



**Report YB2-2659 CR Rev. -**  
Evaluation of Repairability, FCI Lead Free Millipacs receptacle Connectors

26-05-2005

**PURPOSE:**

Lead free Millipacs receptacle connectors were tested to assess mechanical performance of the matte tin plated compliant pins. Results were evaluated by comparison with product specifications. Testing included measurement of insertion and retention forces and evaluation of plated through hole (PTH) integrity during connector repair (3 pins). These results are applicable to all FCI connectors with eye of the needle style compliant sections on press fit (PF) pins fabricated from approximately 0.3 mm thick basis metal for application in printed wiring board (PWB) holes of approximately 0.6 mm nominal diameter.

**CONCLUSIONS:**

The lead-free test samples met the specified requirements for insertion force, retention force, PTH deformation, and remaining PTH copper thickness.

**SAMPLE DESCRIPTION:**

Test sample identity is given in table 1.

**Table 1. Identity of Submitted Samples**

<b>Item</b>	<b>Quantity</b>	<b>Description</b>	<b>Part Number</b>	<b>Lot</b>	<b>PF Plating</b>	<b>Received</b>
<b>1</b>	18	Millipacs receptacle	HM2R02PA55100N9LF	P24461217	Sn / Ni	10-12-2004
<b>2</b>	360	Millipacs receptacle pin	BPC201307000	P24461217	Sn / Ni	10-12-2004

**Note: loose pins had been retracted from receptacle assemblies (row C and D)**

The plating on the compliant section of the lead free press fit pins is 0.5 micrometer to 1.5 micrometers of pure matte tin over 0.5 micrometer to 3 micrometers of nickel.

The lead free press fit product was tested in each of two (2) PTH sizes (minimum and maximum) in PWBs with each of three (3) finishes (a total of 6 sample sets) as listed in table 2.

**Table 2. Identity of Sample Sets**

	PWB Finish	PTH Hole Size
1	Tin-Lead	Minimum
2	Copper / OSP	
3	Tin	
4	Tin-Lead	Maximum
5	Copper / OSP	
6	Tin	

**REFERENCE DOCUMENTS:**

Pertinent documents are listed in table 3.

**Table 3. Reference Documents**

Document ID	Title	Rev. Level (Date)
IEC 60352-5	Solderless connections – Part 5: Press-in connections – General requirements, test methods and practical guidance	Ed. 2.1 (2003 Dec)
FCI GS-12-203	Product specification Millipacs	B (24-1-2005)
FCI GS-20-022	Application spec right angle products	A (16-5-2002)

**TEST SEQUENCE:**

The tests were applied in general accord with test groups A and B of IEC 60352-5, per sections 5.3.2.2 and 5.3.2.3, as listed in table 4

**Table 4. Sequence of Applied Tests by Test Group**

Test Description	Condition	Sequence	
		Group A	Group B
		Connector Repair	Individual Pin Repair
		5 Connectors	20 Pins
Insertion Force Measurement	Initial	1	1
Retention Force Measurement	1 <sup>st</sup>	2	2
Repair: Insertion	2 <sup>nd</sup>	3	3
Retention	2 <sup>nd</sup>	4	4
Insertion	3 <sup>rd</sup>	5	5
Microsectioning	Transverse	6 (10 Pins)	
PTH Deformation		7 (10 Pins)	
Remaining Cu Thickness		8 (10 Pins)	
Microsectioning	Longitudinal	9 (10 Pins)	
PTH Axial Damage		10 (10 Pins)	
Retention Force Measurement	Final (3 <sup>rd</sup> )	11 (Remaining Connectors)	6

**Note: Group A test 1 has been performed manually without force recording only in minimum boards and tests 2, 3, 4, 5 and 11 have not been performed because retention is not possible without destroying the connector or the PCB.**

## **TEST PROCEDURES:**

### **Insertion Force**

The force required to insert the press fit pin(s) into the test board was measured in accordance with IEC 60352-5, section 5.2.2.2, using a tensile/compression test instrument. Insertion proceeded under machine control by pushing the pin(s) into the PWB to the nominal depth at a rate of 12.5 millimeters per minute. The pin insertion force was taken as the maximum force encountered during pin insertion.

### **Retention Force**

The force required to remove the press fit pin(s) from the test board was measured in accordance with IEC 60352-5, section 5.2.2.3, using a tensile/compression test instrument. Removal proceeded under machine control by applying compressive force to the tip of the press fit pin(s) and pushing at a rate of 12.5 millimeters per minute. The pin retention force was taken as the maximum force encountered during pin removal. A minimum recovery period of 24 hours was allowed after pin insertion prior to insertion force measurement.

### **Repair**

Repair (replacement) of pins or connectors was conducted in accordance with IEC 60352-5, section 5.2.2.6.

### **Microsectioning and PTH Integrity**

Microsectioning was done in accordance with IEC 60352-5, section 5.2.2.5. Deformation of the plated through hole was measured on a transverse section through the press fit region 0.3 mm from the top (entry side) surface of the PWB after insertion (with the press fit pin in the PTH) in accordance with IEC 60352-5, section 5.2.2.5.1. Minimum remaining PTH copper thickness was measured on the same section in accordance with IEC 60352-5, section 5.2.2.5.1. Axial damage of the PTH (e.g., cracks or voids in the copper) was evaluated qualitatively on a longitudinal section through the press fit pin in accordance with IEC 60352-5, section 5.2.2.5.2; quantitative measurements were performed only if trace connection deformation was observed.

## **REQUIREMENTS:**

The requirements were taken from ET3302 rev. 00 as listed in table 5.

**Table 5. Requirements**

<b>Test</b>	<b>Item</b>	<b>Value</b>
<b>Insertion Force Measurement</b>	Maximum Insertion Force	55 Newtons
<b>Retention Force Measurement</b>	Minimum Retention Force	5 Newtons
<b>PTH Deformation</b>	Maximum Radial Deformation	50 micrometers
<b>Remaining PTH Copper Thickness</b>	Minimum Cu Thickness	7.5 micrometers

## **TEST RESULTS:**

### **Test Group A (Connectors)**

The results of maximum PTH deformation measurement are summarized in table 6 and displayed graphically in figure 1. The results of minimum remaining PTH copper thickness are summarized in table 7 and displayed graphically in figure 2.

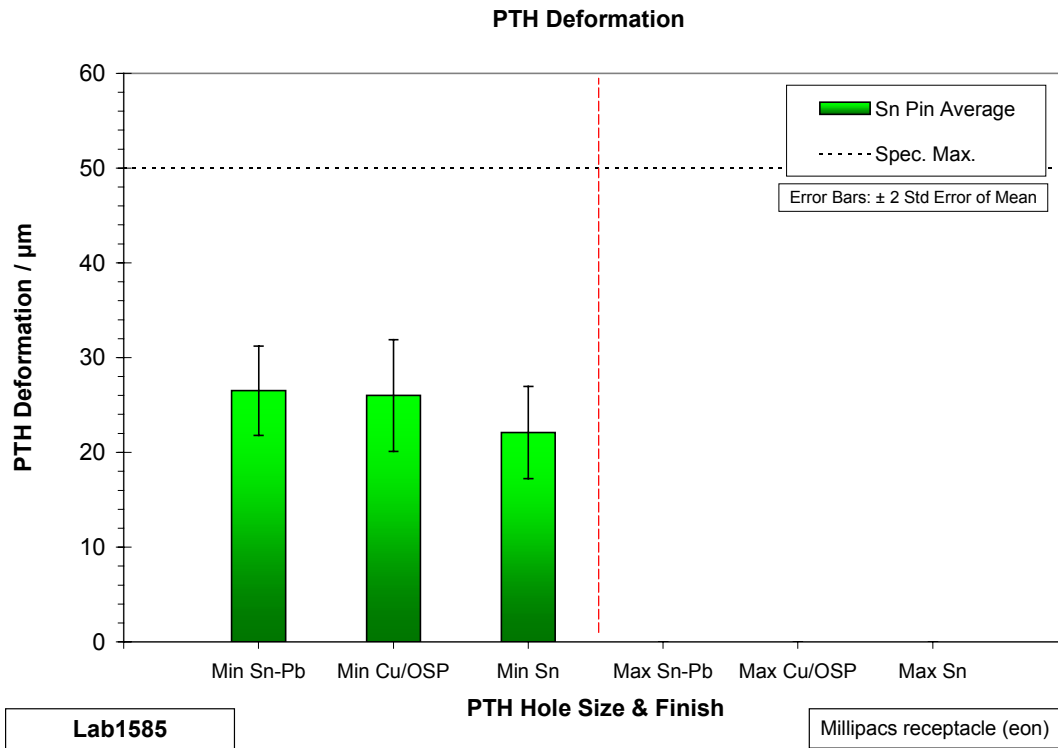
**Table 6. Maximum PTH Deformation**

PTH Size	Minimum			Maximum		
PWB Finish	Sn-Pb	Cu/OSP	Sn	Sn-Pb	Cu/OSP	Sn
Count	10	10	10	0	0	0
	<b>Measured Maximum PTH Deformation / micrometer</b>					
Average	26.5	26.0	22.1	N.A.		
Std Dev	7.5	9.3	7.7			
Minimum	15.0	18.0	10.0			
Maximum	40.0	45.0	30.0			

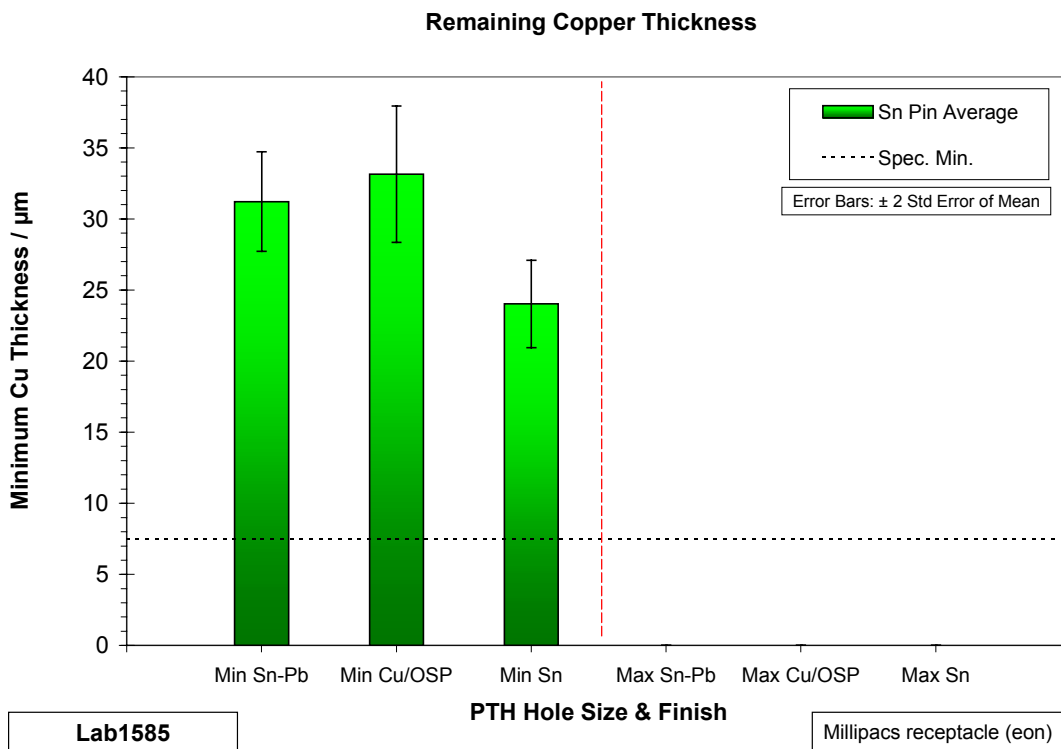
**Table 7. Minimum Remaining PTH Copper Thickness**

PTH Size	Minimum			Maximum		
PWB Finish	Sn-Pb	Cu/OSP	Sn	Sn-Pb	Cu/OSP	Sn
Count	10	10	10	0	0	0
	<b>Measured Minimum Remaining PTH Thickness / micrometer</b>					
Average	31.2	33.2	24.0	N.A.		
Std Dev	5.5	7.6	4.9			
Minimum	24.2	21.5	17.9			
Maximum	42.5	47.2	34.7			

**Figure 1. Maximum PTH Deformation**



**Figure 2. Minimum Remaining PTH Copper Thickness**



**Test Group B (Individual Pins)**

The results of force measurement on individual pins are summarized in tables 8 through 10 and displayed graphically in figures 3 through 5.

**Table 8. Initial Insertion Force (Individual Pins)**

PTH Size	Minimum			Maximum		
PWB Finish	Sn-Pb	Cu/OSP	Sn	Sn-Pb	Cu/OSP	Sn
Count	20	20	20	20	20	20
	[ Measured Force / Pin ] / Newton					
Average	35.9	35.8	35.4	20.0	20.9	20.7
Std Dev	1.7	1.4	0.8	1.1	1.6	1.5
Minimum	33.5	33.6	34.3	17.7	18.9	17.5
Maximum	41.5	38.9	36.9	21.9	25.8	24.7

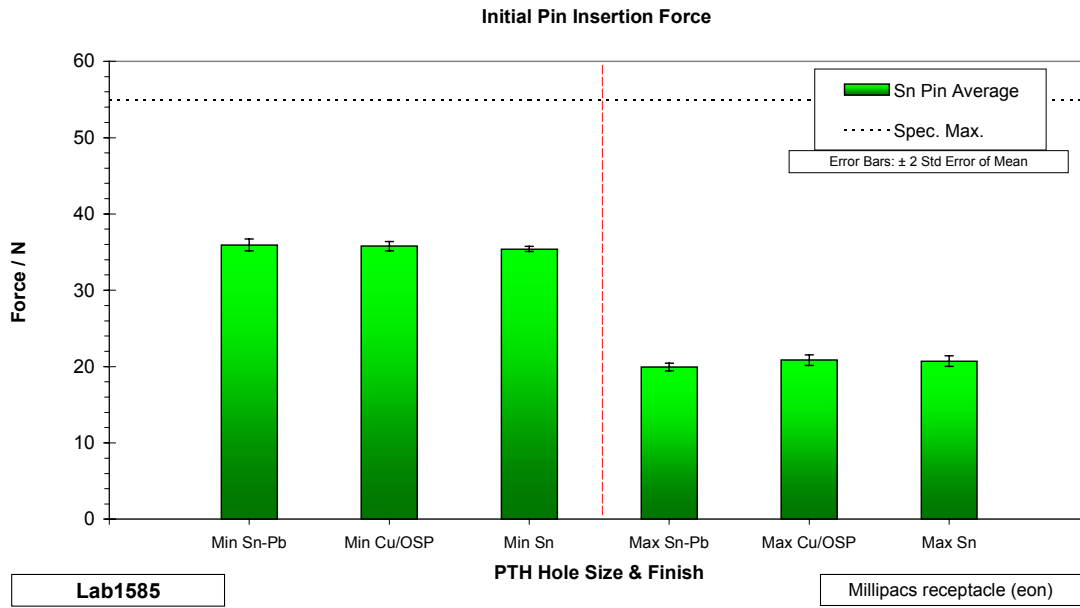
**Table 9. 1st Retention Force (Individual Pins)**

PTH Size	Minimum			Maximum		
PWB Finish	Sn-Pb	Cu/OSP	Sn	Sn-Pb	Cu/OSP	Sn
Count	19	20	20	20	19	19
	[ Measured Force / Pin ] / Newton					
Average	21.7	15.4	15.3	13.3	9.7	13.5
Std Dev	2.2	1.3	2.2	1.0	1.2	1.8
Minimum	18.3	12.2	11.5	11.6	6.4	10.0
Maximum	26.7	17.3	19.8	15.0	11.6	16.5

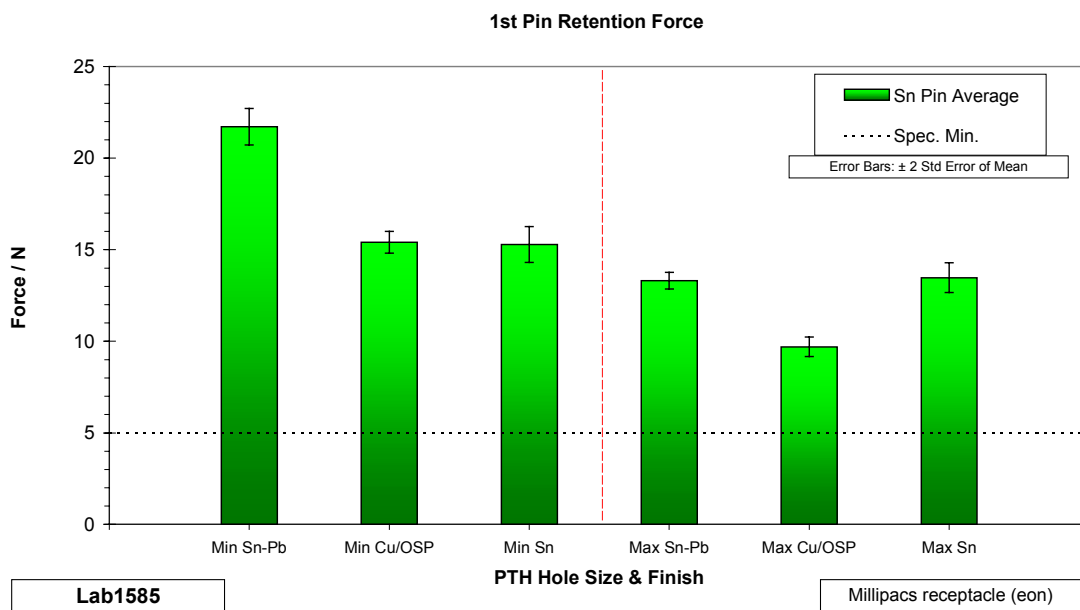
**Table 10. Final Retention Force (Individual Pins)**

PTH Size	Minimum			Maximum		
PWB Finish	Sn-Pb	Cu/OSP	Sn	Sn-Pb	Cu/OSP	Sn
Count	20	20	20	20	20	20
	[ Measured Force / Pin ] / Newton					
Average	15.5	11.2	11.3	12.1	8.4	10.6
Std Dev	1.9	0.8	1.0	1.2	0.8	1.2
Minimum	12.1	10.0	9.3	8.9	6.7	7.0
Maximum	19.1	12.9	13.2	13.7	10.3	12.2

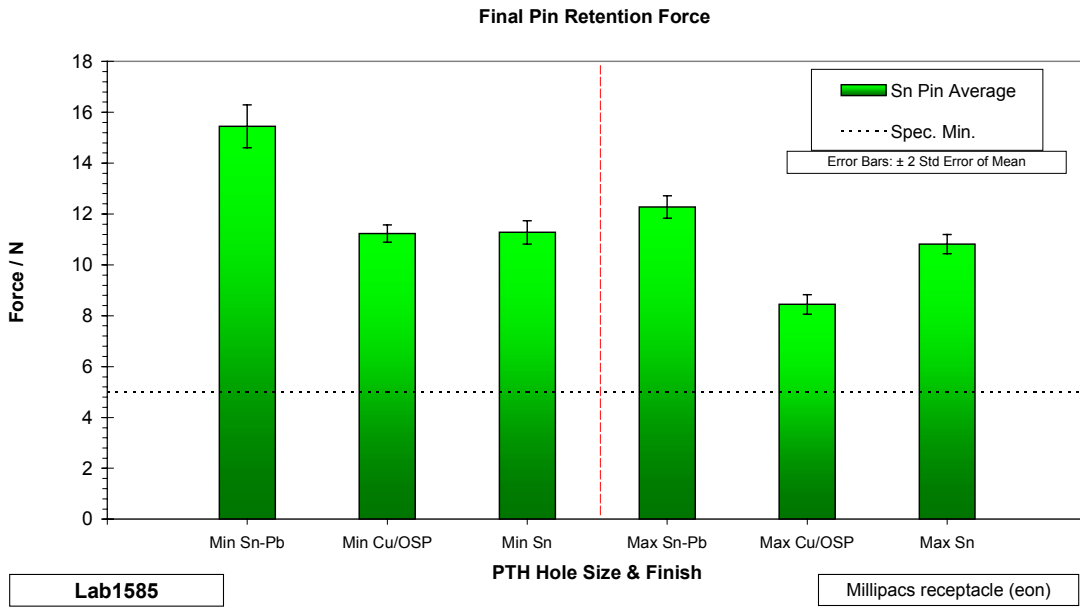
**Figure 3. Initial Insertion Force (Individual Pins)**



**Figure 4. 1<sup>st</sup> Retention Force (Individual Pins)**



**Figure 5. Final Retention Force (Individual Pins)**



**EQUIPMENT:**

<b>Item Description</b>	<b>Manufacturer (Model)</b>	<b>Equip. ID #</b>	<b>Cal. Due Date</b>
Draw bench	Zwick Z020	T-002	19-07-2005
Profile projector	Mitutoyo PJ311	J-118	16-04-2005

REVISION RECORD

<b>Rev. #</b>	<b>Revision Date</b>	<b>Page(s)</b>	<b>Description</b>
–	26-05-2005	All	Original Issue