Mini-Circuits®

Application Note
(AN-00-004)

MINI-CIRCUITS AD FAMILY

CUSTOMER SOLDERING OF MATTE TIN PLATING

DATE ISSUED: JULY 07, 2004

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1.0 Introduction:

The electronics industry has been undergoing dramatic change as a result of environmental concerns over the use of lead (Pb) in component finishes. The availability of alternative platings is limited by specific requirements of leadframe manufacturers.

One popular finish, 100% matte tin over nickel barrier, is attractive because of availability of mass processing, excellent solderability and shelf life. The use of 100% tin, however, is questioned by some users because of the phenomenon known as Tin Whiskering.

While extensive tests for storage, humidity and thermal cycles are being done, no one really understands the ideopathy of this condition. What is known, however, is that encapsulation and fusing can inhibit whisker growth by altering the stresses and grain structure of 100% tin. Mitigation of whiskers is also accomplished by use of a nickel barrier.

Mini-Circuits' lead-free AD type package is inherently whisker free because of its geometry, the nature of the solder encapsulation, and the limited area of exposed matte tin. The exposed area of the lead before reflow soldering is at most 0.03 by 0.03 inches (see fig. 4). The leads themselves are almost totally covered by solder during the customers reflow solder process (see fig. 3). The small size and embedded nature of the leads makes this package virtually leadless.

AD Family Application:

For many years, Mini-Circuits has offered the AD Type package of Mixers, Splitters, Couplers and Transformers as a highly reliable and reasonably priced component. The patented design incorporates embedded leads in a thermoplastic header. (See fig. 1) All internal wire connections are welded. No solder is used.

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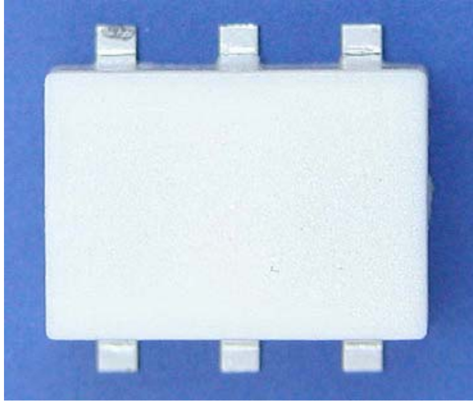
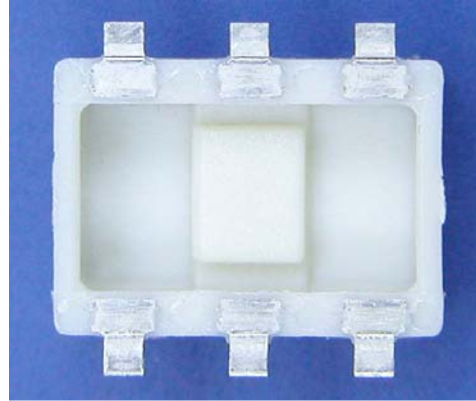
Fig. 1
B12-30-33+ (Q#0420151)



Top View



Bottom View

The lead plating process has been tin/lead over nickel barrier. As a result of the environmental standards placed on the electronic industry (EU RoHS, WEEE and Japanese Standard), Mini-Circuits has qualified 100% matte tin over nickel barrier as a suitable, compliant leadframe finish to replace the tin/lead over nickel barrier. (Ref. Document No. D4-QR-CD-3 Qualification Report of Lead Free Header B12-30-34+). See Appendix on page 7.

What About Whiskers?:

In addition to incorporating mitigations into the design, the case style itself is whisker resistant because of the way customer solder will reflow around the lead.

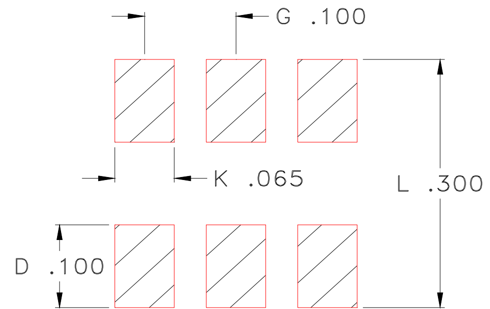


Fig. 2

When using the recommended footprint (See fig. 2) and appropriate aperture and thickness of stencil (6-7 mil), the unit can be expected to reflow according to that seen in figure 3. By using eutectic (SnPb) or Pb-free solder paste (SnCuAg), the 100% Matte Tin of the leadframe is fused and encapsulated. The amount of leadframe exposed after reflow soldering is insignificant,

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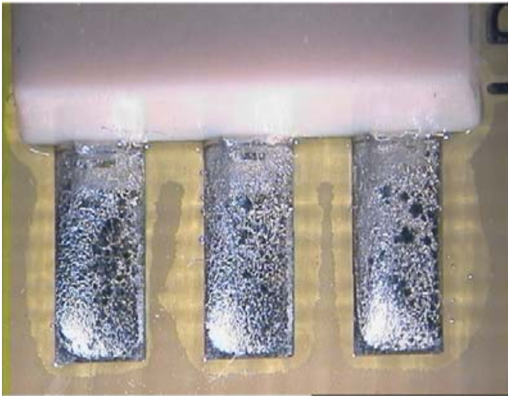
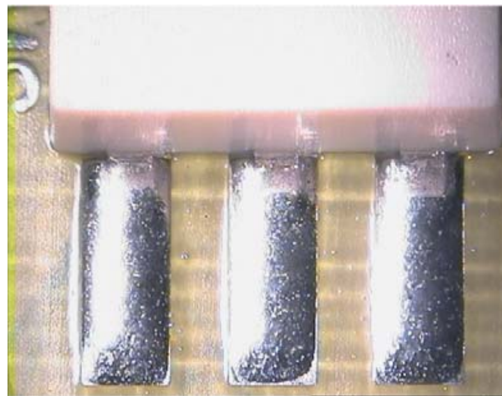
cutting off any attraction of whisker growth that may be expected in between the leads.

Fig. 3
B12-30-34-Q+
Reflowed Units (34.0 x Magnification)



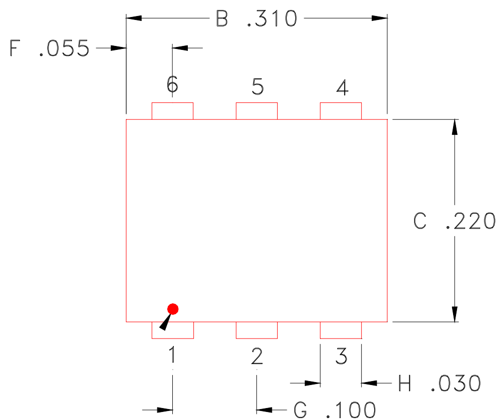
Sample #1
Lead Free Solder



Sample #2
63 / 37: Sn/Pb Solder

Fig. 4

The distance between the leads, 0.07 inch, provides further protection against whisker damage (see Fig. 4). Since whiskers are typically measured in microinches, there is ample gap between the leads to prevent any shorting.



Fusing, or stress relieving by heating is also a recognized mitigation technique. In the case of AD packages, the internal Mini-Circuits process calls for heat curing at 125°C for one half-hour. This, in addition to the reflow carried out by the customer, will stabilize any stresses in the plating.

The units in the Appendix were solder stencilled and reflowed on bare ceramic. This enabled us to view the encapsulation of the 100% Matte Tin leadframe in tin/lead solder

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Conclusion:

Mini-Circuits' patented AD family of package components has been qualified and are guaranteed against whisker growth damage in electronic circuits.

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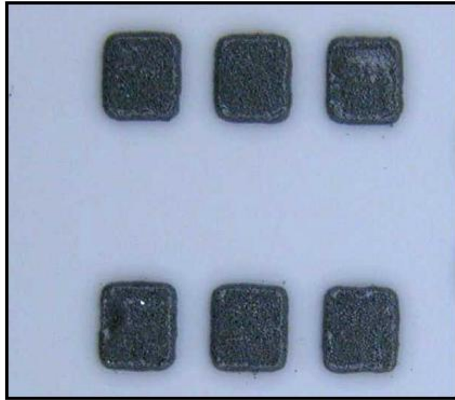
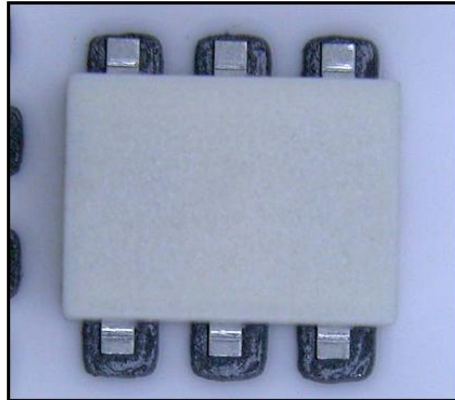
APPENDIX

Solder Paste Deposit & Component Placement on Ceramic Plate

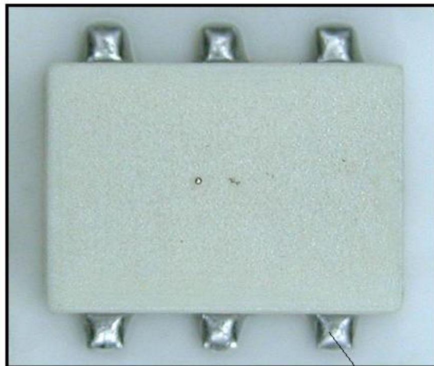


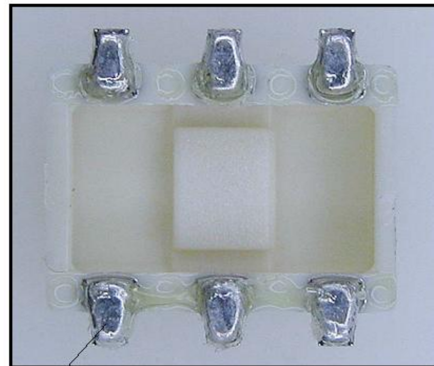


EUTETIC Sn/Pb SOLDER DEPOSIT

ADE PLACED

Top & Bottom view of ADE Model after Soldering





TOP VIEW

LEADS W/SOLDER

BOTTOM VIEW

Magnified view of the Lead

TOP VIEW - LEADS W/SOLDER

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CD Case Style
QUALIFICATION REPORT
FOR RoHS COMPLIANCE

(D4-QR-CD-3)

Date Issued: June 23, 2004

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1.0 INTRODUCTION

This evaluation was performed to qualify 100% matte tin over nickel plating process for the AD family, CD prefix case style of headers. Previously, these headers were plated with 60/40 SnPb. The 100% matte Sn plating was selected to satisfy industry requirement for Pb-free/RoHS compliance.

The Mini-Circuits models using this patented case style include:

- ADE Family of Mixers
- ADT Family of Transformers
- ADP Family of Splitters
- ADC Family of Couplers

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2.0 PURPOSE

To qualify 100% matte tin over nickel plating for CD prefix case style

Qualification Test Purposes		
SEQ	**Type of Tests**	**Purpose**
1	Visual Inspection	Routine Inspection for defect detection
2	Mechanical Dimensions	Routine Inspection for defect and variation.
3	Weld test with pull	Routine Inspection for adhesion strength and process verification.
4	Welding 3 #36 wires to lead	Assembly verification
5	Steamaging – 8 hours, samples from 4	Storage – aging
6	Steamaging – 24 hours, samples from 4	Long term storage aging
7	Solderability, on PCB, samples from 5, Sn/Pb solder	Reverse process (SnPb Solder Paste) compatible
8	Solderability, on PCB, samples from 5, Lead free solder	Forward Process (SnCuAg Solder Paste) compatible
9	Solderability, on PCB, samples from 6, Sn/Pb solder	Reverse Process Compatible after long term storage aging
10	Solderability, on PCB, samples from 6, Lead free solder	Forward process compatible after long term storage aging
11	Thermal Shock, 50 cycles, samples from 7,8,9&10	Joint reliability at customer use
12	Plating thickness	Verification of plating scheme for consistent results
13	Model Evaluation	Verification of electrical performance
14	Tin whisker Growth (see D4-QR-Plate-2)	Whisker growth
15	300 Thermal Cycle on FR4 -55 to +120^0 -30 min. Dwell SnPb & SAC Solder	Long Term Joint Reliability on Customer PCB

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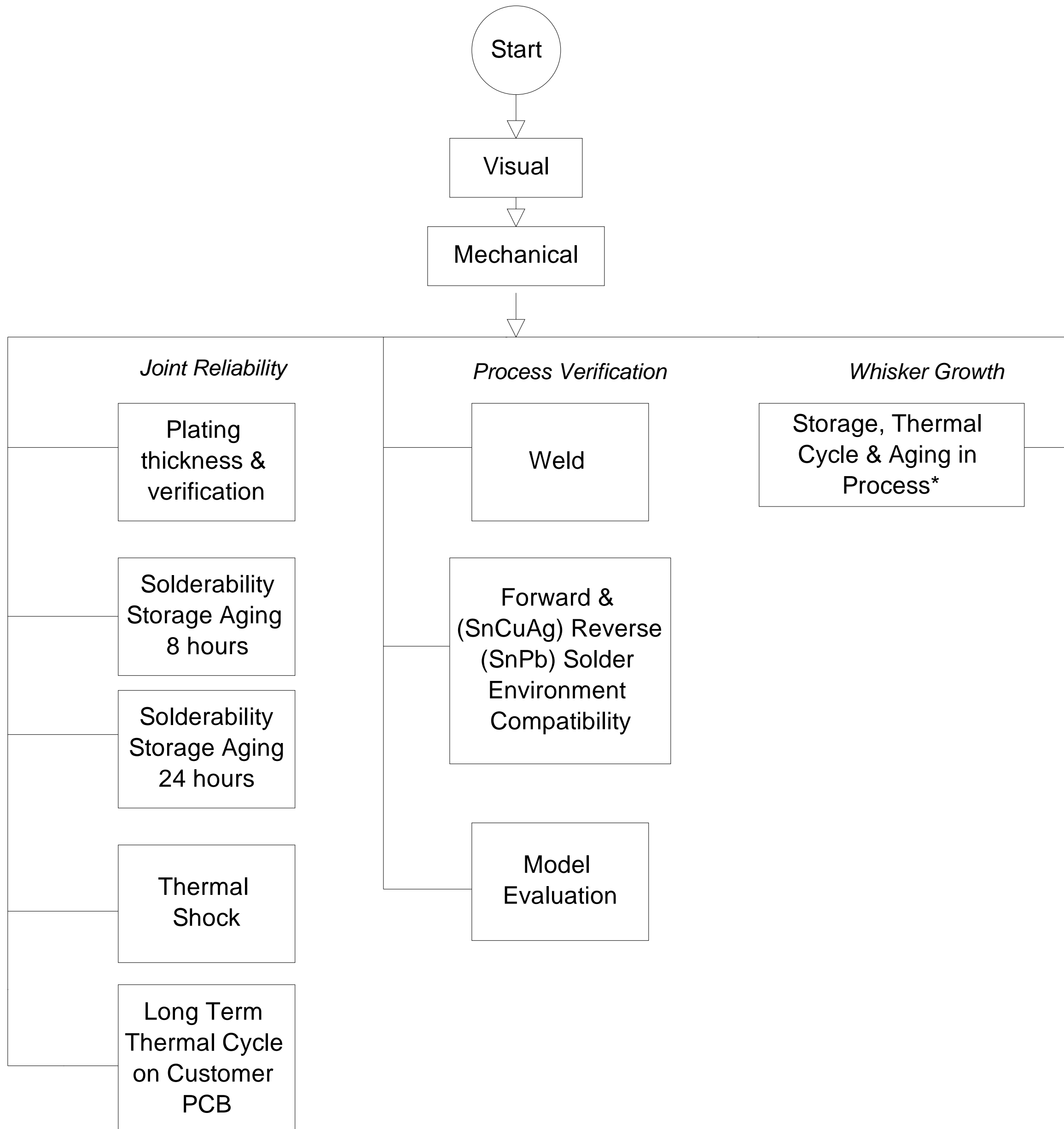
3.0 RELIABILITY QUALIFICATION PLAN

Flowchart



*Similarity applies to successful test of other leads from same supplier. Identical base material and plating. See Application Note: " Encapsulation of 100% Tin Plating in MCL AD-family"

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Qualification Plan & Results

Test	Conditions	Pass / Fail
Visual & Mechanical Inspection		
Visual Inspection	Low power microscope 10 to 15X magnification. Mini-Circuits Spec D4-Q4T0-21	315/0
Mechanical Dimension	Mini-Circuits Spec D4-Q4T0-21	10/0
Assembly Verification		
Weld Test with Pull	Mini-Circuits Spec CP-3301	6/0
Welding 3 # 36 wires to Lead	Mini-Circuits Spec CP-3301	24/0
Storage Aging		
Steam Aging (8 hours), samples from 4	IPC/EIA/JEDEC J-STD-002	12/0
Steam Aging (24 hours), samples from 4	IPC/EIA/JEDEC J-STD-002	12/0
Solderability Test		
Solderability on PCB, samples from SnPb solder	IPC/EIA/JEDEC J-STD-002	6/0
Solderability, on PCB, samples from Lead Free solder	IPC/EIA/JEDEC J-STD-002	6/0
Solderability, on PCB, samples from SnPb solder	IPC/EIA/JEDEC J-STD-002	6/0
Solderability, on PCB, samples from Lead Free solder	IPC/EIA/JEDEC J-STD-002	6/0
Thermal Shock		
Thermal Shock samples from solderability testing (on PCB)	MIL-STD-202 METHOD 107 (-55/100 deg. C, 15 mins., 3 cycles)	24/0
Thermal Cycling using SnPb & SAC Solders	MIL-STD-202 METHOD 107 (-55/120 deg. C, 30 mins., 300 cycles)	11/0
Additional Tests		
Plating Thickness	Per drawing	1 strip/0
Model Evaluation, ED-11718/1	Electrical Specifications of Model	90/0

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4.0 Conclusion

AD headers (case styles with CD prefix) with 100% matte tin plating over nickel barrier meets all storage, solderability, process and electrical requirements and can be used as a direct replacement for the Tin/Lead (SnPb) plated version in both Lead-free and Tin/Lead reflow environments.

Application Note AN-00-004 (Mini Circuits AD Family – Customer Soldering of Matte Tin Finish) supports our position that tin whiskering is mitigated based on the design and use of the header.

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