**BOMBARDIER**
Toronto (de Havilland)
**PROPRIETARY INFORMATION**

# PPS 9.12

**PRODUCTION PROCESS STANDARD**

# Soldering of Electrical and Electronic Components to Printed Circuit Boards

Issue 10
- This standard supersedes PPS 9.12, Issue 9.
- Vertical lines in the left hand margin indicate technical changes over the previous issue.
- Direct PPS related questions to PPS.Group@aero.bombardier.com or (416) 375-4365.
- This PPS is effective as of the distribution date.

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|---|---|---|
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| | Quality | |

Signed original on file. Validation of paper prints is the responsibility of the user.

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## 1 Scope

1.1 This standard specifies the procedure and requirements for assembly of electrical and electronic components to pre-fabricated printed circuit boards.

1.1.1 This PPS complements the engineering drawings that specify its use as an authorized instruction. The procedure specified in this PPS must be followed to ensure compliance with all applicable specifications. In general, if this PPS conflicts with the engineering drawing, follow the engineering drawing. The requirements specified in this PPS are necessary to fulfil the engineering design and reliability objectives.

1.1.2 Refer to PPS 13.26 for the subcontractor provisions applicable to this PPS.

1.1.3 Procedure or requirements specified in a Bombardier BAPS, MPS, LES or P. Spec. **do not** supersede the procedure or requirements specified in this PPS.

## 2 Hazardous Materials

2.1 Before receipt at Bombardier Toronto (de Havilland), all materials must be approved and assigned Material Safety Data Sheet (MSDS) numbers by the Bombardier Toronto (de Havilland) Environment, Health and Safety Department. Refer to the manufacturer's MSDS for specific safety data on any of the materials specified in this PPS. If the MSDS is not available, contact the Bombardier Toronto (de Havilland) Environment, Health and Safety Department.

## 3 References

3.1 PPS 9.07 - Soldering of Electrical Terminals.

3.2 PPS 9.14 - Handling Procedures for Static-Sensitive Electronic Devices.

3.3 PPS 9.23 - Receipt Inspection of Printed Circuit Boards.

3.4 PPS 13.13 - Protective Respiratory Equipment.

3.5 PPS 13.26 - General Subcontractor Provisions.

3.6 PPS 13.28 - Storage Life of Adhesives, Sealants, Paints and Composite Products.

3.7 PPS 25.50 - RTV Silicone Adhesives.

3.8 PPS 31.17 - Solvent Usage.

## 4 Materials and Equipment

### 4.1 Materials

4.1.1 Adhesive, non-corrosive silicone RTV to DSC 233-6.

4.1.2 Encapsulating coating, Hysol PC28 or Chase Specialty Coatings Humiseal 1A33.

4.1.3 Solder for soft soldering:

- Solder, 60/40 (tin/lead), rosin flux cored, 0.75 - 1.5 mm diameter (e.g., QQ-S-571 Sn60 Type S or Kester Solder Co. Kester “44”)
- “No clean” flux core solder Sn 63/Pb 37 - Interflux USA Inc. IF 14 solder wire or Kester Solder Co. Kester #245 solder wire.

4.1.4 Flux:

- Non-active, rosin base, liquid flux (e.g., MIL-F-14256 Type R or Kester Flux MIL 1544). Do not use with “No clean” flux core solder.
- “No clean” liquid flux, for use with “No clean” flux core solder only - Interflux USA Inc. IF-2005M or Kester Solder Co. 951 flux.

4.1.5 Heat sink compound, Dow Corning 340.

4.1.6 Epoxy dissolver, Hysol AC4079.

### 4.2 Equipment

4.2.1 Soldering iron, grounded tip, (e.g., Pace Model SX-301). Soldering equipment must be capable of heating the solder joint to the required temperature without damaging leads, circuit board or components.

4.2.2 Soldering tips, 1/16" Screwdriver type, 700°F (371°C) operating temperature (e.g., Weller PTA7).

## 5 Procedure

### 5.1 General

5.1.1 For the purposes of this standard, the term component refers to an electronic component such as an IC chip, resistor, diode, capacitor, LED, etc.

5.1.2 Observe and utilize anti-static protective procedures and equipment as specified in PPS 9.14 wherever handling, assembling, transporting or inspecting components or printed circuit boards. Perform assembly of components to printed circuit boards at static free work stations set-up and maintained according to PPS 9.14.

5.1.3 Solder components onto printed circuit boards according to Flow Chart 1.

### 5.2 Receipt Checks

5.2.1 Check components to be assembled to printed circuit boards, upon receipt, according to PPS 9.14.

5.2.2 Check printed circuit boards, upon receipt, according to PPS 9.23.

### 5.3 Cleaning of the Soldering Area

5.3.1 Prepare the soldering area for cleaning as follows:

Step 1. For leads exhibiting evidence of scale, use a very fine abrasive to remove the scale. Gold plated leads are not susceptible to scale; **do not** under any circumstances use abrasives on gold plated leads as this will remove the plating.

Step 2. Solvent wash the soldering area according to PPS 31.17.

5.3.2 After cleaning, handle printed circuit boards only by the edges or by areas of the board containing no printed circuitry.

### 5.4 Component Lead Forming

5.4.1 Observe the following general rules when forming component leads

- Ensure that the distance between the component body and the commencement of the initial lead bend is at least 1/32" or 2 times the lead diameter, whichever is greater (see Figure 1).
- Ensure that the inside bend radius is at least 1/32" or 2 times the lead diameter, whichever is larger (see Figure 1).
- Take care to avoid making unnecessary bends in wire leads.
- Centre components with axial leads approximately between the initial lead bends with both leads bent in the same radial plane.
- Mount all components assembled to printed circuit boards as specified on the engineering drawing.
- Form component leads using tools which will not damage or mark the leads (e.g., smooth jawed round nose pliers).

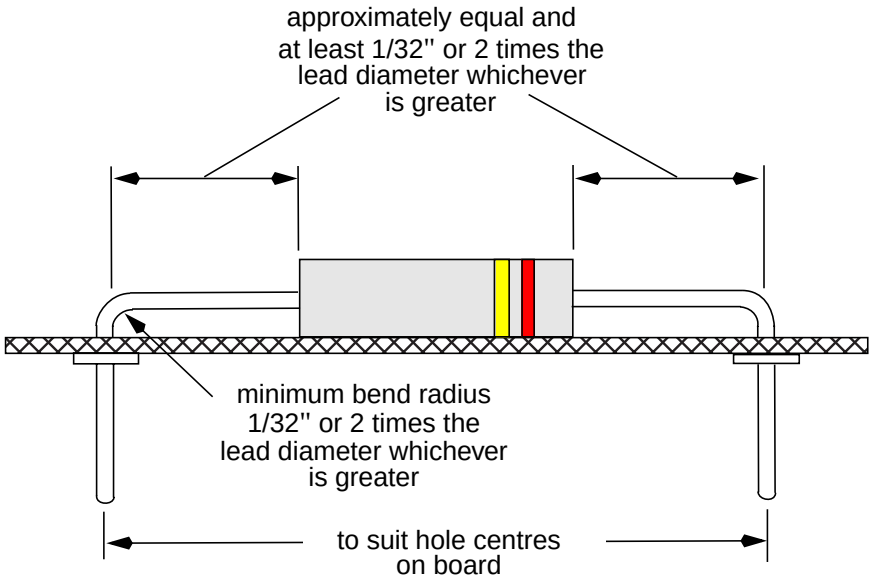


**Figure 1 - Standard Flush Mount**

5.4.2 For standard flush mounting of components with axial leads, bend lead wires 90° on the appropriate hole centres for the particular component location on the printed circuit board (see Figure 1) and ensure that the component body is mounted flush to the board surface within 1/32".

5.4.3 For stand off mounting of resistors with high power ratings, ensure that the resistor stands off the printed circuit board by at least the minimum amount specified on the engineering drawing.

5.4.4 For stress relief mounting of components with axial leads, form the component leads approximately as shown in Figure 2 and mount the component body flush to the board surface within 1/32", approximately centred between the holes.

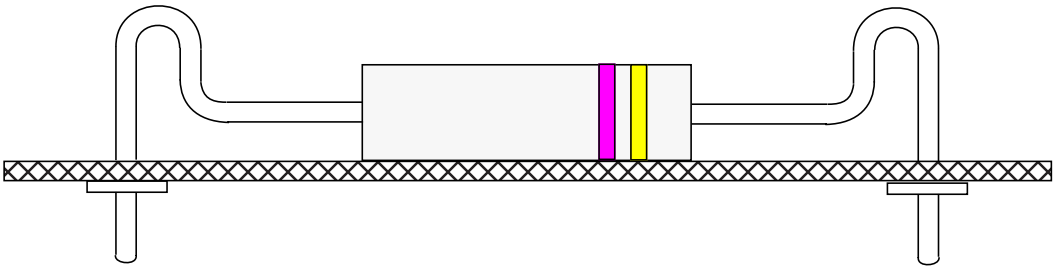

**Figure 2 - Stress Relief Mounting**

5.4.4.1 For side mounting components with axial leads, form the component leads to the configuration shown in Figure 3. Unless otherwise specified on the engineering drawing, ensure side mounting components are flush to the board within 1/32".

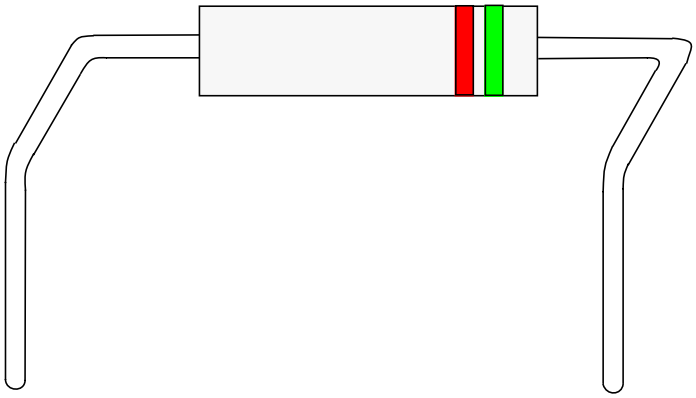

**Figure 3 - Side Mounting**

5.4.4.2 Mount components whose body length exceeds the distance between the mounting holes over the holes and leads approximately as shown in Figure 4. Ensure a clearance between the component body and the leads of at least 1/32".

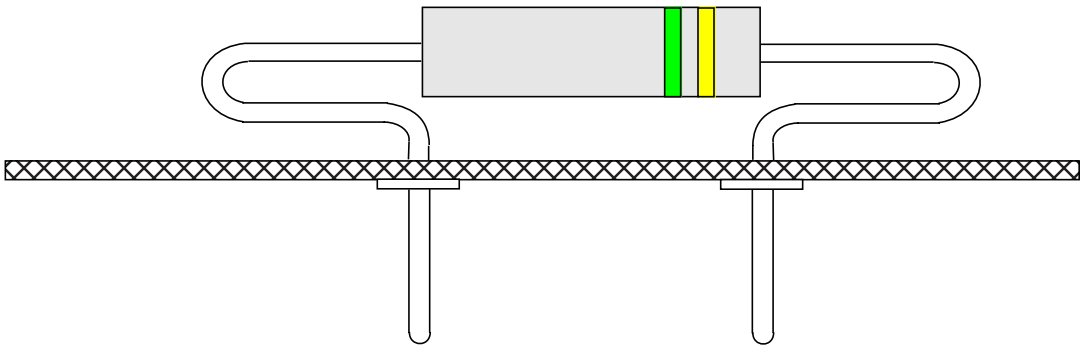

**Figure 4 - Non-Standard Body Mounting**

5.4.5 For stand-off mounting of high power resistors and ceramic, glass or transistor components, unless otherwise specified on the engineering drawing, ensure that the component body will stand-off the board 1/16" - 1/8" (see Figure 5). If flow soldering is being performed, it is permissible to form the component leads such that the component will stand-off the printed circuit board the required distance without mechanical support. Ensure that none of the body material of the component extends into the solder joint. Ceramic or glass bodied components showing evidence of cracks or damage to body material are not acceptable.

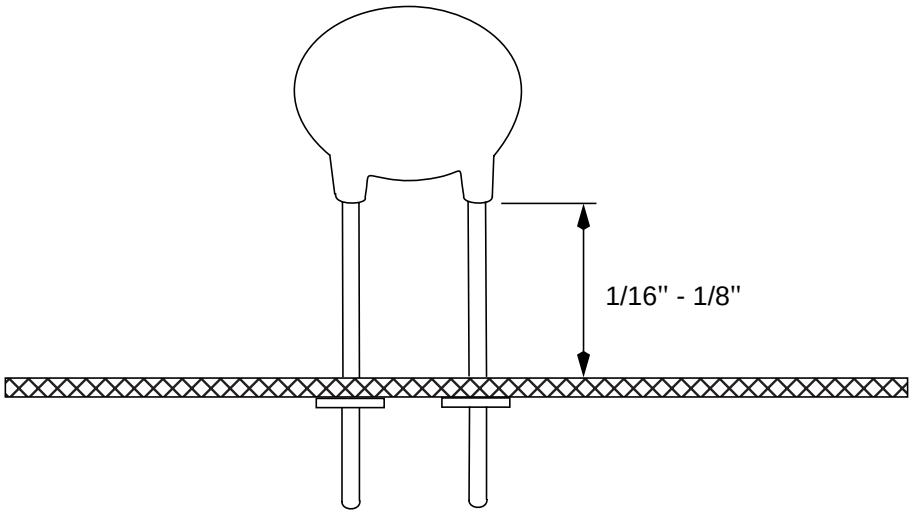


**Figure 5 - Stand-Off Mounting**

### 5.5 Integrated Circuit Component and In-Line Connector Mounting

5.5.1 IC chips are normally supplied in statistically shielded tubes or on conductive foam pads. Remove IC chips from the original package only immediately before assembly onto printed circuit boards.

5.5.2 Mount In-Line connectors flush to the board to within 1/32".

5.5.3 Form rows of component leads by bending each row against a hard, flat surface until the component fits into position easily with each lead centred in its hole.

5.5.4 If specified on the engineering drawing or shop order, fit spreader pads onto relay leads. Press spreader pads fully onto leads and adjust as necessary to maintain leads parallel to one another.

### 5.6 Preparation of Connectors

5.6.1 All connectors, including edge connectors, shall have a shorting strip or plug installed during assembly.

### 5.7 Assembly of Components

5.7.1 Unless otherwise specified on the engineering drawing, all components shall be installed on the “component” side, i.e. screen-printed side of the printed circuit board.

5.7.2 Follow the sequence of component assembly as specified on the shop order. Take care to ensure that polarized components are installed in the correct orientation according to the silk-screen pattern on the board.

5.7.3 Assemble parts which have identification markings to the board such that the identification markings remain visible. If possible, assemble parts which have identification markings to the board so that all identification markings on the board are on the same side.

5.7.4 Take care when handling and inserting IC chips to ensure that leads are not bent and that each lead has properly entered its hole in the printed circuit board. After assembly, semi-clinch each of the corner leads to an angle of approximately 30° from perpendicular to the printed circuit board face.

5.7.5 Do not ream or re-drill component mounting holes on printed circuit boards to facilitate insertion of component leads. If the component leads do not fit into the holes, refer the board to Bombardier Toronto (de Havilland) MRB or Bombardier Toronto (de Havilland) delegated MRB for disposition.

### 5.8 Trimming Leads

5.8.1 Except for IC chip leads, trim leads with flush cutting, diagonal pliers 1/32" - 3/32" from the face of the pad after mounting, **before** soldering. Do not trim IC chip leads unless otherwise indicated on the engineering drawing, in which case trim **after** soldering. When trimming take care to avoid damage to the circuit trace.

### 5.9 Heat Sink Compound Application

5.9.1 If specified on the engineering drawing, apply a thin, even layer of heat sink compound (see materials section, paragraph 4.1.5) to the area of the device to be in contact with the printed circuit board.

### 5.10 General Soldering Practices

5.10.1 Apply flux if it is desired to increase the ease of solder flow.

5.10.2 Tin gold plated leads or eyelets before soldering.

5.10.3 Immediately before making each solder connection, wipe the soldering iron tip, with a single motion, on a water dampened sponge to remove the oxide film on the tinned tip. If the soldering iron has not been used in a long while or has been shut off, re-tin the tip by heating the soldering iron to maximum temperature and contacting the tip with resin cored solder until the solder melts and then wipe the tip, with a single motion, on a water dampened sponge.

5.10.4 When soldering, apply the soldering iron to one side of the lead connection so that the tip contacts the solder pad or terminal. Hold the heating time to a minimum in order to prevent damage to components or to the printed circuits; the maximum recommended heating time is 5 seconds.

5.10.5 When soldering, apply the solder on the opposite side of the lead wire from the soldering iron at the lead wire and terminal pad junction. “Paint” the solder onto the solder pad and lead wire junction to form a small concave fillet, on both sides of a double sided board, with a feather edge on all surfaces. On double sided boards, ensure that the fillet on the component side of the board does not extend beyond the beginning of the first bend or contact the component. Apply only sufficient solder to any joint to make a good connection with solder pads on the printed circuit board just covered by the solder joint.

5.10.6 Remove the solder wire from the joint before removing the iron.

5.10.7 Remove the soldering iron from the joint with a wiping motion covering the end of the lead.

5.10.8 Do not disturb connections until solder has completely solidified, with no forced cooling.

5.10.9 Apply a solder plug to all unused interfacial holes. Ensure that the solder of the solder plug wets the complete wall surface of the plated through hole and the area around the hole for a distance of at least 0.005" without leaving the terminal pad area and that the hole is completely filled with solder. Also ensure that the solder protrudes no more than 3/32" from the face of the printed circuit board.

5.10.10 If stranded wire is to be soldered to post terminals or into holes of a printed circuit board, refer to PPS 9.07 for the insulation gap, amount of acceptable wicking and the method of hook-up.

5.10.11 Solder IC chip leads in the sequence shown in Figure 6.

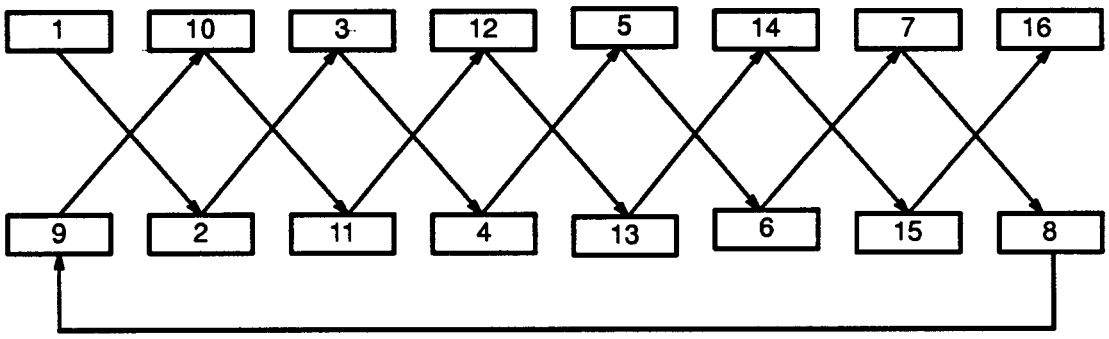


**Figure 6 - Soldering IC Chip Leads**

## 5.11 Bonding

5.11.1 If specified on the engineering drawing, bond components printed circuit boards (after assembly and soldering) with a bead of silicone RTV adhesive (see materials section, paragraph 4.1.1) applied to each side of the component along its length. Refer to PPS 25.50 for the procedure and requirements for handling and applying RTV silicone adhesive. Allow silicone bonded assemblies to cure at room temperature for a minimum of 24 hours before applying encapsulation coating according to section 5.12.

## 5.12 Encapsulation Sealing

5.12.1 Whenever spraying encapsulation coating is specified, hold the aerosol can of encapsulation coating at an angle of 45°, approximately 10" - 12" from the board, and apply the spray in a series of overlapping passes from one side to the other. Shake the can thoroughly before use.

5.12.2 After all assembly operations (including bonding), seal all printed circuit boards on both sides of the board by over spraying all components and solder connections with encapsulation coating as follows:

Step 1. Mask off DIP switches, adjustable controls (e.g. trim pots), connector pins, heat sink areas and ejector contact areas using masking tape.

Step 2. Mask off edge card connector fingers using plastic shunt strips and masking tape.

Step 3. Place the printed circuit board inside the fume extraction booth with the component side **down**.

Step 4. Ground the printed circuit board by means of an alligator clip attached to the board on an edge containing no printed circuitry.

Step 5. Apply a uniform coat of encapsulation coating to the solder connection side of the board according to paragraph 5.12.1.

Step 6. Allow the board to remain in the grounded fume extraction booth, with the fan running, for at least 30 minutes following the application of the encapsulation coating to allow the solvents to flash off.

Step 7. Place the printed circuit board in an ESD protective container and allow the encapsulation coating to air dry at room temperature for a minimum of 3 1/2 hours.

Step 8. Place the printed circuit board, component side **up**, inside the fume extraction booth.

Step 9. Ground the printed circuit board by means of an alligator clip attached to the board on an edge containing no printed circuitry.

Step 10. Apply a thin uniform coat of encapsulation coating to the components and surface of the component side of the board according to paragraph 5.12.1.

Step 11. Rotate the board 90° and apply a 2$^{nd}$ encapsulation coat to the component side of the board and components according to paragraph 5.12.1.

Step 12. Rotate the board 90° and apply a 3$^{rd}$ encapsulation coat to the component side of the board and components according to paragraph 5.12.1.

Step 13. Rotate the board 90° and apply a 4$^{th}$ encapsulation coat to the component side of the board and components according to paragraph 5.12.1.

Step 14. Allow the board to remain in the fume extraction booth, with the fan running, for at least 30 minutes to allow the solvents to flash off.

Step 15. Place the printed circuit board in an ESD protective container and allow the encapsulation coating to cure at room temperature for a minimum of 24 hours, before further handling.

## 5.13 Final Assembly

5.13.1 Once the encapsulation coat has cured remove all masking and complete the assembly as specified on the shop order. Ensure that all trace of residual adhesive is removed from all areas if masking tape was used to mask off components.

### 5.14 Repair

5.14.1 If repair to an encapsulation coated printed circuit board is required, perform the repair as follows:

Step 1. Apply epoxy dissolver to the area to be stripped of encapsulation coating with a cotton swab and carefully work the dissolver in, adding more dissolver as necessary, until the encapsulation coating has evaporated in the affected area. Take care to avoid the use of excessive force which may damage the board.

Step 2. Solvent clean the area thoroughly according to PPS 31.17.

Step 3. Using a vacuum de-soldering tool, melt the solder at the appropriate lead wire solder pad and remove the solder from the connection using a de-soldering tool.

Step 4. Re-solder components to the board as necessary according to section 5.10.

Step 5. Locally touch up encapsulation coating on both sides of the board such that the coating is coherent over the entire board surface.

## 6 Requirements

### 6.1 Visual Examination of Soldered Assemblies

6.1.1 The wiring location and polarization of components positioned on the printed circuit board shall be according to the engineering drawing.

6.1.2 Unless otherwise specified herein or on the engineering drawing, the component bodies of resistors, capacitors, diodes, etc., shall have been positioned neatly flush to the board surface to within 1/32" and approximately centred between the holes.

6.1.3 Transistor cans and ceramic or glass bodied components shall stand off the surface of the printed circuit board 1/16" - 1/8".

6.1.4 Resistors with high power ratings shall stand off the printed circuit board as specified on the engineering drawing.

6.1.5 Identification markings on resistors, capacitors, diodes, etc., must be visible in their assembled position.

6.1.6 If specified on the engineering drawing, components shall have been bonded to the printed circuit board according to section 5.11.

6.1.7 Except for IC chip leads, all leads shall be trimmed 1/32" - 3/32" from the face of the terminal pad. IC chip leads shall not have been trimmed unless otherwise noted on the engineering drawing.

6.1.8 Body material of ceramic or glass bodied components shall not have been included in the lead solder joint.

6.1.9 Component lead lengths, minimum bend radii, lead protrusions through circuit boards, etc. must be as specified herein or on the engineering drawing.

6.1.10 Acceptable solder joints will have a shiny surface and show a wetting action on all surfaces in the solder joint. Solder joints showing evidence of any of the defects described in Table 1 are not acceptable.

**Table 1 - Solder Defects**

| DEFECT | DESCRIPTION | USUAL CAUSE | REMEDIAL ACTION |
|---|---|---|---|
| cold solder joint | • dull and crystalline appearance<br>• solder appears piled or stacked up | • under heated joint<br>• disturbed joint (during cooling) | • increase heat or dwell time<br>• do not handle during cooling cycle |
| dewetting | • solder appears dull and depleted | • produced when molten solder contacts the metal surface, leaving only a thin film of solder on it. | • reduce dwell time<br>• ensure components, board and tools are clean before soldering |
| disturbed solder | • dull, porous and crystalline appearance<br>• solder contains cracks and fractures | • handling shock during cooling cycle<br>• movement between lead and terminal pad during soldering operation | • do not handle during cooling cycle |
| excessive solder | • contour of conductor is completely obscured by solder<br>• solder over flows beyond the confines of the area being soldered (i.e., off the pad) | • excess solder applied to the joint<br>• insufficient heat applied, allowing solder to solidify too rapidly | • apply less solder<br>• increase heat or dwell time |
| fractured solder joint | • solder has cracked or broken down between the joint elements | • mechanical stresses during the cooling cycle<br>• thermal stresses during the cooling cycle | • do not handle during the cooling cycle<br>• allow joint to cool without forced cooling such as fanning or blowing |
| foreign inclusions | • foreign matter contained within the solder joint | • inadequate cleaning of solder joint of soldering iron tip before soldering | • ensure surfaces to be soldered are clean<br>• ensure soldering iron tip is clean |
| insufficient solder | • leads show exposed base metal | • insufficient solder applied to the joint | • apply more solder |
| insufficient solder fillet | • incomplete solder fillet between the terminal pad and the conductor | • excessive heat or dwell time<br>• insufficient solder | • reduce heat or dwell time<br>• apply more solder |
| insufficient solder plug | • solder does not completely wet the plated through wall surface or adjacent circuit area | • excessive heat or dwell time<br>• insufficient solder<br>• physical shock during cooling cycle | • reduce heat or dwell time<br>• apply more solder<br>• do not handle during the cooling cycle |

**Table 1 - Solder Defects**

| DEFECT | DESCRIPTION | USUAL CAUSE | REMEDIAL ACTION |
|---|---|---|---|
| non-wetting | • areas of the joint exhibit the original, bare, un-coated base metal | • produced when molten solder contacts the metal surface but has none of the solder adhere to it | • ensure elements to be soldered are clean |
| over heated solder | • chalky, dull or crystalline appearance<br>• shows evidence of coarse grain porosity or pitting | • excessive heat or dwell time<br>• excessive solder | • reduce heat or dwell time<br>• apply less solder |
| pin holes | • small holes occurring as imperfections which penetrate entirely through the solder to the base material | • contaminates and oxides on the surface<br>• failure of the flux to clean surface<br>• dirty soldering iron tip | • ensure surfaces to be soldered are clean<br>• ensure soldering iron tip is clean |
| pits | • small holes occurring as imperfections in the surface of the solder which do not penetrate entirely through the surface of the solder to the base metal | • contaminates and oxides on the surface<br>• flux and oxidation on the solder surface<br>• too rapid cooling | • ensure soldering iron tip is clean<br>• ensure surfaces to be soldered are clean<br>• allow joint to cool without forced cooling such as fanning or blowing |
| rosin or flux joint | • evidence of rosin entrapped within the joint | • under heated joint (flux not heated sufficiently to produce cleaning action) | • ensure that the joint elements are heated sufficiently to melt and flow the solder freely (flux will activate just before solder flow)<br>• ensure that all raw flux is removed from the completed joint |
| solder fall out | • failure of solder to remain and solidify in plated through holes with component leads installed | • excessive heat or dwell time<br>• physical shock during cooling cycle | • reduce heat or dwell time<br>• do not handle during cooling cycle |
| solder projections | • icicles, spikes, bridges, etc. | • insufficient heat causing solder to “follow tip” when removed from the joint<br>• insufficient dwell time, solder elements are not hot enough to flow solder properly<br>• excessive solder applied | • ensure that the soldering iron and tip are big enough to apply enough heat to flow solder properly<br>• ensure surfaces to be soldered are hot enough to flow solder properly before applying solder<br>• apply only enough solder to wet and bond the joint |

### 6.2 Visual Examination of Finished Assemblies

6.2.1 The finished printed circuit board assembly shall be complete to the engineering drawing.

6.2.2 Except for ejectors, connector pins, heat sink areas, edge card connector fingers or DIP switch rockers, all components and solder connections shall be covered with a uniform, coherent encapsulation coating. Encapsulation coating shall not be applied to ejectors, connector pins, heat sink areas, edge card connector fingers or DIP switch rockers.

6.2.3 The printed circuit board trace shall be free from scratches, breaks or discontinuities.

6.2.4 There shall be no evidence of pad or trace lifting.

6.2.5 There shall be no evidence of residual flux or other contamination on the circuit board or components.

6.2.6 There shall be no evidence of residual adhesive from masking tape used to mask off components during encapsulation coating.

### 6.3 Testing

6.3.1 If specified on the engineering drawing or shop order, test printed circuit boards on completion of assembly.

## 7 Safety Precautions

**7.1 Observe general shop safety precautions when performing the procedure specified herein.**

**7.2 Take care when soldering to ensure that personnel are not accidentally burned by the hot iron.**

**7.3 Place hot soldering irons in the holder provided when not in use.**

**7.4 Eating, drinking and smoking are not permitted in soldering areas.**

**7.5 Encapsulation coating and solvents specified herein are flammable and shall be kept away from fire or other sources of ignition.**

**7.6 Wear rubber gloves and splash goggles when applying encapsulating coating onto printed circuit boards.**

**7.7 Perform all spraying or removal of encapsulation coating on printed circuit boards within a fume extraction booth.**

**7.8 Wear suitable protective respiratory equipment as specified in PPS 13.13 when spraying encapsulation coating onto printed circuit boards.**

**7.9 Store encapsulation coating according to the precautions necessary for flammable materials.**

**7.10 Store aerosol cans of encapsulation coating at a temperature of 60°F - 90°F (16°C - 32°C).**

## 8 Personnel Requirements

8.1 Personnel must have a good working knowledge of the applicable procedure and requirements as specified herein and must have exhibited their competency to their supervisor.

## 9 Storage of Encapsulating Coating Materials and Heat Sink Compound

9.1 Refer to PPS 13.28 for the storage requirements for encapsulating coating (ref. paragraph 4.1.2) and heat sink compound (ref. paragraph 4.1.5).

**Flow Chart 1 - Soldering Procedure**