1 Purpose and Scope

To establish procedures and ensure consistency in requirements for general workmanship and standard practices of electronics hardware.

The documents referenced herein shall represent the minimum workmanship standards for all fabricated printed circuit boards, electronic sub-assemblies and assemblies, as well as mechanical assemblies, which represent ViaSat products. The requirements herein are applicable not only to ViaSat and its Subsidiaries but all contracted product for which this standard would be imposed.

2 Table of Contents

1 Purpose and Scope .................................................................1
2 Table of Contents .................................................................1
3 General Procedure ...............................................................1
4 Metal Fabrication Workmanship Requirements .......................3
5 Welding and Brazing Workmanship Requirements ....................5
6 Mechanical Assemblies ..........................................................6
7 Cleaning of Parts and Assemblies .............................................7
8 Wiring/Cable Crimping and Installation Workmanship .................8
9 Acceptance Criteria for Circular Coax Crimps ..........................11
10 Handling of Equipment ........................................................15
11 References .............................................................................15

3 General Procedure

Verify all workmanship attributes comply with drawing specifications as well as the appropriate reference standard Workmanship

All procedures applied in the manufacture of products as referenced in Section 4 are expected to be in accordance with the best manufacturing practices that will produce the highest quality products. ViaSat, Inc. or any Subsidiaries, as the Buyer, reserves the right to review all Supplier procedures on workmanship practices during a process audit under the AS9100 / ISO 9001 Quality Management System or any additional or subsequent systems that ViaSat, Inc. may deem necessary to impose. Those procedures should detail or reference practices such as:

- soldering practices as specified in IPC documents
- marking of parts and assemblies
- wiring assembly and installation practices
- welding and brazing practices
- plating practices
- riveting practices
- surface finishing practices (e.g., faying, sealing, painting, sanding, conformal coating, passivation, etc.)
- machining operations practices
- screw assembly practices
- deburring practices
- sharp edges removal practices
- proper removal of unwanted contaminate and surface films
The Supplier shall schedule and perform inspections on the contracted product throughout the manufacturing process to insure compliance with approved procedures for workmanship practices. Examples of areas to be inspected are:

- mounting and installing parts and subassemblies
- cleaning of parts and assemblies
- installation of threaded fasteners and rivets
- installation of gear and bearing assemblies
- assembly of wiring
- installation of wiring
- soldering, welding and brazing

The Supplier should develop inspection checklists so that consistent inspections can be conducted to insure good workmanship.
4  Metal Fabrication Workmanship Requirements

SURFACE ROUGHNESS
Unless otherwise specified, surface roughness shall be no greater than a 125 micro inch finish.

BURR AND SHARP EDGE REMOVAL
Unless otherwise specified, when the drawing specifies that the fabricated item shall be deburred, there shall be no projection exceeding 10% of material thickness left above surfaces. Burr removal shall not result in a chamfer, or radius, that exceeds .015 inches, or one-quarter of the material thickness, whichever is smaller. The requirement is applicable to all edges and corners.

INSIDE SHARP CORNERS
Inside sharp corners shown, but not specified as such on the drawing, may have a .015 inch maximum radius, or .015 inch maximum chamfer.

THREAD RELIEF
Unless otherwise noted on the drawing, thread reliefs shall be as follows:

External: The relief diameter shall be equal to:
- Minimum minor diameter +.000/-0.010 inches for threads .25 inch diameter and under.
- Minimum minor diameter +.000/-0.020 inches for threads over .25 inch diameter

Internal: The relief diameter shall be equal to:
- Maximum major diameter +.020"/-0.000 inches for threads .25 inch diameter and under.
- Maximum major diameter +.040"/-0.000 inches for threads over .25 inch diameter

Length of the thread relief shall not exceed 2-1/2 threads.

CONCENTRICITY
Unless otherwise specified, all diameters shown concentric to each other shall be concentric within .010 total indicator runout.

PERPENDICULARITY OF HOLES
Unless otherwise specified, clearance holes shown perpendicular to a surface shall be perpendicular within 0.5 degrees. Unless otherwise specified, tapped holes shown perpendicular to a surface shall be perpendicular within 1.0 degree.

PARALLELISM OF PLANE SURFACES
Unless otherwise specified, all machined or sheared surfaces shown parallel shall be so within the tolerance zone for given length of the surface shown by Figure 1 and Table 1.

Figure 1. Parallelism for Plane Surfaces

![Figure 1. Parallelism for Plane Surfaces](image-url)
Table 1. Parallelism Length/Tolerance

<table>
<thead>
<tr>
<th>Length (inches)</th>
<th>Tolerance (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 – 1.00</td>
<td>.003</td>
</tr>
<tr>
<td>1.00 – 3.00</td>
<td>.005</td>
</tr>
<tr>
<td>3.00 – 5.00</td>
<td>.010</td>
</tr>
<tr>
<td>5.00 – 25.00</td>
<td>.015</td>
</tr>
<tr>
<td>25.0 – 60.0</td>
<td>.050</td>
</tr>
</tbody>
</table>

If tolerance exceeds tolerance on the drawing, the drawing tolerance shall take precedence.

**FLATNESS**

Machined surfaces shall be flat within .002 inch/inch.

**SQUARENESS OF 90 DEGREE BENDS**

Sheet metal bends shown as 90° on drawing shall be 90 +/- 1.0 degree. All formed parts shall have minimum bend reliefs where required.

**GRAIN DIRECTION**

Unless otherwise specified, grain direction in formed metal parts may run in any direction convenient to manufacturing, provided these parts do not fracture at bends.

**COUNTERBORE AND SPOTFACE FILLET RADI**

Counterbore and spotface fillet radii shown as sharp shall be sharp to:

- .010 maximum radius for bore sizes between 0.00 and 1.00 inches
- .030 maximum radius for bore sizes between 1.00 and 2.00 inches

**TANGENCY OF FILLETS AND ROUNDS**

Fillets and rounds shown tangent to adjacent surfaces shall fair smoothly with tangent surfaces +/- .005 inches.
5 Welding and Brazing Workmanship Requirements

FILLER MATERIAL
Filler material shall be of compatible material as part being welded or brazed.

BUTT WELDS
Unless otherwise specified, all butt weld joints shall have complete penetration.

WELD SIZES
Fillet weld sizes shall be at least 140% of the thickness of the thinner material unless specified otherwise.

JOINT APPEARANCE
Welds shall be free from harmful defects (e.g., cracks, porosity, undercuts, voids, and gaps). All welds and brazes shall show no burn-through. Weld bead appearance, cross-section and ripples shall be uniform and smooth.

GRINDING
Grinding shall affect the minimum area possible to satisfy the drawing requirements. Welds shall not be ground unless required by drawing.
6 Mechanical Assemblies

6.1 When mounting and installing parts and/or subassemblies, the following practices will be adhered to wherever applicable:

- Assembled parts and hardware should be secured or mounted in a manner that satisfactorily accomplishes the intended purpose without degrading or becoming damaged in the environment in which they are to be used.
- Electronic equipment comprised of missing, inoperative, defective, bent, broken, or otherwise damaged parts will be deemed unacceptable.
- Parts (e.g., hinges, catches, handles, knobs, etc.) installation should avoid damaging adjacent hardware or the mounting surface.
- Rework to damaged finishes will be considered successfully performed when the surfaces are touched-up with a continuous protective coating of identical composition as the original coating material.
- The touch-up color should match the original finish such that the blended colors are not visually noticeable.

6.2 Installation of Threaded Fasteners and Rivets

Threaded fasteners and rivets should be carefully selected and applied so as to produce a safe, non-corroding, functional and long-lived joining of materials. Commonly practiced procedures, guidelines and requirements are:

- Screws, nuts and bolts should show no evidence of cross threading, mutilation, or detrimental or hazardous burrs.
- The mixing of fasteners composed of different metals should be strictly controlled (e.g., steel nuts against aluminum flat washers) because dissimilar metals encourage corrosion and unequal resistance to mechanical stresses. Exceptions would include breakaway applications.
- Uneven/over stresses between soft and hard materials should be avoided because such stresses cause unwanted fatigue or early failure (e.g., steel screws fastening plastic pieces, aluminum screws to stainless steel nuts, etc.).
- All screw-type fasteners should be tight. Tight is defined as the screw or rivet being firmly secured with no noticeable movement between the attached parts before or after applying maximum force by hand without tools. It should be noted that tight may not guarantee unloosening, over time, due to vibration and movement between joined metals.
- In critical applications or whenever tightening of fasteners is insufficient, the Supplier manufacturing processes should specify the proper torque requirements for threaded fasteners.
- Self-locking fasteners and lock-wiring will be acceptable when specified on the engineering drawing.
- Split-ring lock washers may be used if buffered by flat washers when specified on the engineering drawing.
- Star lock washers will not be allowed.
- Anti-seizing chemical locking agents (e.g., Loctite) may be used and only sparingly, with the exception of instances when grounding bonds of less than 0.10 Ohm are required as specified on the engineering drawing.
- The riveting operation should be carefully performed such that the rivets are tight and satisfactorily headed with the rivet heads tightly seated against their bearing surface.
7 Cleaning of Parts and Assemblies

The proper methods for cleaning parts and assemblies during the fabrication of product are essential in assuring the expected performance and long operational life. The subsequent procedures are offered as examples of acceptable cleanliness practices.

Product shall be cleaned of:

- loose, spattered or excess solder
- weld metal
- metal chips
- mold release agents
- smudges
- any other foreign material which might detract from the intended operation, function, or acceptable appearance of the product
- unwanted particles that could loosen or become dislodged during the normal expected life of the product
- all corrosive material prior to parts assembly into the product
- contaminants (e.g., lubricating oils, mold release agents, waxes, sand, corrosion products, solder fluxes, fingerprints, dust, etc.)
- all contaminants without incurring damage or change of electrical and mechanical properties of the product by using the safest and most appropriate agent and methods

After cleaning, the product should be allowed to dry. Any remaining loose contaminants should be blown or vacuumed away, and all moving parts and assemblies should be relubricated according to design requirements. In addition, post inspection should reveal no damage, unusual wear or presence of contamination on the product.
8 Wiring/Cable Crimping and Installation Workmanship

Requirements

ViaSat and all ViaSat Subcontractors or Suppliers performing wiring/cable crimping operations shall implement the following steps to ensure proper tooling is used and maintained, resulting in acceptable connector contact crimps:

1. Tooling and assembly procedures for wiring shall be per Manufacturers’ instructions unless otherwise specified herein.
2. ViaSat Manufacturing Engineering & Quality Engineering shall review the cable assembly drawings with the Supplier and discuss the assembly materials, tooling and processes to be utilized to manufacture acceptable wiring/cable assemblies.
3. All BOM items shall be reviewed. Extra contact pins shall be required to develop the wiring or cable assembly process and perform the necessary tooling verification tests prior to assembly of production units.
4. Each contact or pin to be crimped shall require specific tooling and this shall be reviewed with the cable manufacturer.
5. All crimp tooling shall be uniquely and permanently identified with a part number and serial number (e.g., S/N 1, 2, 3) and shall be under the calibration control program of the cable manufacturer. As such, a sticker shall be added to each tool stating the calibration interval. Note: In the case of crimpers that use exchangeable die sets, the handles and dies shall each individually be serialized and controlled.
6. The proper wiring/cable preparation and crimping process shall be contained in adequate instructions and referenced in assembly drawings or other appropriate assembly documentation.
7. The visual acceptance criteria for circular coaxial connector contact crimps (which is not covered by IPC documentation) shall be discussed, and reviewed against the ViaSat acceptance criteria procedure (see Reference Documents section.)
8. First Articles of contact crimps, and a detailed first article inspection (FAI) report shall be provided to ViaSat by the wiring/cable manufacturer as required by contract. The First Articles shall be presented to ViaSat for approval such that the cable crimps can be reviewed and inspected without any cable disassembly.
9. In the case of coaxial crimps, a set of go/no-go gauge tools shall be provided by the wiring/cable manufacturer and used to ensure the dimensions of the coaxial crimp tooling is acceptable for the contacts specified on the drawing. An optional method to be measurement of completed crimps to specifications by the crimp contact manufacturer.
10. Operator and Inspector training shall be provided by the wiring/cable manufacturer (both visual and gauge tooling checks) for acceptable crimps per requirements. It shall record names, dates and type of training performed. The Manufacturer, in their training, shall instruct each Operator performing any contact crimps that it is their responsibility to ensure these crimps are acceptable per the specification applicable before handing the cable assemblies to the next operation.
11. A Crimp Tooling Logbook shall be created for crimp tooling, and shall accommodate logging of results of daily a) inspection results of crimp tooling, b) gauge tool checks and c) visual inspection results obtained on the first three (3) production contact crimps produced with the tooling.
12. At the start of each day’s production of assembly wiring/cables, Manufacturing or Quality personnel shall inspect the following and log in the Crimp Tooling Logbook:
   a. The condition of the crimp tooling. The wear conditions shall be noted, along with any other visual abnormalities noted.
   b. Results of the gauge tool check or measurement in the case of coaxial crimp tooling.
   c. The first three (3) production crimps produced with a tool shall be inspected for acceptance per specified criteria, and results noted.
      • If acceptable, the tooling shall be released for use for the day for production crimping.
      • If, however, any contact crimps fail inspection, then production use with this tool shall be withheld until a failure investigation is completed. The Manufacturer may swap out another qualified and released tool/die set for production use, provided the successful daily check of that replacement tool is
noted in the Crimp Tooling Logbook. The cause of the rejects shall be identified, and logged in the
crimp-tooling logbook.

- If the failed crimps are determined to be the result of operator error it shall be recorded in the
  logbook. The tooling shall then be closely inspected under magnification to ensure the operator
did not damage it during the crimping of the previous 3 units. In the case of coaxial crimps, an
additional check shall be done with either the go/no-go gauge of the tool or measurement of the
final crimped contact to verify acceptable dimensions. Results of these checks shall be logged.
To verify that it was indeed operator error, the operator shall repeat the crimping operation on
another three (3) production crimps. If there are no visual failures, then the tooling can be
released for daily production use.

- If the failure analysis determines the crimp failures to be due to crimp tooling wear or
  malfunction, then the tooling shall not be released for production use. Again, this shall be noted in
  the tooling logbook.

- Any tooling that fails inspection, or gauge tool or measurement checks, must be repaired or
  replaced prior to use in production. Sufficient evidence of repair or replacement shall be available.

13. During production, each Operator shall be responsible for the quality of the contact crimps they produce.
Verification of tooling to the Contact Manufacturer specification shall be completed prior to use. ViaSat
encourages use of a “buddy system” whereby an Assembler performs a crimp, then performs a self-check to
ensure the crimp is satisfactory before moving material to the next operation. The next Assembler in the
process flow would then perform a quick check to ensure contacts are crimped properly and may now be
processed through the next assembly sequence.

14. In-process Inspection shall be performed on contact crimps prior to any higher-level or subsequent assembly
steps that may obscure full view of the crimps. Final Inspection shall be performed on the completed cable
assemblies. All results shall be recorded and maintained per the manufacturer’s Quality Management System
documentation as appropriate.

15. All assembly, tooling logbook entries and production/inspection data shall be subject to ViaSat (or ViaSat’s
Subcontractor) review and acceptance.

When installing wiring within an enclosure, the following practices shall be adhered to wherever applicable:

a. Insulated wire running between equipment or subassemblies within one piece of equipment (e.g., between
drawers or chassis and module subassemblies) should be formed into cables or ducted wherever possible.

b. Wire and wire bundles routed through holes in paneling or enclosure walls should be protected with
suitable insulated material (e.g., hole grommets).

c. Wires and cables should be positioned or protected to avoid contact with rough or irregular surfaces and
sharp edges.

d. Wire dress or bundling of wires should not result in improper electrical operation or interference with
mechanical operation that could lead to subsequent damage of the wire or cable.

e. Wiring/wire bundles should be securely supported and carefully routed to minimize chafing and abrasion,
small bend radii (no less than three times the wire or bundle diameter) riding against sharp edges and hard
surfaces, loosening of wire bundles, and occurrence of hotspots at the middle of wire bundles.

f. Riding conditions between wire/wire bundles on hard, sharp edges or surfaces shall be deemed
unacceptable.

g. Cold-flowing characteristics of installed wiring should always be known, understood and be taken into
account when implementing wire routing and bundling schemes.

h. Lacing of cabling should be applied firmly, yet not with excessive pressure such that it could cut into
conductor insulation (e.g., plastic cable ties and “stitch-lock” type lacing tape are acceptable materials for
lacing), as well as be neat and orderly in appearance.

i. Cable or wiring harnesses should be anchored to avoid damage to conductors or adjacent parts.

j. Wire bundles and cables should always be fixed such that there is minimum or no mechanical stresses
(radial, torsional or lateral stresses) at the terminated ends (no wire movement at wire termination points,
e.g., connectors/backshells, contacts, solder and crimp joints, splices, etc.-minimizes the mechanical
stresses).

k. Wire routing should be a safe distance from hot components to eliminate wire insulation deterioration.
1. Generous use of lacing tape, plastic tie-wraps or other non-metallic cable clamps to properly dress and stow wire bundles will be deemed acceptable practice.

m. Insulation should show no evidence of burns, abrading, or pinch marks that could cause short circuits or current leakage. In addition, any condition or stress that exceeds the voltage withstanding or insulation resistance characteristics should be eliminated.

n. Wires in a continuous run between two terminals should not be spliced during the assembly of the product, except where a stranded conductor is spliced to a solid conductor and the two are supported at the splice as allowed by the engineering drawing.

o. Clearance between wires/cables and heat generating parts (e.g., power semiconductors and resistors) should be such as to avoid deterioration of the wires or cables from the heat dissipated by these parts under the specified service conditions of the product.

p. Shielding on wires and cables should be secured in a manner that prevents contact or shorting of exposed current-carrying parts.

q. Shielding should terminate at sufficient distance from the exposed conductors of the cable to prevent shorting or arcing between the cable conductor and the shielding. The ends of the shielding or braid should be secured against fraying.
9 Acceptance Criteria for Circular Coax Crimps

Circular ferrule crimps are not covered in IPC/WHMA-A-620 and therefore have no acceptance criteria associated with them. It is the purpose of this document to provide the acceptance and rejection criteria for those circular ferrule crimps to assist with proper assembly and inspection. Standard inspection methods per IPC/WHMA-A-620 shall be applied for circular ferrule crimps. When applicable, this procedure should be cited on the engineering drawing as the acceptance criteria. Inspections cited herein are accomplished using a high-powered inspection scope with at least 10X magnification. Substitute inspection scopes should be used to provide the necessary detail to detect the assembly defects cited herein.

Note: for coaxial and twin-axial assemblies to function properly, it is critical that all assembly instructions provided by the manufacturer be followed.

Defects/Rejectable Conditions

Defect: Axial Misalignment (See Figure 1) Deformation (banana) of the contact/terminal that affects form, fit, function or reliability. This type of deformation may interfere with proper insertion or extraction from connector assembly.

![Figure 1. Axial Misalignment (Banana) of the Crimped Contact](image)

Defect: Ferrule Fractures and Cracks - Contact has visible fractures (See Figure 2) or cracks (See Figure 3) in the formed ferrule.
Figure 2. Fractured Ferrule

Figure 3. Cracked Ferrule
**Defect: Dislocated Crimp** - Crimp extends past crimp barrel out over the cable.

**Defect: Lose Crimp** - Ferrule and / or connector turns/moves on cable after crimping. This defect indicates the shield and/or inner contact is not secured which may result in conditions such as disconnected inner contact and/or unacceptable RF emissions.

**Acceptable Conditions**

**Acceptable: Slight Deformation (See Figure 4)** - Slight deformation or irregularity of the metal in crimp ridge area due to wear and tear of tool. (Considered to be a process indicator.) Tool should be serviced/repaired as soon as this condition appears in the crimps. No evidence of cracks or fractures under a minimum of 10X magnification.

![Figure 4. Slight Deformation in Crimp Ridge Area](image)

**Acceptable: Small Gap(See Figure 4)** - Very small gap between outer and inner ferrules with no evidence crimp is loose or will rotate/move in any way.

**Acceptable: Uncentered Crimp** - Crimp is not centered on crimp area of terminal but does not cause damage to terminal or fail to hold.

---

ViaSat Proprietary
Target Condition

**Target: No Deformations (See Figure 5 and 6)** - Smooth straight crimp with no rough edges or evidence of cracking or gaps. Part cannot be rotated or moved after crimping.

*Figure 5. Smooth Crimp with No Evidence of Gaps or Cracks*

*Figure 6. Smooth and Straight Crimp*
10 Handling of Equipment

Proper handling of parts and equipment must be exercised to preclude physical and/or electrical damage such as cracks, scratches, twists, fractures, etc. and the possibility of hidden damage such as that produced by flexure of component leads, stressing of solder joints, over tightening of fasteners, electrostatic discharge (ESD), etc. In process work is often particularly susceptible to such damage and, as such, special precautions that may include special fixtures, stowage totes, etc. should be considered.

11 References

Documents

- IPC-A-600 – Workmanship Standards for printed circuit boards
- IPC-A-610 – Workmanship Standards for electronic sub-assemblies
- IPC/WHMA-A-620 – Requirements and Acceptance for Cable and Wire Harness Assemblies