



Report R04-044-2147

Evaluation of Repairability, FCI Lead Free METRAL Header RA Connectors

Rev. /
21/06/2005

PURPOSE:

Lead free METRAL Header RA 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 EON style compliant sections on press fit (PF) pins fabricated from approximately 0.5 mm thick basis metal for application in printed wiring board (PWB) holes of approximately 0.70 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	360	METRAL Signal Pins	8626-2147 ZC	114005	Sn / Ni	15/06/04
2	72	METRAL Connector	HM1L51LDP000 H6	114263	Sn / Ni	W0429

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)

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	2 nd	3	3
Retention	2 nd	4	4
Insertion	3 rd	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)

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:

Table 5. Requirements

Test	Item	Value
Insertion Force Measurement	Maximum Insertion Force	55 Newtons
Retention Force Measurement	Minimum Retention Force	20 Newtons
PTH Deformation	Maximum Radial Deformation	70 micrometers
Remaining PTH Copper Thickness	Minimum Cu Thickness	8 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	3	4	4	4	4	4
	[Average Measured Force / Pin] / Newton					
Average	1555,0	1178,6	1176,3	1452,7	1022,3	1006,5
Std Dev	20,6	15,2	14,1	70,5	18,6	14,7
Minimum	1531,7	1165,7	1159,1	1350,5	999,6	989,9
Maximum	1577,3	1196,6	1192,9	1509,3	1041,6	1022,0

Table 7. 1st Retention Force (Connectors)

PTH Size	Minimum			Maximum		
PWB Finish	Sn-Pb	Cu/OSP	Sn	Sn-Pb	Cu/OSP	Sn
Count	4	4	4	4	4	4
	[Average Measured Force / Pin] / Newton					
Average	915,3	617,9	698,8	1006,9	711,3	733,2
Std Dev	39,8	39,5	50,0	14,6	33,7	16,8
Minimum	882,1	565,4	642,8	999,0	682,3	715,5
Maximum	971,0	659,2	759,0	1028,8	751,4	755,9

Table 8. Final Retention Force (Connectors)

PTH Size	Minimum			Maximum		
PWB Finish	Sn-Pb	Cu/OSP	Sn	Sn-Pb	Cu/OSP	Sn
Count	2	2	2	2	3	3
	[Average Measured Force / Pin] / Newton					
Average	764,8	630,5	751,3	827,6	590,9	715,1
Std Dev	90,7	8,4	51,4	39,9	11,7	10,2
Minimum	700,7	624,6	715,0	799,3	577,5	705,2
Maximum	829,0	636,4	787,7	855,8	598,8	725,5

Initial Connector Insertion Force

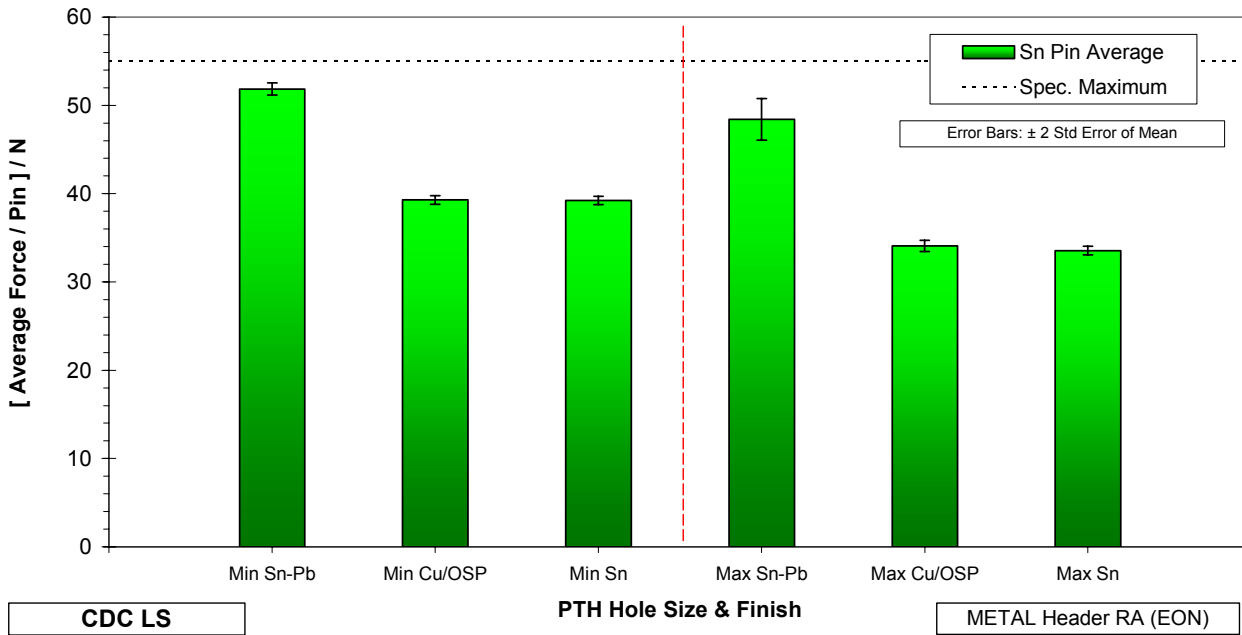


Figure 1. Initial Insertion Force (Connectors)

1st Connector Retention Force

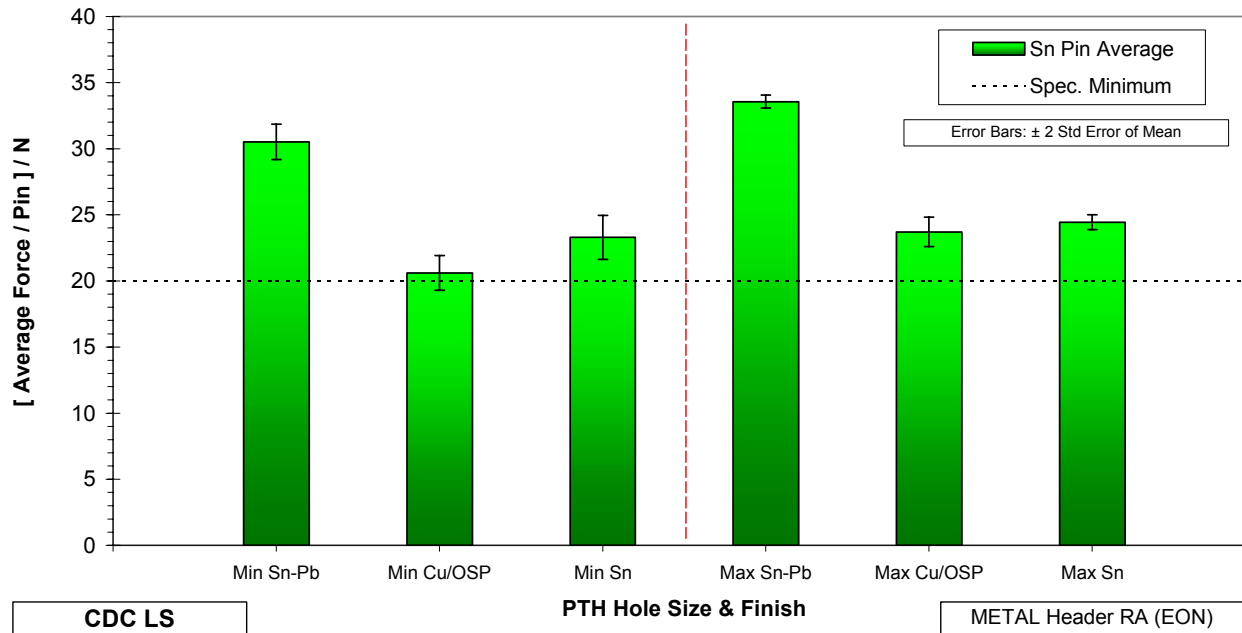


Figure 2. 1st Retention Force (Connectors)

Final Connector Retention Force

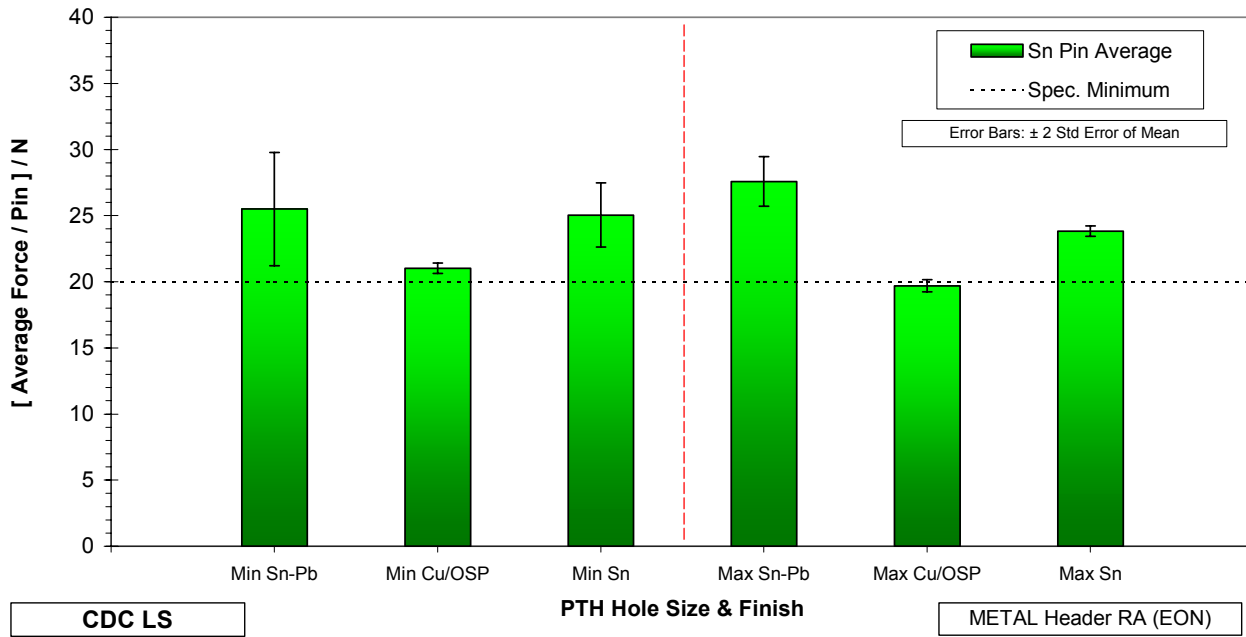


Figure 3. Final Retention Force (Connectors)

Table 9. Maximum PTH Deformation

PTH Size	Minimum		
PWB Finish	Sn-Pb	Cu/OSP	Sn
Count	10	10	10
	Measured Maximum PTH Deformation / micrometer		
Average	23,6	28,5	18,1
Std Dev	8,8	6,1	6,1
Minimum	10,6	19,5	8,3
Maximum	34,9	36,3	28,0

Table 10. Minimum Remaining PTH Copper Thickness

PTH Size	Minimum		
PWB Finish	Sn-Pb	Cu/OSP	Sn
Count	10	10	10
	Measured Minimum Remaining PTH Thickness / micrometer		
Average	34,9	35,6	34,3
Std Dev	8,0	7,3	8,7
Minimum	15,4	25,2	21,6
Maximum	45,5	46,3	44,4

PTH Deformation

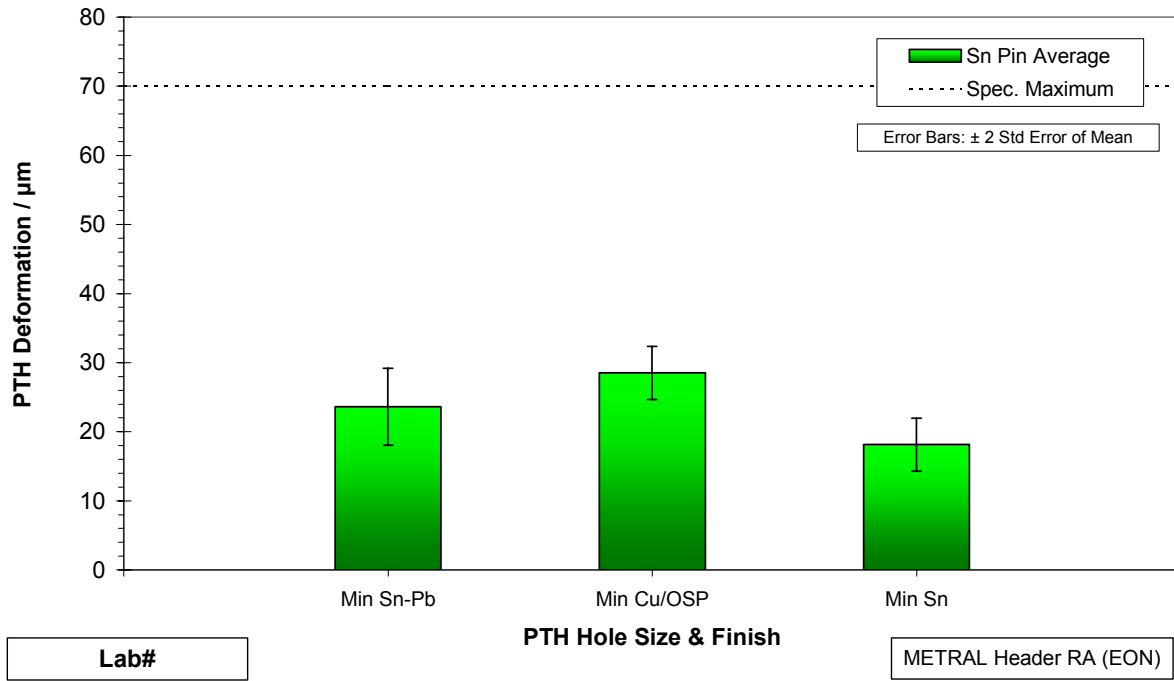


Figure 4. Maximum PTH Deformation

Remaining Copper Thickness

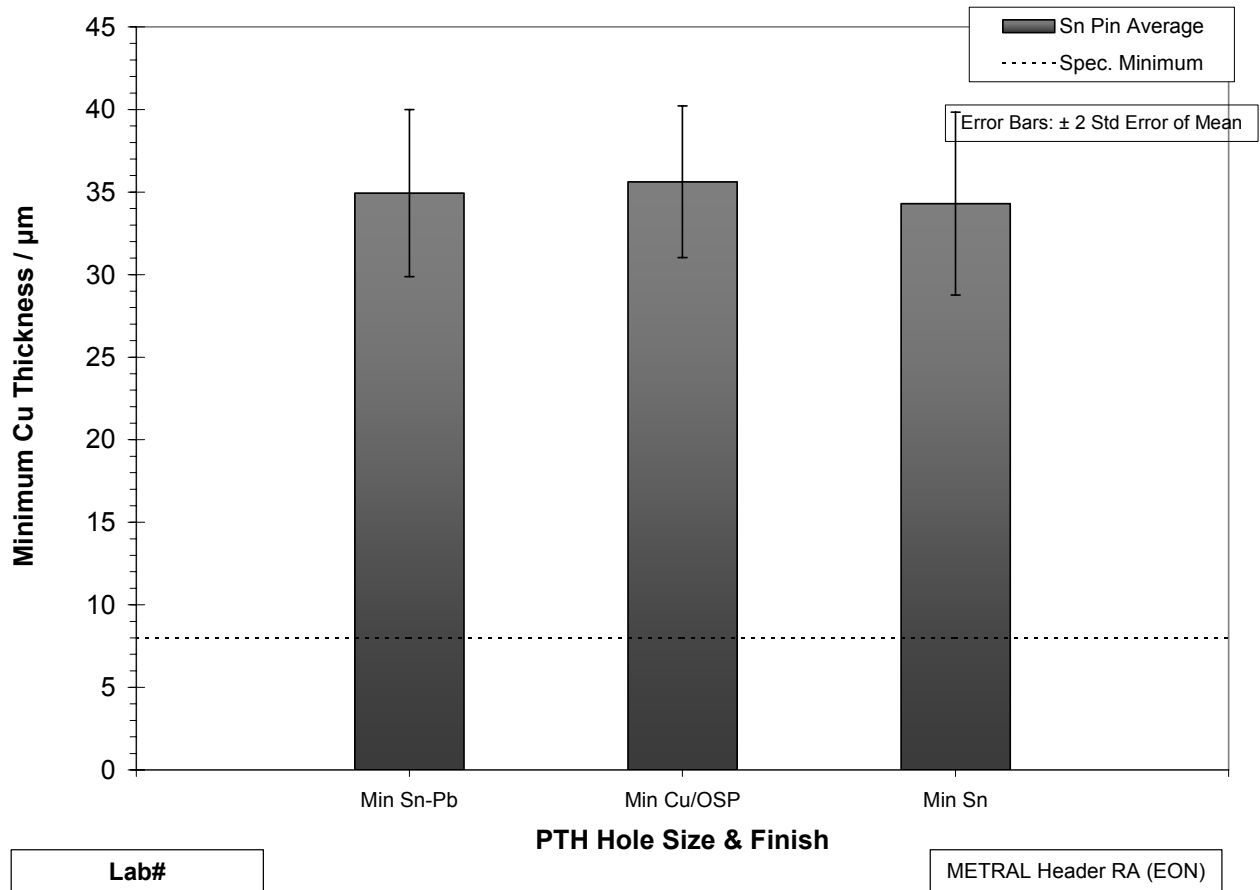


Figure 5. Minimum Remaining PTH Copper Thickness

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	47,5	40,0	38,1	42,7	37,7	31,7
Std Dev	2,8	2,4	2,8	3,8	2,5	1,5
Minimum	42,5	34,9	34,0	35,1	33,5	29,0
Maximum	52,5	44,3	43,9	48,2	43,0	33,8

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	43,9	36,2	42,8	36,0	37,1	38,5
Std Dev	3,7	4,4	5,7	3,0	3,6	3,8
Minimum	39,1	28,9	32,3	31,1	31,3	32,9
Maximum	54,8	45,0	51,5	43,5	43,3	44,5

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	19	20	20	20	20
	[Measured Force / Pin] / Newton					
Average	49,1	37,0	46,2	42,5	34,2	36,0
Std Dev	3,3	4,3	5,3	3,8	3,6	3,5
Minimum	44,2	30,1	36,4	34,4	27,4	28,9
Maximum	55,5	44,1	55,2	48,3	44,3	41,7

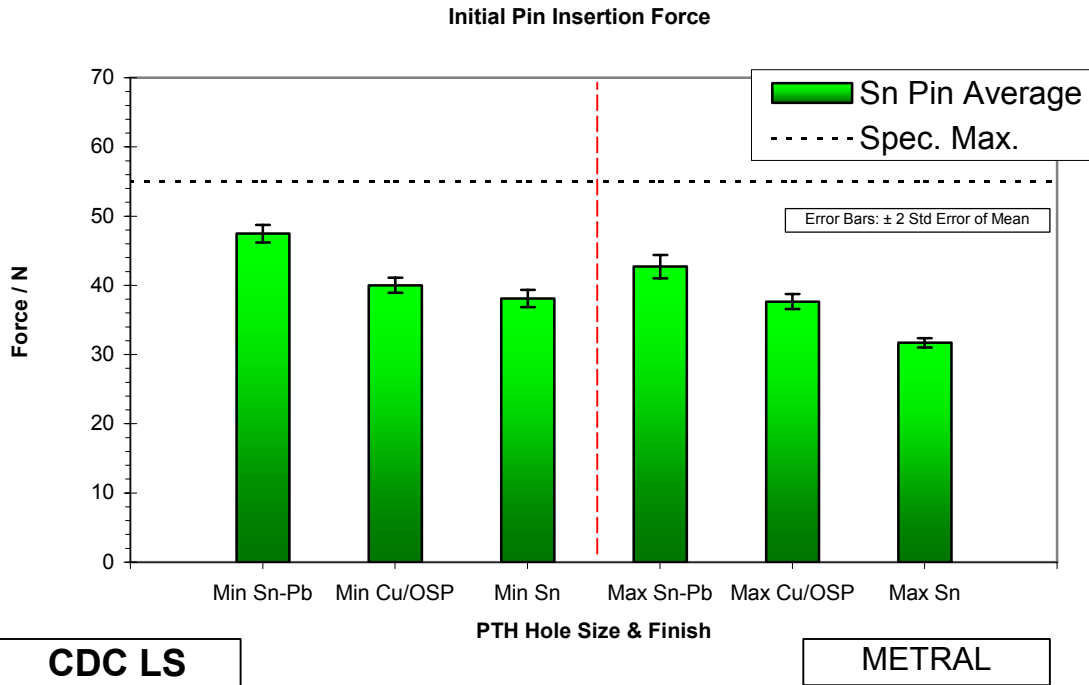


Figure 6. Initial Insertion Force (Individual Pins)

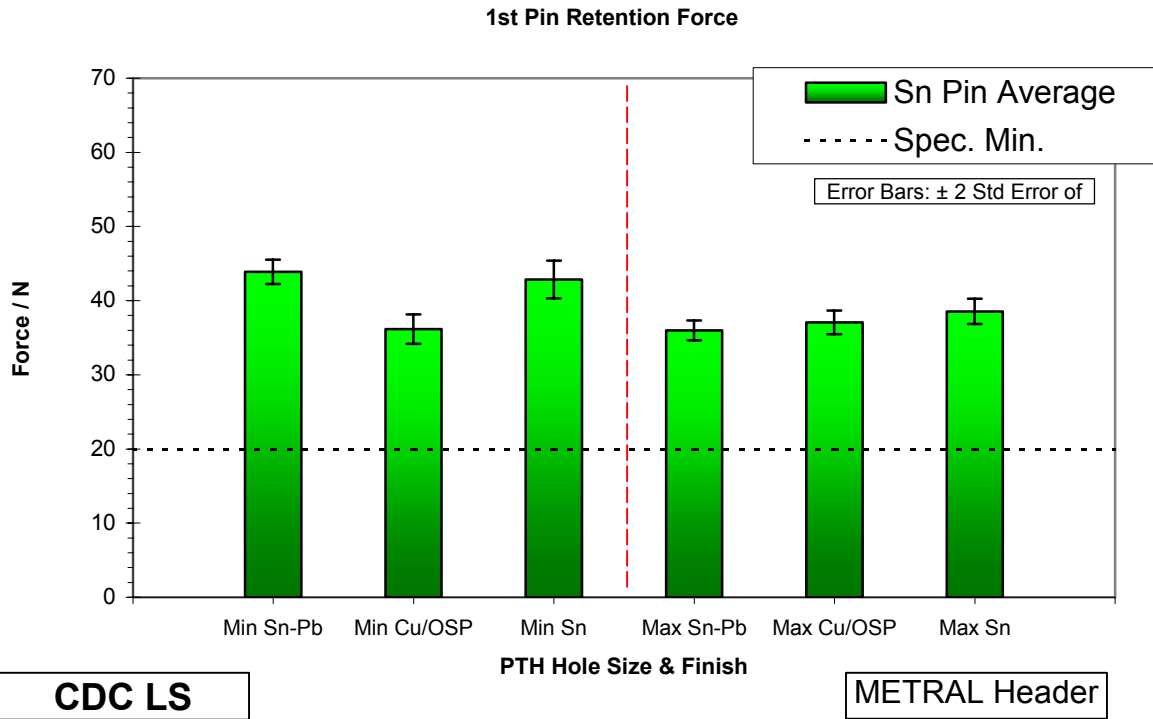


Figure 7. 1st Retention Force (Individual Pins)

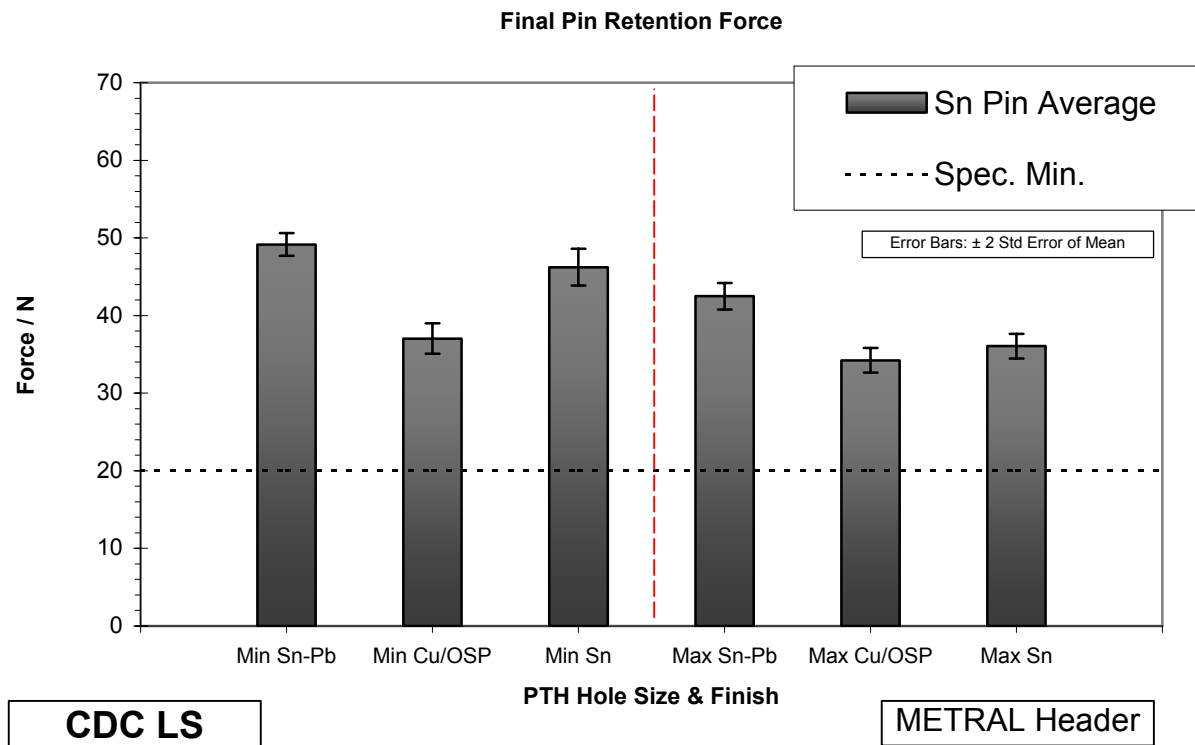


Figure 8. Final Retention Force (Individual Pins)

EQUIPMENT:

Item Description	Manufacturer (Model)	Equip. ID #	Cal. Due Date
Tensile/compression test instrument	Zwick /Z010 NT 2S WN	Displacement sensor : WN148454 Force sensor : WN 148456 1 (500N) Force sensor : WN 148455 (10KN)	02/2006
Microscope with video system	Nikon Epiphot	Lens X10	02/2006
Mirosectioning equipment	Buehler	/	/

REVISION RECORD

Rev. #	Revision Date	Page(s)	Description
-	2005 Jun 21	All	Original Issue