IPC/WHMA-A-620B Amendment 1

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Requirements and Acceptance for Cable and Wire Harness Assemblies

A standard developed by IPC

Association Connecting Electronics Industries

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Wiring Harness Manufacturer's Association

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Table of Contents

2.7 United States Department of Defense (DoD)

~~MIL-HDBK-454 General Guides for Electronic Equipment~~

3.2 Strand Damage and End Cuts

Conductors **shall not** ~~[D1D2D3]~~ **[N1D2D3]** be cut or modified in any manner to reduce circular mil area (CMA) to fit a termination.

4.3.1 Solder Connection – General Requirements

4.7 Birdcaged Wire (Soldered)

Figure 4-16

Acceptable - Class 1,2,3

- Wire strands have separation but:
  - Do not exceed one strand **diameter**.
  - Do not extend beyond wire insulation outside diameter.

Figure 4-17

Acceptable - Class 1
Process Indicator – Class 2
Defect - Class 3

- **Wire strands have separation exceeding 1 strand diameter but do not extend beyond wire insulation outside diameter.**

Acceptable - Class 1
Defect - Class 2,3

- Wire strands:
  - ~~Have separation exceeding 1 strand diameter.~~
  - Extend beyond wire insulation outside diameter.

4.8.1.1 Terminals – Turrets and Straight Pins – Lead/Wire Placement

Table 4-2 Turret and Straight Pin Terminal Lead/Wire **Placement**[2]

4.8.2.1 Terminals – Bifurcated – Lead/Wire Placement – Side Route

Table 4-3 is applicable to leads and wires attached to side-route bifurcated terminals.

Table 4-3 Bifurcated Terminal Lead/Wire Placement - Side Route[1]

Criteria	Class 1	Class 2	Class 3
<90° wrap	Defect		
≥90° wrap	Acceptable		
>360° and wire overlaps itself	Acceptable	Defect	

Note 1: 4.8.2.1 provides exceptions to wrap requirements depending on wire size; 4.8.2.3 provides exceptions to wrap requirements when staking is used.

Figure 4-30

Defect - Class 1,2,3

- Wire does not pass through slot.
- Wire end violates minimum electrical clearance.
- Wire/lead <0.75 mm [0.0295 in] in diameter is wrapped around a post less than 90°. **See 4.8.2.3 for exception.**

4.8.4.1 Terminals – Pierced/Perforated**/Punched** – Lead/Wire Placement

4.8.5.1 Terminals – Hook – Lead/Wire Placement

Figure 4-55

Target - Class 1,2,3

- Wire wrap contacts terminal for a minimum of 180°.
- ~~**Minimum of 1 wire diameter space from end of hook to the closest wire.**~~
- Wires attached within the 180° arc of the hook.
- Wires do not overlap.
- Insulation clearance 1 wire diameter.

5 Crimp Terminations (Contacts and Lugs)

Conductor strands **shall not ~~[D1D2D3]~~ [N1D2D3]** be cut or modified in any manner to reduce circular mil area (CMA) to fit a termination. Contacts **shall not ~~[D1D2D3]~~ [N1D2D3]** be altered to accept oversized wire or an excessive number of conductors. Conductors **shall not {D1D2D3]** be tinned prior to termination, unless otherwise specified. Solid wire **shall not [D1D2D3]** be crimped except as allowed in 13.2.1.

5.1.1.1 Stamped and Formed – Open Barrel – Insulation Support – Inspection Window

Figure 5-3

Acceptable - Class 1,2,3
~~Process Indicator – Class 2,3~~

- Insulation is flush with but does not enter the wire crimp area (1).
- Insulation is flush with the end of the insulation crimp tabs and does not enter the inspection window area (2).

5.1.2 Stamped and Formed – Open Barrel – Insulation Clearance if No Support Crimp

Acceptable - Class 1,2,3

- **Insulation is flush to the end of the contact barrel.**
- **Insulation is flush with but does not enter the wire crimp area.**

Acceptable - Class 2,3

- Conductor is visible between the insulation and contact barrel but no greater than 1 wire diameter.

Acceptable - Class 1
Process Indicator - Class 2,3

- **~~Insulation is flush to the end of the contact barrel.~~**
- Insulation is greater than 1 but less than 2 wire diameters from the end of the contact barrel.
- **~~Insulation is flush with but does not enter the wire crimp area.~~**

Defect - Class 1,2,3

- Insulation is greater than 2 wire diameters from the end of the contact barrel.

5.3.1 Machined Contacts – Insulation Clearance

Figure 5-44

Target - Class 1,2,3

- **Conductor is visible but** less than 50% overall wire diameter (D) clearance (C) between the insulation and contact barrel.

Acceptable - Class 1,2,3

- **Insulation is flush to the end of the contact barrel.**

Figure 5-46

Acceptable - Class 1
Process Indicator - Class 2,3

- ~~**Insulation is flush to the end of the contact barrel.**~~
- Insulation is greater than 1 but less than 2 wire diameters from the end of the contact barrel.

Figure 5-47

Defect - Class 1,2,3

- Insulation is greater than 2 wire diameters from the end of the contact barrel.

6.2.4 Discrete Wire Termination – Insulation Crimp

The requirements of ~~**5.1.1**~~ **5.1.1.2** (Insulation Support Crimp) also apply.

6.2.7 Discrete Wire Termination – Pass Through Connectors

Figure 6-39

Target - Class 1,2,3

- Wire fully seated into the contact.
- Wire passes through the connector uninterrupted.
- ~~**Base**~~ **Bare** conductor not visible.

8.2.1 Crimped Splices – Barrel

Figure 8-44

Defect - Class 1,2,3

- Insulation gap exceeds 2 wire diameters (see Figure 8-44).
- Conductors extend greater than 2 wire diameters beyond crimp barrel.
- Wire insulation extends into barrel splice crimp. (not shown)
- Barrel splice is cracked (see Figure 8-45, arrow).
- Crimp indentation is off the end of the barrel splice, bell mouth is not evident (see Figure 8-46).
- Wires are not contained in the crimp.
- Conductors twisted together before insertion into the contact.
- Ends of all conductors are not visible.
- When required, sleeving **does not overlap** ~~**overlaps**~~ the wire insulation at least 1 wire/bundle diameter on both sides of the barrel splice.
- When required, sleeving is missing.

8.2.2 Crimped Splices – Double Sided

Figure 8-53

Defect - Class 1,2,3

- Wire insulation extends into the wire crimp barrel (see Figure 8-53-A).
- Crimp indent is off the end of the splice (see Figure 8-53-B).
- Wire end(s) are not visible through the inspection window(s) (see Figure 8-53-C).
- Wire insulation gap is greater than 2 wire diameters including insulation (see Figure ~~**8-43-D**~~ **8-53-D**).
- Sleeving, if required, does not overlap wire insulation at least 1 wire diameter on both ends (not shown).
- Wire strands extend out of inspection window (see Figure 8-54).
- Wire strands have pierced the heat shrinkable sleeve (see Figure 8-55).
- Multiple conductors twisted together before insertion into the crimp barrel (not shown).

8.2.3 Crimped Splices – Contact

Figure 8-57

Acceptable - Class 1,2,3

- End splice insulating shrink sleeving is less than 2 wire group diameters beyond the cut end and is sealed.
- End splice insulating shrink sleeving is greater than 2 wire group diameters beyond the cut end.
- Machined contact pin cut end is insulated with shrink sleeving or cap.
- Machined contact is not cracked after cutting off pin.
- **Insulation is flush to the end of the contact barrel.**

Figure 8-58

Acceptable - Class 1
Process Indicator - Class 2,3

- ~~**Insulation is flush to the end of the contact barrel.**~~
- Insulation is greater than 1 but less than 2 wire diameters from the end of the contact barrel.

8.2.4 Wire In-Line Junction Devices (Jiffy Junctions)

Defect - Class 1,2,3

- Multiple wire attachments, when used, do not meet the requirements of 5.3.
- Insulation clearance does not meet the requirements of 5.3.1.
- The conductor location does not meet the requirements of 5.3.3.
- Crimping does not meet the requirements of 5.3.4.
- CMA buildup, when used, does not meet the requirements of 5.3.5.
- Contact installation does not meet the requirements of 9.5.
- Qualification of crimped connection fails Pull Force/Tensile Test per 19.7.2.
- Mated assembly fails Pull Test Contact Retention Verification Test per 19.7.5.

10 Over-Molding/Potting

Potting is typically a single step, relatively low pressure and low temperature process in which the component is introduced into a mold die and is selectively encapsulated. Potting typically used thermoset materials that are applied by hand or by injecting into a mold using low pressure application. The ~~care~~ **cure** may be done by heat, through a chemical reaction (e.g., two-part epoxy) or irradiation.

10.1.5 Over-Molding – Wire Insulation, Jacket or Sleeving Damage

Figure 10-52

Defect - Class 1,2,3

- Wire insulation is damaged beyond the insulation damage criteria listed in 3.5 (see Figures 10-52, 53, 54).
- Cable jacket, sleeve or boot damaged exposing wire, braid, insulation or conductor (see Figures 10-54, 55).
- ~~Sold~~ **Solder** wicking exceeds maximum criteria (see Figure 10-56).

10.2.1 Potting – Filling

Defect - Class 2,3

- Bubbles, voids or cavities that bridge conductors (~~now~~ **not** shown).

Figure 10-64

Defect - Class 1,2,3

- Potting material present on electrical mating surfaces of connector (not shown).

11.3.1 Measuring – Wire – Electrical Terminal Reference Location

Figures 11-9, 11-10 and ~~11-1~~ **11-11** illustrate the dimensional reference location for wires and cables without terminations.

12.7.1 Flag Markers – Adhesive

Figure ~~12-19~~ 12-20

Defect - Class 2,3

- The flag ~~market~~ **marker** side or end misregistration exceeds 10% of the width of the marker.

13.1 Stripping

Figure 13-5

Defect - Class 1,2,3

- Braid twisted/birdcaged (1).
- Any cuts or breaks in outer jacket (not shown).
- Outer jacket thickness is reduced greater than 20% (3).
- Uneven or ragged pieces (frays, tails, tags) of outer jacket are greater than 50% of the outer jacket thickness or 1 mm [0.40 in] whichever is more (3).
- ~~**Internal dielectric damaged (5).**~~
- Uneven cut on braid; any long strands (6).
- Discernible nicks or cuts in center conductor are greater than allowance of Table 13-1.
- Burns or melted areas on dielectric.
- Damage **or indentation** to center dielectric reducing insulation diameter by more than 10% **(5).** ~~**(not shown).**~~

13.6 Coaxial Connector – Center Conductor Solder

Figure 13-29

~~**Target - Class 1,2,3**~~

- ~~**Conductor extends completely through slot and is visible on the exit side.**~~
- ~~**Conductor is in contact with base of terminal area.**~~

Acceptable - Class 1,2,3

- Conductor end is discernible **in the solder** on the exit side of terminal.

13.8.1 Shield Termination – Clamped Ground Rings

Figure 13-39

Defect - Class 1,2,3

- Shield strands do not hold the shield ground ring in tight contact with the cable outer jacket.
- ~~**Cable is displaced from position on ferrule and/or connector after crimping.**~~

13.10.3 Semirigid Coax – Dielectric Cutoff

Figure 13-65

Defect - Class 1,2,3

- Dielectric position is not within connector manufacturer's specification (see Figure 13-65).
- Air gap between dielectric and cable shield (see Figure 13-66).
- Dielectric protrudes above connector face (see Figure 13-67).
- Center conductor is bent (see Figure 13-67).
- Shield roll over reduces the distance from the edge of the center conductor to the shield less than the limits of Table 13-3 (see Figures 13-68, 69).
- **Trim area offset exceeds 10% of the cable diameter (D) beyond the perpendicular angle to the center conductor (see Figure 13-4).**

13.12.1 Soldering and Stripping of Biaxial/Multi-Axial Shielded Wire – Jacket and Tip Installation (cont.)

14.1 Tie Wrap/Lacing Application

A clove hitch knot **shall [N1D2D3]** secure the ~~**budle**~~ **bundle** and the clove hitch **shall [N1D2D3]** be secured with a locking knot, e.g., square knot, surgeons knot.

Figure 14-4

Target - Class 1,2,3

Lacing:

- Spot ties, or the first and last stitch of continuous lacing is tied with a lock stitch such as clove hitch or equivalent and secured with a square knot, surgeon's knot, or other approved lock knot (1).
- Continuous lacing is done with lock stitches (2).
- Continuous lacing utilizes a double lock stitch before and after each breakout of 4 or more wires (3).
- Continuous branch lacing is started on the trunk.
- Lacing is heat-seared to prevent fraying 10 mm [0.40 in] after the knot ~~**(4).**~~

Tie wraps/straps:

- Restraining devices are locking. (They should remain secure for the expected service life of the product.)
- Cut end of tie wrap is square and flush to the face of the tie wrap.

14.3.4.2 Routing – Unused Wire Termination – Flexible Sleeving

Target - Class 1,2,3

- Unused wire is ~~folder~~ **folded** back and tied into the wire bundle.

Acceptable - Class 1,2,3

- Wire may extend straight down length of bundle (see Figure ~~14-32~~ **14-33**) or be ~~folder~~ **folded** back (see Figure ~~14-31~~ **14-32**).
- Flexible sleeving is folded back and restrained.

14.4 Broom Stitching

Broom stitch ties can be used to secure wires or cables together. Each group **shall [D1D2D3]** be ~~ties~~ **tied** with a clove hitch or equivalent. The end of the run **shall [D1D2D3]** be tied with a securing knot.

15.3.1 Shield Termination – Connector – Shrink

Figure 15-34

Target - Class 1,2,3

- ~~**Shrinkable ring is shrunk (see Figure 15-34-A). No movement of the ring or shield is evident. (Ring has lost its original color.)**~~
- Shield is visible between shrinkable ring and the backshell (see Figure 15-34-B).
- Shield is approximately 3 mm [0.12 in] from backshell (see Figure 15-34-C).
- Shield weave pattern is intact.

Figure 15-35

Acceptable - Class 1,2,3

- Shrinkable ring is shrunk (see Figure**s 15-34-A and** 15-35-A). No movement of the ring or shield is evident. (Ring has lost its original color.)
- Shield weave pattern is disturbed (not shown).
- Shield is against backshell and is visible between backshell and ring. (see Figure 15-35-B).

15.3.1 Shield Termination – Connector – Shrink ~~and Crimp~~ (cont.)

19.4.1 Electrical Test – Selection

Table 19-1 is a listing of cable/wire harness testing options that may be agreed upon between the User and Manufacturer. The tests are defined in ~~19.7.1~~ **19.5.1** through ~~19.7.8~~ **19.5.8** and Tables 19-2 through 19-8 are used to specify test parameters when a test is required. Appendix ~~C~~ **B** is a summary of test requirements as a convenient form for passing information between User and Manufacturer and can be copied freely.

19.7.2 Mechanical Test Methods – Pull Force (Tensile)

For crimped multiple-wire applications, pull tests **shall [D1D2D3]** be performed on the smallest wire in the crimp. ~~**Unless otherwise agreed between the User and Manufacturer, Tables 19-11 and 19-12 shall [D1D2D3] be applied accordingly for the specific wire size that is being pulled.**~~

19.7.2.1 Mechanical Test Methods – Pull Force – Without Documented Process Control

Table**s** 19-12 **and 19-13** provide~~s~~ pull-force acceptance values for crimps on stranded copper wire. Where the Pull Force values are not established, the tensile strength of the crimp connection **shall [D1D2D3]** be no less than 60% of the tensile strength of the wire.

19.7.4 Mechanical Test Methods – Crimp Tool Qualification

See ~~1.9d~~ **1.13.1.**

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