



Space product assurance

**Preparation, assembly and mounting
of RF coaxial cables**

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Foreword

This Standard is one of the series of ECSS Standards intended to be applied together for the management, engineering and product assurance in space projects and applications. ECSS is a cooperative effort of the European Space Agency, national space agencies and European industry associations for the purpose of developing and maintaining common standards.

Requirements in this Standard are defined in terms of what shall be accomplished, rather than in terms of how to organize and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

The formulation of this Standard takes into account the existing ISO 9000 family of standards.

This Standard has been prepared by editing ESA PSS-01-718, reviewed by the ECSS Technical Panel and approved by the ECSS Steering Board.

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Introduction

The main part of this Standard is based on industrial experience and recommendations from European soldering technology experts. Modifications are incorporated into the text to provide for the specific requirement of low-outgassing electrical systems which are required by scientific and application satellites. Other additions were made in the light of recent technological advances and results of metallurgical test programmes. The use of processes other than solder assembly is recognized, but only certain general requirements are given in this Standard.

These requirements apply to assemblies designed to operate within the temperature limits from $-45\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$. More extreme temperatures or other unusual environmental applications require special design measures or processing steps to provide environmental survival capability.

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Scope

This Standard defines the technical requirements and quality assurance provisions for the assembly and mounting of high-reliability, radio-frequency (RF) coaxial-cable interconnections for use as transmission lines in spacecraft and associated equipment.

In general, these assemblies are designed for low-loss, stable operation from the relatively low frequencies through the higher frequencies in the microwave regions.

These transmission-line cables should not be confused with low-frequency cables with conductive sheaths (usually copper braid), which are used in applications where shielding of the centre conductors from the surrounding electrical ambient is required. The interconnection of those shielded cables is covered in ECSS-Q-70-08.

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Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revisions of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the publication referred to applies.

ECSS-P-001	Glossary of terms
ECSS-Q-20	Space product assurance — Quality assurance
ECSS-Q-20-09	Space product assurance — Nonconformance control system
ECSS-Q-60	Space product assurance — Electrical, electronic and electromechanical (EEE) components
ECSS-Q-70	Space product assurance — Materials, mechanical parts and processes
ECSS-Q-70-01 ¹⁾	Space product assurance — Contamination and cleanliness control
ECSS-Q-70-02	Space product assurance — Thermal vacuum outgassing test for the screening of space materials
ECSS-Q-70-08	Space product assurance — The manual soldering of high-reliability electrical connections
ECSS-Q-70-26	Space product assurance — Crimping of high-reliability electrical connections
ECSS-Q-70-28 ¹⁾	Space product assurance — Repair and modification of printed-circuit board assemblies
ECSS-Q-70-71 ¹⁾	Space product assurance — Data for selection of space materials
MIL-C-17G(3) SUP1	General specification for cables, radio frequency, flexible and semi-rigid. (8 Jan 1996)

1) To be published.

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Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purpose of this Standard, the terms and definitions given in ECSS-P-001 apply.

3.2 Abbreviated terms

The following abbreviated terms are defined and used within this Standard:

Abbreviation	Meaning
FEP	fluorinated ethylene propylene
PCB	printed circuit board
PTFE	polytetrafluoroethylene
r.m.s.	root-mean-square
VSWR	voltage standing wave ratio

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Principles and prerequisites of reliable soldered or crimped cable connections

4.1 Principles of reliable soldered or crimped semi-rigid cable connections

- a. Reliable soldered or crimped connections result from proper design, control of tools, materials and work environments and careful workmanship.
- b. The basic design concepts, adherence to which ensures reliable connections and prevents joint failure, are:
 - Avoidance of dimensional mismatch between the coaxial-cable assembly and the units being connected; i.e. not forcing the semi-rigid cable assembly into position and thereby cracking or pre-stressing one of the joints.
 - Use of cable-end connectors with retractable (non-captive) coupling nuts; after completion of mounting, the coaxial-cable assembly is not in a state of tension resulting from axial movement when the connectors are threaded together.
 - Minimizing the internal stresses on the soldered or crimped connections resulting from exposure to thermal cycling.

NOTE The thermal coefficient of expansion of the dielectric is about ten (10) times that of copper and in service this can introduce a tensile stress on the joint.

- The various assembly and mounting processes are covered by quality-control inspection steps.

4.2 Prerequisites for assembly and mounting of semi-rigid coaxial cables

- a. Each contractor shall maintain documented soldering or crimping programmes which meet the requirements of this Standard for the types of connections employed and the articles involved. The programmes include procedures for training, certification, maintenance of certified status, recertification and revocation of certified status for soldering, crimping and inspection personnel. The contractor also prepares and has readily available workmanship standards consisting of satisfactory work samples or visual

- aids which clearly illustrate the quality characteristics for all connections involved, including the applicable illustrations in annex A of this Standard.
- b. Records are kept to provide identification between the finished product and the operator. Records are also maintained of the training, testing and certification status of assembly operators. Records are retained for at least one year, or longer if this is a specific requirement of the customer's project.
 - c. Equipment and tools are verified and calibrated periodically for proper operation, and records of tool calibration and verification are maintained (see clause 12).
 - d. For soldering or crimping requirements not covered in this Standard, the contractor submits a process procedure including all pertinent quality requirements to the customer's relevant project office for approval in accordance with ECSS-Q-70.

4.3 Alternative coaxial cable technologies

Alternative coaxial cable technologies are accepted for application in individual customer programmes following the completion of qualification and batch acceptance test programmes in accordance with clause 11. The precise test-programme and results are subject to review and acceptance by the relevant customer programme. For materials used in the alternative technology see ECSS-Q-70-71.

Some mounting requirements for alternative technologies are given in sub-clause 10.3 of this Standard.

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Preparatory conditions

5.1 Facility cleanliness

- a. Unless classified as a cleanroom, the areas in which soldering is carried out shall be maintained in a neat orderly fashion with no loose material (such as dirt, dust, solder particles, oils and clipped wires) that can cause contamination of the soldered connection. Furniture shall be kept to a minimum in the work areas and be arranged to allow easy and thorough cleaning of the floor.
- b. A washroom and eating, drinking and smoking facilities should be located close to, but outside, the soldering areas.
- c. Working surfaces shall be covered with an easily cleaned hard top or have a replaceable surface of clean, non-corrosive silicone-free paper.
- d. Tools used in the soldering operation shall be clean; excess lubricants shall be removed before soldering starts.
- e. Before assembly, wire, terminal and connector contacts shall be visually examined for cleanliness, absence of oil films and freedom from tarnish or corrosion.

5.2 Environmental conditions

The assembly area shall have a controlled environment that limits entry of contamination. The following environmental conditions in the area shall be continuously maintained:

- Room temperature: $(22 \pm 3) ^\circ\text{C}$
- Relative humidity at room temperature shall be $(55 \pm 10) \%$.

The work stations shall not be exposed to draughts. Fresh air shall be supplied to the room through a filtering system and, so that there is a positive pressure difference with respect to adjacent rooms, the exhaust air shall be suitably restricted.

5.3 Lighting requirements

The lighting intensity shall be a minimum of 1 080 lux on the work surface. At least 90 % of the work area shall be shadowless and without severe reflections.

5.4 Equipment and tools

5.4.1 Brushes

Medium-stiff natural- or synthetic-bristle brushes may be used for cleaning, provided that they do not scratch the metal surface to be cleaned or damage adjacent materials beyond their visual inspection requirements. These brushes shall be regularly cleaned in a solvent prescribed in subclause 6.3.

Wire brushes shall not be used.

5.4.2 Files

Files for dressing copper soldering-iron tips and removing burrs from the conductor shall be smooth, single cut, mill type. Files shall not be used on surface-treated tips (e.g. nickel plated) or pretinned items. Files shall be kept in a good condition by regular cleaning.

Files shall not be kept in a cleanroom environment.

5.4.3 Cutting tools

A variety of cutting tools may be used for the preparation of the semi-rigid cable, including

- jeweller's saws (0,28 mm – 0,33 mm blade preferred),
- razor blades (single edged), and
- suitable wire cutters.

The jeweller's saw shall have fine teeth and shall be used together with a cable clamping device such as that shown in Figure 1.

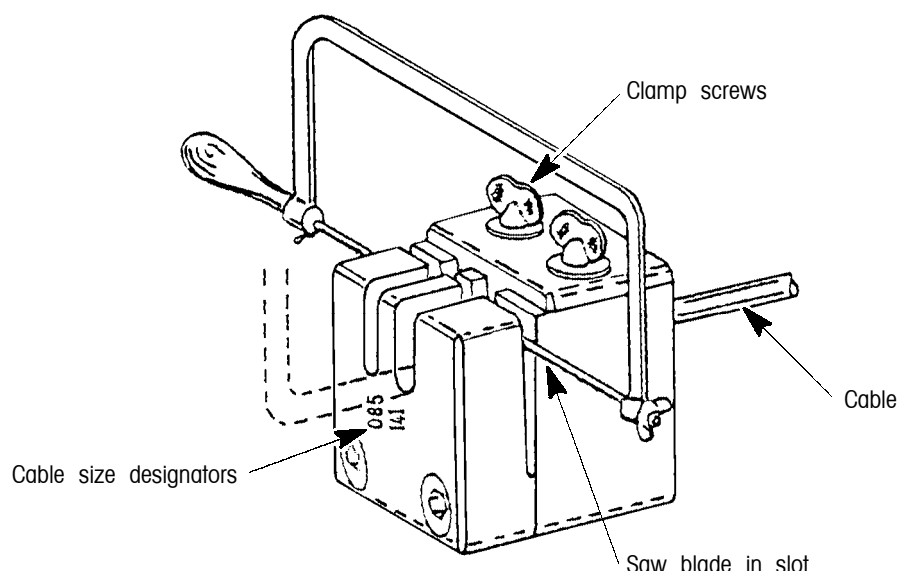


Figure 1: Typical cable cut-off fixture

The dielectric and inner conductor shall be cut with a tool that produces a clean, smooth-cut surface along the entire cutting edge. There shall be no twisting action during this cutting operation.

5.4.4 Cable-forming tools

Bending jigs such as that shown in Figure 2 shall be available to form the cable to predetermined shapes as identified by the contractor's engineering drawing. Roller sizes shall be available for each cable diameter. This equipment shall not introduce dents, nicks, wrinkles or cracks in the cable outer conductor.

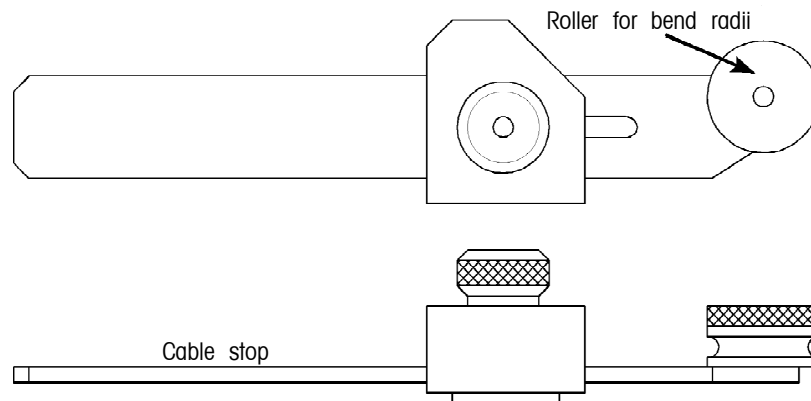


Figure 2: Typical cable-forming tool

5.4.5 Cable stripping and dressing tools

Many pieces of commercially available equipment exist to strip the outer conductor or the dielectric material. These can be automatic, power-driven devices with precision factory-set non-adjustable cutting and stripping dies, or precision hand-type strippers with accurately machined cutting heads. Such tools shall not twist, ring, nick, or score the underlying material surface. They require periodic calibration or sample evaluation during a production run.

5.4.6 Heat-treatment chamber

Thermal cycling cabinets, ovens, refrigeration units or cold chambers shall be capable of maintaining temperatures between $-50\text{ }^{\circ}\text{C}$ and $+90\text{ }^{\circ}\text{C}$; the working zone shall be calibrated to within $\pm 5\text{ }^{\circ}\text{C}$. Under certain circumstances (see Table 2 Step 3) greater temperature extremes may be required.

5.4.7 Soldering equipment

Soldering may be accomplished by hand soldering or by using a resistance heating unit or other appropriate contact heat source that conforms to the requirements of ECSS-Q-70-08A, subclause 5.5. When non-contact heat sources are utilized, the contractor shall set up, operate and demonstrate to the satisfaction of the customer that the particular method and schedule produces joints of an acceptable standard, and this includes verification testing as detailed in clause 11 of this Standard.

5.4.8 Crimping equipment

Manual crimping tools are available; they are custom designed and applicable only for particular connector shells. The settings recommended by the tool manufacturer shall be used as a guide. The tool shall be set up for the cable and connector types by a detailed calibration programme based on the requirements of ECSS-Q-70-26. Verification testing shall be performed as detailed in clause 11 of this Standard.

5.4.9 Assembly equipment, tools and processes for other technologies

The equipment, tools, and processes used for the assembly of the cables and connectors shall be designed to avoid damage or degradation of the cables and connectors. The equipment, tools, and processes can be subject to a manufacturing audit by the customer before application in their programme.

5.4.10 Defective or uncalibrated equipment or tools

Defective or uncalibrated equipment or tools shall be promptly removed from the work areas and replaced.

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Material selection

6.1 Solder

Solder ribbon, wire and preforms may be used, provided that the alloy and flux conform to ECSS-Q-70-08A, clause 6.

The following solder alloys are approved:

- 60 Sn (remainder lead): For degolding operations, coating and pretinning.
- 96 Sn (remainder silver): For making coaxial-cable outer-conductor-to connector solder joint.
- 96 Sn or 63 Sn: For contact-pin soldering and cover soldering of right angle connectors.

Refer also to ECSS-Q-70-08A, Table 1 (Chemical composition of spacecraft solders).

6.2 Flux

Degolding and pretinning operations may be performed with activated fluxes (e.g. either J-STD-004 Type ROL1 or ROH1), but both shall be completely removed immediately after use and before any further soldering operation.

Only pure rosin flux, e.g. J-STD-004 Type ROL0, shall be used for spacecraft assembly work.

6.3 Solvents

The solvents that may be used for the removal of grease, oil, dirt, flux and flux residues shall be non-conductive and non-corrosive, and shall not dissolve or degrade the quality of parts or materials or remove their identification markings. Solvents shall be properly labelled and maintained in a clean and uncontaminated condition. Those showing evidence of contamination or decomposition shall not be used.

Solvents shall not be used in any manner that carries dissolved flux residue onto contact surfaces such as those in switches, potentiometers or connectors.

The following solvents are acceptable when properly used for cleaning and following soldering operations (refer to ECSS-Q-70-08A, clause 11 – Cleaning of PCB assemblies):

- ethyl alcohol, 99,5 % or 95 % pure by volume;

- isopropyl alcohol, best commercial grade, 99 % pure;
- deionized water at 40 °C maximum may be used for certain fluxes; items shall be thoroughly dried after the use of deionized water;
- any mixture of the above.

6.4 Cable selection

The selection of a particular coaxial cable involves consideration of the specific electrical, mechanical and environmental requirements of the project. Semi-rigid cables shall be procured according to the detailed requirements of MIL-C-17G(3) SUP1.

The outer conductor diameter of the semi-rigid cable shall be standardized as either 0,085 or 0,141 inches ($\pm 0,001$ inches) and fabricated from copper, which may be finished with silver plating.

The dielectric material shall be polytetrafluoroethylene (PTFE) or fluorinated ethylene propylene (FEP).

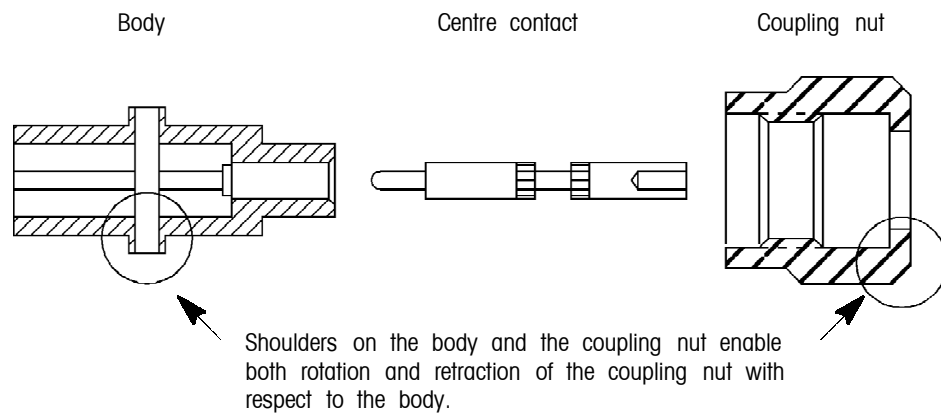
The material composition of the inner conductor shall be selected following a review of the specific project/equipment requirements and with consideration of the proposed connector designs. In general copper is a suitable inner conductor.

6.5 Connector selection

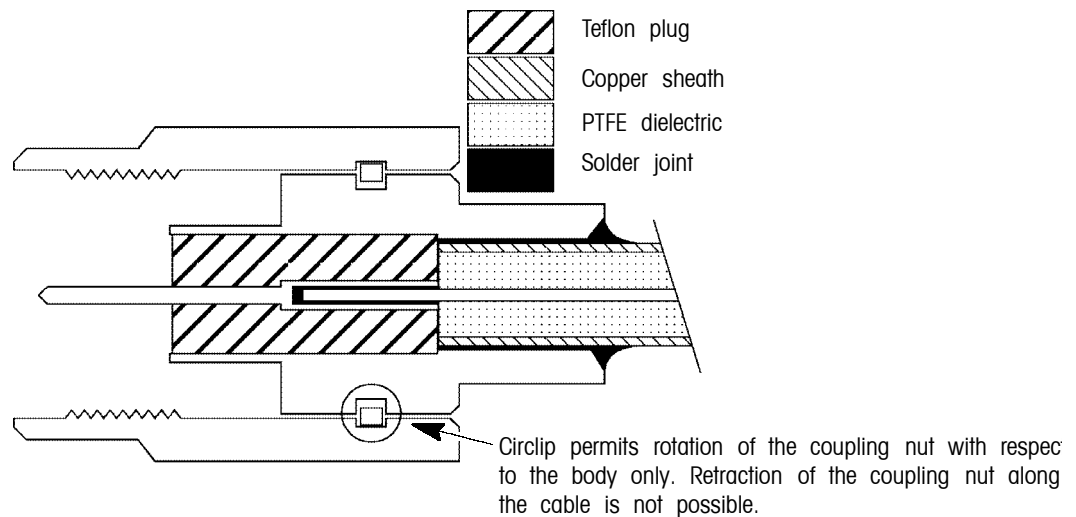
Only approved connectors shall be selected, according to the requirements of ECSS-Q-60, for use in assembling solder-type semi-rigid cables. They may have the form of:

- straight cable-end connector, with a centre contact, and non-captive coupling nut (see Figure 3 for distinction between non-captive and captive coupling nut connectors);
- right angle cable-end connector. The use of these should be minimized and particularly restricted to applications where stress-free mounting of cables with these captive nut connectors can be assured;
- flange-mount male receptacle, either two- or four-hole type.

All non-metallic materials incorporated in the connector shall meet the low-outgassing requirements according to ECSS-Q-70-02A, clause 7. Pure tin or cadmium finishes shall not be used. The use of special connectors for non-solder systems shall be subject to approval by the customer.



a. Approved connector with non-captive coupling nut



b. Non-approved connector with captive coupling nut

Figure 3: Approved and non-approved straight solder-type cable-end connectors

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Preparation of semi-rigid cable

7.1 General

Coaxial cables shall be supplied in the form of straight lengths. The initial preparation is similar for each cable diameter and each connector type and whether joining is by soldering or crimping.

7.2 Inspection of cable

The delivered cable shall be removed from its container and inspected for dents, nicks, wrinkles, blisters and contamination. Such defects shall be cause for rejection.

7.3 Cutting cable to initial oversize length

The total required length of the cable shall be calculated from the engineering drawing, account being taken of bends and angles; then an additional length of approximately 10 mm shall be added to allow for bending, preconditioning and end dressing.

The cable shall be held in a special fixture, such as that illustrated in Figure 1, and cut to the “initial length” using the fine-toothed jeweller’s saw. Do not overtighten the special fixture, as this can cause damage to the cable.

The cut end shall be deburred and examined.

7.4 Cable forming and minimum bend radius

All cables shall be formed to the required shape dimensions before cable preconditioning. A suitable jig (see Figure 2) shall be provided. Only one bending operation shall be performed to form each shape, and no attempt shall be made to reshape a bent cable.

Design rules shall establish minimum bend radii as given in Table 1. This is the inside radius of the bend measured on the outer surface of the cable.

Each finished cable end shall have a minimum straight length of cable to allow for clearance during the assembly and mounting operations. This length shall be greater than 10 mm for 0,085 diameter cable and greater than 20 mm for 0,141 diameter cable.

Extreme care shall be taken in forming the cable to prevent wrinkling or cracking. Bending of the cable shall be by applying a slow, even, continuous pressure.

Table 1: Design rules for minimum bend radius

Cable diameter (inches)	Minimum bend radius (mm)
0,085	3,2
0,141	6,3

7.5 Preconditioning heat treatment

7.5.1 General

The electrical and mechanical performances specified for semi-rigid cables are achieved by a compression fit between the outer conductor and the dielectric core, which, in turn, necessitates manufacturing processes that cause deformation of the core by compression and elongation. The resulting stress that is initially non-uniform tends to equalize by cold flow within a few weeks after the manufacturing and causes withdrawal of the core into the cable. If this occurs in cable that has become part of a cable assembly, the resulting development of an air-gap at the cable/connector interface causes an increase in the voltage standing wave ratio (VSWR). Therefore core stress relief shall be achieved by preconditioning each cable before it becomes a cable assembly.

7.5.2 Heat treatment process

- a. Preconditioning (Table 2) shall be performed on cables that are formed into the required bend configuration.
- b. Preconditioning shall not be performed on a soldered or crimped cable, even if only one lead end is terminated to a connector.
- c. The entire cable shall be placed in the thermal cycling arrangement.
- d. The temperature and its distribution within the heat treatment chamber (see subclause 5.4.6) shall be in calibration.
- e. The rate of change of temperature shall not exceed 2 °C per minute.
- f. Recommendations for dealing with special requirements (e.g. higher operating temperature extremes) should be obtained from cable manufacturers.

Table 2: Preconditioning heat treatment process

Step	Procedure
1	The cable shall be cooled to -45°C and this temperature maintained for at least 1 hour.
2	The cable shall be returned to room temperature and maintained at this temperature for at least 1 hour.
3	The cable shall be heated to the upper temperature and maintained at this temperature for at least 1 hour. The upper temperature shall be at least $+85^{\circ}\text{C}$ for 0,085 inch diameter and 0,141 inch diameter cable. When the equipment or spacecraft qualification temperatures exceed these values, the expected maximum operating temperature shall be used as the upper preconditioning temperature.
4	The cable shall be returned to room temperature. Any protruding core shall be trimmed off flush with the edge of the outer conductor.
5	The cable shall be maintained at room temperature for at least 1 hour.
6	The cable shall be submitted to a minimum of three complete thermal cycles, any dielectric protruding from the end of the cable being trimmed off after each exposure. If trimming of dielectric is necessary after the final cycle, a further cycle shall be performed until a trim-free cycle is achieved. An alternative method is to accurately measure the protrusion after each exposure. When it is recorded that no additional protrusion has taken place, the trimming operation shall be performed at the end of that final thermal cycle.
7	After the last thermal cycle, the cable shall be maintained at room temperature for at least 24 hours before further processing is undertaken.

7.6 Trimming cable to final length

After the preconditioning, the cable form shall be finely adjusted to the tolerance of the engineering drawing. The cable shall be cut to size such that when it is assembled it fits with minimum stress. Cutting shall be performed in accordance with the directions given in subclause 7.3.

7.7 Stripping the cable ends

A variety of tools (see subclause 5.4.5) are suitable for stripping the cable ends, but milling tools should be used. Each stripping operation shall follow written instructions that allow a reproducible process that does not damage the conductor surfaces.

Cutting and milling blades shall be regularly changed.

Burrs shall be removed with the appropriate tool.

7.8 Inspection of stripped cable ends

Each of the stripped ends shall be subject to quality control inspection. There shall be no metal or foreign particles on the face of the dielectric. The outer conductor shall contain no burrs or major surface defects and shall be flush with the dielectric. Unremoved dielectric near the centre conductor not exceeding 0,2 mm is acceptable. The length of the wire inner conductor is dependent on the connector type and shall be specified.

Typical control documentation for cable prior to assembly with SMA connectors having separate pin contacts shall include measurements of the parameters shown in Figure 4.

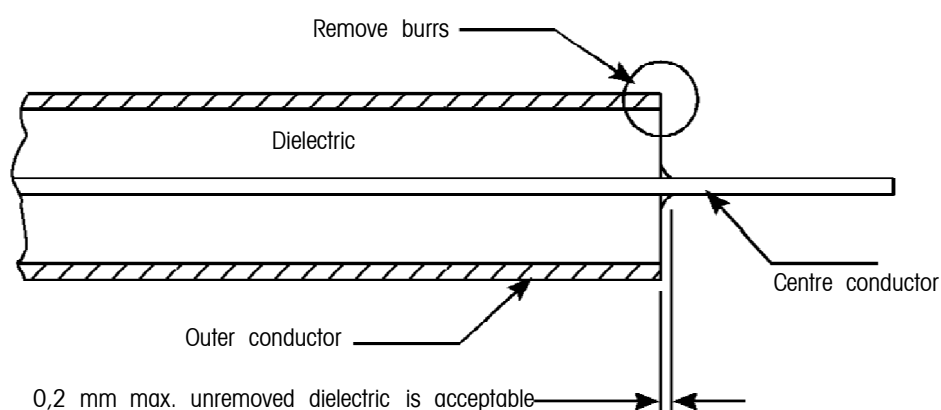


Figure 4: Typical dimensional inspection requirements

Preparation for soldering assembly of semi-rigid cables

8.1 General

Written procedures shall define the various process steps and shall include the following subclauses.

8.2 Degolding and pretinning

Gold shall be removed from all surface areas to be joined by soldering. The central contact pin may be degolded and pretinned with a soldering iron by melting a short length of 63 Sn or 60 Sn solder wire within the cup to dissolve gold plating; the liquid solder can then be wicked-out with stranded wire.

The jointing surface of the connector body shall be degolded and pretinned by fitting the connector to a suitable sized PTFE plug held vertically in a vice. Solder wire can be melted onto the jointing area and removed with the aid of a solder wick. This operation should be repeated at least twice until the solidified pretinned surface has a shiny appearance indicating a gold-free condition.

With the right-angle type of connector, the solder mounting surfaces of the inspection/assembly cover and the corresponding surfaces of the body shall also be degolded and pretinned before assembly.

The cable's outer and inner conductors shall also be pretinned. The cable shall be allowed to cool to room temperature before checking it for possible dielectric protrusion. Any protrusion shall be trimmed with a scalpel blade.

The fit of the pretinned cable in the connector shall be checked.

Activated fluxes should not be used, but they may be utilized for the degolding and pretinning operations. If used they shall be removed immediately after the cable has returned to room temperature. There shall be no dewetting of the solder on the cable conductor or on the connector. All surfaces shall be cleaned with an approved solvent (see subclause 6.3) until they are free from all residual flux and other visible contamination.

NOTE 1 The recommended degolding and pretinning temperatures are 250 °C to 280 °C, and 210 °C to 260 °C, respectively, when using solder immersion.

NOTE 2 Pretinning should be performed just before proceeding with the assembly of the connector on the cable.

8.3 Solder preforms

Some solder preforms with an internal diameter matching the outer diameter of the coaxial cable are available as prefluxed continuous rings. Alternatively, solder preforms may be prepared by winding 96 Sn solder wire around mandrels having the same outer diameter as the coaxial cable (0,085 or 0,141 inches). The diameter of the wire and the number of turns are dependent on the type of connector and shall be predetermined by trials. As many preforms are made as the number of connectors to be soldered. A scalpel blade shall be used to cut solder turns in a direction perpendicular to the wire wrap, as shown in Figure 5. Before use, the preforms shall be thoroughly cleaned with one of the solvent cleaners specified in subclause 6.3

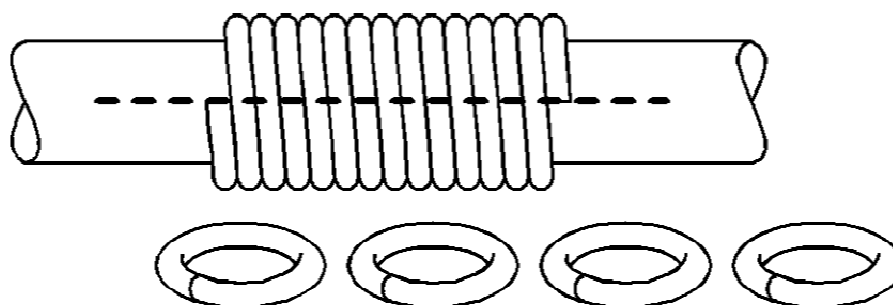


Figure 5: Method of producing solder preforms

Assembly of connectors to RF coaxial cables

9.1 Solder assembly of semi-rigid cables

9.1.1 Straight cable-end connector

9.1.1.1 Centre contact assembly

The centre contact shall be slid onto the prepared centre conductor of the cable with an easy sliding fit. The centre conductor shall be visible across the full diameter of the inspection hole. The gap between the rear/end of the centre contact and the face of the dielectric/outer conductor shall be as specified in the assembly instructions for the type of cable-end connector being used (see Figure 6).

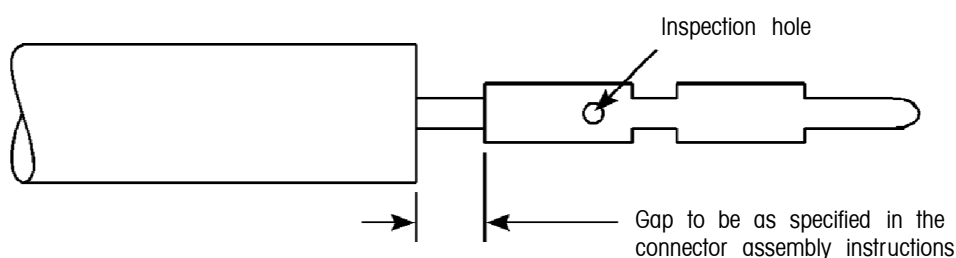


Figure 6: Centre contact assembly

The centre contact shall be soldered to the centre conductor with the solder specified in subclause 6.1 and the equipment specified in subclause 5.4.7. After the solder has solidified and cooled, the joint shall be thoroughly cleaned with one of the solvent cleaners specified in subclause 6.3.

After soldering, the gap between the centre contact and the face of the dielectric/outer conductor shall be rechecked and the solder connection inspected against the following criteria:

- The inspection hole shall be filled with solder.
- The appearance of the solder joint shall satisfy the criteria given in ECSS-Q-70-08A, Figure A-7.
- There shall be no flux or other residues on the cable or the contact.

- d. There shall be no solder spillage or flow onto the mating surfaces of the contact.
- e. Where any solder flow or spillage has occurred on the non-mating outer surfaces of the contact, it shall not cause the effective contact dimensions to exceed those specified for successful connector assembly.

9.1.1.2 Connector-body/cable assembly

The remaining connector parts shall be assembled to the cable in the following sequence:

- a. Slide any cable identification and other sleeves onto the cable in the sequence defined by the cable assembly or layout drawings or specifications.
- b. In the case of a straight cable-end connector, slide the coupling nut onto the cable with the internal thread facing the end of the cable to which the connector is being assembled.
- c. Slide the solder pre-form (if used) onto the cable.
- d. Assemble the body of the connector to the centre contact and the end of the cable. This assembly should be with an easy sliding fit in both cases (centre contact and pretinned outer conductor fitting).

At this stage the dimensional relationships of the connector body to the centre conductor and the correct full insertion of the cable outer conductor into the connector body should be checked.

The outer conductor of the cable shall be soldered to the body of the connector with the solder specified in subclause 6.1 and the equipment specified in subclause 5.4.7. After the solder has solidified and cooled the joint shall be thoroughly cleaned with one of the solvent cleaners specified in subclause 6.3.

9.1.1.3 Inspection of assembly

After soldering and cleaning, the assembly of the connector to the cable shall be inspected against the following criteria:

- a. The dimensional relationship of the centre contact and body of the connector shall be correct.
- b. The appearance of the outer conductor to connector body solder joint shall satisfy the visual criteria given in ECSS-Q-70-08A, annex A.
- c. There shall be no solder flow or other residues on the cable or connector.
- d. There shall be no solder flow or spillage onto the mating surfaces of the connector or onto the shoulder of the connector body where it interfaces with the coupling nut.
- e. Any other solder flow or spillage onto the body of the connector shall not affect the operation of the coupling nut.
- f. There shall be no solder spillage or other contamination on the coupling nut.

9.1.2 Right angle cable-end connector

The connector shall be assembled to the cable-end according to the following sequence of operations:

- a. After preconditioning (as defined in subclause 7.5), the cable-end shall be cut to the dimensions necessary for correct fitting to the connector as shown in Figure 7. It shall then be degolded and pretinned as defined in subclause 8.2.
- b. Prepare the connector by degolding the bifurcated pin, the seating for the cover and the cover.
- c. The cable shall be inserted into the connector and the assembly (cable and connector) held in a suitable fixture to ensure that the angular relationship between preformed cable and connector is correct. The insertion of the cable

into the connector shall be inspected via the inspection/assembly hole to ensure that it is in conformance with Figure 7.

- d. The solder joint between the inner conductor of the cable and the bifurcated pin of the connector shall be made first, with the aid of a fine soldering iron and the solder defined in subclause 6.1. After the solder has solidified and cooled, the centre-conductor solder joint and the cavity in the connector body shall be thoroughly cleaned with one of the solvent cleaners specified in subclause 6.3. The solder joint shall be inspected to ensure that full insertion of the inner conductor of the cable into the bifurcated pin of the centre conductor of the connector has taken place (see Figure 7) and in order to satisfy the inspection requirements of ECSS-Q-70-08A, clause 12.
- e. The outer conductor of the cable shall now be soldered to the body of the connector with the aid of the solder specified in subclause 6.1 and the equipment specified in subclause 5.4.7. After the solder has solidified and cooled, the joint shall be thoroughly cleaned with one of the solvent cleaners specified in subclause 6.3.
- f. The solder joints between the cable and the connector shall be inspected to ensure that the dimensions of the cable-connector interface still conform to Figure 7 and that the solder joints conform to the inspection requirements of ECSS-Q-70-08A, clause 12.
- g. The cover shall now be assembled to the inspection/assembly hole and the solder joint formed with a soldering iron using the solder specified in subclause 6.1. Extra solder shall not be added during this operation; the joint shall rely on reflowing of the solder applied during the degolding/pretinning operation only. This is to prevent the flow of excess solder into the cavity in the connector body. After the solder has solidified and cooled, the joint shall be thoroughly cleaned with one of the solvent cleaners specified in subclause 6.3.
- h. The cover solder joint shall be inspected with respect to the following criteria:
 - 1. The solder joint shall extend around the complete periphery of the cover.
 - 2. The cover shall be fully inserted into the shoulder of the hole (see Figure 7).
 - 3. The solder joint shall conform to the inspection requirements of ECSS-Q-70-08A, clause 12.

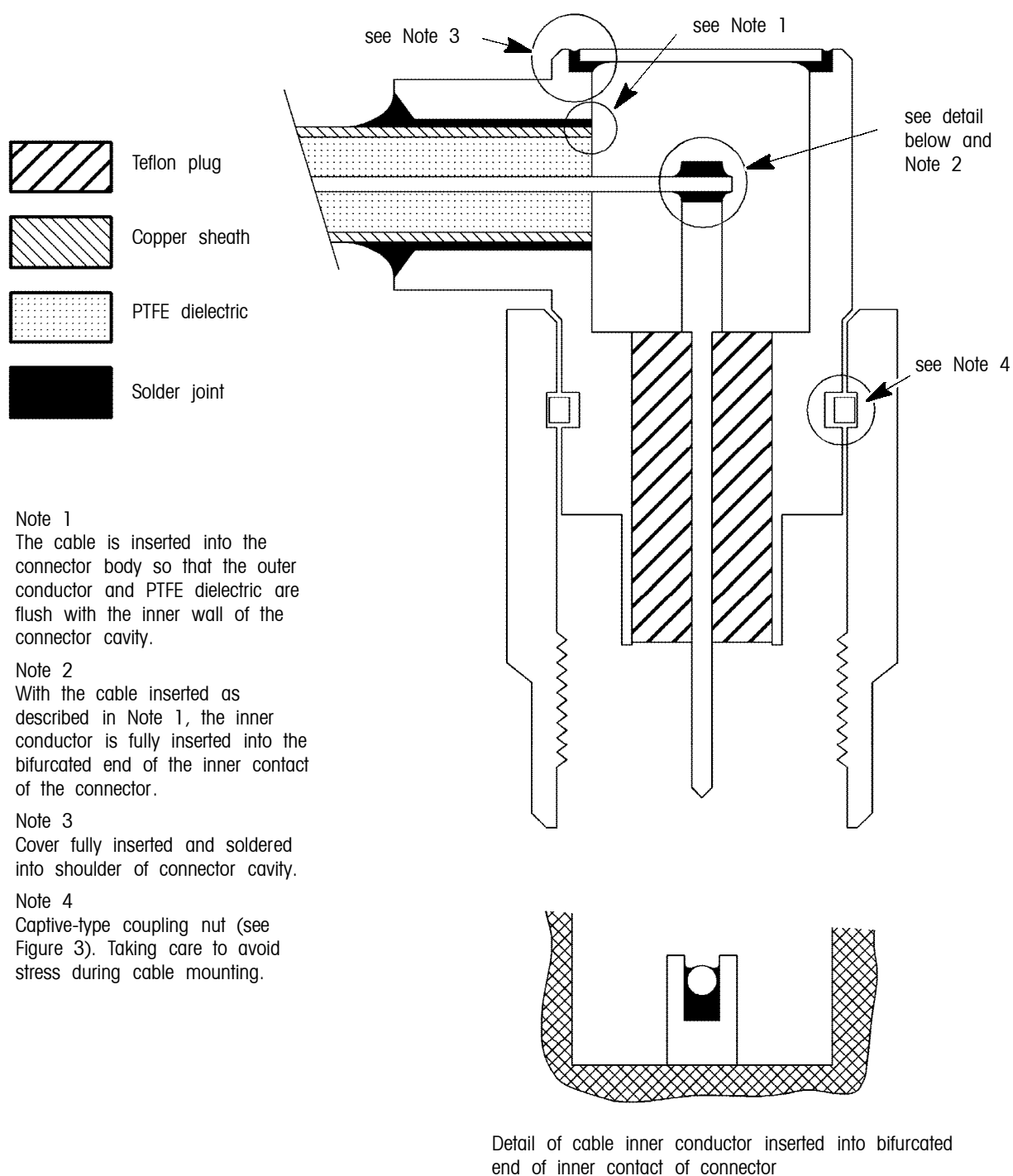


Figure 7: Right angle cable-end connector assembly

9.2 Crimp assembly of semi-rigid cables and other assembly techniques

The connectors and cables shall be assembled in accordance with formally documented and qualified processes and procedures. These processes and procedures shall be subject to formal acceptance by the customer. This acceptance can involve a customer audit of the facilities, processes and procedures used for assembling the cables and connectors. The final stage of assembly shall be a thorough inspection covering dimensional conformance, cleanliness, lack of damage and quality of the assembly techniques used.

9.3 Completed assemblies

When the assembly of the cable and connectors is complete, it shall be inspected to ensure that it is dimensionally correct (i.e. in accordance with the layout drawing or jig) and clean (e.g. free from contaminants, particles and burrs).

The completed and inspected cable assembly shall have protective caps fitted over the connectors. The cable shall be stored in an adequate container inside a sealed bag with an inert atmosphere. The storage packaging shall be adequate to protect the cable against deformation, damage and contamination.

Where the completed cable is transported to the user, an adequate shipping container shall be provided to give the necessary additional protection to the storage packaging.

Where for thermal or other reasons the cable assembly is painted, the paint shall be applied to the outer conductor of the cable only and shall stop at least 5 mm before the joint to the connector (e.g. solder fillet and crimp ferrule ²⁾). The paint used shall conform to the requirements of ECSS-Q-70-02A, clause 7. The connectors shall not be painted.

2) Crimping is covered in ECSS-Q-70-26.

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10

Mounting of cables

10.1 Semi-rigid cables with straight solder-type connectors

The following mounting sequence shall be followed:

- a. The assembled cable shall be removed from its storage packaging only when it is needed for immediate mounting. After removal from the storage packaging, the cable assembly shall be fully inspected before mounting. Ensure that the mating surfaces and screw threads are clean and free from damage.
- b. The connector coupling nuts shall be retracted along the cable until they are at least 1 cm clear of the relevant connector body.
- c. The connector inner contacts shall be inserted into the relevant receptacles in the mating halves and slid home so that the mating faces of the bodies of the mating connectors are in contact. During this operation absolutely no lateral force shall be applied to correct misalignment of the cable-end connectors and the mating connectors. Longitudinal force may only be applied in the case where the connectors mating with the cable are facing each other; the force shall be limited to that required to compress the cable temporarily by the length of one connector inner contact mating face; the cable shall have generous stress relief bends which allow the temporary “compression” to be, in fact, a very slight temporary bending.
- d. At the completion of the connector mating operation, the cable shall be lying without external force, both cable-end connectors having the inner contacts fully inserted and the cable lying in contact with all support points.
- e. The two connector coupling nuts shall now be loosely screwed onto the mating connector bodies and tightened to the specified torque (this shall be as specified for the particular connector, but should be in the range 0,8 Nm to 1,1 Nm). During the nut mating and torquing operations, ensure that no rotation of the cable-end connector body or of the cable takes place.
- f. The cable shall now be secured to its support points (where applicable).
- g. Any cable that cannot be installed according to the procedure described above shall be rejected and a new cable provided to the correct dimensions.

10.2 Semi-rigid cables with right-angle connectors

The following mounting sequence shall be followed:

- a. Unpacking and inspection as defined in subclause 10.1 a. above.
- b. The cable-end connectors shall be aligned with their mating connectors simultaneously and the centre contacts aligned with their mating receptacles. During this operation absolutely no lateral force shall be applied to correct misalignment of the cable-end connectors and the mating connectors.
- c. The connector coupling nuts shall be screwed onto the mating connector bodies until finger-tight, then unscrewed 1/4 turn. In this condition the cable shall be resting in contact with its support points (where applicable), but shall be free to move within the constraint given by the 1/4 turn loosening of the connectors.
- d. The connectors shall now be finger-tightened and torqued to the specified figure for the particular connector (the torque should be in the range 0,8 Nm to 1,1 Nm). During the nut mating and torquing operations, ensure that no rotation of the cable-end connector body or of the cable takes place.

10.3 Other cable mounting technologies

The mounting requirements for other technologies should be defined by the suppliers of the connectors, cables or assemblies. Special attention shall be paid to the following points:

- a. Stress-free mounting of assembled cables to the interfacing connectors shall be used everywhere.
- b. For each technology, the bend-radius constraints for the particular type of cable shall be respected.
- c. The cable-support requirements for the particular type of cable shall be respected. Particularly in the case of flexible cables having an expanded type of dielectric, the cable clamps should be of a carefully designed rigid type that enables any forces resulting from vibration to be distributed over a significant length of the cable. This shall be done to avoid local dielectric crushing and, hence, degradation of electrical performance.

11

Process verification

11.1 General

Verification tests shall be conducted to establish confidence in the reliability of solder-joint configurations and processing methods not shown in this Standard. The configuration is considered verified if no cracked solder joints or part damage is found after 200 thermal cycles in accordance with the test conditions given in subclause 11.2 and when the configuration is examined under 15× minimum magnification. The absence of cracks within the interconnection shall be ascertained by metallography, microsections being made in the longitudinal mid-plane of the assembly.

11.2 Temperature cycling

The test specimen shall be temperature cycled in an air-circulating oven from room temperature to -55 °C to +100 °C and back to room temperature at a rate not exceeding 10 °C per minute. The temperature extremes may be increased to actual spacecraft qualification temperatures if these exceed the range -55 °C to +100 °C. Soak time at each temperature extreme should be 15 minutes. The duration of each cycle should average one hour. These conditions may be modified by the customer to conform with the particular environmental qualification conditions for the assembly being verified.

11.3 Vibration

After completion of the temperature cycling, the test specimen shall be subjected to vibration. The test levels, frequencies and durations shall be derived from the

system requirements, but the severity of the vibration tests shall not be inferior to that shown in Table 3.

Table 3: Minimum severity for vibration testing

Sine vibration	Frequency range	10 Hz - 2000 Hz at 15 g
	Vibration amplitude	(peak to peak) 10 Hz - 70 Hz at 1,5 mm
	Sweep speed	1 octave per minute
	Duration	1 cycle from 10 Hz - 2000 Hz - 10 Hz
Random vibration	Frequency range	20 Hz - 2000 Hz at 15 g (r.m.s.)
	Power spectral density	0,1 g ² /Hz
	Duration	10 minutes per axis

12

Quality assurance

12.1 General

The quality assurance requirements are defined in ECSS-Q-20.

12.2 Data

The quality records (e.g. logbooks) shall be retained for at least ten years, or in accordance with project contract requirements, and contain, as a minimum, the following:

- copy of final inspection documentation;
- nonconformance reports and corrective actions;
- copy of the inspection and test results with reference to the relevant procedure, drawings, personnel, tools, solders, fluxes and solvents utilized.

12.3 Nonconformance

Any nonconformance observed in respect of the soldering process shall be dispositioned in accordance with quality assurance requirements (see ECSS-Q-20-09). If a repair procedure is agreed, it shall be performed in accordance with ECSS-Q-70-28.

12.4 Calibration

Each insulation stripper, soldering iron, piece of measuring equipment and reference standard shall be periodically calibrated. Any suspected or actual equipment failure shall be recorded as a project nonconformance report so that previous results can be examined to ascertain whether or not re-inspection or retesting is required. The final customer shall be notified of the nonconformance details.

12.5 Traceability

Traceability shall be maintained throughout the process from incoming inspection to final test, including details of test equipment and personnel employed in performing the task.

12.6 Workmanship standards

Visual standards consisting of satisfactory work samples or visual aids that clearly illustrate the quality characteristics of all soldered connections involved shall

be prepared and shall be available to each operator and inspector. The illustrations presented in annex A of this Standard, supplemented as necessary, shall be included as examples.

12.7 Inspection

During all stages of the process, the inspection points shall be observed.

12.8 Operator and inspector training and certification

Trained and competent personnel shall be employed for all soldering and crimping operations and inspections. A training programme shall be developed, maintained and implemented to provide for excellence of workmanship and personnel skills and a thorough knowledge of the requirements detailed in this Standard.

Trained personnel performing soldering and crimping operations and inspections shall be certified. This certification shall be based upon objective evidence of quality, resulting from test and inspection of completed joints. Retraining or reassessment of personnel shall apply in cases of repetitive unacceptable quality levels and changes in soldering or assembly techniques, parameters or required skills.

Records shall be maintained of the training and certification status of operators and inspection personnel.

All training shall be performed at a school authorized by the final customer.

Annex A (informative)

Workmanship standards

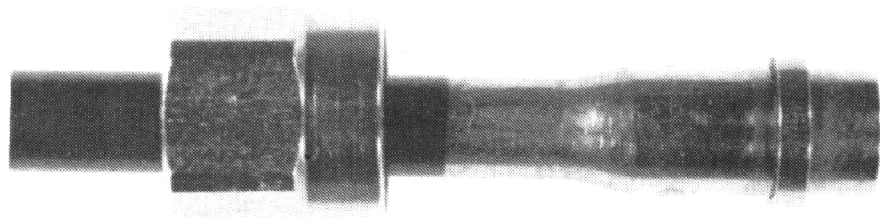


Figure A-1: Photograph showing non-captive nut and preferred solder fillet

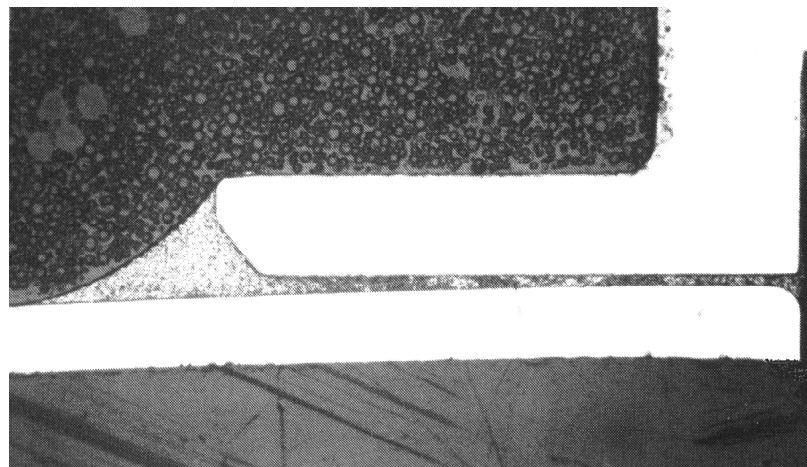


Figure A-2: Microsection through preferred solder fillet, revealing full penetration of solder path

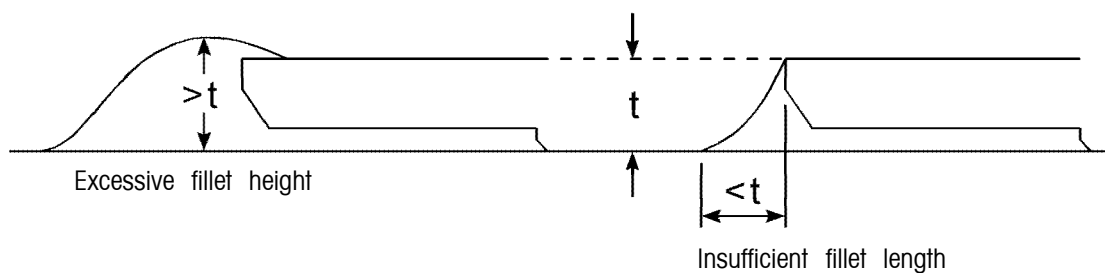


Figure A-3: Unacceptable solder fillet dimensions

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ECSS Document Improvement Proposal		
1. Document I.D. ECSS-Q-70-18A	2. Document date 31 August 2001	3. Document title Preparation, assembly and mounting of RF coaxial cables
4. Recommended improvement (identify clauses, subclauses and include modified text or graphic, attach pages as necessary)		
5. Reason for recommendation		
6. Originator of recommendation		
Name:	Organization:	
Address:	Phone: Fax: e-mail:	7. Date of submission:
8. Send to ECSS Secretariat		
Name: W. Kriedte ESA-TOS/QR	Address: ESTEC, P.O. Box 299 2200 AG Noordwijk The Netherlands	Phone: +31-71-565-3952 Fax: +31-71-565-6839 e-mail: Werner.Kriedte@esa.int

Note: The originator of the submission should complete items 4, 5, 6 and 7.

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