IPC-A-610J

Acceptability of Electronic Assemblies

If a conflict occurs between the English language and translated versions of this document, the English version will take precedence.

Developed by the IPC-A-610 Task Group (7-31b), IPC-A-610 Task Group – Europe (7-31b-EU) and IPC-A-610 Task Group – China (7-31b-CN) of the Product Assurance Committee (7-30) of IPC

Supersedes:
IPC-A-610H – September 2020
IPC-A-610G – October 2017
IPC-A-610F WAM1 – February 2016
IPC-A-610F – July 2014
IPC-A-610E – April 2010
IPC-A-610D – February 2005
IPC-A-610C – January 2000
IPC-A-610B – December 1994
IPC-A-610A – March 1990
IPC-A-610 – August 1983

Users of this publication are encouraged to participate in the development of future revisions.

Contact:

IPC
3000 Lakeside Drive, Suite 105N
Bannockburn, Illinois
60015-1249
Tel 847 615.7100
Fax 847 615.7105

Table of Contents

1.0 General 1-1
1.1 Scope 1-1
1.2 Purpose 1-2
1.3 Classification 1-2
1.4 Measurement Units and Applications 1-2
1.4.1 Verification of Dimensions 1-2
1.5 Requirements 1-2
1.5.1 Acceptance Criteria 1-3
1.5.1.1 Acceptable 1-3
1.5.1.2 Defect 1-3
1.5.1.2.1 Disposition 1-3
1.5.1.3 Process Indicator 1-3
1.5.1.4 Conditions Not Specified 1-3
1.5.1.5 Specialized Designs 1-3
1.5.1.6 Should 1-3
1.6 Process Control Methodologies 1-3
1.7 Order of Precedence 1-4
1.7.1 Clause References 1-4
1.7.2 Appendices 1-4
1.8 Terms and Definitions 1-4
1.8.1 Board Orientation 1-4
1.8.1.1 Primary Side 1-4
1.8.1.2 Secondary Side 1-4
1.8.1.3 Solder Source Side 1-4
1.8.1.4 Solder Destination Side 1-4
1.8.2 Bubble 1-4
1.8.2.1 Bridging Bubble 1-4
1.8.3 Cold Solder Connection 1-4
1.8.4 Common Conductors 1-4
1.8.5 Conductor Overlap 1-4
1.8.6 Conductor Overwrap 1-4
1.8.7 Diameter 1-5
1.8.8 Electrical Clearance 1-5
1.8.9 Engineering Documentation 1-5
1.8.10 FOD (Foreign Object Debris) 1-5
1.8.11 Form, Fit, Function (F/F/F) 1-5
1.8.12 High Voltage 1-5
1.8.13 Intrusive Solder 1-5
1.8.14 Kink 1-5

1.8.15 Locking Mechanism ... 1-5
1.8.16 Manufacturer ... 1-5
1.8.17 Meniscus (Component) ... 1-5
1.8.18 Noncommon Conductors ... 1-5
1.8.19 Nonfunctional Land ... 1-5
1.8.20 Pin-in-Paste ... 1-5
1.8.21 Solder Balls ... 1-5
1.8.22 Standard Industry Practice (SIP) ... 1-5
1.8.23 Stress Relief ... 1-6
1.8.24 Supplier ... 1-6
1.8.25 Tempered Leads ... 1-6
1.8.26 User ... 1-6
1.9 Requirements Flowdown ... 1-6
1.10 Personnel Proficiency ... 1-6
1.11 Acceptance Requirements ... 1-6
1.11.1 Missing Parts and Components ... 1-6
1.11.2 Jumper Wire or Z-Wire ... 1-6
1.12 Minimum Electrical Clearance (MEC) ... 1-7
1.13 Inspection Methodology ... 1-9
1.13.1 Lighting ... 1-9
1.13.2 Magnification Aids ... 1-9

2.0 Applicable Documents ... 2-1
2.1 IPC Documents ... 2-1
2.2 Joint Industry Documents ... 2-2
2.3 Electrostatic Association Documents ... 2-2
2.4 International Electrotechnical Commission Documents ... 2-2
2.5 ASTM ... 2-2
2.6 Military Standards ... 2-3
2.7 SAE International ... 2-3

3.0 Handling Electronic Assemblies ... 3-1

4.0 Hardware ... 4-1
4.1 Hardware Installation ... 4-2
4.1.1 Hardware Installation — Electrical Clearance ... 4-2
4.1.2 Hardware Installation — Interference ... 4-3
4.1.3 Hardware Installation — Component Mounting – High Power ... 4-4
4.1.4 Hardware Installation — Heatsinks ... 4-6
4.1.4.1 Hardware Installation — Heatsinks – Insulators and Thermal Compounds ... 4-6
4.1.4.2 Hardware Installation — Heatsinks – Contact ... 4-7
4.1.5 Hardware Installation — Threaded Fasteners and Other Threaded Hardware ... 4-8
4.1.5.1 Hardware Installation — Threaded Fasteners and Other Threaded Hardware – Torque ... 4-10

4.1.5.2 Hardware Installation — Threaded Fasteners and Other Threaded Hardware – Solid Wires 4-12
4.1.5.3 Hardware Installation — Threaded Fasteners and Other Threaded Hardware – Stranded Wires..... 4-14
4.2 Jackpost Mounting 4-15
4.3 Connector Pins 4-16
4.3.1 Connector Pins — Edge Connector Pins..... 4-16
4.3.2 Connector Pins — Press Fit Pins..... 4-16
4.3.2.1 Connector Pins — Press Fit Pins – Land/Annular Ring 4-18
4.3.2.2 Connector Pins — Press Fit Pins – Soldering..... 4-19
4.4 Wire Bundle Securing..... 4-20
4.5 Routing — Wires and Wire Bundles 4-20

5.0 Soldering 5-1
5.1 Soldering Acceptability Requirements..... 5-2
5.2 Soldering Anomalies 5-3
5.2.1 Soldering Anomalies — Exposed Basis Metal..... 5-3
5.2.2 Soldering Anomalies — Pin Holes/Blow Holes/Voids..... 5-5
5.2.3 Soldering Anomalies — Reflow of Solder Paste..... 5-6
5.2.4 Soldering Anomalies — Nonwetting..... 5-7
5.2.5 Soldering Anomalies — Cold Connection 5-8
5.2.6 Soldering Anomalies — Dewetting 5-8
5.2.7 Soldering Anomalies — Excess Solder 5-9
5.2.7.1 Soldering Anomalies — Excess Solder – Solder Balls 5-10
5.2.7.2 Soldering Anomalies — Excess Solder – Bridging 5-11
5.2.7.3 Soldering Anomalies — Excess Solder – Solder Webbing/Splashes 5-12
5.2.8 Soldering Anomalies — Disturbed Solder 5-13
5.2.9 Soldering Anomalies — Cooling Lines and Secondary Reflow 5-14
5.2.10 Soldering Anomalies — Fractured Solder 5-15
5.2.11 Soldering Anomalies — Solder Projections..... 5-16
5.2.12 Soldering Anomalies — Pb-Free Fillet Lift..... 5-17
5.2.13 Soldering Anomalies — Pb-Free Hot Tear/Shrink Hole 5-18
5.2.14 Probe Marks and Other Similar Surface Conditions in Solder Joints..... 5-19
5.2.15 Inclusions..... 5-20
5.3 Partially Visible or Hidden Solder Connections 5-20
5.4 Heat Shrinkable Soldering Devices 5-21

6.0 Terminal Connections..... 6-1
6.1 Swaged Hardware 6-2
6.1.1 Swaged Hardware — Terminals 6-2
6.1.1.1 Swaged Hardware — Terminals – Terminal Base to Land Separation 6-2
6.1.1.2 Swaged Hardware — Terminals – Turret 6-4
6.1.1.3 Swaged Hardware — Terminals – Bifurcated 6-5
6.1.2 Swaged Hardware — Rolled Flange..... 6-6

6.1.3 Swaged Hardware — Flared Flange 6-7
6.1.4 Swaged Hardware — Controlled Split 6-8
6.1.5 Swaged Hardware — Solder 6-9
6.2 Insulation 6-11
6.2.1 Insulation — Damage 6-11
6.2.1.1 Insulation — Damage – Presolder 6-11
6.2.1.2 Insulation — Damage – Post-Solder 6-13
6.2.2 Insulation — Clearance 6-14
6.2.3 Insulation — Insulation Sleeving 6-16
6.2.3.1 Insulation — Insulation Sleeving – Placement 6-16
6.2.3.2 Insulation — Insulation Sleeving – Damage 6-18
6.3 Conductor 6-19
6.3.1 Conductor — Deformation 6-19
6.3.2 Conductor — Damage 6-20
6.3.2.1 Conductor — Damage – Stranded Wire 6-20
6.3.2.2 Conductor — Damage – Solid Wire 6-21
6.3.3 Conductor — Strand Separation (Birdcaging) – Presolder 6-21
6.3.4 Conductor — Strand Separation (Birdcaging) – Post-Solder 6-22
6.3.5 Conductor — Tinning 6-23
6.4 Service Loops 6-25
6.5 Routing — Wires and Wire Bundles – Bend Radius 6-26
6.6 Stress Relief 6-27
6.6.1 Stress Relief — Wire 6-27
6.7 Lead/Conductor Placement — General Requirements 6-29
6.8 Solder — General Requirements 6-30
6.9 Turrets and Straight Pins 6-32
6.9.1 Turrets and Straight Pins — Conductor Placement 6-32
6.9.2 Turrets and Straight Pins — Solder 6-34
6.10 Bifurcated 6-35
6.10.1 Bifurcated — Conductor Placement – Side Route Attachments 6-35
6.10.2 Bifurcated — Conductor Placement – Staked Wires 6-37
6.10.3 Bifurcated — Conductor Placement – Bottom and Top Route Attachments 6-38
6.10.4 Bifurcated — Solder 6-39
6.11 Slotted 6-41
6.11.1 Slotted — Conductor Placement 6-41
6.11.2 Slotted — Solder 6-42
6.12 Pierced/Perforated 6-43
6.12.1 Pierced/Perforated — Conductor Placement 6-43
6.12.2 Pierced/Perforated — Solder 6-45
6.13 Hook 6-46
6.13.1 Hook — Conductor Placement 6-46

6.13.2 Hook — Solder ... 6-48
6.14 Solder Cups ... 6-49
6.14.1 Solder Cups — Conductor Placement ... 6-49
6.14.2 Solder Cups — Solder ... 6-50
6.15 AWG 30 and Smaller Diameter Wires — Conductor Placement ... 6-52
6.16 Series Connected ... 6-54
6.17 Edge Clip — Position ... 6-55

7.0 Through-Hole Technology ... 7-1
7.1 Component Mounting ... 7-1
7.1.1 Component Mounting — Orientation ... 7-1
7.1.1.1 Component Mounting — Orientation – Horizontal ... 7-2
7.1.1.2 Component Mounting — Orientation – Vertical ... 7-3
7.1.2 Component Mounting — Lead Forming ... 7-4
7.1.2.1 Component Mounting — Lead Forming – Bend Radius ... 7-4
7.1.2.2 Component Mounting — Lead Forming – Space between Seal/Weld and Bend ... 7-5
7.1.2.3 Component Mounting — Lead Forming – Stress Relief ... 7-6
7.1.2.4 Component Mounting — Lead Forming – Damage ... 7-8
7.1.3 Component Mounting — Leads Crossing Conductors ... 7-9
7.1.4 Component Mounting — Hole Obstruction ... 7-10
7.1.5 Component Mounting — DIP/SIP Devices and Sockets ... 7-11
7.1.6 Component Mounting — Radial Leads – Vertical ... 7-13
7.1.6.1 Component Mounting — Radial Leads – Vertical – Spacers ... 7-14
7.1.7 Component Mounting — Radial Leads – Horizontal ... 7-15
7.1.8 Component Mounting — Connectors ... 7-16
7.1.8.1 Component Mounting — Connectors – Right Angle ... 7-17
7.1.8.2 Component Mounting — Connectors – Vertical Shrouded Pin Headers and Vertical Receptacle Connectors ... 7-18
7.2 Component Securing ... 7-19
7.2.1 Component Securing — Mounting Clips ... 7-19
7.2.2 Component Securing — Adhesive Bonding ... 7-20
7.2.2.1 Component Securing — Adhesive Bonding – Nonelevated Components ... 7-21
7.2.2.2 Component Securing — Adhesive Bonding – Elevated Components ... 7-24
7.2.3 Component Securing — Other Devices ... 7-27
7.3 Supported Holes ... 7-28
7.3.1 Supported Holes — Axial Loaded – Horizontal ... 7-28
7.3.2 Supported Holes — Axial Loaded – Vertical ... 7-29
7.3.3 Supported Holes — Leads/Conductors Protrusion ... 7-31
7.3.4 Supported Holes — Lead/Conductor Clinches ... 7-32
7.3.5 Supported Holes — Solder ... 7-33
7.3.5.1 Supported Holes — Solder – Vertical Fill (A) ... 7-36
7.3.5.2 Supported Holes — Solder – Solder Destination Side – Lead to Barrel (B) ... 7-38

7.3.5.3 Supported Holes — Solder – Solder Destination Side – Land Area Coverage (C) 7-40
7.3.5.4 Supported Holes — Solder – Solder Source Side – Lead to Barrel (D) 7-41
7.3.5.5 Supported Holes — Solder – Solder Source Side – Land Area Coverage (E) 7-42
7.3.5.6 Supported Holes — Solder Conditions – Solder in Lead Bend 7-43
7.3.5.7 Supported Holes — Solder Conditions – Touching Through-Hole Component Body 7-44
7.3.5.8 Supported Holes — Solder Conditions – Meniscus in Solder 7-45
7.3.5.9 Supported Holes — Lead Cutting After Soldering 7-47
7.3.5.10 Supported Holes — Coated Wire Insulation in Solder 7-48
7.3.5.11 Supported Holes — Interfacial Connection without Lead – Vias 7-49
7.3.5.12 Supported Holes — Board in Board 7-50
7.4 Unsupported Holes 7-53
7.4.1 Unsupported Holes — Axial Leads – Horizontal 7-53
7.4.2 Unsupported Holes — Axial Leads – Vertical 7-54
7.4.3 Unsupported Holes — Wire/Lead Protrusion 7-55
7.4.4 Unsupported Holes — Wire/Lead Clinches 7-56
7.4.5 Unsupported Holes — Solder 7-58
7.4.6 Unsupported Holes — Lead Cutting After Soldering 7-60

8.0 Surface Mount Assemblies 8-1
8.1 Staking Adhesive 8-2
8.1.1 Staking Adhesive — Component Bonding 8-2
8.1.2 Staking Adhesive — Mechanical Strength 8-3
8.2 SMT Leads 8-5
8.2.1 SMT Leads — Plastic Components 8-5
8.2.2 SMT Leads — Damage 8-5
8.2.3 SMT Leads — Flattening 8-6
8.3 SMT Connections 8-6
8.3.1 Chip Components — Bottom Only Terminations 8-7
8.3.1.1 Chip Components — Bottom Only Terminations – Side Overhang (A) 8-8
8.3.1.2 Chip Components — Bottom Only Terminations – End Overhang (B) 8-9
8.3.1.3 Chip Components — Bottom Only Terminations – End Joint Width (C) 8-10
8.3.1.4 Chip Components — Bottom Only Terminations – Side Joint Length (D) 8-11
8.3.1.5 Chip Components — Bottom Only Terminations – Maximum Fillet Height (E) 8-12
8.3.1.6 Chip Components — Bottom Only Terminations – Minimum Fillet Height (F) 8-12
8.3.1.7 Chip Components — Bottom Only Terminations – Solder Thickness (G) 8-13
8.3.1.8 Chip Components — Bottom Only Terminations – End Overlap (J) 8-13
8.3.2 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) 8-14
8.3.2.1 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Side Overhang (A) 8-15
8.3.2.2 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – End Overhang (B) 8-17

8.3.2.3 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – End Joint Width (C) 8-18
8.3.2.4 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Side Joint Length (D) 8-20
8.3.2.5 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Maximum Fillet Height (E) 8-21
8.3.2.6 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Minimum Fillet Height (F) 8-22
8.3.2.7 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Solder Thickness (G) 8-23
8.3.2.8 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – End Overlap (J) 8-24
8.3.2.9 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Termination Variations 8-25
8.3.2.9.1 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Termination Variations – Mounting on Side (Billboarding) 8-25
8.3.2.9.2 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Termination Variations – Mounting Upside Down 8-27
8.3.2.9.3 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Termination Variations – Stacking 8-28
8.3.2.9.4 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Termination Variations – Tombstoning 8-29
8.3.2.10 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Center and Lateral Terminations 8-30
8.3.2.10.1 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Center and Lateral Terminations – Solder Width of Side Termination 8-31
8.3.2.10.2 Rectangular or Square End Chip Components — 1, 2, 3 or 5 Side Termination(s) – Center and Lateral Terminations – Minimum Fillet Height of Side Termination 8-32
8.3.3 Cylindrical End Cap Terminations 8-33
8.3.3.1 Cylindrical End Cap Terminations — Side Overhang (A) 8-34
8.3.3.2 Cylindrical End Cap Terminations — End Overhang (B) 8-35
8.3.3.3 Cylindrical End Cap Terminations — End Joint Width (C) 8-36
8.3.3.4 Cylindrical End Cap Terminations — Side Joint Length (D) 8-37
8.3.3.5 Cylindrical End Cap Terminations — Maximum Fillet Height (E) 8-38
8.3.3.6 Cylindrical End Cap Terminations — Minimum Fillet Height (F) 8-39
8.3.3.7 Cylindrical End Cap Terminations — Solder Thickness (G) 8-40
8.3.3.8 Cylindrical End Cap Terminations — End Overlap (J) 8-41
8.3.3.9 Cylindrical End Cap Terminations — Center and Lateral Terminations 8-42
8.3.4 Castellated Terminations 8-43
8.3.4.1 Castellated Terminations — Side Overhang (A) 8-44
8.3.4.2 Castellated Terminations — End Overhang (B) 8-45
8.3.4.3 Castellated Terminations — Minimum End Joint Width (C) 8-45
8.3.4.4 Castellated Terminations — Minimum Side Joint Length (D) 8-46

8.3.4.5 Castellated Terminations — Maximum Fillet Height (E) ... 8-46
8.3.4.6 Castellated Terminations — Minimum Fillet Height (F) ... 8-47
8.3.4.7 Castellated Terminations — Solder Thickness (G) ... 8-47
8.3.5 Flat Gull Wing Leads ... 8-48
8.3.5.1 Flat Gull Wing Leads — Side Overhang (A) ... 8-49
8.3.5.2 Flat Gull Wing Leads — Toe Overhang (B) ... 8-52
8.3.5.3 Flat Gull Wing Leads — Minimum End Joint Width (C) ... 8-53
8.3.5.4 Flat Gull Wing Leads — Minimum Side Joint Length (D) ... 8-54
8.3.5.5 Flat Gull Wing Leads — Maximum Heel Fillet Height (E) ... 8-55
8.3.5.6 Flat Gull Wing Leads — Minimum Heel Fillet Height (F) ... 8-56
8.3.5.7 Flat Gull Wing Leads — Solder Thickness (G) ... 8-57
8.3.5.8 Flat Gull Wing Leads — Coplanarity ... 8-58
8.3.6 Round or Flattened (Coined) Gull Wing Leads ... 8-59
8.3.6.1 Round or Flattened (Coined) Gull Wing Leads — Side Overhang (A) ... 8-60
8.3.6.2 Round or Flattened (Coined) Gull Wing Leads — Toe Overhang (B) ... 8-61
8.3.6.3 Round or Flattened (Coined) Gull Wing Leads — Minimum End Joint Width (C) ... 8-61
8.3.6.4 Round or Flattened (Coined) Gull Wing Leads — Minimum Side Joint Length (D) ... 8-62
8.3.6.5 Round or Flattened (Coined) Gull Wing Leads — Maximum Heel Fillet Height (E) ... 8-63
8.3.6.6 Round or Flattened (Coined) Gull Wing Leads — Minimum Heel Fillet Height (F) ... 8-64
8.3.6.7 Round or Flattened (Coined) Gull Wing Leads — Solder Thickness (G) ... 8-65
8.3.6.8 Round or Flattened (Coined) Gull Wing Leads — Minimum Side Joint Height (Q) ... 8-65
8.3.6.9 Round or Flattened (Coined) Gull Wing Leads — Coplanarity ... 8-66
8.3.7 J Leads ... 8-67
8.3.7.1 J Leads — Side Overhang (A) ... 8-67
8.3.7.2 J Leads — Toe Overhang (B) ... 8-69
8.3.7.3 J Leads — End Joint Width (C) ... 8-70
8.3.7.4 J Leads — Side Joint Length (D) ... 8-71
8.3.7.5 J Leads — Maximum Heel Fillet Height (E) ... 8-72
8.3.7.6 J Leads — Minimum Heel Fillet Height (F) ... 8-73
8.3.7.7 J Leads — Solder Thickness (G) ... 8-75
8.3.7.8 J Leads — Coplanarity ... 8-75
8.3.8 Butt/I Connections ... 8-76
8.3.8.1 Butt/I Connections — Modified Through-Hole Terminations ... 8-76
8.3.8.1.1 Butt/I Connections — Modified Through-Hole Terminations – Maximum Side Overhang (A) ... 8-77
8.3.8.1.2 Butt/I Connections — Modified Through-Hole Terminations – Toe Overhang (B) ... 8-77
8.3.8.1.3 Butt/I Connections — Modified Through-Hole Terminations – Minimum End Joint Width (C) ... 8-78
8.3.8.1.4 Butt/I Connections — Modified Through-Hole Terminations – Minimum Side Joint Length (D) ... 8-78
8.3.8.1.5 Butt/I Connections — Modified Through-Hole Terminations – Maximum Fillet Height (E) ... 8-78
8.3.8.1.6 Butt/I Connections — Modified Through-Hole Terminations – Minimum Fillet Height (F) ... 8-79
8.3.8.1.7 Butt/I Connections — Modified Through-Hole Terminations – Solder Thickness (G) ... 8-79
8.3.8.2 Butt/I Connections — Solder Charged Terminations ... 8-80

8.3.8.2.1 Butt/I Connections — Solder Charged Terminations – Maximum Side Overhang (A) 8-81
8.3.8.2.2 Butt/I Connections — Solder Charged Terminations – Maximum Toe Overhang (B) 8-81
8.3.8.2.3 Butt/I Connections — Solder Charged Terminations – Minimum End Joint Width (C)..... 8-82
8.3.8.2.4 Butt/I Connections — Solder Charged Terminations – Minimum Fillet Height (F)..... 8-82
8.3.9 Flat Lug Leads 8-83
8.3.10 Tall Profile Components Having Bottom Only Terminations..... 8-84
8.3.11 Inward Formed L-Shaped Ribbon Leads 8-85
8.3.12 Surface Mount Area Array 8-87
8.3.12.1 Surface Mount Area Array — Alignment..... 8-88
8.3.12.2 Surface Mount Area Array — Solder Ball Spacing..... 8-88
8.3.12.3 Surface Mount Area Array — Solder Connections 8-89
8.3.12.4 Surface Mount Area Array — Voids 8-91
8.3.12.5 Surface Mount Area Array — Underfill/Staking..... 8-91
8.3.12.6 Surface Mount Area Array — Package on Package 8-92
8.3.13 Bottom Termination Components (BTC) 8-94
8.3.14 Components with Bottom Thermal Pad Terminations (D-Pak)..... 8-96
8.3.15 Flattened Post Connections 8-98
8.3.15.1 Flattened Post Connections — Maximum Termination Overhang – Square Solder Land..... 8-98
8.3.15.2 Flattened Post Connections — Maximum Termination Overhang – Round Solder Land..... 8-99
8.3.15.3 Flattened Post Connections — Maximum Fillet Height 8-99
8.3.16 P-Style Terminations 8-100
8.3.16.1 P-Style Terminations — Maximum Side Overhang (A) 8-101
8.3.16.2 P-Style Terminations — Maximum Toe Overhang (B) 8-101
8.3.16.3 P-Style Terminations — Minimum End Joint Width (C) 8-102
8.3.16.4 P-Style Terminations — Minimum Side Joint Length (D)..... 8-102
8.3.16.5 P-Style Terminations — Minimum Fillet Height (F) 8-103
8.3.17 Vertical Cylindrical Cans with Outward L-Shaped Lead Terminations..... 8-104
8.3.18 Flexible and Rigid Flex Printed Circuitry with Flat Uniformed Leads 8-106
8.3.19 Wrapped Terminals..... 8-107
8.3.19.1 Wrapped Terminals — Side Overhang (A) 8-108
8.3.19.2 Wrapped Terminals — End Joint Width (C) 8-108
8.3.19.3 Wrapped Terminals — Side Joint Length (D)..... 8-108
8.3.19.4 Wrapped Terminals — Minimum Heel Fillet Height (F) 8-109
8.3.19.5 Wrapped Terminals — Solder Thickness (G) 8-109
8.3.20 Flat Leaded Surface Mount Connectors..... 8-110
8.4 Specialized SMT Terminations..... 8-111
8.5 Surface Mount Connectors 8-112
8.5.1 Surface Mount Connectors — Surface Mount Threaded Standoffs (SMTS) or Surface Mount Fasteners... 8-113

9.0 Component Damage..... 9-1
9.1 Loss of Metallization..... 9-2

9.2 Chip Resistor Element ... 9-3
9.3 Leaded/Leadless Devices ... 9-4
9.4 Ceramic Chip Capacitors ... 9-8
9.5 Connectors ... 9-10
9.6 Relays ... 9-13
9.7 Ferrite Core Components ... 9-13
9.8 Connectors, Handles, Extractors, Latches ... 9-14
9.9 Edge Connector Pins ... 9-15
9.10 Press Fit Pins ... 9-16
9.11 Backplane Connector Pins ... 9-17
9.12 Heatsink Hardware ... 9-18
9.13 Threaded Items and Hardware ... 9-19

10.0 Printed Boards and Assemblies ... 10-1
10.1 Non-Soldered Contact Areas ... 10-1
10.1.1 Non-Soldered Contact Area — Contamination ... 10-1
10.1.2 Non-Soldered Contact Area — Damage ... 10-3
10.2 Laminate Conditions ... 10-3
10.2.1 Laminate Conditions — Measling and Crazing ... 10-5
10.2.2 Laminate Conditions — Blistering and Delamination ... 10-7
10.2.3 Laminate Conditions — Weave Texture/Weave Exposure ... 10-10
10.2.4 Laminate Conditions — Haloing ... 10-11
10.2.5 Laminate Conditions — Nicks and Cracks ... 10-13
10.2.6 Laminate Conditions — Burns ... 10-15
10.2.7 Laminate Conditions — Bow and Twist ... 10-16
10.2.8 Laminate Conditions — Depanelization ... 10-17
10.2.9 Laminate Conditions — Mechanical Damage ... 10-19
10.3 Conductors/Lands ... 10-20
10.3.1 Conductors/Lands — Reduction ... 10-20
10.3.2 Conductors/Lands — Lifted ... 10-21
10.3.3 Conductors/Lands — Mechanical Damage ... 10-23
10.4 Flexible and Rigid-Flex Printed Boards ... 10-24
10.4.1 Flexible and Rigid-Flex Printed Boards — Damage ... 10-24
10.4.2 Flexible and Rigid-Flex Printed Boards — Delamination/Blister ... 10-27
10.4.2.1 Flexible and Rigid-Flex Printed Boards — Delamination/Blister – Flex ... 10-27
10.4.2.2 Flexible and Rigid-Flex Printed Boards — Delamination/Blister – Flex to Stiffener ... 10-29
10.4.3 Flexible and Rigid-Flex Printed Boards — Solder Wicking ... 10-30
10.4.4 Flexible and Rigid-Flex Printed Boards — Attachment ... 10-31
10.5 Marking ... 10-32
10.5.1 Marking — Etched (Including Hand Printing) ... 10-34
10.5.2 Marking — Screened ... 10-35

10.5.3 Marking — Stamped 10-36
10.5.4 Marking — Laser 10-37
10.5.5 Marking — Labels 10-37
10.5.5.1 Marking — Labels – Bar Coding/Data Matrix 10-37
10.5.5.2 Marking — Labels – Readability 10-38
10.5.5.3 Marking — Labels – Adhesion and Damage 10-39
10.5.5.4 Marking — Labels – Position 10-39
10.5.6 Marking — Radio Frequency Identification (RFID) Tags 10-40
10.6 Cleanliness 10-41
10.6.1 Cleanliness — Flux Residues 10-42
10.6.1.1 Cleanliness — Flux Residues – Cleaning Required 10-42
10.6.1.2 Cleanliness — Flux Residues – No Clean Process 10-43
10.6.2 Cleanliness — Foreign Object Debris (FOD) 10-44
10.6.3 Cleanliness — Chlorides, Carbonates and White Residues 10-45
10.6.4 Cleanliness — Surface Appearance 10-47
10.7 Solder Mask Coating 10-48
10.7.1 Solder Mask Coating — Wrinkling/Cracking 10-49
10.7.2 Solder Mask Coating — Voids, Blisters, Scratches 10-51
10.7.3 Solder Mask Coating — Breakdown 10-53
10.7.4 Solder Mask Coating — Discoloration 10-54
10.8 Conformal Coating 10-54
10.8.1 Conformal Coating — General 10-54
10.8.2 Conformal Coating — Coverage 10-55
10.8.3 Conformal Coating — Thickness 10-57
10.9 Electrical Insulation Coating 10-58
10.9.1 Electrical Insulation Coating — Coverage 10-58
10.9.2 Electrical Insulation Coating — Thickness 10-58
10.10 Encapsulation 10-59

11.0 Discrete Wiring 11-1
11.1 Solderless Wrap 11-1

12.0 High Voltage 12-1

13.0 Jumper Wires 13-1
13.1 Wire Routing 13-2
13.2 Wire Staking — Adhesive or Tape 13-3
13.3 Terminations 13-4
13.3.1 Terminations — Lap 13-5
13.3.1.1 Terminations — Lap – Component Lead 13-5
13.3.1.2 Terminations — Lap – Land 13-7
13.3.2 Terminations — Wire in Hole 13-8
13.3.3 Terminations — Wrapped 13-9

13.3.4 Terminations — SMT 13-10
13.3.4.1 Terminations — SMT – Chip and Cylindrical End Cap Components 13-10
13.3.4.2 Terminations — SMT – Gull Wing 13-11
13.3.4.3 Terminations — SMT – Castellations 13-13

Tables

Table 1-1 Summary of Related Documents 1-1
Table 1-2 Inspection Magnification (Land Width) 1-9
Table 1-3 Magnification Aid Applications For Wires And Soldered Conductors 1-10
Table 1-4 Magnification Aid Applications – Other 1-10
Table 6-1 Swaged Hardware Minimum Soldering Requirements 6-9
Table 6-2 Strand Damage 6-20
Table 6-3 Minimum Bend Radius Requirements 6-26
Table 6-4 Turret or Straight Pin Terminal Conductor Placement 6-32
Table 6-5 Bifurcated Terminal Conductor Placement – Side Route 6-35
Table 6-6 Staking Requirements of Side Route Straight Through Connections – Bifurcated Terminals 6-37
Table 6-7 Bifurcated Terminal Conductor Placement – Bottom Route 6-38
Table 6-8 Pierced or Perforated Terminal Conductor Placement 6-43
Table 6-9 Hook Terminal Conductor Placement 6-46
Table 6-10 AWG 30 and Smaller Wire Wrap Requirements 6-52
Table 7-1 Lead Bend Radius 7-4
Table 7-2 Component to Land Clearance 7-29
Table 7-3 Protrusion of Leads/Conductors in Supported Holes 7-31
Table 7-4 Supported Hole – Minimum Solder Requirements 7-35
Table 7-5 Board in Board – Minimum Acceptable Solder Conditions 7-50
Table 7-6 Protrusion of Leads in Unsupported Holes 7-55
Table 7-7 Unsupported Holes with Component Leads, Minimum Acceptable Conditions 7-58
Table 8-1 Dimensional Criteria – Chip Component – Bottom Only Termination Features 8-7
Table 8-2 Dimensional Criteria – Rectangular or Square End Chip Components – 1, 2, 3 or 5 Side Termination(s) 8-14
Table 8-2A Dimensional Criteria – Center/Lateral Termination (When Present) – Rectangular or Square End Chip Components – 1, 2, 3 or 5 Side Termination(s) 8-30
Table 8-3 Dimensional Criteria – Cylindrical End Cap Termination 8-33
Table 8-3A Dimensional Criteria – Cylindrical End Cap Terminations – Center and Lateral Terminations 8-42
Table 8-4 Dimensional Criteria – Castellated Terminations 8-43
Table 8-5 Dimensional Criteria – Flat Gull Wing Leads 8-48
Table 8-6 Dimensional Criteria – Round or Flattened (Coined) Gull Wing Lead Features 8-59
Table 8-7 Dimensional Criteria – J Leads 8-67
Table 8-8 Dimensional Criteria – Butt/I Connections – Modified Through-Hole Leads 8-76
Table 8-9 Dimensional Criteria – Butt/I Connections – Solder Charged Terminations 8-80
Table 8-10 Dimensional Criteria – Flat Lug Leads 8-83
Table 8-11 Dimensional Criteria – Tall Profile Components Having Bottom Only Terminations 8-84

Table 8-12 Dimensional Criteria – Inward Formed L-Shaped Ribbon Leads 8-85
Table 8-13 Dimensional Criteria – Ball Grid Array Components with Collapsing Balls 8-87
Table 8-14 Ball Grid Array Components with Noncollapsing Balls 8-87
Table 8-15 Column Grid Array 8-87
Table 8-16 Dimensional Criteria – BTC 8-94
Table 8-17 Dimensional Criteria – Bottom Thermal Pad Terminations (D-Pak) 8-96
Table 8-18 Dimensional Criteria Flattened Post Connections 8-98
Table 8-19 Dimensional Criteria – P-Style Terminations 8-100
Table 8-20 Dimensional Criteria – Vertical Cylindrical Cans with Outward L-Shaped Lead Terminations 8-105
Table 8-21 Dimensional Criteria – Flexible and Rigid-Flex Circuitry with Flat Unformed Leads 8-106
Table 8-22 Dimensional Criteria – Wrapped Terminals 8-107
Table 8-23 Dimensional Criteria – Flat Leaded Surface Mount Connectors 8-110
Table 8-24 SMTS/Surface Mount Fasteners – Minimum Acceptable Solder Conditions 8-113
Table 9-1 Nick or Chip-Out Criteria 9-8
Table 10-1 Coating Thickness Requirements 10-57
Table A-1 Typical Static Charge Sources A-3
Table A-2 Typical Static Voltage Generation A-3
Table A-3 Recommended Practices for Handling Electronic Assemblies A-6

Appendix A Protecting the Assembly — ESD and Other Handling Considerations A-1
A.1 ESD Prevention A-1
A.1.1 ESD Control Program A-1
A.1.2 ESD Protective Area (EPA) Requirements A-2
A.1.3 Minimizing Static Charge A-3
A.1.4 ESD Protective Packaging A-4
A.1.5 Training A-4
A.1.6 Tools And Equipment A-4
A.1.7 Compliance Verification A-5
A.1.8 ESD Prevention – Warning Labels A-5
A.2 General Handling A-6
A.2.1 Handling Considerations A-6
A.2.2 Preventing Contamination A-7
A.2.3 Handling Considerations – Gloves and Finger Cots A-7
A.3 Moisture Sensitive Devices A-8

Index Index-1

1.0 General

1.1 Scope This standard is a collection of visual quality acceptability requirements for electronic assemblies. This standard does not provide criteria for cross-section evaluation or x-ray inspection. There are x-ray guidelines located in J-STD-001.

This document presents acceptance requirements for the manufacture of electrical and electronic assemblies. Historically, electronic assembly standards contained a more comprehensive tutorial addressing principles and techniques. For a more complete understanding of this document's recommendations and requirements, one may use this document in conjunction with IPC-HDBK-001 or IPC-AJ-820.

The criteria in this standard are not intended to define processes to accomplish assembly operations nor is it intended to authorize repair/modification or change of the product. For instance, the presence of criteria for adhesive bonding of components does not imply/authorize/require the use of adhesive bonding and the depiction of a leads/conductors wrapped clockwise around a terminal does not imply/authorize/require that all leads/conductors be wrapped in the clockwise direction.

Users of this standard should be knowledgeable of the applicable requirements of the document and how to apply them, see 1.3 Classification.

IPC-A-610 has criteria outside the scope of J-STD-001 defining mechanical and other workmanship requirements.Table 1-1 is a summary of related IPC documents that the user may want to be familiar with to better understand the requirements of this document. For additional referenced documents see section 2.0 Applicable Documents.

Table 1-1 Summary of Related Documents

Document Purpose	Spec.#	Definition
Design Standard	IPC-222X IPC-7351 IPC-CM-770	Design requirements reflecting three levels of complexity (Levels A, B, and C) indicating finer geometries, greater densities, more process steps to produce the product. Component and Assembly Process Guidelines to assist in the design of the bare board and the assembly where the bare board processes concentrate on land patterns for surface mount and the assembly concentrates on surface mount and through-hole principles which are usually incorporated into the design process and the documentation.
Printed Board – Requirements	IPC-601X IPC-A-600	Requirements and acceptance documentation for rigid, rigid flex, flex and other types of substrates.
Process Requirement Standard	J-STD-001	Requirements for soldered electrical and electronic assemblies depicting minimum end product acceptable characteristics as well as methods for evaluation (test methods), frequency of testing and applicable ability of process control requirements.
Acceptability Standard	IPC-A-610	Pictorial interpretive document indicating various characteristics of the board and/or assembly as appropriate relating to desirable conditions that exceed the minimum acceptable characteristics indicated by the end item performance standard and reflect various out-of-control (process indicator or defect) conditions to assist the shop process evaluators in judging need for corrective action.
Training Programs (Optional)		Documented training for process, procedures, techniques and requirements.
Rework and Repair	IPC-7711/7721	Documentation providing the procedures to accomplish conformal coating and component removal and replacement, solder resist repair, and modification/repair of laminate material, conductors, and PTHs (plated through-holes).
Assembly and Joining Handbook	IPC-AJ-820	IPC-AJ-820 is a supporting document that provides information regarding the intent of this specification content and explains or amplifies the technical rationale for transition of limits through Acceptable to Defect condition criteria. In addition, supporting information is provided to give a broader understanding of the process considerations that are related to performance but not commonly distinguishable through visual assessment methods The explanations provided in IPC-AJ-820 should be useful in determining disposition of conditions identified as Defect, processes associated with Process Indicators, as well as answering questions regarding clarification in use and application for defined content of this specification. Contractual reference to IPC-A-610 does not additionally impose the content of IPC-AJ-820 unless specifically referenced in contractual documentation.

1.2 Purpose The visual standards in this document reflect the requirements of existing IPC and other applicable specifications. For the content of this document to apply, the assembly/product should comply with other existing IPC requirements, such as IPC-7351, IPC-222X (where X is the last digit in the IPC document number), IPC-601X and IPC-A-600. If the assembly does not comply with these or with equivalent requirements, the acceptance criteria **shall** be defined between the User and Supplier.