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- Show relationship to Design for Manufacturability (DFM) and Design for the Environment (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

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- Inhibit innovation
- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

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2.7 United States Department of Defense (DoD)

Conductors shall not 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)
4.8.1.1 Terminals – Turrets and Straight Pins – Lead/Wire Placement

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

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>
<thead>
<tr>
<th>Criteria</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;90° wrap</td>
<td></td>
<td>Defect</td>
<td></td>
</tr>
<tr>
<td>≥90° wrap</td>
<td>Acceptable</td>
<td>Acceptable</td>
<td></td>
</tr>
<tr>
<td>&gt;360° and wire overlaps itself</td>
<td>Acceptable</td>
<td></td>
<td>Defect</td>
</tr>
</tbody>
</table>

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

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

### 5 Crimp Terminations (Contacts and Lugs)

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

**Acceptable - Class 1,2,3**
- 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).

**Process Indicator - Class 2,3**

#### 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**
- 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 *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 Sleeve Damage

**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).
- *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 *not shown*.

11.3.1 Measuring – Wire – Electrical Terminal Reference Location

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

12.7.1 Flag Markers – Adhesive

**Defect - Class 2,3**
- The flag 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 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 Sleevings

**Target - Class 1,2,3**
- Unused wire is *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 *folded* back (see Figure 14-31 & 14-32).
- Flexible sleevings is folded back and restrained.

14.4 Broom Stitching

Broom stitch ties can be used to secure wires or cables together. Each group shall be tied with a clove hitch or equivalent. The end of the run shall 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.

**Acceptable - Class 1,2,3**
- Shrinkable ring is shrunk (see Figures 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.)
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 through 19.7.8 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.

### 19.4.1 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 through 19.7.8 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 be performed on the smallest wire in the crimp. Unless otherwise agreed between the User and Manufacturer, Tables 19-11 and 19-12 shall 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

Tables 19-12 and 19-13 provide 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 be no less than 60% of the tensile strength of the wire.

### 19.7.4 Mechanical Test Methods – Crimp Tool Qualification

See 1.13.1.