



TEST SUMMARY

TIN WHISKER FORMATION TESTING ON REFLOW MATTE TIN (RMT) PLATING

1.0 SCOPE

This Test Summary covers the Tin whisker formation testing for Reflow Matte Tin (RMT) plating.

2.0 PRODUCT DESCRIPTION

2.1 PRODUCT NAME

- A. MINI-FIT JR. SERIES BANDOLIER PINS
- B. MINI-FIT JR. SERIES HEADER ASSEMBLIES
- C. C-GRID SERIES BANDOLIER PINS
- D. C-GRID SERIES ASSEMBLIES
- E. KK SERIES BANDOLIER PINS
- F. KK SERIES ASSEMBLIES

2.2 PLATING TYPE AND THICKNESS

- A. MINI-FIT JR AND C-GRID AND KK REFLOW MATTE TIN (RMT) - 60 MICROINCHES MINIMUM REFLOW MATTE TIN (RMT) OVER 50 MICROINCHES MINIMUM NICKEL
- B. MINI-FIT JR MATTE TIN - 100 MICROINCHES MINIMUM MATTE TIN OVER 50 MICROINCHES MINIMUM NICKEL
- C. MINI-FIT JR BRIGHT TIN - 100 MICROINCHES MINIMUM MATTE TIN OVER 50 MICROINCHES MINIMUM NICKEL
- D. C-GRID MATTE TIN - 150 MICROINCHES MINIMUM MATTE TIN OVER 50 MICROINCHES MINIMUM NICKEL
- E. C-GRID BRIGHT TIN - 150 MICROINCHES MINIMUM MATTE TIN OVER 50 MICROINCHES MINIMUM NICKEL

3.0 REFERENCE DOCUMENTS

JEDEC JESD-201 Environmental Acceptance Requirements for Tin Whisker Sususeptibility of Tin and Tin Alloy Surface Finishes
 ES-40000-5013 Connector Heat Resistance Specification
 EIA-364-1000 Environmental test methodology for assessing the performance of electrical connectors and sockets used in controlled environment applications

4.0 INTRODUCTION

One of the concerns raised with pure tin finishes has been the fear that pure tin finishes will suffer from tin whisker failures. Tin whiskers are hair-like crystals that can grow spontaneously from the surface of tin and high tin content alloys and, in some cases, can potentially cause electrical shorts. They appear to be driven by the release of stress that has been induced in the plating finish.

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DOCUMENT NUMBER: RTS-5556-003	CREATED / REVISED BY: NNGUYEN	CHECKED BY: JBELL	APPROVED BY: FSMITHROEMER



TEST SUMMARY

Despite a significant amount of effort within the electronics industry, the fundamental mechanisms that cause whisker formation are not yet fully understood. In addition, numerous studies have attempted to identify accelerated tests for longer-term validation of the absence of whiskers. While no acceleration factors have been established correlating these tests to actual field performance, the predominant accelerated test methods that have evolved from these studies appear to have converged on the application of the following conditions:

- Heat & Humidity
- Thermal Cycling

In response to these investigations, an Acceptance Test standard was developed and released by the JEDEC standards organization (March 2006). JESD-201 provides a detailed test regimen for evaluation of tin and high-tin content coatings on electronic components.

This test report summarizes the results of testing conducted using the JESD-201 Specification (Environmental Acceptance Requirements for Tin Whisker Susceptibility of Tin and Tin Alloy Surface Finishes) as a basis for the test sample selection, environmental exposures and acceptance criteria.

5.0 TEST SAMPLE DESCRIPTION

For this test, two connectors representative of the type manufactured at the Molex Lincoln facility were selected. First sample was a 2.54 mm pitch, C-Grid header connector. The terminals of this part are comprised of a brass base alloy coated with a nickel underplate and a tin surface finish. The second sample was a 4.2 mm pitch, Mini Fit Jr. header connector. The terminals of this part are comprised of a brass base alloy coated with a nickel underplate and a tin surface finish. Loose pins from both connectors were also tested. Reflow matte tin was tested along with bright and matte tin finishes for comparison See section 2.2 for the minimum specified thicknesses for the nickel and tin deposits. All test samples were manufactured using the standard production process. The details of the samples used for this test are included in Table I.

Table I. Test sample details for Tin Whisker Acceptance Test

Part #	Terminals per Part	Part Family	Plating Type	No. of Samples
50362296	12	Mini-Fit	Reflow Matte	8
50362296	12	Mini-Fit	Bright	8
50362296	12	Mini-Fit	Matte	8
15912080	8	C-grid	Reflow Matte	8
15912080	8	C-grid	Bright	8
15912080	8	C-grid	Matte	8
Mini-Fit pins	1	Mini-Fit	Reflow Matte	48
Mini-Fit pins	1	Mini-Fit	Bright	48
Mini-Fit pins	1	Mini-Fit	Matte	48
C-Grid pins	1	C-grid	Reflow Matte	48
C-Grid pins	1	C-grid	Bright	48
C-Grid pins	1	C-grid	Matte	48

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6.0 TEST PROCEDURES

The stress conditions used in this study correspond to a Technology Acceptance test for Class 2 products per the JESD-201 standard (the testing for Class 2 Products represents the most strenuous stress conditions specified in the test standard). Details of these stress conditions are listed in Table II. Half of the samples were subjected to a Lead Free Reflow Exposure for preconditioning of the samples before the stress conditions. The other half of the samples did not received the preconditioning.

Table II. Summary of Stress Conditions Used in Tin Whisker Acceptance Test

Stress Type	Test Conditions	Duration
Temperature Cycling	-55 +0/-10 °C to 85 +10/-0 °C, air to air; 10 min. soak; ~3 cycles/hr	1500 cycles
High Temperature / Humidity Storage	55 ± 3 °C and 85 ± 3% RH	4000 hours

An initial inspection prior to exposing the samples to the stress conditions was completed using an optical microscope at a minimum of 55X magnification. A final inspection to confirm the absence or presence of whiskers was conducted to a minimum of 55X magnification. If whiskers were present, a 250X minimum magnification SEM detailed inspection was to be completed. Test sequences are included in appendix A. The acceptance criterion for the Class 2 product Acceptance Test calls for no whisker longer than 45 µm after the temperature cycling exposure and no whisker longer than 40 µm after the high temperature/humidity exposures.

6.1 LEAD FREE REFLOW EXPOSURE

Samples were processed through a reflow oven using an air atmosphere and a peak reflow temperature of 260C +/-5C as outlined in ES-40000-5013. Bandolier pins and completed assemblies were secured to the PCB using Kapton tape and no solder paste was used.

6.2 TEMPERATURE CYCLING

Samples were subjected to 1500 cycles of thermal shock cycles between -55°C and 85°C. The dwell time at each extreme was 10 minutes. Samples were allowed to return to room ambient conditions prior to further tests.

(Reference EIA-364-32)

6.3 HIGH TEMPERATURE / HUMIDITY

Samples were exposed to 55°C and 85% relative humidity for 4000 hours. Samples were allowed to return to room ambient conditions prior to further tests.

(Reference EIA-364-31)

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7.0 RESULTS

No whiskers were observed after any of the test exposures. The results of the Acceptance Test are summarized in Table III.

Table III. Results of Final Whisker Inspection

Stress Condition	Plating type	Part #	Max. Whisker Length	Pass/Fail?
Temperature Cycling	Reflow matte	50362296	0	Pass
Temperature Cycling	Bright	50362296	0	Pass
Temperature Cycling	Matte	50362296	0	Pass
Temperature Cycling	Reflow matte	15912080	0	Pass
Temperature Cycling	Bright	15912080	0	Pass
Temperature Cycling	Matte	15912080	0	Pass
High Temperature / Humidity	Reflow matte	50362296	0	Pass
High Temperature / Humidity	Bright	50362296	0	Pass
High Temperature / Humidity	Matte	50362296	0	Pass
High Temperature / Humidity	Reflow matte	15912080	0	Pass
High Temperature / Humidity	Bright	15912080	0	Pass
High Temperature / Humidity	Matte	15912080	0	Pass
Temperature Cycling	Reflow matte	Mini-Fit pins	0	Pass
Temperature Cycling	Bright	Mini-Fit pins	0	Pass
Temperature Cycling	Matte	Mini-Fit pins	0	Pass
Temperature Cycling	Reflow matte	C-Grid pins	0	Pass
Temperature Cycling	Bright	C-Grid pins	0	Pass
Temperature Cycling	Matte	C-Grid pins	0	Pass
High Temperature / Humidity	Reflow matte	Mini-Fit pins	0	Pass
High Temperature / Humidity	Bright	Mini-Fit pins	0	Pass
High Temperature / Humidity	Matte	Mini-Fit pins	0	Pass
High Temperature / Humidity	Reflow matte	C-Grid pins	0	Pass
High Temperature / Humidity	Bright	C-Grid pins	0	Pass
High Temperature / Humidity	Matte	C-Grid pins	0	Pass

Images of representative regions of the surfaces are included in Appendix B.

8.0 CONCLUSION

The reflow matte tin plating finish used in Molex Lincoln passes the JESD-201 Acceptance Test.

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APPENDIX A

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Sequence 1

Sequence 2

Sequence 3

Sequence 4

Samples:
(2) Mini Fit & C-Grid Connectors
(12) 5569 & 71308 Pins of each plating type:
(Bright, Matte & Reflow Matte)

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(12) 5569 & 71308 Pins of each plating type:
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(2) Mini Fit & C-Grid Connectors
(12) 5569 & 71308 Pins of each plating type:
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Visual Examination

Visual Examination

Lead Free Reflow Exposure

Lead Free Reflow Exposure

High Temperature/
Humidity

Temperature
Cycling

Visual
Examination

Visual
Examination

Visual Examination
(If whiskers are present, SEM
250X Analysis)

Visual Examination
(If whiskers are present, SEM
250X Analysis)

High Temperature/
Humidity

Temperature
Cycling

Visual Examination
(If whiskers are present, SEM
250X Analysis)

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(If whiskers are present, SEM
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CREATED / REVISED BY:
NNGUYEN

CHECKED BY:
JBELL

APPROVED BY:
FSMITHROEMER



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APPENDIX B

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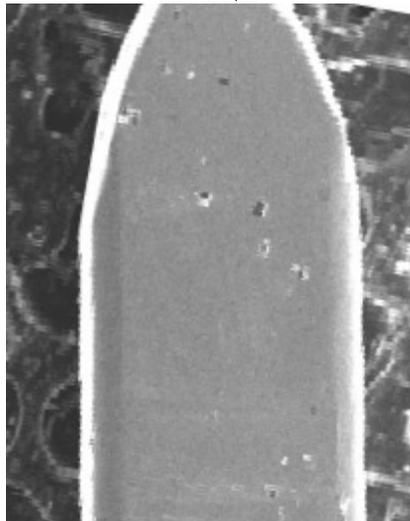
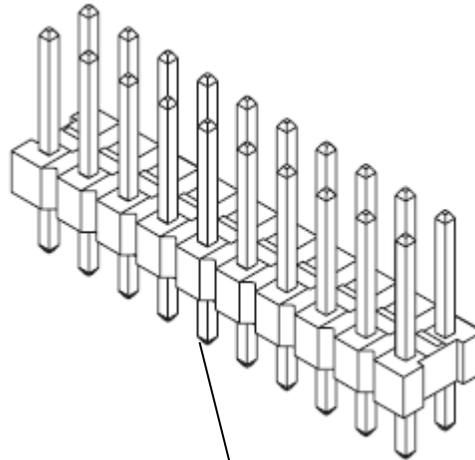


Fig 1. Representative drawing of a sample and photograph of terminal area of interest from test samples (20X).

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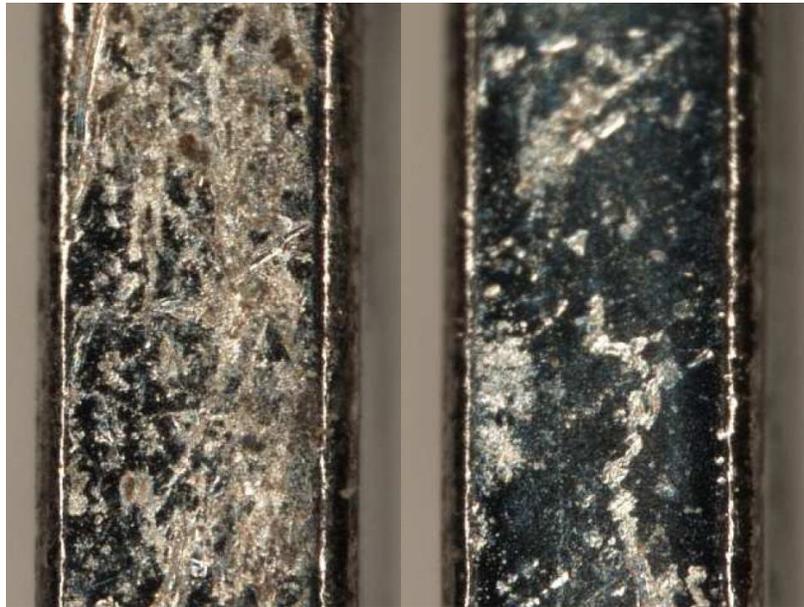


Fig 2. Representative photograph of a C-Grid terminal with reflow matte tin plating after 1500 hours temperature cycling exposure per JESD-201 (55X magnification). The terminal on the left is without lead free reflow exposure and terminal on the right was exposed to lead free reflow exposure.

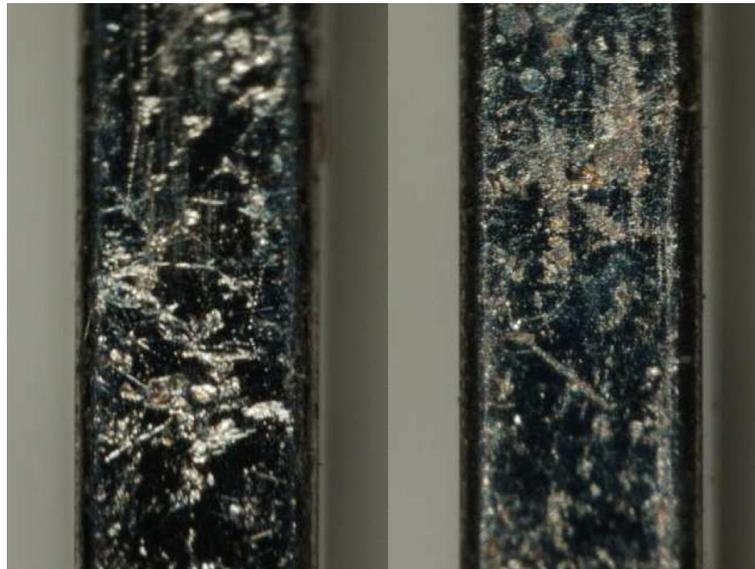


Fig 3. Representative photograph of a C-Grid terminal with reflow matte tin plating after 4000 hours 55°C / 85% RH exposure per JESD-201 (55X magnification). The terminal on the left is without lead free reflow exposure and terminal on the right was exposed to lead free reflow exposure.

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