**SURFACE MOUNT TECHNOLOGY (SMT) GENERAL REQUIREMENTS**

Surface mount technology (SMT) is used to mount electronic components on the metallized surface of printed wiring boards (PWB) or substrates. SMT makes it possible to mount components on one or both sides of the printed wiring assembly (PWA), producing more reliable electronic assemblies at greatly reduced weight, volume, and cost.

**PREFERRED**

The solder joint surface is smooth, nonporous, undisturbed, with a finish varying from satin to bright. The fillet completely wets all elements to the periphery of the connection and is concave.

NASA-STD-8739.2 [12.8.1]

**ACCEPTABLE CHIP-OUTS (NICKS)**

Chip-outs (nicks) of the top surface (adhesive coating), less than 0.25mm from the component edge, are acceptable. Chips in the component body, element area, or termination area are unacceptable.

NASA-STD-8739.2 [8.7.4.b], [12.8.2]

**UNACCEPTABLE CHIP-OUTS (NICKS)**

The use of chip-scale parts with chips in the component body or termination area, and any resistive elements with chip outs, is prohibited.

NASA-STD-8739.2 [12.8.2.a.3]

**ACCEPTABLE SMOOTH TOOL IMPRESSION MARKS**

Smooth tool impression marks (slight cuts, nicks, scratches or scrapes) on the conductor surface, which do not expose base metal or reduce cross-sectional area are acceptable.

NASA-STD-8739.2 [12.8.2.a.4]

**UNACCEPTABLE ADHESIVE INCLUSION**

Adhesive material in the solder joint shall be cause for rejection.

NASA-STD-8739.2 [8.10.3], [12.8.2.b.9]

**UNACCEPTABLE BLOWHOLE**

Blowholes are typically caused by trapped gases or flux during the formation of the solder fillet, and are unacceptable.

NASA-STD-8739.2 [12.8.2.b.5]

**ACCEPTABLE TILT**

Part tilt shall not exceed 25% of component height (H) or diameter (i.e.: MELFs), and shall not interfere with the proper placement of adjacent parts.

Best Workmanship Practice

**UNACCEPTABLE EXCESS TILT**

Excessive tilting of a component may impact the long-term reliability and integrity of the solder termination, and may interfere with the proper placement and thermal profile of adjacent parts.

Best Workmanship Practice
**UNACCEPTABLE BRIDGING**
Bridging is an indicator of poor process controls (i.e., excess solder, smeared paste, improper placement, incorrect heat).

NASA-STD-8739.2 [12.8.2.c.4]

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**UNACCEPTABLE CHARRING**
Charring of components and/or laminate is an indicator of poor process control (i.e., excessive heat).

NASA-STD-8739.2 [12.8.2.a.3]

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**UNACCEPTABLE COLD SOLDER JOINT**
A cold solder joint is an indicator of incorrect process control (i.e., inadequate heat).

NASA-STD-8739.2 [12.8.2.b.1]

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**UNACCEPTABLE CONTAMINATION**
Contamination is a reliability concern. Residual flux and other contaminants can lead to corrosion and circuit failure.

NASA-STD-8739.2 [12.8.2.b.9]

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**UNACCEPTABLE COPLANARITY**
Improper coplanarity of leaded parts will result in bridging, shorts, and misalignment. Parts shall be reworked prior to installation.

NASA-STD-8739.2 [7.1]

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**UNACCEPTABLE CRACKS (COMPONENT)**
Cracks (especially in ceramic components) are an indicator of poor process control (i.e., improper preheat, thermal/mechanical shock, etc.).

NASA-STD-8739.2 [12.8.2.a.3]

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**UNACCEPTABLE EXPOSED BASE METAL**
Exposed base metal on the vertical edges of circuit traces, lands, and pads is acceptable.

NASA-STD-8739.2 [12.8.2.c.5]

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**UNACCEPTABLE EXPOSED BASE METAL**
Exposed base metal is prohibited, except for the vertical edges of circuit traces, lands, and pads.

NASA-STD-8739.2 [12.8.2.c.5]

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**ACCEPTABLE NONUNIFORM / UNEVEN FLOW / REFLOW**
A solder filet exhibiting a nonuniform/uneven flow line is acceptable, provided there is evidence of good wetting.

NASA-STD-8739.2 [12.8.1.g]

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**ACCEPTABLE MEASLING**
Whitish, discrete spots or crosses below the laminate surface - usually induced by thermal shock/stress. Measling that bridges uncommon conductors is unacceptable.

NASA-STD-8739.2 [12.8.2.c.3]

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**ACCEPTABLE MEASLING**
Measling that bridges uncommon conductors is unacceptable.

NASA-STD-8739.2 [12.8.2.c.3]

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**UNACCEPTABLE NONUNIFORM / UNEVEN FLOW / REFLOW**
The uneven flow/reflow of solder is typically caused by an inadequate/uneven application of heat. The condition is acceptable if good wetting is evident.

NASA-STD-8739.2 [12.8.1.g], [12.8.2.b.4]

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**UNACCEPTABLE CHARRING**
Charring of components and/or laminate is an indicator of poor process control (i.e., excessive heat).

NASA-STD-8739.2 [12.8.2.a.3]

---

**UNACCEPTABLE CRACKS (COMPONENT)**
Cracks (especially in ceramic components) are an indicator of poor process control (i.e., improper preheat, thermal/mechanical shock, etc.).

NASA-STD-8739.2 [12.8.2.a.3]
Dewetting is an indicator of poor process control (i.e., excessive heat dwell following reflow).

NASA-STD-8739.2 [12.8.2.b.10]

Parts with damaged seals shall not be used.

NASA-STD-8739.2 [12.7.2.b]

Dewetting is an indicator of poor process control (i.e., excessive heat dwell following reflow).

NASA-STD-8739.2 [12.8.2.b.10]

Parts shall be mounted with the identification markings visible.

NASA-STD-8739.2 [8.7.4.a], [12.6.3.1]

Leads shall not exhibit spacing separation in excess of 0.26mm (0.010 inch) above the solder land.

NASA-STD-8739.2 [12.6.2.a.10]

A disturbed solder joint is an indicator of improper process control.

NASA-STD-8739.2 [12.8.2.b.3]

Tinned surfaces shall exhibit at least 95% coverage.

NASA-STD-8739.2 [7.2], [12.8.2.a.1]

Cracks or fractures in the solder fillet are an indication of mechanical / thermal shock, or temperature coefficient mismatch.

NASA-STD-8739.2 [12.8.2.b.3]

Gold intermetallic can severely embrittle a solder joint.

NASA-STD-8739.2 [12.8.2.b.22]

Gold plated surfaces that will become a part of the finished solder connection shall be tinned prior to soldering to remove the gold plating.

NASA-STD-8739.2 [7.2.1.b]

Burns that physically damage the laminate surface or the assembly are not allowed. Slight discoloration is allowable.

NASA-STD-8739.2 [12.8.2.c.2]

Cracks in the laminate are a reliability concern and are a cause for rejection.

Best Workmanship Practice

Cracks or fractures in the solder fillet are an indication of mechanical / thermal shock, or temperature coefficient mismatch.

NASA-STD-8739.2 [12.8.2.b.3]

Gold intermetallic can severely embrittle a solder joint.

NASA-STD-8739.2 [12.8.2.b.22]

Gold plated surfaces that will become a part of the finished solder connection shall be tinned prior to soldering to remove the gold plating.

NASA-STD-8739.2 [7.2.1.b]
### NASA WORKMANSHIP STANDARDS

**SURFACE MOUNT TECHNOLOGY (SMT) GENERAL REQUIREMENTS (cont.)**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td><strong>UNACCEPTABLE INSUFFICIENT SOLDER</strong>&lt;br&gt;Insufficient solder is an indicator of improper process control, and may result in reduced reliability. In this example, there is no side or heel fillet.</td>
<td>NASA-STD-8739.2 [ 12.8.2.b.6 ]</td>
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<tr>
<td><strong>UNACCEPTABLE LEACHING</strong>&lt;br&gt;Parts exhibiting leaching or loss of metalization in the termination area shall be rejected.</td>
<td>NASA-STD-8739.2 [ 12.8.1.b.6 ]</td>
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<td><strong>UNACCEPTABLE LEADS USED AS TERMINALS</strong>&lt;br&gt;Part leads shall not be used as terminals, except when the part lead is used as a terminal.</td>
<td>NASA STD-8739.2 [ 12.8.2.a.9 ]</td>
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<td><strong>UNACCEPTABLE LIFTED PAD / TRACE</strong>&lt;br&gt;Termination pads or traces exhibiting separation from the substrate shall be cause for rejection.</td>
<td>NASA-STD-8739.2 [ 12.8.2.c.1 ], [ 12.8.2.c.9 ]</td>
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<td><strong>UNACCEPTABLE MENISCUS CONTACT</strong>&lt;br&gt;Parts exhibiting contact with, or embedment of, the meniscus and the solder joint, shall be rejected.</td>
<td>NASA-STD-8739.2 [ 12.8.2.b.12 ]</td>
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<tr>
<td><strong>UNACCEPTABLE NICKS</strong>&lt;br&gt;The use of parts with nicks in the component body or termination area is prohibited.</td>
<td>NASA-STD-8739.2 [ 12.6.3.2 ], [ 12.8.2.a.3 ]</td>
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<td><strong>UNACCEPTABLE MENISCUS CONTACT</strong>&lt;br&gt;Excessive bow or twist may inhibit proper mounting and may result in mechanical interference or shorting to adjacent assemblies or chassis.</td>
<td>Best Workmanship Practice</td>
<td></td>
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<td><strong>UNACCEPTABLE MENISCUS CONTACT</strong>&lt;br&gt;The unprotected exposure of die or circuit elements is not allowed unless specified in the engineering documentation.</td>
<td>NASA-STD-8739.2 [ 8.8.2 ]</td>
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<td><strong>UNACCEPTABLE EXCESS SOLDER</strong>&lt;br&gt;The solder fillet shall exhibit a positive wetting angle and shall not contact the component body.</td>
<td>NASA-STD-8739.2 [ 12.8.2.b.12 ]</td>
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<td><strong>UNACCEPTABLE EXCESS SOLDER</strong>&lt;br&gt;Flux residue indicates improper / incomplete cleaning.</td>
<td>NASA-STD-8739.2 [ 12.8.2.a.5 ]</td>
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<td><strong>UNACCEPTABLE FLUX RESIDUE</strong>&lt;br&gt;Flux splatter is an indication of an improper process parameter (heat / moisture).</td>
<td>NASA-STD-8739.2 [ 12.8.2.b.7 ]</td>
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<tr>
<td><strong>UNACCEPTABLE FLUX RESIDUE</strong>&lt;br&gt;Thick film components shall be mounted with the protective glass film side in the up position.</td>
<td>NASA-STD-8739.2 [ 8.8.3 ], [ 12.7.1 ]</td>
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</table>

**NASA WORKMANSHIP STANDARDS**

**SURFACE MOUNT TECHNOLOGY (SMT) GENERAL REQUIREMENTS (cont.)**

**SURFACE MOUNT TECHNOLOGY (SMT) GENERAL REQUIREMENTS (cont.)**
UNACCEPTABLE
NO FLOW / REFLOW
The lack of proper flow / reflow of solder paste / preforms is an indicator of poor process control or layout design (i.e.: inadequate heat, shadowing).
NASA-STD-8739.2 [12.8.1]

UNACCEPTABLE
NO SOLDER
The lack of solder is an indicator of poor process control.
NASA-STD-8739.2 [12.6.1.a.4], [12.8.2.b.6]

UNACCEPTABLE
NONWETTING
Nonwetting is an indicator of poor solderability or contamination.
NASA-STD-8739.2 [12.8.2.b.11]

UNACCEPTABLE
OPENS / VOIDS
Opens / voids are an indicator of insufficient solder, solder wicking, and/or coplanarity problems.
NASA-STD-8739.2 [12.8.2.b.5], [12.8.2.b.6]

UNACCEPTABLE
OVERHEATED SOLDER
Overheated solder has a dull, gray, frosty, and/or crystallized appearance and is the result of excessive exposure to heat.
NASA-STD-8739.2 [12.8.2.b.2]

UNACCEPTABLE
PART MISALIGNMENT
Part misalignment is an indicator of improper process control.
NASA-STD-8739.2 [8.7.4], [12.8.2.a.2]

UNACCEPTABLE
SCRATCHES (SOLDER FILLET)
Scratches in the solder are prohibited.
NASA-STD-8739.2 [12.8.2.b.14]

UNACCEPTABLE
SOLDER BALLS / SOLDER FINES
Solder balls or fines are an indication of improper process control (inadequate preheat), and/or the use of outdated solder / flux.
NASA-STD-8739.2 [12.8.2.b.19]

UNACCEPTABLE
SOLDER IN STRESS RELIEF BEND
Solder shall not extend into the stress relief bend of any leaded part. In this example, the solder is also in contact with the part body and the body seal.
NASA-STD-8739.2 [12.8.2.b.16]

UNACCEPTABLE
SOLDER PEAKS, ICICLES, SHARP EDGES
Solder peaks, icicles, and/or sharp edges are an indicator of an improper process parameter and are a reliability and short-circuit concern.
NASA-STD-8739.2 [12.8.2.c.4]

UNACCEPTABLE
SOLDER SLIVERS
Solder slivers are an indication of improper process control, and are a reliability and short-circuit concern.
NASA-STD-8739.2 [12.8.2.b.20]

UNACCEPTABLE
SOLDER WEBBING
Webbing is an indication of improper process control, and is a reliability and short-circuit concern.
NASA-STD-8739.2 [12.8.2.b.18]

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NO FLOW / REFLOW
The lack of proper flow / reflow of solder paste / preforms is an indicator of poor process control or layout design (i.e.: inadequate heat, shadowing).
NASA-STD-8739.2 [12.8.1]

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NO SOLDER
The lack of solder is an indicator of poor process control.
NASA-STD-8739.2 [12.6.1.a.4], [12.8.2.b.6]

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NONWETTING
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SOLDER WEBBING
Webbing is an indication of improper process control, and is a reliability and short-circuit concern.
NASA-STD-8739.2 [12.8.2.b.18]
A whisker is a slender needle-shaped metallic growth, and is typically the result of mechanical stresses in high tin-alloy plating on component leads. Whiskers are mechanically stronger than dendrites, and are a “dead-short” reliability risk.

Parts having spliced leads shall be rejected.

Tombstoning is an indicator of poor process control, primarily inadequate solder paste, or inadequate / uneven application of heat.

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Tombstoning is an indicator of poor process control, primarily inadequate solder paste, or inadequate / uneven application of heat.

Parts having spliced leads shall be rejected.

Poor wetting is an indicator of poor solderability, improper flux, or contamination.

Piggybacking, or stacking, of parts not designed specifically for that configuration is prohibited.

Popcorning is caused by the release of pressure entrapped in the component body during the soldering process. The effect can be relatively minor (body distortion), or destructive (seal breach or delidding).

Porous solder is an indication of improper process control (i.e.: excessive flux, inadequate dwell time).

A rosin solder joint is an indication of improper process control (i.e.: excessive flux, inadequate dwell time).