

Report EL-2005-06-012 CR
Evaluation of Repairability, FCI Lead Free BERGSTIK® Connectors
Rev. B
2006 May 08

PURPOSE:

Lead free BERGSTIK® 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 SPLIT-LIF (Bow Tie) style compliant sections on press fit (PF) pins fabricated from approximately 0.6 mm thick basis metal for application in printed wiring board (PWB) holes of approximately 1 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

Item	Quantity	Description	Part Number	Lot	PF Plating	Received
1	1500	BERGSTIK® Pin	94604-A001B LF	EPR V42551P 2005 May 19	Sn / Ni	2005 Jun 06
3	165	BERGSTIK® Header	94674-164LF	EPR V42552A 2005 May 20	Sn / Ni	2005 Jun 06

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-12-005	Product Specification, SPLIT-LIF Compliant Pin	Rev. D, 2000 Aug 15

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 st	2	2
Repair:	Insertion	3	3
	Retention	4	4
	Insertion	5	5
Microsectioning	Transverse	6 (10 Pins, Min PTH Only)	
PTH Deformation		7 (10 Pins, Min PTH Only)	
Remaining Cu Thickness		8 (10 Pins, Min PTH Only)	
Microsectioning	Longitudinal	9 (10 Pins, Min PTH Only)	
PTH Axial Damage		10 (10 Pins, Min PTH Only)	
Retention Force Measurement	Final (3 rd)	11 (Remaining Connectors)	6

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 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 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 performed on pins in minimum size PTHs in accordance with IEC 60352-5, sections 5.2.2.5, 5.3.2.1.1, and 5.3.2.2. 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 the third (3rd) 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 are listed in table 5. The requirements for forces and for remaining copper thickness were taken from FCI product specification GS-12-005; the requirement for PTH deformation (which is unspecified in FCI GS-12-005) was taken from IEC 60352-5.

Table 5. Requirements

Test	Item	Value
Insertion Force Measurement	Maximum Insertion Force	178 Newtons / Pin
Retention Force Measurement	Minimum Retention Force	22.2 Newtons / Pin
PTH Deformation	Maximum Radial Deformation	70 micrometers
Remaining PTH Copper Thickness	Minimum Average of Minimum Cu Thickness	7.6 micrometers

TEST RESULTS:

Test Group A (Connectors)

The results of force measurements on assembled connectors are summarized in tables 6 through 8 and displayed graphically in figures 1 through 3. The results of maximum PTH deformation measurement are summarized in table 9 and displayed graphically in figure 4. The results of minimum remaining PTH copper thickness are summarized in table 10 and displayed graphically in figure 5.

Table 6. Initial Insertion Force (Connectors)

PTH Size	Minimum			Maximum		
PWB Finish	Sn-Pb	Cu/OSP	Sn	Sn-Pb	Cu/OSP	Sn
Count	5	5	5	5	5	5
[Average Measured Force / Pin] / Newton						
Average	131.8	141.6	130.6	96.6	141.5	99.4
Std Dev	1.8	5.5	4.0	0.7	1.3	0.9
Minimum	129.0	133.9	126.3	95.6	140.3	98.5
Maximum	133.7	149.0	135.7	97.6	143.7	100.8

Table 7. 1st Retention Force (Connectors)

PTH Size	Minimum			Maximum		
PWB Finish	Sn-Pb	Cu/OSP	Sn	Sn-Pb	Cu/OSP	Sn
Count	5	5	5	5	5	5
[Average Measured Force / Pin] / Newton						
Average	72.9	97.9	94.4	58.4	85.1	76.4
Std Dev	1.2	5.1	3.6	0.8	4.6	3.4
Minimum	70.9	93.2	89.2	57.2	77.8	70.9
Maximum	74.3	104.1	97.9	59.2	89.9	79.6

Table 8. Final Retention Force (Connectors)

PTH Size	Minimum			Maximum		
PWB Finish	Sn-Pb	Cu/OSP	Sn	Sn-Pb	Cu/OSP	Sn
Count	3	3	3	3	3	3
[Average Measured Force / Pin] / Newton						
Average	90.1	94.4	95.7	82.3	88.1	83.0
Std Dev	4.5	1.1	2.2	1.7	4.3	2.4
Minimum	87.0	93.6	93.4	80.7	83.2	81.0
Maximum	95.2	95.6	97.9	84.1	91.4	85.6

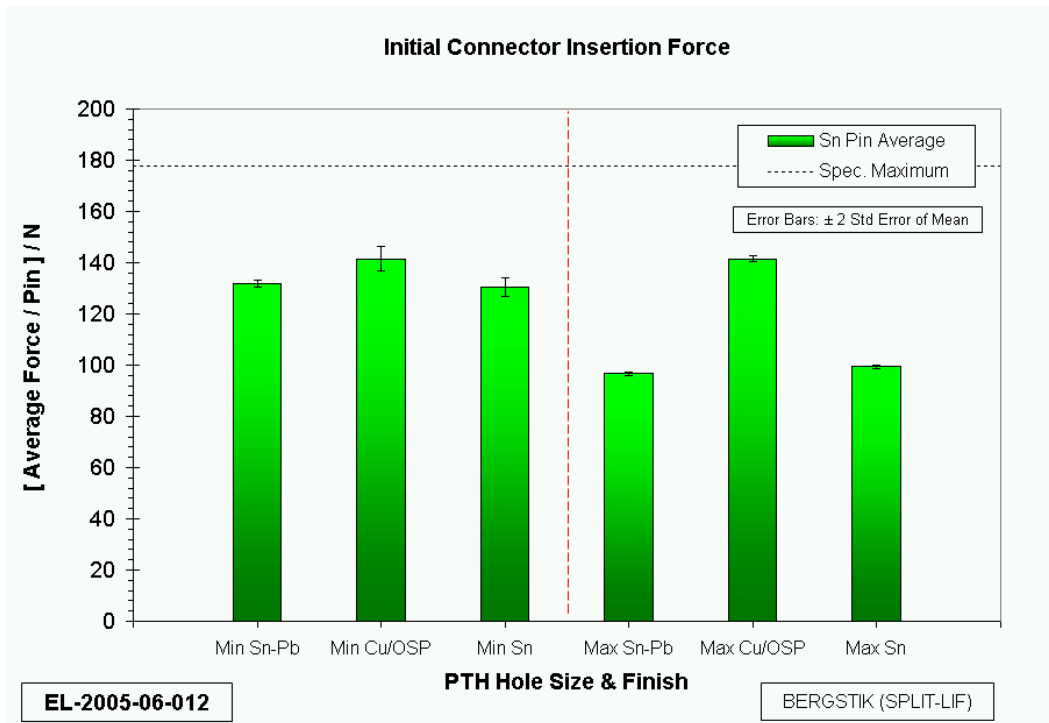


Figure 1. Initial Insertion Force (Connectors)

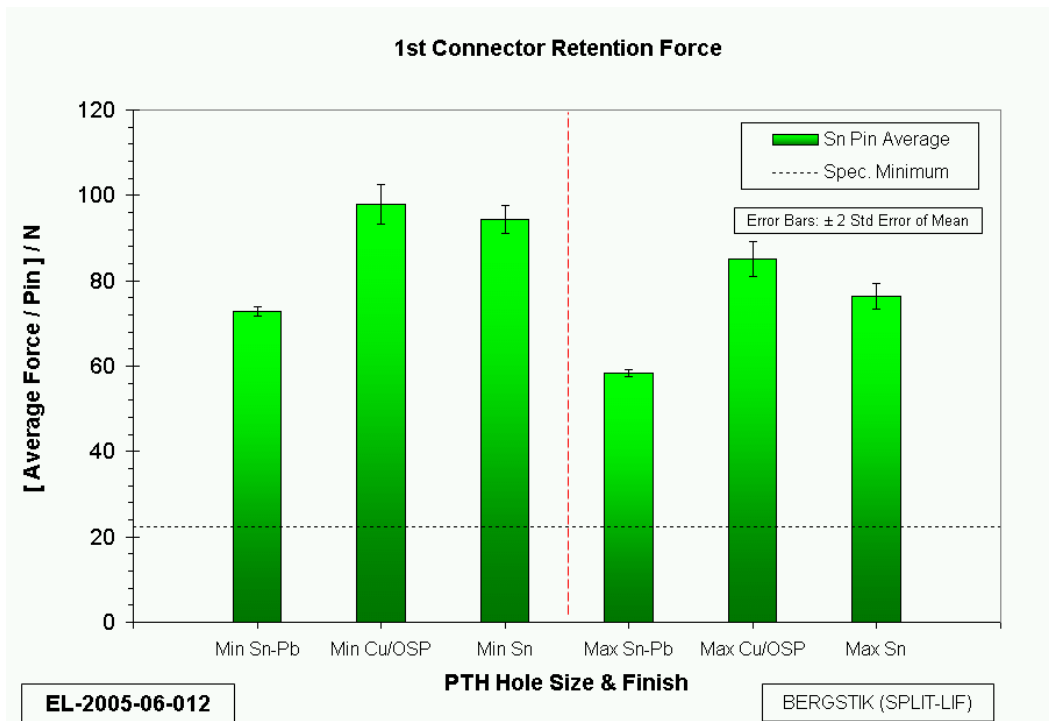


Figure 2. 1st Retention Force (Connectors)

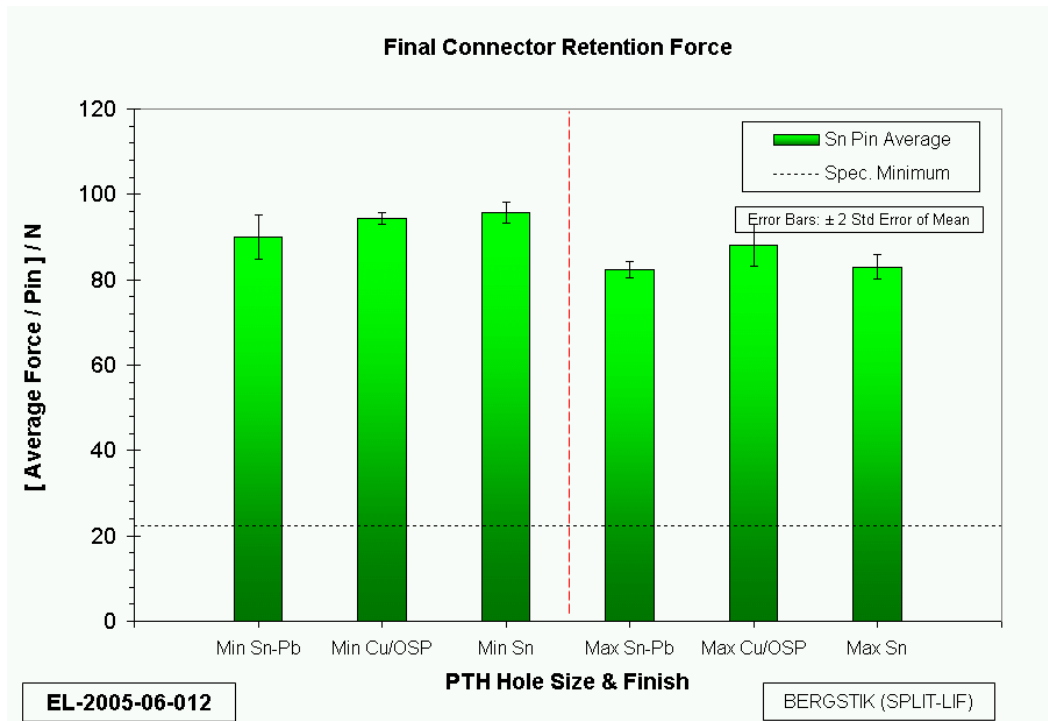


Figure 3. Final Retention Force (Connectors)

Table 9. Maximum PTH Deformation

PTH Size	Minimum		
	Sn-Pb	Cu/OSP	Sn
PWB Finish			
Count	10	10	10
Measured Maximum PTH Deformation / micrometer			
Average	29.2	26.7	41.4
Std Dev	8.6	4.0	6.0
Minimum	25.4	25.4	33.0
Maximum	50.8	38.1	45.7

Table 10. Minimum Remaining PTH Copper Thickness

PTH Size	Minimum		
	Sn-Pb	Cu/OSP	Sn
PWB Finish			
Count	10	10	10
Measured Minimum Remaining PTH Thickness / micrometer			
Average	27.9	20.2	20.9
Std Dev	4.9	3.1	5.3
Minimum	20.7	15.6	14.7
Maximum	37.3	25.2	31.1

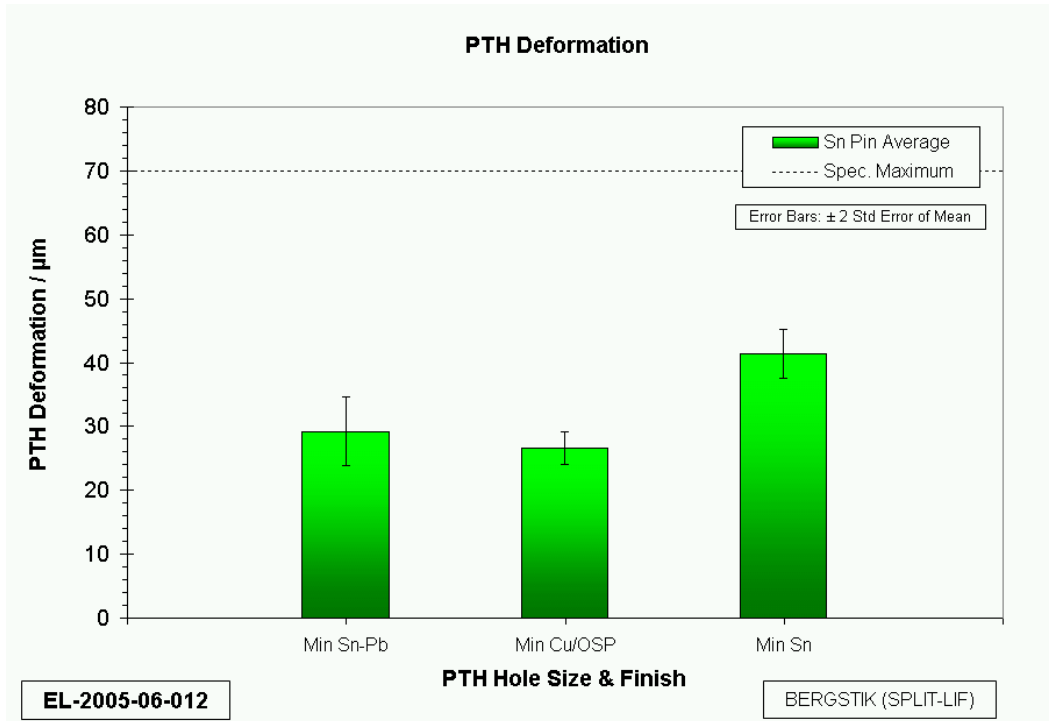


Figure 4. Maximum PTH Deformation

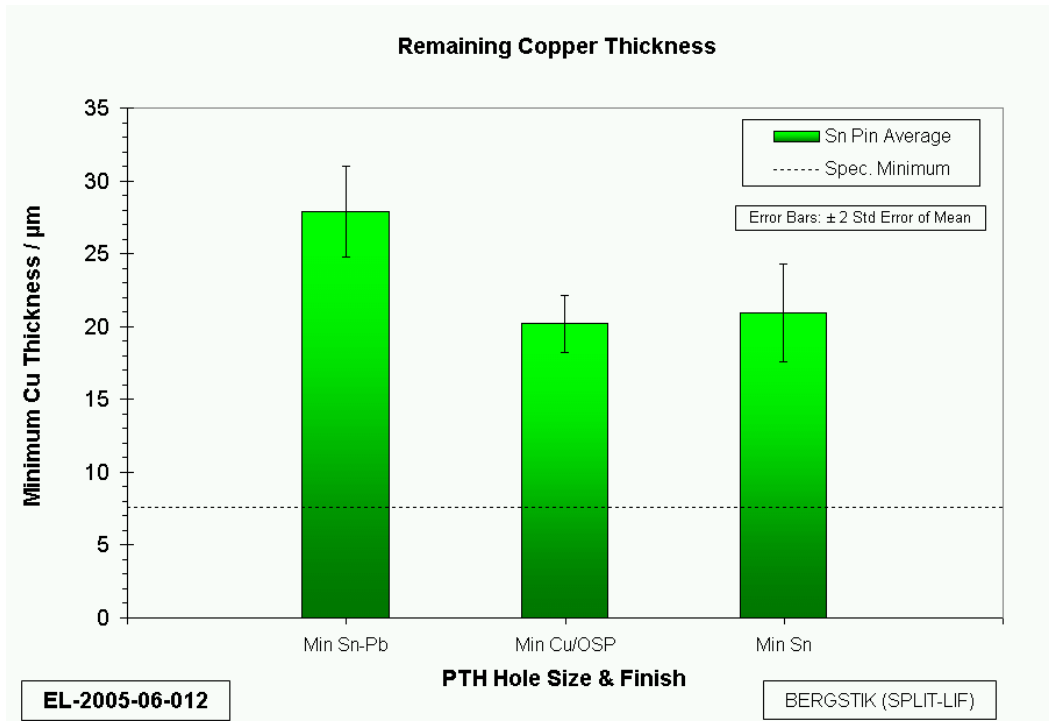


Figure 5. Minimum Remaining PTH Copper Thickness

Test Group B (Individual Pins)

The results of force measurement on individual pins are summarized in tables 11 through 13 and displayed graphically in figures 6 through 8.

Table 11. 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	129.2	127.9	120.7	103.3	145.9	96.1
Std Dev	5.6	5.6	2.4	11.6	10.6	6.3
Minimum	115.2	120.1	116.5	91.6	131.2	82.3
Maximum	137.9	140.6	125.0	150.8	169.5	104.1

Table 12. 1st 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	93.1	115.7	107.2	77.0	116.2	97.3
Std Dev	4.1	8.8	8.9	2.7	11.3	13.3
Minimum	85.0	99.6	80.1	72.1	80.5	68.5
Maximum	102.3	128.1	117.9	82.3	133.0	115.2

Table 13. 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	85.3	108.3	102.9	89.1	99.8	79.7
Std Dev	6.0	10.4	10.5	5.3	9.2	4.5
Minimum	73.4	89.4	78.7	78.3	74.3	73.4
Maximum	95.6	128.6	126.3	96.1	115.7	88.5

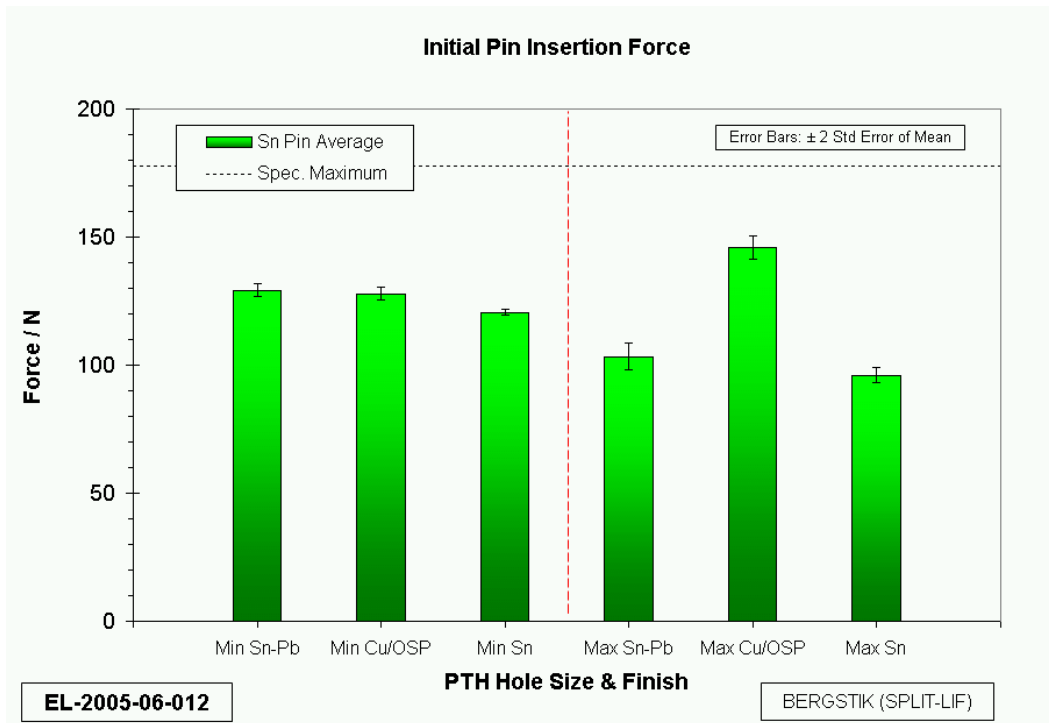


Figure 6. Initial Insertion Force (Individual Pins)

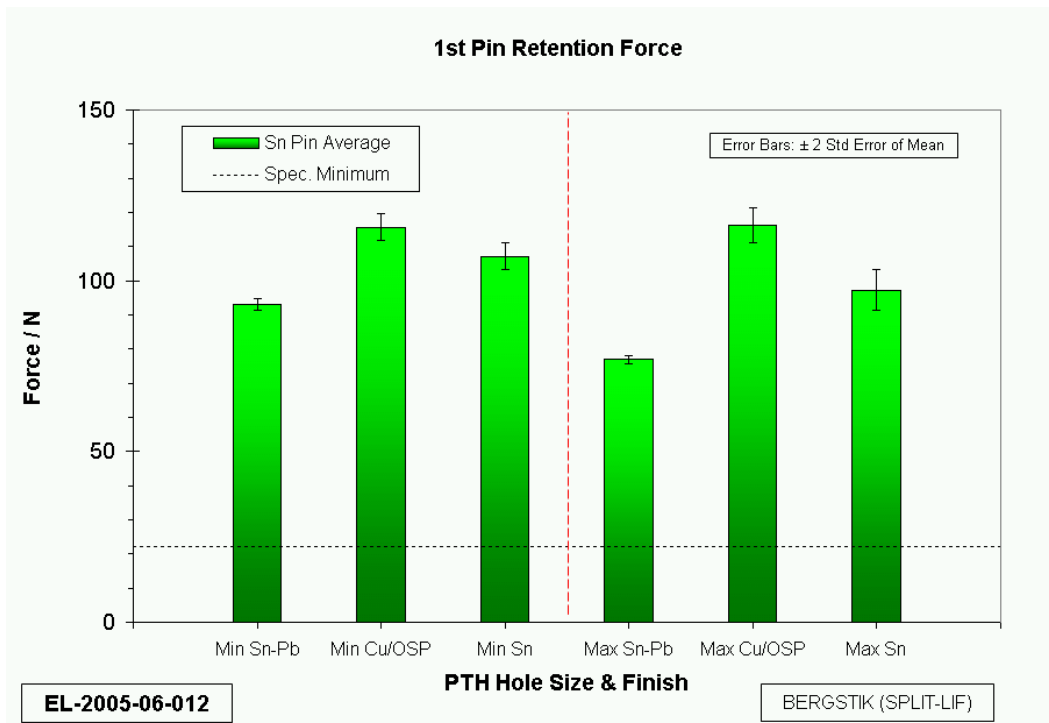


Figure 7. 1st Retention Force (Individual Pins)

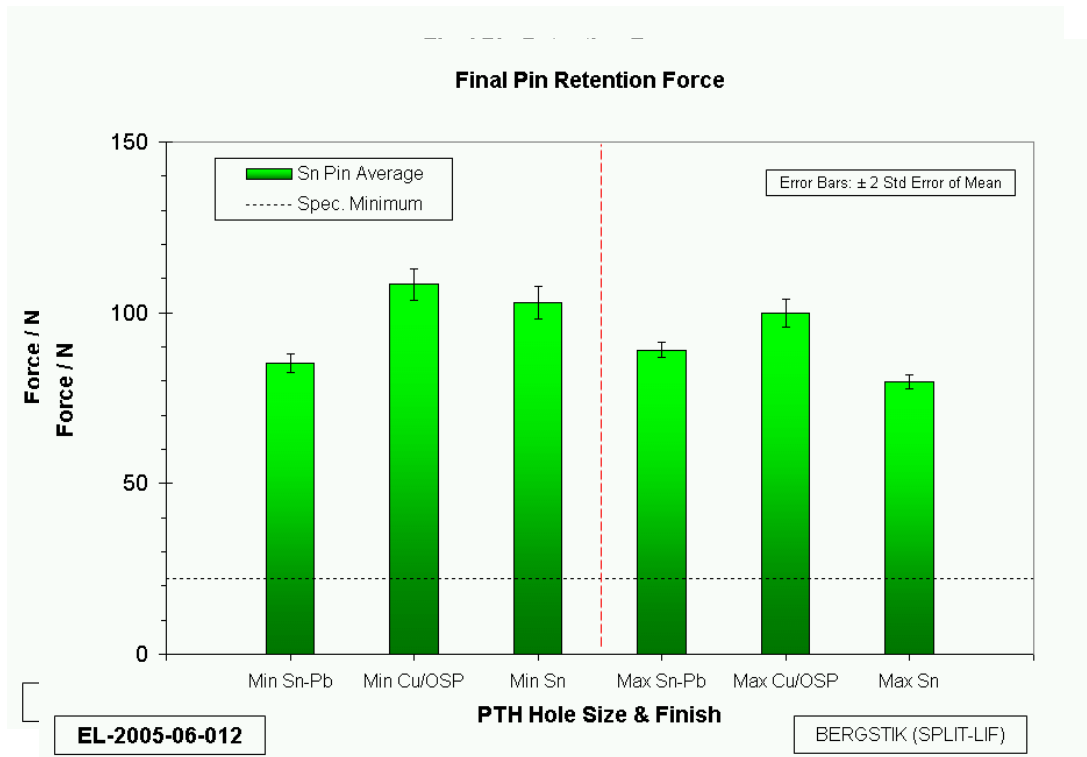


Figure 8. Final Retention Force (Individual Pins)

EQUIPMENT:

Item Description	Manufacturer (Model)	Equip. ID #	Cal. Due Date
Microscope	Bausch & Lomb (StereoZoom 5)	VG6620	Not Calibrated
Tensile/Compression Tester	Instron (Model 1122, SN 4664)	VG6464	2005 Jul
Tensile/Compression Tester	Instron (Model 1122, SN 4471)	VG7171	2005 Jul
Tensile/Compression Tester	Instron (Model 1122, SN 5013)	VG6461	2005 Jul
Load Cell	Instron (50 kg, SN 114)	VG6962	Cal. Before Use
Load Cell	Instron (1000 lb, SN 1281)	VG6460	2005 Jul
Load Cell	Instron (1000 lb, SN 1693)	VG6452	2005 Jul
Calibration Mass	Instron (10 lb, #1)	VG6253	2005 Aug
Calibration Mass	Instron (10 lb, #2)	VG6254	2005 Aug
Micrometer	Mitutoyo (M825-1", SN 193-211)	VG6809	2006 Jan
Metallographic Microscope	Reichert-Jung (Polyvar-MET, SN 392265)	VG7398	Not Calibrated
Digital Camera	Diagnostics Instruments (Insight Model 3.2.0)	VG7749	Not Calibrated
Stage Micrometer	SPI (2266)	VG7648	2010 Oct
Comparator	Nikon (Profile Projector Model V-12)	VG6416	2005 Dec

REVISION RECORD

Rev. #	Revision Date	Page(s)	Description
-	2005 Jun 30	All	Original Issue
A	2006 Apr 03	1	Updated Corporate Logo
B	2006 May 08	1	Repositioned Corporate Logo