-5	Damaged Photoresist Image . . . . .	10-6
Figure 8-36	Nodules Near Interface of Resist Sidewall and Surface . . . . .	8-42	Figure 10-6	Resist Breakdown and Lifting . . . . .	10-7
Figure 8-37	Plating Fold . . . . .	8-43	Figure 10-7	Skip Plating . . . . .	10-10
Figure 8-38	Barrel Plating Cracks . . . . .	8-44	Figure 10-8	Photoresist Residue . . . . .	10-11
Figure 8-39	Corner Cracks . . . . .	8-45	Figure 10-9	Damaged Photoresist . . . . .	10-13
Figure 8-40	Plating Nodules in Contact Area . . . . .	8-46	Figure 10-10	Shadows . . . . .	10-15
Figure 8-41	Microvia Not Completely Filled . . . . .	8-47	Figure 10-11	Bubbles . . . . .	10-16
Figure 8-42	Columnar Grain Structure . . . . .	8-48	Figure 10-12	Resist Ink That Ran Through Screen . . . . .	10-17
Figure 8-43	Nodules . . . . .	8-49	Figure 10-13	Slow Breakaway . . . . .	10-17
Figure 8-44	Excess Foam . . . . .	8-50	Figure 10-14	Pin-Holing . . . . .	10-18
Figure 8-45	Plating Pits . . . . .	8-50	Figure 10-15	Plating Resist Bleeding . . . . .	10-18
Figure 8-46	High-Density Interconnect (HDI) Substrate with Plugged Vias . . . . .	8-51	Figure 10-16	Voids in Conductor . . . . .	10-19
Figure 8-47	Over-Metallized Via-in-Pad . . . . .	8-51	Figure 10-17	Ragged Conductor Lines . . . . .	10-19
Figure 8-48	Excessive CTE Leading to Plated Cu Lifting From Filled Via . . . . .	8-52	Figure 10-18	Marred Ink . . . . .	10-20
Figure 8-49	Cracked Via Plug Caused by an Uncontrolled and Excessively Fast Curing Process . . . . .	8-53	Figure 10-19	Deposition of Coating Film . . . . .	10-22
Figure 8-50	Filled Material Depression . . . . .	8-54	Figure 10-20	Nonuniform Oxide . . . . .	10-26
Figure 8-51	Insufficient Wrap Plating . . . . .	8-54	Figure 10-21	Nonuniform Oxide Coating (Left) and Resist Residues on Surface (Right) . . . . .	10-27
Figure 8-52	Cu Plating Separation . . . . .	8-55	Figure 10-22	Nonuniform Oxide Coating . . . . .	10-30
Figure 8-53	Filled Via Voiding . . . . .	8-55	Figure 11-1	Excessive Undercut . . . . .	11-2
Figure 9-1	Examples of Brushes . . . . .	9-2	Figure 11-2	Excess Cu . . . . .	11-3
Figure 9-2	Hole Void Due to Broken Tent . . . . .	9-7	Figure 11-3	Attacked Resist . . . . .	11-3
Figure 9-3	Sample Results of Brush Footprint Test . . . . .	9-14	Figure 11-4	Over-Etching . . . . .	11-6
Figure 9-4	Contact Profilometry Scan . . . . .	9-15	Figure 11-5	Under or Incomplete Etching . . . . .	11-7
Figure 9-5	Example Optical Profilometry (Surface Data) . . . . .	9-15	Figure 11-6	Etch Resist Breaking Down, Leading to Opens . . . . .	11-8
Figure 9-6	Preferred Roughness and Speed Ranges for Brush Types . . . . .	9-16	Figure 11-7	Over-Etching . . . . .	11-9
Figure 9-7	Preferred Roughness and Cutting Speed for Brush Types . . . . .	9-16	Figure 11-8	Under-Etching . . . . .	11-10
Figure 9-8	Water Break Test . . . . .	9-17	Figure 11-9	Over-Etching . . . . .	11-14
Figure 9-9	Pumice Particle Size Distribution Chart . . . . .	9-17	Figure 12-1	Laminate Evaluation Area Overview . . . . .	12-1
			Figure 12-3	Breakout . . . . .	12-4
			Figure 12-4	Example of Bow (Left) and Twist (Right) . . . . .	12-5
			Figure 12-5	Laminate Voids . . . . .	12-6
			Figure 12-6	Resin Starvation . . . . .	12-7
			Figure 12-7	Pits . . . . .	12-8
			Figure 12-8	Measling . . . . .	12-9
			Figure 12-9	Misaligned Internal Layers . . . . .	12-10

Figure 12-10 Severe Misregistration . . . . .	12-11	Figure 14-4 Air Entrapment . . . . .	14-7
Figure 12-11 Resin Fracture . . . . .	12-11	Figure 14-5 Solder Mask Wrinkle . . . . .	14-8
Figure 12-12 Examples of Delamination . . . . .	12-12	Figure 14-6 Resist on Land . . . . .	14-9
Figure 12-13 Line of Laminate Voids . . . . .	12-13	Figure 14-7 Development Time Too Long . . . . .	14-10
Figure 12-14 Delamination and Blister . . . . .	12-14	Figure 14-8 Solder Resist Breakdown . . . . .	14-11
Figure 12-15 Conductive Anodic Filament (CAF) . . . . .	12-16	Figure 14-9 White Residue on Solder Resist . . . . .	14-11
Figure 12-16 Dielectric Thickness Violated . . . . .	12-17	Figure 14-10 Adhesion Failure . . . . .	14-13
Figure 12-17 Misregistration of Layers on Different Cores . . . . .	12-19	Figure 14-11 Exposed Features after Solder Resist . . . . .	14-14
Figure 12-18 Prepreg Separation . . . . .	12-22	Figure 14-12 Bubbles in Dried Resist Film . . . . .	14-16
Figure 12-19 Light Colored Areas Over Innerlayer Oxide Surface . . . . .	12-24	Figure 14-13 Solder Resist on Holes . . . . .	14-18
Figure 12-20 Blisters and Delamination . . . . .	12-25	Figure 14-14 Solder Leveling Adhesion Failure . . . . .	14-19
Figure 12-21 Blisters . . . . .	12-29	Figure 14-15 Unsoldered Lands . . . . .	14-20
Figure 12-22 Incomplete Hole Fill . . . . .	12-31	Figure 15-1 Poor Coverlay Coverage Caused by Surface Preparation . . . . .	15-1
Figure 12-23 Weave Exposure . . . . .	12-32	Figure 15-2 Poor Coverlay Coverage Caused by Poor Mechanical Preparation . . . . .	15-2
Figure 12-24 Dry Glass Weave . . . . .	12-32	Figure 15-3 Adhesive Squeeze-Out . . . . .	15-2
Figure 13-1 Skip Plating . . . . .	13-1	Figure 15-4 Adhesive Squeeze-Out – Foil Surface . . . . .	15-3
Figure 13-2 Lack of Plating . . . . .	13-4	Figure 15-5 Access Hole Misregistration . . . . .	15-3
Figure 13-3 Rough Plating . . . . .	13-5	Figure 15-6 Plating Defects on Flex . . . . .	15-4
Figure 13-4 Stray Plating . . . . .	13-6	Figure 15-7 Transition Zone Squeeze-Out . . . . .	15-5
Figure 13-5 Skip Plating . . . . .	13-7	Figure 15-8 Solder Wicking . . . . .	15-6
Figure 13-6 Ni Foot . . . . .	13-8	Figure 15-9 Voids in Flex . . . . .	15-7
Figure 13-7 Stray Plating . . . . .	13-8	Figure 15-10 Etchback . . . . .	15-8
Figure 13-8 Hyper Corrosion . . . . .	13-9	Figure 15-11 Smear Removal . . . . .	15-9
Figure 13-9 Au Peeling Away from Ni . . . . .	13-10	Figure 15-12 Poorly Trimmed Edges . . . . .	15-10
Figure 13-10 Nonuniform OSP Coating . . . . .	13-12	Figure 15-13 Ag Film . . . . .	15-10
Figure 13-11 Excess OSP . . . . .	13-13	Figure 15-14 Insufficient Squeeze-Out . . . . .	15-11
Figure 13-12 Incomplete Solder Flow-Up . . . . .	13-13	Figure 15-15 Incorrect Radius . . . . .	15-11
Figure 13-13 Etch Artifacts . . . . .	13-26	Figure 15-16 Stiffener Delamination . . . . .	15-12
Figure 13-14 Plating Artifacts . . . . .	13-26	Figure 15-17 Flex Edge Damage . . . . .	15-12
Figure 13-15 Missing Surface Cu Plating . . . . .	13-27	Figure 15-18 Flex Open . . . . .	15-13
Figure 13-16 Flex Deformation . . . . .	13-27	Figure 15-19 Delamination Due to Fabrication . . . . .	15-13
Figure 13-17 Cap Plating Pulled Off . . . . .	13-28	Figure 15-20 Instances of Foreign Material . . . . .	15-14
Figure 13-18 Staggered Via Failure . . . . .	13-28	Figure 15-21 Holes in Flex Area . . . . .	15-14
Figure 13-19 Microvia Voids . . . . .	13-29	Figure 15-22 Holes in Transition Areas . . . . .	15-15
Figure 13-20 Rim Void . . . . .	13-30	Figure 15-23 Delamination . . . . .	15-15
Figure 13-21 Rim Void . . . . .	13-30	Figure 15-24 Examples of Good and Bad Cu Nesting and Stacking Designs . . . . .	15-16
Figure 13-22 Rim Void . . . . .	13-31	Figure 15-25 Insufficient Radius . . . . .	15-17
Figure 13-23 Rim Void . . . . .	13-31	Figure 15-26 Wrinkle in Coverlay . . . . .	15-17
Figure 14-1 Misregistration . . . . .	14-2	Figure 15-27 Wrinkling During Flexing . . . . .	15-18
Figure 14-2 Adhesion Failure . . . . .	14-4	Figure 15-28 Material Too Rigid for Depanelization . . . . .	15-19
Figure 14-3 Skipping . . . . .	14-6		

# Table of Contents

## Section 1

<b>1</b>	<b>SCOPE</b> .....	1-1
1.1	Purpose .....	1-1
1.2	Classification .....	1-1
1.3	Use of “Lead” .....	1-1
1.4	Abbreviations and Acronyms .....	1-1
1.5	Terms and Definitions .....	1-1
1.6	IPC-9121 Format Example .....	1-1
1.7	Guidelines for Effective Troubleshooting and Process Control .....	1-2
1.8	Parameter Analysis .....	1-3
1.8.1	Brainstorming .....	1-3
1.8.2	Process Audit .....	1-3
1.8.3	Initial Capability Study .....	1-3
1.8.4	Optimization .....	1-3
1.8.5	Confirmation and Final Capability Assessment .....	1-4
1.8.6	Parameter Control .....	1-4
1.8.7	Corrective Action Plan .....	1-4

# Troubleshooting for Printed Board Fabrication Processes

## Section 1 – Scope

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### 1 SCOPE

This handbook provides problems, causes and possible corrective actions related to printed board manufacturing processes.

**1.1 Purpose** The purpose of this standard is to help designers, manufacturers and users of printed boards to troubleshoot fabrication processes to build electronics better.

**1.2 Classification** IPC standards recognize that electrical and electronic assemblies are subject to classifications by intended end-item use. Three general end-product classes have been established to reflect differences in manufacturability, complexity, functional performance requirements, and verification (inspection/test) frequency. It should be recognized that there may be overlaps of equipment between classes.

#### **CLASS 1 General Electronic Products**

Includes products suitable for applications where the major requirement is function of the completed assembly.

#### **CLASS 2 Dedicated Service Electronic Products**

Includes products where continued performance and extended life is required, and for which uninterrupted service is desired but not critical. Typically, the end-use environment would not cause failures.

#### **CLASS 3 High Performance/Harsh Environment Electronic Products**

Includes products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.

**1.3 Use of “Lead”** For readability and translation, the metallic element lead is always written as Pb.

**1.4 Abbreviations and Acronyms** See Appendix A for full spellings of abbreviations (including elements) and acronyms used in this standard.

**1.5 Terms and Definitions** Terms and definitions **shall** be in accordance with IPC-T-50 and 1.6.1 through 1.6.32.

**1.6 IPC-9121 Format Example** This document follows the general format seen below. In instances where there is no photo, a photo is not necessary or one could not be found. Potential test methods for discovery and verification are included in tables where applicable.

IPC encourages readers to submit process problems with photos as well as proposed causes and solutions to the IPC 7-24 Printed Board Process Effects Handbook Subcommittee. Submissions will be considered for document revisions.

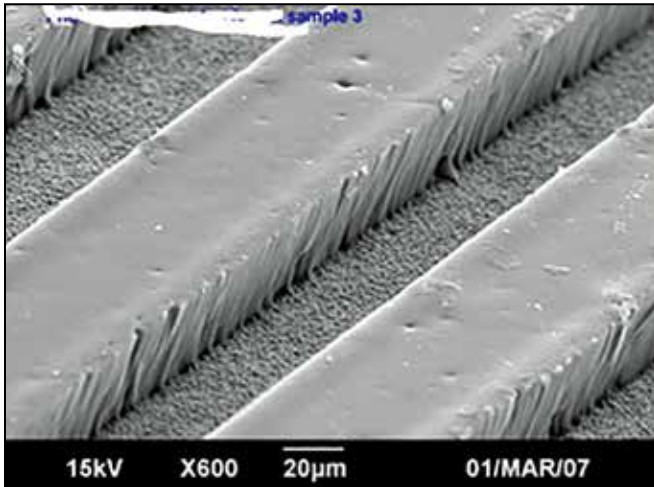


Figure 1-1 Photo Resist Under-Exposure

CAUSE	ACTION
UV source inadequate	Check exposure intensity/wavelength/duration
Expose intensity inadequate	Review, reinstated exposure control procedures
Expose time inadequate	Review, reinstated exposure control procedures
Oxygen exposure of photoresist prior to exposure	Review photoresist shelf life
Potential test methods (discover)	Potential test method (verification)
AOI (line/space reproduction)	AOI
Etch-outs	Periodic UV photometer and step tablet exposure checks

**1.7 Guidelines for Effective Troubleshooting and Process Control** One of the keys to effective problem solving is a structured routine that addresses key points each time a major problem is encountered. This section suggests steps to effectively find the cause of a problem and to solve it permanently. Refer to IPC-9191 for suggested methodology for statistical process control (SPC).

1. Before beginning a detailed troubleshooting project, use common sense in defining the problem.
  - Verify there is a problem.
  - Observe the defective product and compare it to the standard.
  - Identify the standard process and product and then determine any present deviation from the standard or any change in the product.
2. Establish whether operating procedures were followed and whether an assignable cause can be quickly identified as the reason for the problem.
  - Only continue into more detailed analysis if the initial questions do not lead to an obvious answer.
  - Even if the answer appears to be obvious, confirm the answer by operation of the process before closing the project.
3. Develop a clear, concise problem statement that quantifies the problem whenever possible and reduces the scope of the investigation to a manageable size.
4. Gather all pertinent data and facts.
  - Use statistical process control (SPC), historical data, records, logs, etc.
  - This includes temperature charts, analysis records, maintenance logs, etc.
5. Perform a causal analysis:
  - Producing out-of-specification parts requires immediate action (i.e., shut down the process).
  - Out-of-control processes require determination whether the process can continue to operate.
  - Severe process variation requires evaluation of the severity and effect of the problem on the final product.
6. Develop an action plan which includes the procedures for addressing products produced during out-of-specification or out-of-control conditions. The plan should also indicate who should make those decisions. These issues include but are not limited to:
  - Disposition of the defective material (repair, scrap, replace, etc.).

- Checking the effect on scheduled delivery.
- Informing the effect on scheduled delivery.
- Request for nonconformance authority or Material Review Board (MRB) action.
- Establish a corrective action plan to reduce or eliminate the likelihood of recurrence.

7. Conduct a Measurement System Evaluation, which is a means used to detect and identify the problem. This includes not only the measuring apparatus, but also:

- The sampling method.
- The operator (and his/her instructions).
- Accuracy and calibration of equipment.
- Environmental factors (e.g., lighting, temperature, and relative humidity (RH))

8. The variation inherent in the measurement of attribute data and responses that are subjective in nature can be addressed. The evaluation is more complex in nature, but it is still an essential part of the analysis of the problem. IPC-9191 discusses this subject in greater detail.

**1.8 Parameter Analysis** The purpose of parameter analysis, as detailed in IPC-9191, is to establish cause-effect relationships and to identify, isolate and rank major sources of variation. Common sources are:

- Positional variation (within a piece).
- Cyclical variation (piece to piece).
- Temporal variation (over time).

**1.8.1 Brainstorming** The development of a cause-and-effect diagram by a cross-functional problem-solving team is critical to the identification of variables to be studied. Care should be taken to include representatives of the disciplines that are part of the process being studied, such as engineering, quality, manufacturing operators, analysis laboratory, etc.

Identify all possible causes of the problem, including process steps, raw materials, materials handling, inspection and personnel (i.e., “fishbone” diagram for root cause analysis). The ranking of these factors by the problem-solving team should be used to establish those factors that will be studied experimentally. The problem-solving team should, at a minimum, include manufacturing engineers, quality engineering and operators who are intimate with the process. The team should take care to openly consider new ideas on the problem.

Situations may occur in which the formation of a brainstorming team is inappropriate. Only someone with troubleshooting experience should make the decision to approach a problem alone. Considerable time and effort can be wasted by failure to get input from all knowledgeable sources.

**1.8.2 Process Audit** Process an audit by reviewing the entire operation (e.g., documentation, transfer, handling, processing, etc.). Identify current conditions and compare to the standard. Define process windows. An audit is best conducted by someone not directly involved in the day-to-day operation of the process.

**1.8.3 Initial Capability Study** Initial capability studies are ideally done before the process is accepted for production. This means creating a match between the process and the product, and it results in a process control window that is capable of producing the product.

One approach to troubleshooting that quantifies improvement for reporting to management involves a capability assessment. IPC-9191 discusses in greater detail the generation of capability indices. This step promotes a clear understanding of the process matrices, but it requires time and resources.

**1.8.4 Optimization** This step includes the variety of techniques used to isolate factors that affect the response being studied. The most important technique is to alter one-factor-at-a-time change. Comparison of the output at both settings is mandatory to establish the real effect of the process change. Outside factors that are not controlled when a new factor setting is evaluated can cause incorrect conclusions to be drawn.