



IPC J-STD-001F

Requirements for Soldered Electrical and Electronic Assemblies

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

A joint standard developed by the J-STD-001 development team including Task Group (5-22A), Task Group Asia (5-22ACN) and Task Group India (5-22AIN) of the Assembly and Joining Committees (5-20 and 5-20CN) of IPC

Supersedes:

J-STD-001E - April 2010
J-STD-001D - February 2005
J-STD-001C - March 2000
J-STD-001B - October 1996
J-STD-001A - April 1992

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

Contact:

IPC

3000 Lakeside Drive, Suite 309S
Bannockburn, IL 60015-1249
Phone (847) 615-7100
Fax (847) 615-7105

Table of Contents

1 GENERAL	1	3 MATERIALS, COMPONENTS AND EQUIPMENT REQUIREMENTS	7
1.1 Scope	1	3.1 Materials	7
1.2 Purpose	1	3.2 Solder	7
1.3 Classification	1	3.2.1 Solder – Lead Free	7
1.4 Measurement Units and Applications	1	3.2.2 Solder Purity Maintenance	7
1.4.1 Verification of Dimensions	1	3.3 Flux	8
1.5 Definition of Requirements	2	3.3.1 Flux Application	8
1.5.1 Hardware Defects and Process Indicators	2	3.4 Solder Paste	8
1.5.2 Material and Process Nonconformance	2	3.5 Solder Preforms	8
1.6 General Requirements	3	3.6 Adhesives	8
1.7 Order of Precedence	3	3.7 Chemical Strippers	8
1.7.1 Conflict	3	3.8 Components	9
1.7.2 Clause References	3	3.8.1 Component and Seal Damage	9
1.7.3 Appendices	3	3.8.2 Coating Meniscus	9
1.8 Terms and Definitions	3	3.9 Soldering Tools and Equipment	9
1.8.1 Disposition	3	4 GENERAL SOLDERING AND ASSEMBLY REQUIREMENTS	9
1.8.2 Electrical Clearance	3	4.1 Electrostatic Discharge (ESD)	9
1.8.3 FOD (Foreign Object Debris)	3	4.2 Facilities	9
1.8.4 High Voltage	4	4.2.1 Environmental Controls	9
1.8.5 Manufacturer (Assembler)	4	4.2.2 Temperature and Humidity	9
1.8.6 Objective Evidence	4	4.2.3 Lighting	10
1.8.7 Process Control	4	4.2.4 Field Assembly Operations	10
1.8.8 Proficiency	4	4.3 Solderability	10
1.8.9 Solder Destination Side	4	4.4 Solderability Maintenance	10
1.8.10 Solder Source Side	4	4.5 Removal of Component Surface Finishes	10
1.8.11 Supplier	4	4.5.1 Gold Removal	10
1.8.12 User	4	4.5.2 Other Metallic Surface Finishes Removal	10
1.8.13 Wire Overwrap	4	4.6 Thermal Protection	10
1.8.14 Wire Overlap	4	4.7 Rework of Nonsolderable Parts	11
1.9 Requirements Flowdown	4	4.8 Preprocessing Cleanliness Requirements	11
1.10 Personnel Proficiency	5	4.9 General Part Mounting Requirements	11
1.11 Acceptance Requirements	5	4.9.1 General Requirements	11
1.12 General Assembly Requirements	5	4.9.2 Lead Deformation Limits	11
1.13 Miscellaneous Requirements	5	4.10 Hole Obstruction	11
1.13.1 Health and Safety	5	4.11 Metal-Cased Component Isolation	11
1.13.2 Procedures for Specialized Technologies	5	4.12 Adhesive Coverage Limits	11
2 APPLICABLE DOCUMENTS	6	4.13 Mounting of Parts on Parts (Stacking of Components)	11
2.1 EIA	6	4.14 Connectors and Contact Areas	11
2.2 IPC	6	4.15 Handling of Parts	11
2.3 Joint Industry Standards	7		
2.4 ASTM	7		
2.5 Electrostatic Discharge Association	7		

4.15.1	Preheating	11	5.6.3	Wire Staking	21
4.15.2	Controlled Cooling	12	5.6.4	Land	22
4.15.3	Drying/Degassing	12	5.6.5	Supported Holes	22
4.15.4	Holding Devices and Materials	12	5.6.6	SMT	22
4.16	Machine (Nonreflow) Soldering	12	6	THROUGH-HOLE MOUNTING AND TERMINATIONS	23
4.16.1	Machine Controls	12	6.1	Through-Hole Terminations – General	23
4.16.2	Solder Bath	12	6.1.1	Lead Forming	24
4.17	Reflow Soldering	12	6.1.2	Termination Requirements	24
4.17.1	Intrusive Soldering (Paste-in-Hole)	12	6.1.3	Lead Trimming	25
4.18	Solder Connection	12	6.1.4	Interfacial Connections	25
4.18.1	Exposed Surfaces	13	6.1.5	Coating Meniscus In Solder	25
4.18.2	Solder Connection Anomalies	13	6.2	Supported Holes	26
4.18.3	Partially Visible or Hidden Solder Connections	13	6.2.1	Solder Application	26
4.19	Heat Shrinkable Soldering Devices	14	6.2.2	Through-Hole Component Lead Soldering	26
5	WIRES AND TERMINAL CONNECTIONS	14	6.3	Unsupported Holes	26
5.1	Wire and Cable Preparation	14	6.3.1	Lead Termination Requirements for Unsupported Holes	26
5.1.1	Insulation Damage	14	7	SURFACE MOUNTING OF COMPONENTS	27
5.1.2	Strand Damage	14	7.1	Surface Mount Device Lead	27
5.1.3	Tinning of Stranded Wire	14	7.1.1	Plastic Components	27
5.2	Solder Terminals	15	7.1.2	Forming	27
5.3	Bifurcated, Turret and Slotted Terminal Installation	15	7.1.3	Unintentional Bending	28
5.3.1	Shank Damage	15	7.1.4	Flat Pack Parallelism	28
5.3.2	Flange Damage	15	7.1.5	Surface Mount Device Lead Bends	28
5.3.3	Flared Flange Angles	15	7.1.6	Flattened Leads	28
5.3.4	Terminal Mounting – Mechanical	16	7.1.7	Parts Not Configured for Surface Mounting ...	28
5.3.5	Terminal Mounting – Electrical	16	7.2	Leaded Component Body Clearance	28
5.3.6	Terminal Mounting – Soldering	16	7.2.1	Axial-Leaded Components	28
5.4	Mounting to Terminals	16	7.3	Parts Configured for Butt/I Lead Mounting ...	28
5.4.1	General Requirements	16	7.4	Hold Down of Surface Mount Leads/Components	28
5.4.2	Turret and Straight Pin Terminals	18	7.5	Soldering Requirements	28
5.4.3	Bifurcated Terminals	18	7.5.1	Misaligned Components	29
5.4.4	Slotted Terminals	19	7.5.2	Unspecified and Special Requirements	29
5.4.5	Hook Terminals	20	7.5.3	Bottom Only Chip Component Terminations	30
5.4.6	Pierced or Perforated Terminals	20	7.5.4	Rectangular or Square End Chip Components – 1, 3 or 5 Side Termination	31
5.4.7	Cup and Hollow Cylindrical Terminals – Placement	21	7.5.5	Cylindrical End Cap Terminations	32
5.5	Soldering to Terminals	21	7.5.6	Castellated Terminations	33
5.5.1	Bifurcated Terminals	21	7.5.7	Flat Gull Wing Leads	34
5.5.2	Slotted Terminal	21	7.5.8	Round or Flattened (Coined) Gull Wing Leads	35
5.5.3	Cup and Hollow Cylindrical Terminals – Soldering	21	7.5.9	J-Lead Terminations	36
5.6	Jumper Wires	21			
5.6.1	Insulation	21			
5.6.2	Wire Routing	21			

7.5.10	Butt/I Terminations	37	10.2	Conformal Coating – Masking	51
7.5.11	Flat Lug Leads	39	10.3	Conformal Coating – Application	51
7.5.12	Tall Profile Components Having Bottom Only Terminations	40	10.3.1	Conformal Coating on Components	51
7.5.13	Inward Formed L-Shaped Ribbon Leads	40	10.3.2	Thickness	52
7.5.14	Surface Mount Area Array Packages	42	10.3.3	Uniformity	52
7.5.15	Bottom Termination Components (BTC)	44	10.3.4	Transparency	52
7.5.16	Components with Bottom Thermal Plane Terminations (D-Pak)	45	10.3.5	Bubbles and Voids	52
7.5.17	Flattened Post Connections	46	10.3.6	Delamination	52
7.5.18	P-Style Terminations	47	10.3.7	Foreign Objects Debris	52
7.6	Specialized SMT Terminations	47	10.3.8	Other Visual Conditions	52
8	CLEANING PROCESS REQUIREMENTS	48	10.3.9	Inspection	52
8.1	Cleanliness Exemptions	48	10.3.10	Rework or Touchup of Conformal Coating	53
8.2	Ultrasonic Cleaning	48	10.4	Encapsulation	53
8.3	Post-Solder Cleanliness	48	10.4.1	Application	53
8.3.1	Foreign Object Debris (FOD)	48	10.4.2	Performance Requirements	53
8.3.2	Flux Residues and Other Ionic or Organic Contaminants	48	10.4.3	Rework of Encapsulant Material	53
8.3.3	Post-Soldering Cleanliness Designator	48	10.4.4	Encapsulant Inspection	53
8.3.4	Cleaning Option	48	10.5	Staking	53
8.3.5	Test for Cleanliness	48	10.5.1	Staking – Application	53
8.3.6	Testing	49	10.5.2	Staking – Adhesive	54
9	PCB REQUIREMENTS	50	10.5.3	Staking – Inspection	54
9.1	Printed Circuit Board Damage	50	11	WITNESS (TORQUE/ANTI-TAMPERING) STRIPE	54
9.1.1	Blistering/Delamination	50	12	PRODUCT ASSURANCE	54
9.1.2	Weave Exposure/Cut Fibers	50	12.1	Hardware Defects Requiring Disposition	54
9.1.3	Haloing	50	12.2	Inspection Methodology	54
9.1.4	Edge Delamination	50	12.2.1	Process Verification Inspection	54
9.1.5	Land/Conductor Separation	50	12.2.2	Visual Inspection	54
9.1.6	Land/Conductor Reduction in Size	50	12.2.3	Sampling Inspection	55
9.1.7	Flexible Circuitry Delamination	50	12.3	Process Control Requirements	55
9.1.8	Flexible Circuitry Damage	50	12.3.1	Opportunities Determination	55
9.1.9	Burns	50	12.4	Statistical Process Control	55
9.1.10	Non-Soldered Edge Contacts	50	13	REWORK AND REPAIR	56
9.1.11	Measles	50	13.1	Rework	56
9.1.12	Crazing	51	13.2	Repair	56
9.2	Marking	51	13.3	Post Rework/Repair Cleaning	56
9.3	Bow and Twist (Warpage)	51	APPENDIX A	Guidelines for Soldering Tools and Equipment	57
9.4	Depanelization	51	APPENDIX B	Minimum Electrical Clearance – Electrical Conductor Spacing	59
10	COATING, ENCAPSULATION AND STAKING (ADHESIVE)	51	APPENDIX C	J-STD-001 Guidance on Objective Evidence of Material Compatibility	61
10.1	Conformal Coating – Materials	51			

Figures

Figure 1-1	Overwrap	4
Figure 1-2	Overlap	4
Figure 4-1	Hole Obstruction	11
Figure 4-2	Acceptable Wetting Angles	13
Figure 5-1	Flange Damage	15
Figure 5-2	Flare Angles	15
Figure 5-3	Terminal Mounting – Mechanical	16
Figure 5-4	Terminal Mounting	16
Figure 5-5	Insulation Clearance Measurement	16
Figure 5-6	Service Loop for Lead Wiring	17
Figure 5-7	Stress Relief Examples	17
Figure 5-8	Wire and Lead Wrap Around	18
Figure 5-9	Bifurcated Terminal Side Route Placement with Wrap	18
Figure 5-10	Bifurcated Terminal Side Route Placement – Straight Though and Staked	19
Figure 5-11	Bifurcated Terminal Top and Bottom Route Connection	19
Figure 5-12	Slotted Terminal	19
Figure 5-13	Hook Terminal Connections	20
Figure 5-14	Pierced or Perforated Terminal Wire Placement	20
Figure 5-15	Solder Height	21
Figure 6-1	Component Lead Stress Relief Examples	23
Figure 6-2	Lead Bends	24
Figure 6-3	Lead Trimming	25
Figure 6-4	Vertical Fill Example	25
Figure 7-1	Surface Mount Device Lead Forming	27
Figure 7-2	Surface Mount Device Lead Forming	27
Figure 7-3	Bottom Only Terminations	30
Figure 7-4	Rectangular or Square End Chip Components	31
Figure 7-5	Cylindrical End Cap Terminations	32
Figure 7-6	Castellated Terminations	33
Figure 7-7	Flat Gull Wing Leads	34
Figure 7-8	Round or Flattened (Coined) Gull Wing Leads	35
Figure 7-9	J Leads	36
Figure 7-10	Butt/I Connection for Modified Through-Hole Leads	37
Figure 7-11	Butt/I Connection for Solder Charged Leads	38
Figure 7-12	Flat Lug Leads	39
Figure 7-13	Tall Profile Components Having Bottom Only Terminations	40
Figure 7-14	Inward Formed L-Shaped Ribbon Lead	41
Figure 7-15	BGA Solder Ball Clearance	43
Figure 7-16	Bottom Termination Component	44

Figure 7-17	Bottom Thermal Plane Termination	45
Figure 7-18	Flattened Post Termination	46
Figure 7-19	P-Style Termination	47

Tables

Table 1-1	Design, Fabrication and Acceptability	3
Table 3-1	Maximum Limits of Solder Bath Contaminant	8
Table 4-1	Solder Anomalies	13
Table 5-1	Allowable Strand Damage	15
Table 5-2	Terminal Mounting Minimum Soldering Requirements	16
Table 5-3	Turret and Straight Pin Wire Placement	18
Table 5-4	AWG 30 and Smaller Wire Wrap Requirements	18
Table 5-5	Bifurcated Terminal Wire Placement – Side Route with Wrap	18
Table 5-6	Bifurcated Terminal Side Route Straight-Through Staking Requirements	19
Table 5-7	Bifurcated Terminal Wire Placement – Bottom Route	19
Table 5-8	Hook Terminal Wire Placement	20
Table 5-9	Pierced or Perforated Terminal Wire Placement	20
Table 5-10	Solder Requirements Wire to Post	21
Table 6-1	Component to Land Clearance	23
Table 6-2	Components with Spacers	23
Table 6-3	Lead Bend Radius	24
Table 6-4	Protrusion of Leads in Supported Holes	24
Table 6-5	Protrusion of Leads in Unsupported Holes	24
Table 6-6	Supported Holes with Component Leads, Minimum Acceptable Conditions	25
Table 6-7	Unsupported Holes with Component Leads, Minimum Acceptable Conditions	26
Table 7-1	SMT Lead Forming Minimum Lead Length (L)	27
Table 7-2	Surface Mount Components	29
Table 7-3	Dimensional Criteria – Bottom Only Chip Component Terminations	30
Table 7-4	Dimensional Criteria – Rectangular or Square End Chip Components – 1, 3 or 5 Side Termination	31
Table 7-5	Dimensional Criteria – Cylindrical End Cap Terminations	32
Table 7-6	Dimensional Criteria – Castellated Terminations	33
Table 7-7	Dimensional Criteria – Flat Gull Wing Leads	34
Table 7-8	Dimensional Criteria – Round or Flattened (Coined) Gull Wing Leads	35
Table 7-9	Dimensional Criteria – J Leads	36
Table 7-10	Dimensional Criteria – Butt/I Connections	37

Table 7-11	Dimensional Criteria – Butt/I Terminations – Solder Charged Terminations	38
Table 7-12	Dimensional Criteria – Flat Lug Leads	39
Table 7-13	Dimensional Criteria – Tall Profile Components Having Bottom Only Terminations	40
Table 7-14	Dimensional Criteria – Inward Formed L-Shaped Ribbon Leads	41
Table 7-15	Dimensional Criteria – Ball Grid Array Components with Collapsing Balls	43
Table 7-16	Ball Grid Array Components with Noncollapsing Balls	43
Table 7-17	Column Grid Array	43
Table 7-18	Dimensional Criteria – BTC	44
Table 7-19	Dimensional Criteria – Bottom Thermal Plane Terminations	45
Table 7-20	Dimensional Criteria Flattened Post Connections	46
Table 7-21	Dimensional Criteria – P-Style Terminations	47
Table 8-1	Designation of Surfaces to be Cleaned	48
Table 8-2	Cleanliness Testing Designators	48
Table 10-1	Coating Thickness	52
Table 12-1	Magnification Aid Applications for Solder Connections	55
Table 12-2	Magnification Aid Applications – Other	55

Requirements for Soldered Electrical and Electronic Assemblies

1 GENERAL

1.1 Scope This standard prescribes practices and requirements for the manufacture of soldered electrical and electronic assemblies. For a more complete understanding of this document's recommendations and requirements, one may use this document in conjunction with IPC-HDBK-001 and IPC-A-610.

1.2 Purpose This standard describes materials, methods and acceptance criteria for producing soldered electrical and electronic assemblies. The intent of this document is to rely on process control methodology to ensure consistent quality levels during the manufacture of products. It is not the intent of this standard to exclude any procedure for component placement or for applying flux and solder used to make the electrical connection.

1.3 Classification This standard recognizes 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 producibility, complexity, functional performance requirements, and verification (inspection/test) frequency. It should be recognized that there may be overlaps of equipment between classes.

The User, see 1.8.12, is responsible for defining the product class. The product class should be stated in the procurement documentation package.

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.

1.4 Measurement Units and Applications All dimensions and tolerances, as well as other forms of measurement (temperature, weight, etc.) in this standard are expressed in SI (System International) units (with Imperial English equivalent dimensions provided in brackets). Dimensions and tolerances use millimeters as the main form of dimensional expression; micrometers are used when the precision required makes millimeters too cumbersome. Celsius is used to express temperature. Weight is expressed in grams.

1.4.1 Verification of Dimensions Actual measurement of specific part mounting and solder fillet dimensions and determination of percentages are not required except for referee purposes. For the purposes of determining conformance to this specification, all specified limits in this standard are absolute limits as defined in ASTM E29.