

Report EL-2005-04-037 CR

Evaluation of Tin Whisker Growth, FCI Lead Free METRAL® 1000 Receptacle Shields

Rev. B

2006 May 08

PURPOSE:

Lead free METRAL® 1000 receptacle connectors were tested to assess the growth of whiskers from the matte tin plating on the shielding elements. Testing encompassed exposure to two (2) treatment environments: humid heat aging and room temperature storage. Testing was conducted according to FCI specification GS-19-028, which requires thermal shock preconditioning prior to both aging treatments. Evaluation was focused on the portions of the shields that are formed during assembly since these represent conditions of induced stress in the plated material. Whiskers were identified by visual examination of the tin (or tin-lead) plated areas of the IMLA at approximately 100X magnification. Results were evaluated by comparison with the requirement for whisker growth specified in FCI GS-19-028. These results are applicable to all FCI connectors with tin plated shields that are formed after plating for interconnection of the shielding elements.

CONCLUSIONS:

No whiskers were observed on the lead free (tin plated) shielding elements of the METRAL® 1000 receptacle connectors.

SAMPLE DESCRIPTION:

Test sample identity is given in table 1. An example of the connector is depicted in figure 1.

Table 1. Identity of Submitted Samples

Item	Quantity	Description	Part Number	Lot	PF Plating	Received
1	5	METRAL® 1000 Receptacle	74981-102LF	EPR V2566	Sn / Ni	2005 Apr 01

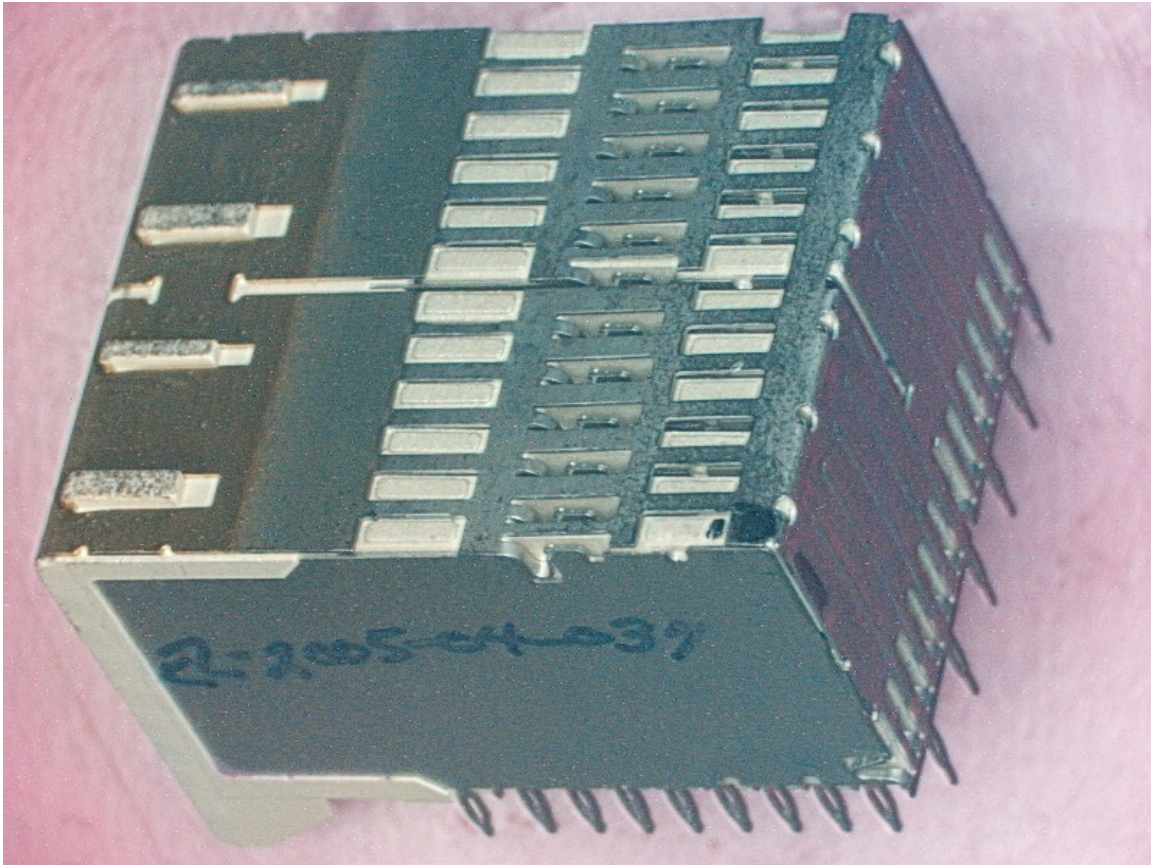


Figure 1. Example of METRAL® 1000 Receptacle – 4X

The plating on the shielding elements of the lead free receptacle connector was 0.5 micrometer to 1.5 micrometers of pure matte tin over nickel underplate (1.3 micrometers minimum on vertical shields and 2 micrometers minimum on top and bottom shields). Each insert molded leadframe assembly contained twelve (12) vertical shields, one (1) top shield, and one (1) bottom shield.

REFERENCE DOCUMENTS:

Pertinent documents are listed in table 3.

Table 3. Reference Documents

Document ID	Title	Rev. Level (Date)
FCI GS-19-028	Test Specification, Test Procedure for Tin Whisker Formation in Lead-free Connector Terminal Finishes	A (2004 Feb 09)
FCI EL-2004-01-032C	Test Summary, Thomas D. Moyer, Designed Experiment to Determine the Reliability of Various Commercial Plating Baths and the Key Factors Affecting Whisker Formation	(2004 Nov 24)

TEST SEQUENCE:

The tests were performed in accordance with the humid heat aging and room temperature storage environments specified in FCI GS-19-028 sections 5.4.1.2 and 5.4.1.3, respectively, after preconditioning by thermal shock exposure per FCI GS-19-028 section 5.2.2. Aging in dry heat (FCI GS-19-028 section 5.4.1.1) was not performed since this environment has previously been shown to be benign with respect to whisker growth (FCI test summary EL-2004-01-032C). The applied test sequence is given in table 4

Table 4. Sequence of Applied Tests by Test Group

Test Description	Condition	Sequence	
		Group C	Group D
		Humid Heat Aging	Room Temperature Storage
		3 Connectors	2 Connectors
Whisker Evaluation	Initial	1	1
Thermal Shock	Preconditioning	2	2
Whisker Evaluation	after T Shock	3	3
Humid Heat Aging	250 hr	4	
Room Temperature Storage	250 hr		4
Whisker Evaluation	at 250 hr	5	5
Humid Heat Aging	+ 480 hr	6	
Room Temperature Storage	+ 480 hr		6
Whisker Evaluation	at 1 Month	7	7
Humid Heat Aging	+ 1 Mo	8	
Room Temperature Storage	+ 1 Mo		8
Whisker Evaluation	at 2 Months	9	9
Humid Heat Aging	+ 1 Mo	10	
Room Temperature Storage	+ 1 Mo		10
Whisker Evaluation	at 3 Months	11	11
Humid Heat Aging	+ 1 Mo	12	
Room Temperature Storage	+ 1 Mo		12
Whisker Evaluation	at 4 Months	13	13
Humid Heat Aging	+ 1 Mo	14	
Room Temperature Storage	+ 1 Mo		14
Whisker Evaluation	at 5 Months	15	15
Humid Heat Aging	+ 1 Mo	16	
Room Temperature Storage	+ 1 Mo		16
Whisker Evaluation	Final (at 6 Mo)	17	17

TEST PROCEDURES:

Whisker Evaluation

The presence of whiskers was evaluated by visual observation using a binocular optical microscope at approximately 100X magnification.

Whisker evaluation was focused on the portions of the shields that are subjected to mechanical deformation after plating since these represent conditions of induced stress (which drives whisker formation) in the plated material. These features include areas where the top shield is formed into spring members (on the top and on the back near the bottom of the connector assembly) to provide interconnection with the vertical shield and areas where the bottom shield is formed into compliant pins (on the bottom near the front of the connector assembly) to provide grounding connection to the printed wiring board. The areas of evaluation are delineated in figures 2 through 4. Details of the formed features are shown in figures 5 through 7.

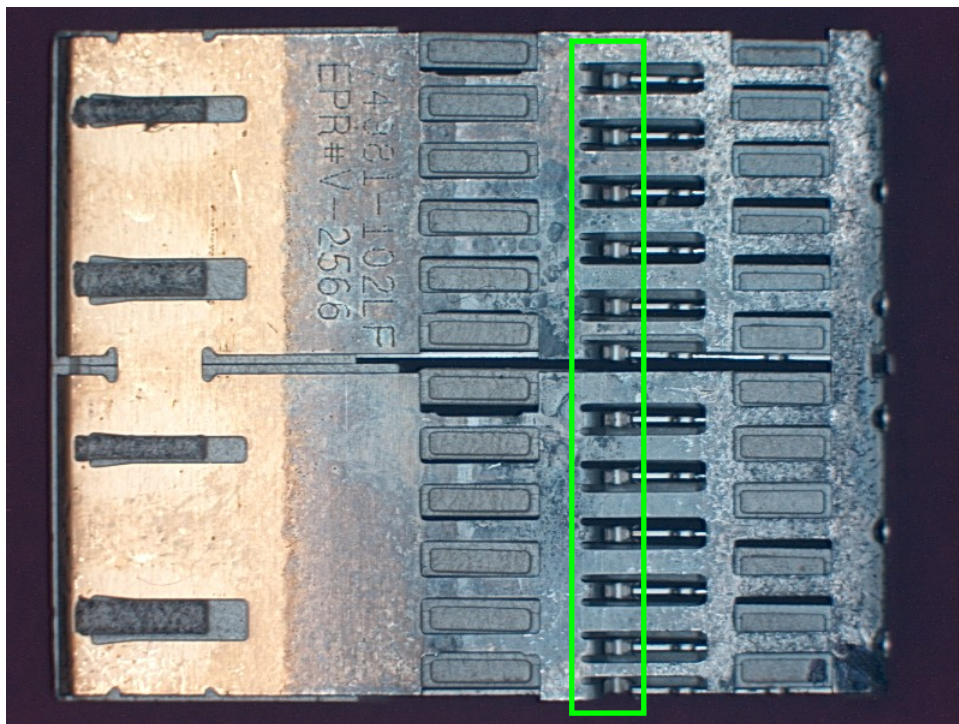


Figure 2. Top View of METRAL® 1000 Receptacle Showing Whisker Evaluation Areas – 4X

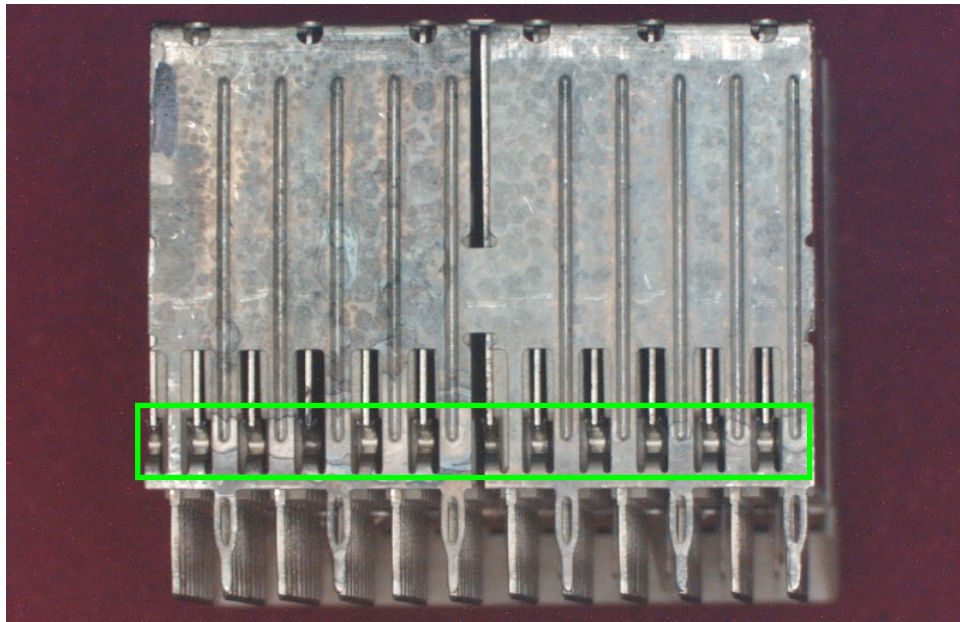


Figure 3. Rear View of METRAL® 1000 Receptacle Showing Whisker Evaluation Areas – 4X

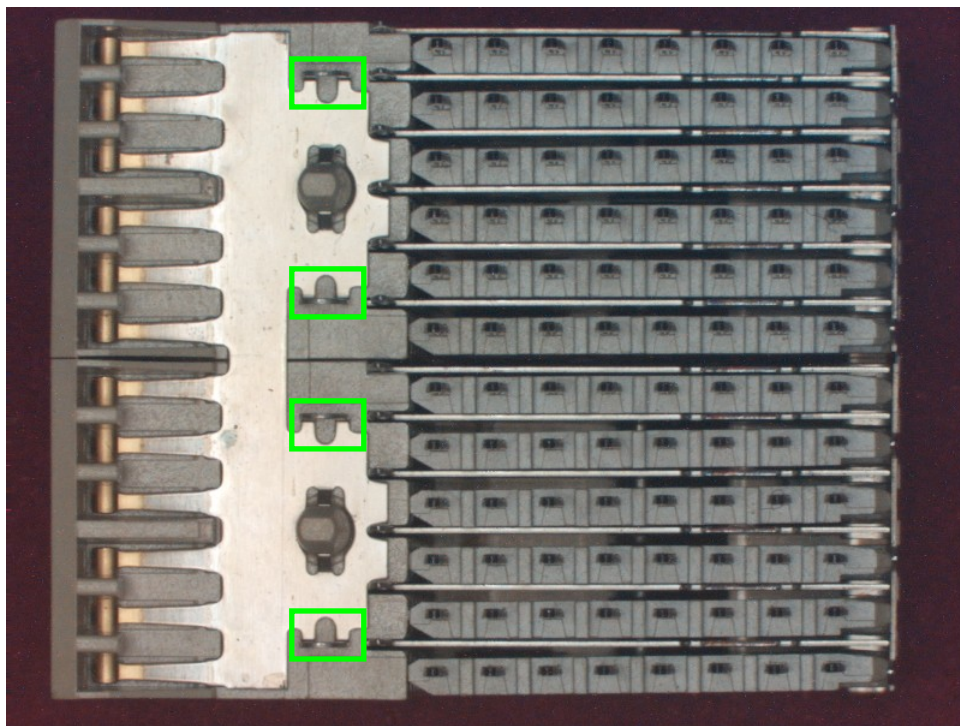


Figure 4. Bottom View of METRAL® 1000 Receptacle Showing Whisker Evaluation Areas – 4X

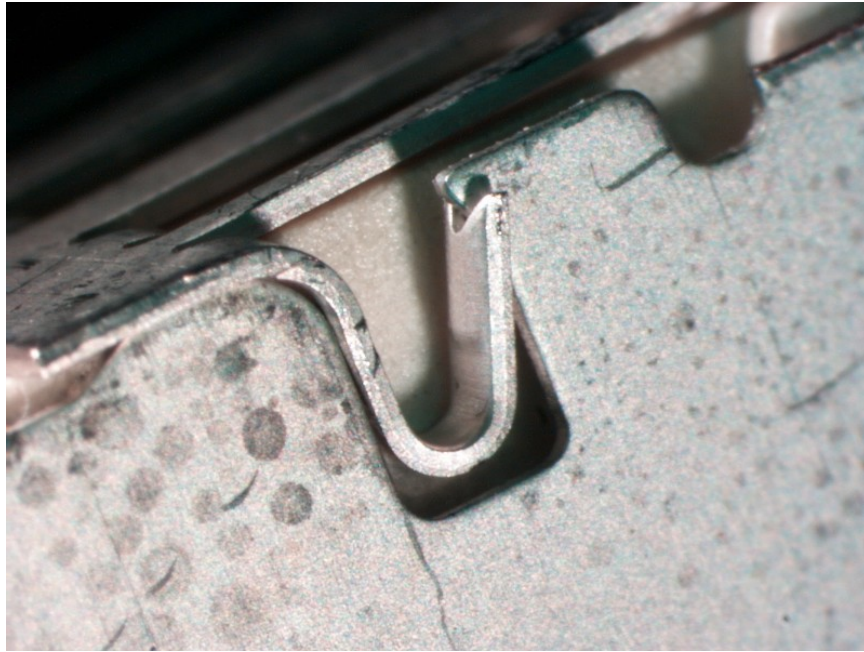


Figure 5. Formed Interconnection Feature at Top of METRAL® 1000 Receptacle – 20X



Figure 6. Formed Interconnection Feature at Bottom Rear of METRAL® 1000 Receptacle – 20X

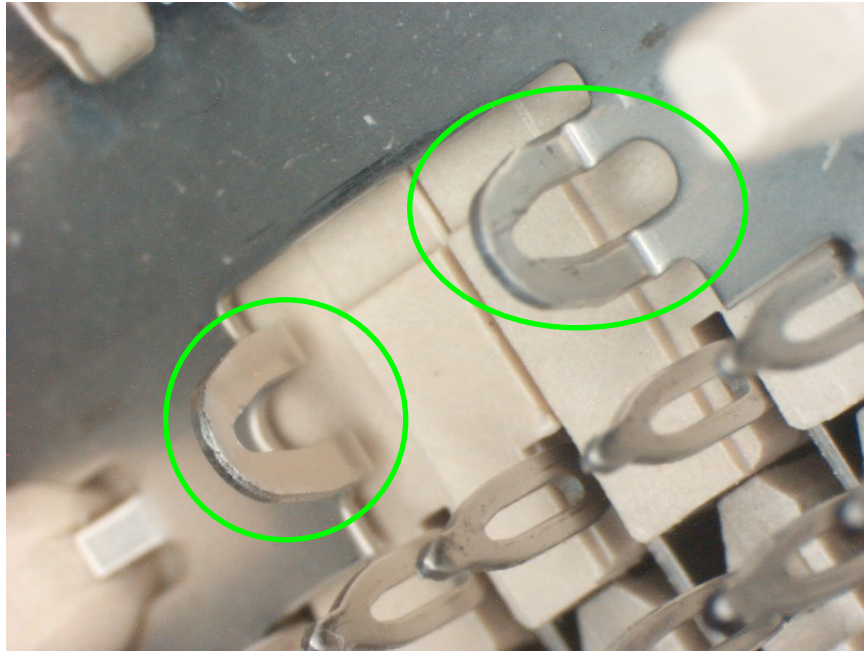


Figure 7. Formed Compliant Feature on Bottom Shield of METRAL® 1000 Receptacle – 15X

Examination for whiskers was conducted initially, after preconditioning, and monthly during the six (6) month environmental treatments; an examination was also conducted after 250 hours of treatment to check for rapid initial whisker growth.

Thermal Shock

The test samples were preconditioned by exposure to repetitive thermal cycling between temperature extremes of $-55\text{ }^{\circ}\text{C}$ and $85\text{ }^{\circ}\text{C}$ in accordance with section 5.2.2 of FCI test specification GS-19-028; 500 cycles of 20 minutes each were applied.

Humid Heat Aging

The test samples were subjected to aging under conditions of humid heat at $52\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ and $90\% \pm 5\%$ relative humidity in accordance with section 5.4.1.2 of FCI test specification GS-19-028.

Room Temperature Storage

The test samples were subjected to room temperature storage under ambient conditions ($23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ with humidity uncontrolled) in accordance with section 5.4.1.3 of FCI test specification GS-19-028.

REQUIREMENTS:

The requirement for whisker length was 50 micrometers maximum in accordance with FCI test specification GS-19-028.

TEST RESULTS:

Whisker Evaluation

No whiskers were observed on any of the test samples under any of the applied treatment conditions.

EQUIPMENT:

Item Description	Manufacturer (Model)	Equip. ID #	Cal. Due Date
Microscope	Wild (M8)	VG7088	Not Calibrated
Microscope	Olympus (SZH)	VG7399	Not Calibrated
Digital Camera	Polaroid (DMC 1e)	VG7555	Not Calibrated
Thermal Shock Chamber	Cincinnati Sub-Zero (Model VTS-1.5-105-105-S/AC)	VG7403	2006 May
Humidity Chamber	Blue M (FR-251B-MP1, SN F1-169)	VG6474	2006 May
Humidity Chamber	Espec (ESX-3CA, SN 015530)	VG7930	2006 Apr

REVISION RECORD

Rev. #	Revision Date	Page(s)	Description
-	2006 Jan 09	All	Original Issue
A	2006 Apr 03	1	Updated Corporate Logo
B	2006 May 08	1	Repositioned Corporate Logo