Requirements: NA

3. CABLE HARNESS ASSEMBLY

3.1. Requirements and Acceptance for Cable and Wire Harness Assemblies

3.1.1. Scope/Purpose The purpose of WS-003 is to supplement IPC/WHMA-A-620, by providing additional Class 3 requirements and acceptance criteria applicable to the assembly of cables and wire harnesses. The criteria may be new where none exists, add clarification to existing criteria or add criteria that are unique to L3 Communications (CSW’s) products or processes.

Where WS-003 does not provide supplemental criteria to IPC/WHMA-A-620, the Class 3 requirements of IPC/WHMA-A-620 apply (see IS-003). These requirements apply to stand alone cable assemblies as well as LRUs, System integration or anywhere similar characteristics exist.

WS-003 is organized in the same order as the IPC/WHMA-A-620. This is deliberate to simplify its use and to group criteria into areas common to IPC/WHMA-A-620. Where no unique or additional criteria exist, the header is marked “see IPC/WHMA-A-620 for criteria.”

The product classes to which the criteria apply has been omitted; only Class 3 requirements are addressed in WS-003A.

Interpreting L3 Communications Cable/Harness Drawings is located in 60102381.

Note: Torque requirements for threaded hardware shall be in accordance with 60083155, Specification of Torque and Retention Requirements for Threaded Hardware.
3.1.2. Terms and Definitions

**Cable** – An assembly of one or more wires carrying electrical current, with connectors on either end, formed together to create a single assembly. The terms cable and harness are used interchangeably, but harnesses normally have more than two connectors. RF cables are a special type of cable that transmit RF signals and use coaxial type of wire and use coaxial type of connectors.

3.2. Applicable Documents

**Document Information Table 3-1**

<table>
<thead>
<tr>
<th>Responsible Organization:</th>
<th>Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Level function:</td>
<td>Workmanship Standards</td>
</tr>
<tr>
<td><strong>Governing Document:</strong></td>
<td>Y-001, Quality Management System</td>
</tr>
<tr>
<td></td>
<td>IPC/WHMA-A-620, Requirements and Acceptance for Cable and Harness Assemblies</td>
</tr>
<tr>
<td><strong>Subordinate Documents:</strong></td>
<td>NA</td>
</tr>
<tr>
<td><strong>Related documents:</strong></td>
<td>1M-160, Manage Tool Services (Calibration Services)</td>
</tr>
<tr>
<td></td>
<td>IS-001, Use of NON-Specified Hardware/Material</td>
</tr>
<tr>
<td></td>
<td>IS-002, Alternate Piece Marking Method</td>
</tr>
<tr>
<td></td>
<td>IS-003, Workmanship Acceptability of Electronic Assemblies</td>
</tr>
<tr>
<td></td>
<td>IS-008, Part Number/Suffix Configuration</td>
</tr>
<tr>
<td></td>
<td>IS-010, Unique Identification Number (UID)</td>
</tr>
<tr>
<td></td>
<td>P-047, Inspection</td>
</tr>
<tr>
<td></td>
<td>W-103, Heat Shrink Terminations for shielded wire</td>
</tr>
<tr>
<td></td>
<td>W-215, Specialized Connector Torque Application</td>
</tr>
<tr>
<td></td>
<td>W-404, Inspection of Connector Contact/Pin Seating</td>
</tr>
<tr>
<td></td>
<td>W-432, Practices for EMC-EMI Electromagnetic Compatibility</td>
</tr>
<tr>
<td></td>
<td>W-442, Unique Identification (UID) Piece Marking Label Printing and Verification</td>
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<tr>
<td></td>
<td>60083155, Specification of Torque and Retention Requirements for Threaded Hardware</td>
</tr>
<tr>
<td></td>
<td>60100697, Specification for Dielectric Withstanding Voltage (DWV) for Cable Assemblies</td>
</tr>
</tbody>
</table>
3.3 Preparation –
See IPC/WHMA-A-620 for criteria

3.4 Soldered Terminations
See IPC/WHMA-A-620 for criteria

3.5 Crimp Terminations (Contacts and Lugs)
This section provides additional crimp termination (contact and Lug) requirements and acceptance criteria that are currently not in IPC/WHMA-A-620, and are unique to CSW products or processes.

3.5.1 Crimping Solid Leads and Wires
The following criteria are applicable when the design requires a solid lead/wire to be crimped in a termination. Open or closed barrel contacts, the solid lead/wire shall be soldered to the termination in the brush inspection window (see Figure 3-1). When solid leads/wires are crimped in machined contacts without insulation support, the lead/wire shall be soldered to the contact in the insulation gap (insulation clearance area) (see Figure 3-2). When solid leads/wires are crimped in machined contacts with insulation support (see IPC/WHMA-A-620, Figure 5-47) the lead/wire shall be soldered to the contact at the wire inspection window (see Figure 3-2).

Note: Soldering is performed after the crimping operation.

Figure 3-1

Acceptable

• Solid lead/wire soldered to Terminal.
• Meets solder requirements.
• Machined contacts may have a thin film of solder on the outside of the contact but may not extend onto the locking mechanism or the electrical mating surface.

Note: Also applies to open barrel contacts.

Figure 3-2

1. Inspection Window
2. Insulation Gap (clearance area)
Defect

- Solid lead/wire not soldered.
- Solder does not meet requirements.
- Any evidence of non-wetting to wire or terminal.
- De-wetting of either wire or terminal.
- Solder buildup that affects form, fit, or function.
- Machined contacts where the solder extends onto the locking mechanism or the electrical mating surface.
3.5.2  Stamped and Formed – Insulation Crimp –
See IPC/WHMA-A-620 for criteria
See IS-003 for exception

3.5.3  Terminal Lugs – Without Metal Insulation Support
Terminals without a metal insulation support are exempt from the insulation crimp requirements due to the spring-back action (memory) of the plastic after crimping, all other criteria apply.

Figure 3-5

Acceptable
- Wire insulation is within the insulation support barrel.
- Wire insulation does not enter the conductor crimp area. (Figure 3-5)
- Wire crimp area is well formed and properly positioned.

Figure 3-6

Defect
- Wire insulation is not within the insulation support barrel. (Figure 3-6)
- Wire insulation enters the conductor crimp area.
- Insulation gap is greater than one wire diameter.
3.5.4 Terminal Lugs – For Aluminum/Copper Code Conductors

This section addresses the visual criteria for closed barrel crimped lugs that typically accommodate wire sizes that range from #10 AWG through 4/0. Some lugs in this range are high conductivity wrought aluminum approved for aluminum and copper conductors, performing equally well on both metals. These lugs are filled with a high temperature oxide inhibitor compound. Lugs are electro tin plated to prevent electrolytic corrosion when in contact with copper.

**Caution:** The oxide inhibitor must never be removed prior to use.

**Note:** Insulated terminals may or may not have an insulation crimp depending upon the terminal and the crimping tool used.

Figure 3-7

Target

- There is visible clearance between the terminal lug and the conductor insulation.
- Crimp indents are centered on the crimp barrel.
- Lug is not cracked or fractured.

Figure 3-8
Acceptable

- Insulation gap is a maximum of 0.25 inch.
- Crimp indents are not centered and the terminal is not bent. (Fig. 3-9)
- Wire entry end of the barrel is not deformed by the crimp.
- Burnishing, tooling marks and deformation required to crimp the terminal. (Fig. 3-10)
Defect

- Insulation gap greater than 0.25 inch.
- Wire strands not contained in the crimp. (Fig. 3-11)
- Contact is fractured or cracked (not shown).
- Wire entry end of the terminal is deformed.
- Terminal insulation damaged exposing metal. (Fig. 3-12)
- Wire insulation enters barrel of terminal. (Fig. 3-13)
- Terminal is bent (not shown).
3.5.5 Stamped and Formed – Wire Braid Terminations

This section addresses the insulation support crimp of Stamped and Formed – Closed Barrel Terminations. When wire braid is required to be terminated to a crimped lug the braid should be formed round and concentric to the wire barrel and inserted through the barrel. The crimped terminal must meet all other criteria for crimped lugs (see IPC/WHMA-A-620). The braid may continue its round form and extend through the insulation crimp or it may be left flat in the insulation support area.

**Acceptable**

- Round form or the metal braid extends through the insulation crimp.
- Wire braid is flat in the insulation crimp.

**Note:** Heat shrink sleeving has been pulled back for clarity.

See IPC/WHMA-A-620, Section 5 for additional criteria.
3.5.6 Stamped and Formed – Open Barrel – Soldered Metal Braid

This section addresses open barrel terminals that are hand formed (no crimping tool available) and terminated to metal braid, then soldered to ensure connection integrity.

Figure 3-16

Target

- Solder fillet is wetted to 100% of the contact area between the braid and the wire crimp barrel interface.
- Wire braid extends slightly past the crimp barrel.
- Braid is contained within the wire crimp barrel.
- Braid is contained in the insulation crimp.
- No damaged strands in the wire braid.

Figure 3-17
Acceptable

- Solder is wetted to a minimum of 75% of the contact area of the braid and the wire barrel interface.
- Wire braid is flush to the end of the wire crimp barrel.
- The braid end does not extend into the mating area of the terminal.
- Less than 6% of the braid strands are cut, broken, or damaged. (See IPC/WHMA-A-620, Table 13-1).
- The wire crimp and the insulation crimp are gripping the wire braid.
- Solder has wicked past the insulation crimp in a smooth even flow.

Defect

- Solder fillet is wetted to less than 75% of the contact area between the braid and the wire crimp barrel interface (Fig. 3-20).
- Wire braid not completely contained within the wire barrel and or the insulation crimp (Fig. 3-21)
- Wire braid extends into the mating area of the contact (not shown).
- Braid damage See IS-003,
- Solder ridges, sharp solder flow lines, solder protrusions or icicles that could cause damage to product or are a potential safety hazard (Fig. 3-23 & 3-24).
3.6 Insulation Displacement Connections (ICD)

See IPC/WHMA-A-620 for criteria

3.6.1 Connector Damage – Modular connectors (RJ Type)

The following criteria apply to RJ type connectors with or without load bars.

**Note:** Magnification aid shall not be used to inspect the Polycarbonate plug connector material for cosmetic imperfection, parting lines, etc.

**Target**
- No visible flaws
- No visible clouding from compression

Figure 3-24 a,b,c,d
Acceptable
- Internal stress cracks
- Micro cracking resulting from installation
- Mold flow lines
- One hole located at any single wire insert location is acceptable when under 0.050” (fig 3-26)
- Up to two holes less than 0.050” each and holes are not adjacent

Defect
- Surface cracks or damage that inhibits the mating connector function or may become FOD.
- Charred, milky, cloudy in appearance.
- Contacts are over-inserted
- A single uncharacteristic hole with a diameter greater than 0.050 inch (exposed wire).
- Two uncharacteristic holes less than 0.050 inch diameter in bordering wire insert locations (both with exposed wires).
- Any RJ45 connector with more than two uncharacteristic holes less than 0.050 inch diameter at wire insert locations (all with exposed wires).
3.7 Ultrasonic Welding
Not applicable to L3 CSW Processes

3.8 Splices
See IPC/WHMA-A-620 for criteria

3.9 Connectorization See IPC/WHMA-A-620 for criteria

3.9.1 Strain Relief – Clamp Fit

Figure 3-28

Defect

- Pinched sleeving or wire.

3.9.2 Connector, Adapter, or Cap Damage – Cadmium Plated Surfaces

This section addresses visual acceptance criteria of cadmium plated surfaces e.g., connectors, adaptors, dust caps, etc. This criterion takes exception to IPC/WHMA-A-620A, 9.4.1, Defect – Class 2, 3, that does not allow exposure of base metal.

**Note:** Surface finish inspection shall be performed without magnification.

**Note:** Connector, Adapter, or Cap that have wear blemishes from mating or proper handling is not cause for rejection. These blemishes may include scratches on threads, pins, or small cad, gold platting particles. Small particles that are not foreign to the part are not cause for rejection providing the particles don’t affect the functionality. Example: cad plating that wears off during insertion is a natural occurring blemish.

**Note:** Connectors that incorporate a jam nut retaining ring (Figure 3-39) as part of the cap restraining mechanism (chain/lanyard), the positioning of the jam nut retaining ring is not defined, unless dimensioned on the engineering drawing; however the retaining ring tab may not obscure any panel marking.
**Target**

- Free of scratches, mars, burrs, gouges, grooves, scores or other damage.
- Gasket material (located inside the cap) is in place (not shown).

**Acceptable**

- Scratched, marred or burnished. (Fig. 3-30 A-C)
3.9.3 Connector Damage – Connector Molding Compound – Socket Style

This section addresses the molding compound that is used around the center core of the connector insert during the fabrication of socket style, Amphenol Connectors.

Defect
- Scored, notched or gouged. (Fig. 3-31A-B) (Burrs not shown)
- Jam nut retaining ring (when used) (see Fig. 3-29) obscures panel marking (not shown).
Acceptable

- Exposed molding compound around the center core of the connector.

**Note:** The molding compound is not required to be visible for 100% of the perimeter of the connector center core.

**Defect**

- Molding compound is flaking.
- Molding compound causes an interference condition.

3.9.4 Installation of Sealing Plugs

3.9.4.1 Connector sealing plug length may be trimmed as needed to prevent sealing plug dislodgement or provide backshell clearance as needed. Sealing plugs shall not be trimmed below the top surface of the connector grommet.

3.9.4.2 Installation of Sealing Plugs into shorting blocks.

This section addresses sealing plugs that are installed into Terminal Junction/Shorting blocks. Figure 3-43 illustrates a typical sealing plug (A). It should be noted that sealing plugs that feature a head are installed into the Terminal Junction/Shorting Block with the shaft first and the head against the insert grommet and the head completely visible.

**Acceptable**

(Shorting Blocks Only)

- Sealing plug (A) is installed with the shaft first.
- Sealing plug shaft is captured by the insert grommet (head is visible).

**Note:** Where a sealing plug is installed, a contact will not be installed.
3.9.5 Raychem MTC 50 Connector Termination

Defect
(Shorting Blocks Only)

- Sealing Plug (A) installed head end first (head not visible).

Target

- The stripped conductor overlaps the connector terminal more than two stripped wire diameters. (Fig. 3-35)
- The solder pre-form is completely melted and there is no remnant of the solder pre-form shape.
- There is an acceptable solder fillet between the wire and the terminal.
- The heat shrinkable sleeving (A) is fully shrunk onto the wire and the terminal. (Fig 3-36)
- The heat shrinkable sleeving is not burnt or charred, and does not have any splits or tears.
- The minimum electrical clearance between electrically conductive surfaces. (B) is greater than .015 inch. (Fig. 3-36)

Note: Heat shrinkable sleeving has been partially removed for clarity.
Acceptable

- The wire overlaps the terminal a minimum of two stripped wire diameters.
- Side overhang of the wire does not exceed 25% of the stripped wire diameter. (Fig. 3-37)
- The minimum electrical clearance between electrically conductive surfaces (B) is a minimum of .015 inch.
- There is a visible fillet between the wire and the terminal.

Defect

- Side overhang of the wire exceeds 25% of the stripped diameter. (Fig. 3-38)
- The minimum electrical clearance between electrically conductive surfaces is less than .015 inch.
- Wire overlap is less than two stripped wire diameters.
- Heat shrinkable sleeving not completely shrunk.
- The heat shrinkable sleeving is charred, split or torn.
- The solder pre-form not completely flowed. (Fig. 3-39)
- Wire insulation overlaps the solder termination area.
3.9.6 Raychem MTC 100 Connector Termination

Figure 3-40

Solder ferrule (heat shrinkable device) consist of an outer shrinkable sleeve (1), two meltable sealing rings (2) and a solder ring (3) see Figure 3-40.

Figure 3-41

Target

- The stripped conductor extends the full length of the cupped area (4) of the solder terminal.
- The stripped conductor overlaps the solder terminal (4) more than two stripped wire diameters.
- The stripped conductor is parallel to the solder terminal.
- The wire insulation (5) has not entered the solder terminal area.
- The meltable sealing ring (3) is overlapping the wire insulation.
- The end of solder ferrule sleeve (2) is within .040 inch of the connector body (1).
- Solder preform (ring) is completely melted and a properly wetted and a fillet are visible between the lead and the terminal.
- The meltable sealing rings (3) have melted and flowed.
- The shrinkable sleeve or the wire insulation shows no sign of discoloration.
Acceptable

- The wire overlaps the terminal a minimum of two stripped wire diameters.
- Side overhang of the wire does not exceed 25% of the stripped wire diameter. (Fig. 3-43)
- Conductors have not ruptured or damaged the ferrule (shrinkable) sleeve.
- Shrinkable sleeve is discolored but is not burnt or charred.
- Solder fillet is visible between the lead and the terminal.
- Solder pre-form has flowed properly leaving no evidence of solder ring.
- No pits or cracks are visible in the connector body. (Fig. 3-42)
Defect

- Side overhang of the wire exceeds 25% (Fig. 3-44)
- Conductor strands are protruding through the solder ferrule sleeve
- Wire overlap is less than 2 wire diameters.
- Incomplete reflow of the solder pre-form.
- The shrinkable sleeving is charred, split or torn.
- Wire insulation overlaps the solder termination area.
- Solder fillet not visible between the lead and the terminal.
- Pits or cracks are visible in the connector body (applies to both MTC 50 and MTC 100 connectors). (Fig. 3-45)

3.9.6.1 Raychem MTC 50 & MTC 100 Connector Termination – Sealing Boot

Note: Criteria apply to both MTC 50 and MTC 100 connectors.

MTC 100 and MTC 50 sealing boots consist of heat shrinkable sleeve and meltable adhesive inside the boot (see Fig. 3-46).
Acceptable

- Sealing boot is shrunk (boot is tight).
- Melttable adhesive has properly flowed.
- Insulating boot is discolored but is not split, torn burnt or charred.
- Boot is properly positioned (overlaps onto the connector and the wire insulation).

Defect (no illustrations)

- Boot is loose
- Melttable adhesive has not completely flowed.
- Boot is split, torn or charred.
- Pits or cracks are visible in the connector body

3.9.6.2 Raychem MTC 50 & MTC 100 Connector Termination – Flat Cable
Acceptable

- Flat cable is oriented correctly (color strip or numbers or letters identify pin one).
- Cable is not misaligned (skewed).
- Boot is not damaged.
- Acceptable solder fillets are evident. (Fig. 3-48)
- Conductor side overhang is less than 25% of the conductor width.
- Shrinkable sleeving or boot discolored but not burnt or charred.

Defect

- Flat cable misaligned, side overhang is greater than 25% of the conductor width or violates electrical clearance.
- Flat cable is oriented incorrectly (color strip or numbers or letters) not matching connector pin one.
- Overheated or disturbed solder.
- Shrinkable sleeving or boot is split, torn or charred.
- Solder rings not completely flowed. (Fig. 3-49)
- Meltable adhesive not flowed.
- Boot is loose or not completely shrunk.
- Connector body damage pits or cracks.

3.10 Over-Molding/Potting

Definitions

Blow Through: any location where mold material migrates through the connector insert or contacts.

Braid Fold Back: portion of the braid that is folded back to allow a solder connection between the braid and the foil.

Connector Insert: usually the Green, Black or Blue plastic piece inside the vendor supplied connector.

Connector/Mold Interface: the location where the connector is in contact with the mold.

Float: internal components visible at the surface of the mold material.

Injection gate: location on the mold where the material is injected into the mold cavity.

Lap Joint: when a piece of foil is positioned to lie on top of another conductive surface (i.e. connector, other foil etc.).
Mismatch: where matched mold parts are not properly aligned.

Pull out (Pop out): where the sleeve, cable jacket or insulation is pulled out of the molded connector.

Solder Wicking: capillary movement of solder between metal surfaces such as strands of wire.

Streaking: discoloration of the part usually fanning out from the injection gate.

Surface Imperfections: rough surfaces on the molded component.

Wire/Cable Bundle and Mold Interface: the location where the cable enters into the molded connector.

NOTE: All criteria stated below, unless otherwise specified, apply to both injection molding and potting operations. The term “mold material” applies to either potting or injection molding materials.

3.10.1 Mold fill – Inner

<table>
<thead>
<tr>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mold material is in contact with the connector and has no gaps, no cracks and the connector is secure in the mold material.</td>
</tr>
<tr>
<td>• Mold material does not interfere with fit or function of connector.</td>
</tr>
<tr>
<td>• No mold material on the mating surfaces of the connector/contacts.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOTE: Applies to initial molding step of a multi-step mold process.</td>
</tr>
<tr>
<td>• Voids do not expose conductor(s).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Voids of any size that expose conductors.</td>
</tr>
</tbody>
</table>
### 3.10.2 Mold Fill – Outer

**Target**
- Required markings are present and legible.
- Mold material is in contact with the entire circumference of wire(s), sleeve or cable jacket interface.
- No mold material on the mating surfaces of the connector/contacts.
- Mold material is in contact with the connector and has no gaps, no cracks and the connector is secure in the mold material.
- Mold material does not interfere with fit or function of connector.
- No sink marks, or rough edges.
- No exposed wire, foil, insulation, ferrules, braid, etc.

![Figure 3-51](image-url)
Acceptable

- Mold material is in contact with the wire(s), sleeve or cable jacket but may have separation/gaps providing internal components (e.g., wires, shielding, etc.) are not visible and connector is secure.
- Textured surface visible after the removal of flash.

**NOTE:** Flash must be secure without potential for creating Foreign Object Debris (FOD).

- Mold material is in contact with connector, but may have small separations/gaps, providing:
  - void criteria are not violated
  - connector is secure in mold material
  - and connector/backshell acts substantially as a single structural unit.
Acceptable

- Flash has been removed without damage to the cable, wire, insulation, sleeve or jacket.
- Flash less than 1/16 (.06) inch at the cable/wire bundle and mold connector interface.
3.10.3 Final molding – surface conditions

Figures 3-54 A, B, & C

Defect
- Cracks, or separations that measure > 0.005 inch in width at the surface.
- Rework/touch-up that affects form, fit or function.
- Rework/touch-up material is different than the original material used.
3.10.4 EMI-RFI Shielding – Foil

**Figures 3-55 A, B, & C**

**Target**

- A complete solder fillet on the lap joint.
- No opening/holes in the foil.
- Foil lap joints are soldered for the full length.

- Foil soldered to the folded back portion of braid (cable braid foil interface).

- Soldered 360 degrees at braid fold-back and foil interface (no voids).
- Braid fold-back solder is not bridged to cable braid.
Figures 3-56 A, B, & C

Acceptable

- Solder flow visible on connector.
- Cumulative 75% minimum fillet along any length of a lap soldered joint.
- Foil opening/damage covered with a foil patch soldered in place.
- Braid soldered directly to the foil.
- Fold back foil solder bridged to the cable braid.
- Cumulative 90% minimum wetting of fold-back braid and foil interface.
Defect

- Cumulative solder fillet is less than 75% of the length of any lap solder joint.
- Less than 90% cumulative wetting of fold-back braid and foil interface.
- Openings/Holes in foil.
<table>
<thead>
<tr>
<th>Figure 3-58</th>
<th>Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image.png" alt="Image" /></td>
<td>- Molding captures cable jacket, insulation, sleeve or boot. Adhesion is not required, unless specified.</td>
</tr>
</tbody>
</table>
3.10.6  Hardware Installation – Jackscrews

The criteria in this section addresses the installation of connector mounting hardware (i.e., jackscrews or jackposts) in Injection Molded or Cold Pour potted connectors

**Note:** A trial mating of connector to connector or connector to assembly may be required for final acceptance.

<table>
<thead>
<tr>
<th>Figures 3-59 A, B</th>
<th><strong>Target</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Mold design provides clearance for hardware installation.</td>
</tr>
<tr>
<td></td>
<td>• Mates with mating connector hardware.</td>
</tr>
</tbody>
</table>
Acceptable

- Molding material does not obstruct or interfere with the mounting hardware.
- Mold obstruction adjacent the mounting hardware is trimmed flush to the surface to provide hardware clearance.
3.11 Cable Assemblies and Wires
   (See IPC/WHMA-A-620 for criteria)
3.12 Marking and Labeling   (See IPC/WHMA-A-620 for criteria)
3.13 Coaxial and Twinaxial Cable Assemblies
   3.13.1 Center Conductor Termination – Coax Pin Insulation Gap

**Defect**
- Connector hardware is misaligned due to molding obstruction.
- Will not mate with mating connector hardware.
- Trimming or damage to the molding material that exposes the foil or connector housing.
Note: Center conductor must be inserted for the full depth of the cup.

**Target**
- Insulation end (dielectric) is positioned within solder cup and support barrel area (A). (Fig. 3-61)

**Acceptable**
- Insulation end contacts the solder cup but does not prevent the formation of an acceptable solder connection. (Fig. 3-62)

**Defect**
- Insulation (dielectric) end is not positioned within solder cup and support barrel area (A). (Fig. 3-63)
- Insulation end prevents the formation of an acceptable solder connection (not shown).

3.14 Securing See IPC/WHMA-A-620,

3.14.2 Excess Wire Length – Loop in Bundle

*Note:* This section only applies to wires terminated from point to point. Does not apply to pick-off or drain wires.
Defect

Excess wire length is looped folded back

Figure 3-64

Figure 3-65

Figure 3-66

Figure 3-67
3.15 Harness/Cable Electrical Shielding

3.15.1 Shield Termination – Braided pick off

Acceptable (unsleeved)

- Solder ring is completely melted wetting the braid and the cable shield and meets the requirements of IPC/WHMA-A-620, Section 15.
- Crimp termination meets the requirements of IPC/WHMA-A-620, Section 5.
- Braid is undamaged. (see IPC-620 table 13-1)

Acceptable (sleeved)

When the braided pick off is required to be sleeved the following are met:

- Solder ring is completely melted wetting the braid and the cable shield and meets the requirements of IPC/WHMA-A-620, Section 15.
- Sleeving is tight on the braid- no lateral movement.
- No cracks, tears or burns.
- The braid sleeving is flush to the heat shrink device and less than 2 sleeve diameters
- The braid sleeving extends into the insulation crimp area of the crimped termination.

Defect

- When required to be sleeved, braid is not sleeved.
- When sleeved the insulation gap between the sleeving and the heat shrink device is greater than 2 sleeving diameters.
- Violation of soldering requirements, see IPC/WHMA-A-620, Section 15.
- Violation of crimping requirements, see IPC/WHMA-A-620, Section 5.
- Braid is damaged. (see IPC-620 table 13-1)
3.15.2 Shield Termination – Soldered to Connector Housing

This section is only applicable when specified by engineering documentation. This section addresses wires soldered to metal connector housings. Typically this type of termination requires the plating to be removed from a limited portion of the connector housing in order to create a solderable surface.

Acceptable
- Wire overlap to the metal surface is greater than 3, less than 5 wire diameters.
- The wire is in contact with and parallel to the metal surface of the connector.
- Solder is wetted and forms a fillet from the wire to the metal connector housing a minimum of 3 wire diameters.
- Wire contour is visible in the solder.
- Damage to the non-metal portion of the connector has not distorted the contact cavity.
- Insulation gap is within 2 wire diameters of solder fillet.
- Connector is clean and free of flux residue and foreign matter
- The buffed metal area of the connector is covered with wetted solder or other approved coating.

Defect
- Wire or insulation damage beyond limits (see IPC/WHMA-A-620).
- Soldered portion of the ground wire is not parallel to the connector surface.
- Wire is not in contact with the metal surface.
- Wire overlap is less than 3 or greater than 5 wire diameters.
- Solder wetting at the connector and wire interface is less than 3 wire diameters in length.
- Solder is de-wetted or no-wetted.
- Contact cavity (dielectric) of the connector is distorted.
- Insulation gap greater than 2 wire diameters from solder fillet.
- Flux residue or foreign matter evident on solder connection, connector or connector contacts.
  The buffed metal area of the connector is not covered with wetted solder or other approved coating.
3.15.3 Shield Termination – Connector – Spring Band

Acceptable

- Shield is secured/retained.
- Shield is flush against “boot groove” and not visible (not shown).
- Shield is visible between spring band and the “boot groove”.
- Shield weave pattern is intact (A).

Figure 3-72

Defect

- Shield extends beyond the “boot groove” (B).
- Backshell is damaged (not shown).
- Spring band is not completely wrapped around backshell (not shown).
- Spring band is not within the “banding channel”.

A  Boot Groove

Banding Channel
3.15.4 Shield Termination – EMI Braid to Braid

When braids overlap other braids, the contact areas must be cleaned and electrically bonded together. Soldering is the preferred connection method. Conductive epoxy may be called out if wire under the braids may be damaged by soldering temperatures. When conductive epoxy is used to bond the braids the bond shall be verified to be less than 2.5 milliohms after curing.

**TARGET:**

- Solder joint (Bonding) is continuous around 360° of the connection area.
- Solder joint (Bonding) length is 0.5 the Diameter of the largest braid.
- Solder joint (Bonding) is smooth and even with no wicking
ACCEPTABLE:

- Solder joint (Bonding) length is does not exceed one Diameter of the largest braid.
- Solder joint (Bonding) is smooth with limited wicking.

DEFECTS:

- Solder joint (Bonding) is NOT continuous around 360° of the connection area.
- Solder joint is not wetted to other braids around the 360° solder joint.
- Solder joint (Bonding) length exceeds one Diameter of the largest braid.
- Solder joint (Bonding) length is less than 0.5 Diameter of the largest braid.
- Solder joint (Bonding) is rough and/or uneven.
- Solder wicking is excessive creating rigid sections where wires will be damaged.

3.16 Cable Harness Protective Coverings

3.16.1 Braid – Prewoven (plastic)

(see IPC/WHMA-A-620).
3.16.2 Heat Shrink Tubing – Indoor Applications

**Note:** Unless otherwise specified on the engineering drawing, all cable and wire harness assemblies are considered to be designed for an indoor environment.

**Note:** Silicone self fusing tape may be used within cable assemblies under the cable’s outer jackets to build up cable diameter, to improve strain relief, and smooth out transitions to prevent sleeving /boot damage. (See IS-001)

Sleeving or boots overlapped on clampless adaptors are required to be adhesive bonded in place and shall meet the bonding requirements of this section. Adhesive lined sleeving e.g., boots satisfy the bonding requirements when specified on the engineering bill of material. When adhesive lined sleeving (e.g., boots) is used, evidence of the adhesive may not be visible at the overlapped junction. Other sleeving overlapped junctions are not required to be adhesive bonded, unless specified per engineering documentation. However when adhesive bonding material is not listed on the engineering bill of material, a harnessing adhesive (material number 7917693-00) may be applied to any interface between the connector backshell or the connector and the cable jacket as part of the standard process. A harnessing epoxy may also be applied to any sleeving overlap, junction, or splice as part of the standard process; see IS-001. When adhesive bonding is used it shall be bonded for a minimum of 270º (75%) of the circumference of the sleeving.

3.16.2.1 Heat Shrink Tubing – Indoor Applications Breakouts & Slewing Splices

(see IPC/WHMA-A-620).

3.16.2.2 Heat Shrink Tubing – Indoor Applications – Cable Jacket/Sleeving Position

Figure 3-75

Acceptable

- Cable jacket/sleeving (B) extends to within one cable diameter of the clampless adapter (A).
- Environmental connector(C) the cable jacket/sleeving extends into the sealing grommet (D).
- Cable jacket/sleeving extends slightly past the adapter clamps.
**Note:** Figure 3-76 illustrates a connector with a clampless adapter. This configuration requires a boot/sleeving, see 3.16.3.3.

Figure 3-76

![Figure 3-76](image1.png)

Figure 3-77

![Figure 3-77](image2.png)
Defect

- Cable jacket/sleeving (B) does not extend to within one cable diameter of the clampless adapter (A).
- On an environmental connector (C) the cable jacket/sleeving does not extend into the sealing grommet (D).
- Connectors that have strain relief clamps see IPC/WHMA- A-620, Section 9 for acceptance criteria.

3.16.2.3 Heat Shrink Tubing – Indoor Applications – Boots/Sleeving

Figure 3-79
Acceptable

- Boot/sleeving (A) extends onto the clampless adapter a minimum of 50% of adapter length.
- The boot/sleeving is bonded (B) to the clampless adapter for a minimum of 270° (75%) of its circumference.

**Note:** The boot/sleeving is not required to be bonded to the cable Jacket/sleeving.

Figure 3-80

---

Defect

- Boot/Sleeving is overlapped less than 50% of the clampless adapter length (A).
- The boot/sleeving is bonded less than 270° (75%) of the circumference of the clampless adapter.
- Adhesive is on any electrical mating surface.
- Adhesive has flowed beyond the boundaries of the joint.
- Adhesive is on a surface that prevents proper mating or mechanical attachment of the connector.
- Boot /Sleeving is damage i.e., tears, cuts, cracks, splits or translucent.

Figure 3-81
3.16.3 Heat Shrink Tubing – Outdoor Applications

Cable or wire harness designated on the engineering drawing as Outdoor Application are designed to withstand exposure to external environments. These cables/wire harnesses shall be built in accordance with the drawing, and parts as designated on the bill of material. This section addresses the adhesive bonding and sealing criteria of overlapped tubing splices, overlapped breakout junctions, and sealing of the cable jacket/sleeving to the connector.

Note: Adhesive bonding for outdoor application is applicable to the following areas:
- Breakouts where there is sleeving on all legs (3.16.3.1)
- Sleeve splices (3.16.3.1)
- Sleeve to clampless adapters (3.16.3.3)

Other areas requiring adhesive bonding shall be specified on the drawing.

Note: Silicone self fusing tape may be used within cable assemblies under the cable’s outer jackets to build up cable diameter, to improve strain relief, and smooth out transitions to prevent sleeving/boot damage. (see IS-001)

Note: Adhesive lined sleeving satisfies bonding requirements when specified on the engineering bill of material. When adhesive lined sleeving (e.g., boots) is used, evidence of the adhesive may not be visible at the overlapped junction.

3.16.3.1 Heat Shrink Tubing – Outdoor Applications – Breakouts & Sleeve Splices
Acceptable

- Visual evidence of a 360º seal (B) of the overlapped junction or a 360º seal around each branch of an overlapped breakout junction.
- Tactile evidence (perceived by touch) of adhesive between sleeving layers (overlap interface) a minimum of 1 cable diameter or 0.25 inch whichever is greater.

Defect

- No evidence of a 360º seal (B) of the overlapped junction or a 360º seal around each branch of an overlapped breakout junction.
- Adhesive has not adhered to the sleeving.
- Voids or separation in the adhesive.
- Adhesive has flowed beyond the boundaries of the joint.
- No tactile evidence (perceived by touch) of adhesive between sleeving layers (overlap interface) less than 1 cable diameter or 0.25 inch whichever is less.
- Boot/Sleeving is damaged (i.e., tears, cuts, cracks, splits or translucent).
3.16.3.2 Heat Shrink Tubing – Outdoor Applications – Cable Jacket/Sleeving Position.
Acceptable

- Cable jacket/sleeving (B) extends to within one cable diameter of the clampless adapter (A)
- Environmental connector (Fig. 3-92) the cable jacket/sleeving extends into the sealing grommet (D) and is sealed.

Note: Figure 3-89 illustrates a connector with a clampless adapter this configuration requires a boot/sleeving, see 3.16.3.3.

Figure 3-90

Note: Environmental connectors as shown in Fig. 3-90 do not require a bonded boot/sleeving (assembly is complete).

Figure 3-91
Defect

- Cable jacket/sleeving does not extend to within one cable diameter of the clampless adapter (not shown).
- On an environmental connector (Fig. 3-91) the cable jacket/sleeving does not extend into the sealing grommet.
- On an environmental connector the jacket/sleeving extends into the sealing grommet but is not sealed (Fig 3-92).

Note: The sealing grommet shall provide a 360° seal around the jacket/sleeving.

Figure 3-92

Note: Fig. 3-91 and 3-92 illustrate environmental connectors.

3.16.3.3 Heat Shrink Tubing – Outdoor Applications – Boots and Sleevings
(Applies only to clampless adaptors)

Figure 3-93
Acceptable

- Boot/sleeving (D) extends over the clampless adapter for at least 50% of the adapter length.
- Boot/sleeving (D) is securely shrunk on the rear of the connector adapter (no lateral movement).
- Boot/sleeving does not extend onto the threaded adapter ring (B).
- Boot/sleeving is bonded with evidence of a 360 seal (C) at each end.
- Bonding adhesive does not extend onto the threaded adapter ring (B).
- Boot/sleeving or bonding adhesive does not interfere with the connector coupling ring.

Defect

- Boot/sleeving (A) extends over the clampless adapter for less than 50% of the adapter length.
- Boot/sleeving (A) is loose on the rear of the connector adapter.
- Boot/sleeving extends onto the threaded adapter ring.
- Not bonded and sealed (B) for 360° of circumference of the boot/sleeving (either end).
- Bonding adhesive extends onto the threaded adapter ring.
- Boot/sleeving or bonding adhesive interferes with the connector coupling ring.
- Boot/Sleeving is damage i.e., tears, cuts, cracks, splits or translucent.

3.17 Finishes Assembly Installation

60083155, Specification of Standard Torque limits for Threaded Hardware, establish requirements for threaded hardware used at L3 CSW.

(See IPC/WHMA-A-620 for criteria)

3.18 Solderless Wrap

(See IPC/WHMA-A-620 for criteria)
3.19 Testing
60100697, Specification for Dielectric Withstanding Voltage (DWV) for Cable Assemblies, provides guidance when it is appropriate to reduce dielectric withstanding voltage (DWV) for Class 3 cable assemblies tested per IPC/WHMA-A-620.

(See IPC/WHMA-A-620 for criteria)

Note: Pull tests shall be performed per W-083 Wire Crimp Pull Tests.

RECORDS

There are no records associated with this document.

END OF DOCUMENT
**Revision History Summary**

<table>
<thead>
<tr>
<th>Revision #</th>
<th>Description of Change</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - C</td>
<td>Initial release through revision C.</td>
<td>VARIOUS</td>
</tr>
<tr>
<td>NA</td>
<td>P-127 has been deleted, removed reference from list of related documents. No revision upgrade necessary.</td>
<td>8/21/2013</td>
</tr>
<tr>
<td>NA</td>
<td>Updated references to P-023 as P-023 was deleted and replaced by 1M-160. No revision upgrade necessary.</td>
<td>9/9/2013</td>
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<tr>
<td>NA</td>
<td>Updated legacy terminology throughout. Changes are indicated with blue text. No revision upgrade necessary.</td>
<td>1/15/2014</td>
</tr>
<tr>
<td>NA</td>
<td>Removed “and/” from section 3.16.2. No revision upgrade necessary.</td>
<td>4/7/2014</td>
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<tr>
<td>D</td>
<td>Changed contact name. Modified to reflect changes made to IS-001. Modified note in section 3.9.3. Added notes to sections 3.9.4, 3.16.2 and 3.16.3. Added last bullet in defects sections of 3.16.2.1, 3.16.2.3, 3.16.3.1 and 3.16.3.3. Added figures 3-109, 3-110, 3-115 and 3-116 and renumbered other figures accordingly.</td>
<td>3/19/2015</td>
</tr>
<tr>
<td>E</td>
<td>Formatted in accordance with new WS template. Added section 3.15.3. Added references to figures throughout.</td>
<td>6/27/2016</td>
</tr>
<tr>
<td>F</td>
<td>Removed reference to IS-001 in section 3.9.4. Added note in section 3.16.3.</td>
<td>12/19/2016</td>
</tr>
<tr>
<td>NA</td>
<td>Added records section. No revision upgrade necessary.</td>
<td>03/08/2017</td>
</tr>
<tr>
<td>G</td>
<td>Added new figures 3-7B and 3-8. Deleted “or lacing/string tie as called out on the part list/drawing” from section 3.14. Added new section 3.15.4.</td>
<td>08/10/2017</td>
</tr>
<tr>
<td>H</td>
<td>Added new sections 3.9.5.1 and 3.9.5.2. Updated section 3.9.7.2 and updated figures 3-58 and 3-58. Deleted section 3.10 and figures 3-60 through 3-82. Renumbered rest of sections and figures accordingly.</td>
<td>9/20/2017</td>
</tr>
<tr>
<td>I</td>
<td>Added “, Adapter, or Cap” and removed “Only dust caps are shown due to the ease of displaying visual surface appearance.” From section 3.9.4. Removed “natural occurring” and “natural wear” from 2nd note in section 3.9.4 and added “, Adapter, or” and “proper handling”. Removed reference to WS-018 from section 3.10. Added new sections 3.10.1. through 3.10.7. Added “Bundle or tie wrap is loose” to Defect for Figure 3-68. Added “Adhesive has flowed beyond the boundaries of the joint” to Defect items listed in section 3.16.2.3.</td>
<td>06/06/2018</td>
</tr>
<tr>
<td>J</td>
<td>Major revision to remove redundancy between IPC-620 and this document. Also added acceptable and defect definition for RJ-45’s. Deleted several figures and renumbered applicable figures throughout.</td>
<td>4/2/2019</td>
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