



IPC/WHMA-A-620E



# Requirements and Acceptance for Cable and Wire Harness 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 Task Group (7-31f) of the Product Assurance Subcommittee (7-30) and WHMA

**Supersedes:**

IPC/WHMA-A-620D – January 2020

IPC/WHMA-A-620C – January 2017

IPC/WHMA-A-620B with

Amendment 1 – August 2013

IPC/WHMA-A-620B – October 2012

IPC/WHMA-A-620A – July 2006

IPC/WHMA-A-620 – January 2002

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

Contact:

IPC

Tel 847 615.7100

Fax 847 615.7105

Wiring Harness Manufacturers  
Assoc.

(An affiliate of IPC)

Tel 847 615.7100

email: [contact.us@whma.org](mailto:contact.us@whma.org)

# Table of Contents

<b>1.0</b>	<b>General</b> .....	1-1	<b>1.13</b>	<b>Facilities</b> .....	1-6
<b>1.1</b>	<b>Scope</b> .....	1-1	1.13.1	Field Assembly Operations .....	1-6
<b>1.2</b>	<b>Purpose</b> .....	1-1	1.13.2	Health and Safety .....	1-6
<b>1.3</b>	<b>Classification</b> .....	1-1	<b>1.14</b>	<b>Electrostatic Discharge (ESD) Protection</b> .....	1-6
<b>1.4</b>	<b>Measurement Units and Applications</b> .....	1-1	<b>1.15</b>	<b>Tools and Equipment</b> .....	1-6
1.4.1	Verification of Dimensions .....	1-1	1.15.1	Control .....	1-6
<b>1.5</b>	<b>Definition of Requirements</b> .....	1-1	1.15.2	Calibration .....	1-7
1.5.1	Inspection Conditions .....	1-2	<b>1.16</b>	<b>Materials and Processes</b> .....	1-7
1.5.1.1	Acceptable .....	1-2	<b>1.17</b>	<b>Electrical Clearance</b> .....	1-7
1.5.1.2	Defect .....	1-2	<b>1.18</b>	<b>Contamination</b> .....	1-7
1.5.1.2.1	Disposition .....	1-2	<b>1.19</b>	<b>Rework/Repair</b> .....	1-8
1.5.1.3	Process Indicator .....	1-2	1.19.1	Rework .....	1-8
1.5.1.4	Conditions Not Specified .....	1-2	1.19.2	Repair .....	1-8
1.5.1.5	Uncommon or Specialized Designs .....	1-2	1.19.3	Post Rework/Repair Cleaning .....	1-8
1.5.2	Material and Process Nonconformance .....	1-3	<b>2.0</b>	<b>Applicable Documents</b> .....	2-1
<b>1.6</b>	<b>Process Control</b> .....	1-3	<b>2.1</b>	<b>IPC</b> .....	2-1
1.6.1	Statistical Process Control .....	1-3	<b>2.2</b>	<b>Joint Industry Standards</b> .....	2-1
<b>1.7</b>	<b>Order of Precedence</b> .....	1-3	<b>2.3</b>	<b>Society of Automotive Engineers (SAE)</b> .....	2-1
1.7.1	Clause References .....	1-4	<b>2.4</b>	<b>American National Standards Institute (ANSI)</b> .....	2-1
1.7.2	Appendices .....	1-4	<b>2.5</b>	<b>International Organization for Standardization (ISO)</b> .....	2-2
<b>1.8</b>	<b>Terms and Definitions</b> .....	1-4	<b>2.6</b>	<b>ESD Association (ESDA)</b> .....	2-2
1.8.1	FOD (Foreign Object Debris) .....	1-4	<b>2.7</b>	<b>United States Department of Defense (DoD)</b> ..	2-2
1.8.2	Inspection .....	1-4	<b>2.8</b>	<b>International Electrotechnical Commission (IEC)</b> .....	2-2
1.8.3	Manufacturer (Assembler) .....	1-4	<b>2.9</b>	<b>Aerospace Industries Association (AIA/NAS)</b> ..	2-2
1.8.4	Objective Evidence .....	1-4	<b>2.10</b>	<b>Electronics Industries Alliance</b> .....	2-2
1.8.5	Process Control .....	1-4	<b>2.11</b>	<b>ASTM International</b> .....	2-2
1.8.6	Supplier .....	1-4	<b>2.12</b>	<b>Institute of Electrical and Electronics Engineers</b> .....	2-2
1.8.7	User .....	1-4	<b>3.0</b>	<b>Wires</b> .....	3-1
1.8.8	Diameter .....	1-4	<b>3.1</b>	<b>Stripping</b> .....	3-1
1.8.8.1	Conductor .....	1-4	<b>3.2</b>	<b>Strand Damage and End Cuts</b> .....	3-1
1.8.8.2	Wire .....	1-4	<b>3.3</b>	<b>Conductor Deformation/Birdcaging</b> .....	3-4
1.8.8.3	Strand .....	1-4	<b>3.4</b>	<b>Twisting of Wires</b> .....	3-6
1.8.9	Engineering Documentation .....	1-4	<b>3.5</b>	<b>Insulation Damage – Stripping</b> .....	3-7
<b>1.9</b>	<b>Requirements Flowdown</b> .....	1-4	<b>4.0</b>	<b>Soldered Terminations</b> .....	4-1
<b>1.10</b>	<b>Personnel Proficiency</b> .....	1-5	<b>4.1</b>	<b>Materials and Components</b> .....	4-1
<b>1.11</b>	<b>Acceptance Requirements</b> .....	1-5			
<b>1.12</b>	<b>Inspection Methodology</b> .....	1-5			
1.12.1	Process Verification Inspection .....	1-5			
1.12.2	Visual Inspection .....	1-5			
1.12.2.1	Lighting .....	1-5			
1.12.2.2	Magnification Aids .....	1-5			

## Table of Contents (cont.)

4.1.1	Materials	4-1	4.8.5	Hook	4-37
4.1.1.1	Solder	4-1	4.8.5.1	Lead/Wire Placement	4-37
4.1.1.1.1	Solder Purity Maintenance	4-2	4.8.5.2	Solder	4-39
4.1.1.2	Flux	4-3	4.8.6	Cup	4-40
4.1.1.3	Adhesives	4-3	4.8.6.1	Lead/Wire Placement	4-40
4.1.1.4	Solderability	4-4	4.8.6.2	Solder	4-41
4.1.2	Gold Removal	4-4	4.8.7	Series Connected	4-43
<b>4.2</b>	<b>Cleanliness</b>	4-5	4.8.8	Connection Requirements – Lead/Wire Placement – AWG 30 and Smaller Diameter Wires	4-44
4.2.1	Presoldering	4-5	<b>5.0</b>	<b>Crimp Terminations (Contacts and Lugs)</b>	5-1
4.2.2	Postsoldering	4-5	<b>5.1</b>	<b>Stamped and Formed – Open Barrel</b>	5-3
4.2.2.1	Foreign Object Debris (FOD)	4-5	5.1.1	Insulation Support	5-4
4.2.2.2	Flux Residue	4-6	5.1.1.1	Inspection Window	5-4
4.2.2.2.1	Cleaning Required	4-6	5.1.1.2	Crimp	5-6
4.2.2.2.2	No-Clean Process	4-6	5.1.2	Insulation Clearance if No Support Crimp	5-8
<b>4.3</b>	<b>Solder Connection</b>	4-7	5.1.3	Conductor Crimp	5-9
4.3.1	General Requirements	4-9	5.1.4	Crimp Bellmouth	5-11
4.3.2	Soldering Anomalies	4-10	5.1.5	Conductor Brush	5-13
4.3.2.1	Exposed Basis Metal	4-10	5.1.6	Carrier Cutoff Tab	5-15
4.3.2.2	Partially Visible or Hidden Solder Connections	4-10	5.1.7	Individual Wire Seal	5-16
<b>4.4</b>	<b>Wire/Lead Preparation, Tinning</b>	4-11	<b>5.2</b>	<b>Stamped and Formed – Closed Barrel</b>	5-18
<b>4.5</b>	<b>Wire Insulation</b>	4-13	5.2.1	Insulation Clearance	5-19
4.5.1	Clearance	4-13	5.2.2	Insulation Support Crimp	5-20
4.5.2	Postsolder Damage	4-15	5.2.3	Conductor Crimp and Bellmouth	5-21
<b>4.6</b>	<b>Insulation Sleeving</b>	4-16	5.2.4	Cutoff Tabs	5-23
<b>4.7</b>	<b>Soldered Strand Separation (Birdcaging)</b>	4-18	<b>5.3</b>	<b>Machined Contacts</b>	5-24
<b>4.8</b>	<b>Terminals</b>	4-19	5.3.1	Insulation Clearance	5-24
4.8.1	Turrets and Straight Pins	4-22	5.3.2	Insulation Support Style	5-26
4.8.1.1	Lead/Wire Placement	4-22	5.3.3	Conductor	5-27
4.8.1.2	Solder	4-24	5.3.4	Crimping	5-29
4.8.2	Bifurcated	4-25	5.3.5	CMA Buildup	5-31
4.8.2.1	Lead/Wire Placement – Side Route	4-25	<b>5.4</b>	<b>Termination Ferrule Crimp</b>	5-33
4.8.2.2	Lead/Wire Placement – Bottom and Top Route	4-27	<b>5.5</b>	<b>Shrink Sleeving – Wire Support – Crimped Terminals</b>	5-35
4.8.2.3	Lead/Wire Placement – Staked/Constrained Wires	4-29	<b>6.0</b>	<b>Insulation Displacement Connection (IDC)</b>	6-1
4.8.2.4	Solder	4-30	<b>6.1</b>	<b>Mass Termination, Flat Cable</b>	6-2
4.8.3	Slotted	4-32	6.1.1	End Cutting	6-2
4.8.3.1	Lead/Wire Placement	4-32	6.1.2	Notching	6-3
4.8.3.2	Solder	4-33	6.1.3	Planar Ground Plane Removal	6-4
4.8.4	Pierced/Perforated/Punched	4-34	6.1.4	Connector Position	6-5
4.8.4.1	Lead/Wire Placement	4-34	6.1.5	Connector Skew and Lateral Position	6-8
4.8.4.2	Pierced/Perforated/Punched – Solder	4-36	6.1.6	Retention	6-9

## Table of Contents (cont.)

<b>6.2</b>	<b>Discrete Wire Termination</b> .....	6-10	9.2.2	Wire Dress .....	9-6
6.2.1	General .....	6-10	9.2.2.1	Straight Approach .....	9-7
6.2.2	Position of Wire .....	6-11	9.2.2.2	Side Approach .....	9-8
6.2.3	Overhang (Extension) .....	6-12	<b>9.3</b>	<b>Sleeving and Boots</b> .....	9-9
6.2.4	Insulation Crimp .....	6-13	9.3.1	Position .....	9-9
6.2.5	Damage in Connection Area .....	6-15	9.3.2	Bonding .....	9-10
6.2.6	End Connectors .....	6-16	<b>9.4</b>	<b>Connector Damage</b> .....	9-13
6.2.7	Pass Through Connectors .....	6-17	9.4.1	Criteria .....	9-13
6.2.8	Wiremount Connectors .....	6-18	9.4.2	Limits – Hard Face – Mating Surface .....	9-14
6.2.9	Subminiature D-Connector (Series Bus Connector) .....	6-19	9.4.3	Limits – Soft Face – Mating Surface or Rear Seal Area .....	9-15
6.2.10	Modular Connectors (RJ Type) .....	6-21	9.4.4	Contacts .....	9-16
<b>7.0</b>	<b>Ultrasonic Welding</b> .....	7-1	<b>9.5</b>	<b>Installation of Contacts and Sealing Plugs into Connectors</b> .....	9-17
<b>7.1</b>	<b>Insulation Clearance</b> .....	7-1	9.5.1	Installation of Contacts .....	9-17
<b>7.2</b>	<b>Weld Nugget</b> .....	7-3	9.5.2	Installation of Sealing Plugs .....	9-19
<b>8.0</b>	<b>Splices</b> .....	8-1	<b>10.0</b>	<b>Over-Molding/Potting</b> .....	10-1
<b>8.1</b>	<b>Soldered Splices</b> .....	8-1	<b>10.1</b>	<b>Over-Molding</b> .....	10-2
8.1.1	Mesh .....	8-2	10.1.1	Mold Fill .....	10-2
8.1.2	Wrap .....	8-3	10.1.1.1	Inner .....	10-2
8.1.3	Hook .....	8-4	10.1.1.2	Outer .....	10-5
8.1.4	Lap .....	8-5	10.1.1.2.1	Mismatch .....	10-8
8.1.4.1	Two or More Conductors .....	8-5	10.1.1.2.2	Fit .....	10-9
8.1.4.2	Insulation Opening (Window) .....	8-7	10.1.1.2.3	Cracks, Flow Lines, Chill Marks (Knit Lines) or Weld Lines .....	10-12
8.1.5	Heat Shrinkable Solder Devices .....	8-8	10.1.1.2.4	Color .....	10-14
<b>8.2</b>	<b>Crimped Splices</b> .....	8-10	10.1.2	Blow Through .....	10-15
8.2.1	Barrel .....	8-10	10.1.3	Position .....	10-16
8.2.1.1	Insulation Opening (Window) .....	8-13	10.1.4	Flashing .....	10-19
8.2.2	Double Sided .....	8-14	10.1.5	Wire Insulation, Jacket or Sleeving Damage .....	10-21
8.2.3	Contact .....	8-17	10.1.6	Curing .....	10-22
8.2.4	Wire In-Line Junction Devices (Jiffy Junctions) .....	8-18	<b>10.2</b>	<b>Potting (Thermoset Molding)</b> .....	10-23
<b>8.3</b>	<b>Ultrasonic Weld Splices</b> .....	8-19	10.2.1	Filling .....	10-23
<b>8.4</b>	<b>Sleeving Over Splices</b> .....	8-20	10.2.2	Fit to Wire or Cable .....	10-26
<b>9.0</b>	<b>Connectorization</b> .....	9-1	10.2.3	Curing .....	10-28
<b>9.1</b>	<b>Hardware Mounting</b> .....	9-1	<b>10.3</b>	<b>Over-Molding of Flexible Flat Ribbon</b> .....	10-29
9.1.1	Jackpost – Height .....	9-1	10.3.1	Mounting and Alignment Feature Adhesion .....	10-31
9.1.2	Jackscrews – Protrusion .....	9-2	10.3.2	Adhesion Between Ribbon and Connector Potting .....	10-31
9.1.3	Retaining Clips .....	9-3	10.3.3	Mounting Hardware .....	10-32
9.1.4	Connector Alignment .....	9-4	<b>11.0</b>	<b>Measuring Cable Assemblies and Wires</b> .....	11-1
<b>9.2</b>	<b>Strain Relief</b> .....	9-5			
9.2.1	Clamp Fit .....	9-5			

## Table of Contents (cont.)

<b>11.1 Measuring – Cable and Wire Length</b>		13.7.1 Soldering . . . . .	13-15
<b>Tolerance</b> . . . . .	11-1	13.7.2 Press Fit . . . . .	13-16
<b>11.2 Measuring – Cable</b> . . . . .	11-1	<b>13.8 Shield Termination</b> . . . . .	13-17
11.2.1 Reference Surfaces – Straight/Axial Connectors . . . . .	11-1	13.8.1 Clamped Ground Rings . . . . .	13-17
11.2.2 Reference Surfaces – Right-Angle Connectors . . . . .	11-2	13.8.2 Crimped Ferrule . . . . .	13-18
11.2.3 Length . . . . .	11-2	<b>13.9 Center Pin</b> . . . . .	13-20
11.2.4 Breakout . . . . .	11-3	13.9.1 Position . . . . .	13-20
11.2.4.1 Breakout Measurement Points . . . . .	11-3	13.9.2 Damage . . . . .	13-21
11.2.4.2 Breakout Length . . . . .	11-4	<b>13.10 Semirigid Coax</b> . . . . .	13-22
<b>11.3 Measuring – Wire</b> . . . . .	11-5	13.10.1 Bending and Deformation . . . . .	13-23
11.3.1 Electrical Terminal Reference Location . . . . .	11-5	13.10.2 Surface Condition . . . . .	13-25
11.3.2 Length . . . . .	11-6	13.10.2.1 Solid . . . . .	13-25
<b>12.0 Marking/Labeling</b> . . . . .	12-1	13.10.2.2 Conformable Cable . . . . .	13-27
<b>12.1 Content</b> . . . . .	12-1	13.10.3 Dielectric Cutoff . . . . .	13-28
<b>12.2 Legibility</b> . . . . .	12-2	13.10.4 Dielectric Cleanliness . . . . .	13-30
<b>12.3 Permanency</b> . . . . .	12-3	13.10.5 Center Conductor Pin . . . . .	13-31
<b>12.4 Location and Orientation</b> . . . . .	12-4	13.10.5.1 Point . . . . .	13-32
<b>12.5 Functionality</b> . . . . .	12-5	13.10.5.2 Damage . . . . .	13-34
<b>12.6 Marker Sleeve</b> . . . . .	12-6	13.10.6 Semirigid Coax – Solder . . . . .	13-34
12.6.1 Wrap Around . . . . .	12-6	<b>13.11 Swage-Type Connector</b> . . . . .	13-36
12.6.2 Tubular . . . . .	12-8	<b>13.12 Soldering and Stripping of Biaxial/Multi-Axial     Shielded Wire</b> . . . . .	13-37
<b>12.7 Flag Markers</b> . . . . .	12-9	13.12.1 Jacket and Tip Installation . . . . .	13-37
12.7.1 Adhesive . . . . .	12-9	13.12.2 Ring Installation . . . . .	13-39
<b>12.8 Tie Wrap Markers</b> . . . . .	12-10	<b>14.0 Securing</b> . . . . .	14-1
<b>13.0 Coaxial and Biaxial Cable Assemblies</b> . . . . .	13-1	<b>14.1 Tie Wrap/Lacing Application</b> . . . . .	14-1
<b>13.1 Stripping</b> . . . . .	13-1	14.1.1 Tightness . . . . .	14-6
<b>13.2 Center Conductor Termination</b> . . . . .	13-4	14.1.2 Damage . . . . .	14-7
13.2.1 Crimp . . . . .	13-4	14.1.3 Spacing . . . . .	14-7
13.2.2 Solder . . . . .	13-6	<b>14.2 Breakouts</b> . . . . .	14-8
<b>13.3 Solder Ferrule Pins</b> . . . . .	13-8	14.2.1 Individual Wires . . . . .	14-8
13.3.1 General . . . . .	13-8	14.2.2 Spacing . . . . .	14-9
13.3.2 Insulation . . . . .	13-10	<b>14.3 Routing</b> . . . . .	14-12
<b>13.4 Coaxial Connector –     Printed Wire Board Mount</b> . . . . .	13-11	14.3.1 Wire Crossover . . . . .	14-12
<b>13.5 Coaxial Connector – Center Conductor     Length – Right Angle Connector</b> . . . . .	13-12	14.3.2 Bend Radius . . . . .	14-13
<b>13.6 Coaxial Connector –     Center Conductor Solder</b> . . . . .	13-13	14.3.3 Coaxial Cable . . . . .	14-14
<b>13.7 Coaxial Connector – Terminal Cover</b> . . . . .	13-15	14.3.4 Unused Wire Termination . . . . .	14-15
		14.3.4.1 Shrink Sleeving . . . . .	14-15
		14.3.4.2 Flexible Sleeving . . . . .	14-16
		14.3.5 Ties over Splices and Ferrules . . . . .	14-16
		<b>14.4 Broom Stitching</b> . . . . .	14-17
		<b>15.0 Harness/Cable Electrical Shielding</b> . . . . .	15-1

## Table of Contents (cont.)

<b>15.1 Braided</b> .....	15-1	17.2.1.1	Minimum Torque	17-5
15.1.1 Direct Applied .....	15-2	17.2.2	Wires	17-7
15.1.2 Prewoven .....	15-4	17.2.2.1	Solid Wires	17-8
<b>15.2 Shield Termination</b> .....	15-5	17.2.2.2	Stranded Wires	17-10
15.2.1 Shield Jumper Wire .....	15-5	17.2.3	Safety Wiring	17-11
15.2.1.1 Attached Lead .....	15-5	17.2.4	Safety Cable	17-13
15.2.1.1.1 Solder .....	15-6	<b>17.3 Wire/Harness Installation</b> .....		17-14
15.2.1.1.2 Crimp .....	15-10	17.3.1	Stress Relief	17-14
15.2.1.2 Shield Braid .....	15-11	17.3.2	Wire Dress	17-15
15.2.1.2.1 Woven .....	15-11	17.3.3	Service Loops	17-16
15.2.1.2 Combed and Twisted .....	15-11	17.3.4	Clamping	17-17
15.2.1.3 Daisy Chain .....	15-12	17.3.5	Tie Wrap/Lacing	17-17
15.2.1.4 Common Ground Point .....	15-12	17.3.6	Raceways	17-18
15.2.2 Unterminated Shield .....	15-13	17.3.7	Grommets	17-19
15.2.2.1 Shield Not Folded Back .....	15-13	17.3.7.1	Sealing Not Required	17-19
15.2.2.2 Shield Folded Back .....	15-14	17.3.7.2	Sealing Required	17-20
<b>15.3 Shield Termination – Connector</b> .....	15-15	<b>18.0 Solderless Wrap</b> .....		18-1
15.3.1 Shrink .....	15-15	<b>19.0 Testing</b> .....		19-1
15.3.2 Crimp .....	15-17	<b>19.1 Nondestructive Tests</b> .....		19-1
15.3.3 Shield Jumper Wire Attachment .....	15-19	<b>19.2 Testing After Rework or Repair</b> .....		19-1
15.3.4 Soldered .....	15-20	<b>19.3 Intended Table Usage</b> .....		19-1
<b>15.4 Shield Termination – Splicing Prewoven</b> .....	15-20	<b>19.4 Electrical Test</b> .....		19-2
15.4.1 Soldered .....	15-21	19.4.1 Selection .....		19-2
15.4.2 Tie/Tape On .....	15-23	<b>19.5 Electrical Test Methods</b> .....		19-3
<b>15.5 Tapes – Barrier and Conductive, Adhesive or Non-Adhesive</b> .....	15-24	19.5.1 Continuity .....		19-3
<b>15.6 Conduit (Shielding)</b> .....	15-25	19.5.2 Shorts .....		19-4
<b>15.7 Shrink Tubing – Conductive Lined</b> .....	15-26	19.5.3 Dielectric Withstanding Voltage (DWV) ..		19-5
<b>16.0 Cable/Wire Harness Protective Coverings</b> .....	16-1	19.5.4 Insulation Resistance (IR) .....		19-6
<b>16.1 Braid</b> .....	16-1	19.5.5 Voltage Standing Wave Ratio (VSWR) ...		19-7
16.1.1 Direct Applied .....	16-1	19.5.6 Insertion Loss .....		19-7
16.1.2 Prewoven .....	16-3	19.5.7 Reflection Coefficient .....		19-8
<b>16.2 Sleeving/Shrink Tubing</b> .....	16-5	19.5.8 User Defined .....		19-8
16.2.1 Sealant .....	16-6	<b>19.6 Mechanical Test</b> .....		19-9
<b>16.3 Spiral Plastic Wrap (Spiral Wrap Sleeving)</b> .....	16-7	19.6.1 Selection .....		19-9
<b>16.4 Wire Loom Tubing – Split and Unsplit</b> .....	16-8	<b>19.7 Mechanical Test Methods</b> .....		19-10
<b>16.5 Tapes, Adhesive and Non-Adhesive</b> .....	16-8	19.7.1 Crimp Height (Dimensional Analysis) ...		19-10
<b>17.0 Finished Assembly Installation</b> .....	17-1	19.7.1.1 Terminal Positioning .....		19-11
<b>17.1 General</b> .....	17-1	19.7.2 Pull Force (Tensile) .....		19-12
<b>17.2 Hardware Installation</b> .....	17-2	19.7.2.1 Without Documented Process Control ...		19-13
17.2.1 Threaded Fasteners .....	17-3	19.7.3 Crimp Force Monitoring .....		19-17
		19.7.4 Crimp Tool Qualification .....		19-17
		19.7.5 Contact Retention Verification .....		19-17

## Table of Contents (cont.)

19.7.6	RF Connector Shield Pull Force (Tensile)	19-18
19.7.7	RF Connector Shield Ferrule Torsion . . . . .	19-19
19.7.8	User Defined . . . . .	19-19
<b>20.0</b>	<b>High Voltage Applications</b> . . . . .	<b>20-1</b>
<b>Appendix A</b>	<b>Terms and Definitions</b> . . . . .	<b>A-1</b>
<b>Appendix B</b>	<b>Reproducible Test Tables</b> . . . . .	<b>B-1</b>
<b>Appendix C</b>	<b>Guidelines for Soldering Tools and Equipment</b> . . . . .	<b>C-1</b>
<b>Appendix D</b>	<b>X-Ray Guidelines</b> . . . . .	<b>D-1</b>

### Tables

Table 1-1	Magnification Aid Applications – Wire and Wire Connections . . . . .	1-5
Table 1-2	Magnification Aid Applications – Other. . . . .	1-6
Table 3-1	Allowable Strand Damage . . . . .	3-3
Table 4-1	Maximum Limits of Solder Bath Contaminant . . . . .	4-2
Table 4-2	Solder Connection Anomalies . . . . .	4-10
Table 4-3	Turret or Straight Pin Terminal Lead/Wire Placement . . . . .	4-22
Table 4-4	Bifurcated Terminal Lead/Wire Placement – Side Route. . . . .	4-25
Table 4-5	Bifurcated Terminal Lead/Wire Placement – Bottom Route . . . . .	4-27
Table 4-6	Staking Requirements of Side Route Straight Through Connections – Bifurcated Terminals . . . . .	4-29
Table 4-7	Pierced/Perforated/Punched Terminal Lead/Wire Placement . . . . .	4-34
Table 4-8	Hook Terminal Lead/Wire Placement. . . . .	4-37
Table 4-9	AWG 30 and Smaller Wire Wrap Requirements . . . . .	4-44
Table 11-1	Cable/Wire Length Measurement Tolerance. . . . .	11-1
Table 13-1	Coaxial and Biaxial Shield and Center Conductor Damage. . . . .	13-1
Table 13-2	Semirigid Coax Deformation . . . . .	13-24
Table 13-3	Dielectric Cutoff. . . . .	13-28
Table 14-1	Minimum Bend Radius Requirements . . . . .	14-13
Table 17-1	Minimum Swaged Ferrule Pull-Off Load . . . . .	17-13
Table 19-1	Electrical Test Requirements . . . . .	19-3

Table 19-2	Continuity Test Minimum Requirements . . . . .	19-4
Table 19-3	Shorts Test (low voltage isolation) Minimum Requirements. . . . .	19-5
Table 19-4	Dielectric Withstanding Voltage Test (DWV) Minimum Requirements . . . . .	19-6
Table 19-5	Insulation Resistance (IR) Test Minimum Requirements . . . . .	19-7
Table 19-6	Voltage Standing Wave Ratio (VSWR) Test Parameters. . . . .	19-8
Table 19-7	Insertion Loss Test Parameters. . . . .	19-8
Table 19-8	Reflection Coefficient Test Parameters . . . . .	19-9
Table 19-9	Mechanical Test Requirements. . . . .	19-10
Table 19-10	Crimp Height Testing . . . . .	19-11
Table 19-11	Pull Force Testing Minimum Requirements . . . . .	19-14
Table 19-12	Pull Test Force Values. . . . .	19-15
Table 19-13	Pull Test Force Values (Classes 1 & 2) For UL, SAE, GM and Volvo . . . . .	19-16
Table 19-14	Pull Test Force Values (Classes 1 & 2) For IEC. . . . .	19-17
Table 19-15	RF Connector Shield Pull Force Testing. . . . .	19-19
Table A-1	Electrical Clearance . . . . .	A-2
Table 19-1	Electrical Test Requirements . . . . .	B-2
Table 19-2	Continuity Test Minimum Requirements . . . . .	B-3
Table 19-3	Shorts Test (low voltage isolation) Minimum Requirements. . . . .	B-4
Table 19-4	Dielectric Withstanding Voltage Test (DWV) Minimum Requirements . . . . .	B-5
Table 19-5	Insulation Resistance (IR) Test Minimum Requirements . . . . .	B-6
Table 19-6	Voltage Standing Wave Ratio (VSWR) Test Parameters. . . . .	B-7
Table 19-7	Insertion Loss Test Parameters. . . . .	B-8
Table 19-8	Reflection Coefficient Test Parameters . . . . .	B-9
Table 19-9	Mechanical Test Requirements. . . . .	B-10
Table 19-10	Crimp Height Testing . . . . .	B-11
Table 19-11	Pull Force Testing Minimum Requirements . . . . .	B-12
Table 19-15	RF Connector Shield Pull Force Testing. . . . .	B-13

# 1.0 General

**1.1 Scope** This standard prescribes practices and requirements for the manufacture of cable, wire and harness assemblies. This standard does not provide criteria for cross-section or X-ray evaluation. For X-ray guidelines, see Appendix D X-Ray Guidelines.

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

The illustrations in this document portray specific points noted in the title of each section. The development committee recognizes that different parts of the industry have different definitions for some terms used herein. For the purposes of this document, the terms cable and wire harness are used interchangeably.

IPC/WHMA-A-620 can be used as a stand-alone document for purchasing products, however it does not specify frequency of in-process inspection or frequency of end product inspection. No limit is placed on the number of process indicators or the number of allowable repair/rework of defects. Such information should be developed with a statistical process control plan (see IPC-9191).

**1.2 Purpose** This standard describes materials, methods, tests and acceptability criteria for producing crimped, mechanically secured, or soldered interconnections and the related assembly activities associated with cable and harness assemblies.

The intent of this document is to rely on process control methodology to ensure consistent quality levels during the manufacture of products.

Any method that produces an assembly conforming to the acceptability requirements described in this standard may be used.

Standards may be updated at any time, including with the use of amendments. The use of an amendment or newer revision is not automatically required. The revision in effect **shall [D1D2D3]** be as specified by the User.

**1.3 Classification** Use of this standard requires agreement on the Class to which the product belongs. The User has the ultimate responsibility for identifying the Class to which the assembly is evaluated. If the User does not establish and document the acceptance Class, the Manufacturer may do so. Criteria defined in this standard reflect three Product Classes, which are as follows:

**Class 1 General Electronic Products**

Includes products suitable for applications where the major requirement is the 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 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 systems and other critical systems.

**1.4 Measurement Units and Applications** This document uses the International System of Units (SI) in accordance with IEEE/ASTM SI 10, American National Standard for Metric Practice (Section 3). Imperial English equivalent units follow in brackets. The derived SI units used in this document are millimeters (mm) [in] for dimensions and dimensional tolerances, Celsius (°C) [°F] for temperature and temperature tolerances, grams (g) [oz] for weight, and lux (lx) [foot-candles] for illuminance.

**1.4.1 Verification of Dimensions** Where not specifically invoked by this standard, actual measurements, e.g., of specific solder fillet dimensions, determination of damage and wrap percentages, are not required except for referee purposes.

**1.5 Definition of Requirements** The words “**shall**” or “**shall not**” are used in the text of this document wherever there is a requirement for materials, process or acceptance of cable, wire and harness assemblies.

Where the words “**shall**” or “**shall not**” indicates a requirement for at least one Class, the requirements for each Class are in brackets next to the “**shall**” or “**shall not**” requirement.

N = No requirement has been established for this Class

A = Acceptable

P = Process Indicator

D = Defect

**Examples:**

[A1P2D3] is Acceptable Class 1, Process Indicator Class 2 and Defect Class 3

[N1D2D3] is Requirement Not Established Class 1, Defect Classes 2 and 3



## 1.0 General (cont.)

[A1A2D3] is Acceptable Classes 1 and 2, Defect Class 3

[D1D2D3] is Defect for all Classes.

Unless specifically stated otherwise, a defect for a Class 1 product means that the characteristic is also a defect for Class 2 and 3. A defect for a Class 2 product means that the characteristic is also a defect for a Class 3 product, but may not be a defect for a Class 1 product where less demanding criteria may apply.

The word “should” reflects recommendations and is used to reflect general industry practices and procedures for guidance only.

Many of the examples (figures) shown are grossly exaggerated to clearly depict the condition being described. Line drawings and illustrations are depicted herein to assist in the interpretation of the written requirements of this standard, many of these examples (figures) are grossly exaggerated to clearly depict the condition being described.

**In the case of a discrepancy, the written description or written criteria always takes precedence over the illustrations.**

**1.5.1 Inspection Conditions** The inspector **shall not [D1D2D3]** select the Product Class for the assembly under inspection. Documentation that specifies the applicable Class for the assembly under inspection **shall [D1D2D3]** be provided to the inspector. Criteria are given for each Product Class in three conditions: Acceptable, Defect or Process Indicator.

**1.5.1.1 Acceptable** This characteristic indicates a condition that, while not necessarily perfect, will maintain the integrity and reliability of the assembly in its service environment.

**1.5.1.2 Defect** A defect is a condition that fails to meet the acceptance criteria of this document or negatively affects the form, fit or function of the assembly in its end use environment. The Manufacturer **shall [N1D2D3]** document and disposition each defect.

It is the responsibility of the Manufacturer to identify defects that are unique to the assembly process. It is the responsibility of the User to define unique defect categories applicable to the product.

**1.5.1.2.1 Disposition** Disposition is the determination of how defects should be treated. Dispositions include, but are not limited to, rework, use as is, scrap or repair.

User concurrence **shall [N1D2D3]** be required for use as is and **shall [N1N2D3]** be required for repair dispositions.

**1.5.1.3 Process Indicator** A process indicator is a condition that identifies a characteristic that does not affect the form, fit, function or reliability of a product. A process indicator is not a defect.

- Such condition is a result of material, design and/or operator/machine related causes that create a condition that neither fully meets the acceptance criteria nor is a defect.
- Process indicators should be monitored as part of the process control system. If the number of process indicators indicates an abnormal variation in the process, identifies an undesirable trend, or displays other conditions that indicate the process is (or is approaching) out of control, the process should be analyzed. This may result in action to reduce the variation and improve yields.
- Disposition of individual process indicators is not required and affected product should be used as is.
- Not all process indicators are specified by this standard.
- It is the responsibility of the Manufacturer to identify process indicators that are unique to the assembly process.

**1.5.1.4 Conditions Not Specified** Conditions that are not specified are considered acceptable unless it can be established that the condition affects end user defined form, fit, function or reliability.

**1.5.1.5 Uncommon or Specialized Designs** IPC/WHMA-A-620, as an industry consensus document, cannot address all of the possible product design combinations. However, the standard does provide criteria for commonly used technologies. Where uncommon or specialized technologies are used, it may be necessary to develop unique acceptance criteria. The development should include User involvement. The acceptance criteria **shall [N1N2D3]** have User agreement. Requirements for specialized processes and/or technologies not specified herein **shall [N1D2D3]** be performed in accordance with documented procedures which are available for review.

Whenever possible, new criteria or criteria on specialized products should be submitted, using the Standard Improvement Form included in this standard, to the IPC Technical Committee to be considered for inclusion in upcoming revisions of this standard.