Multi-Beam XLE Power Distribution Connector System

1. INTRODUCTION

1.1. Purpose

Testing was performed on Multi-beam XLE Power Distribution Connector System to determine its conformance to requirements of product Specification 108-2292, Revision B

1.2. Scope

This report covers the electrical, mechanical, and environmental performance of Multi-beam XLE Power Distribution Connector System. Testing was performed at the China Engineering Center Testing Laboratory and Harrisburg Electrical Components Test Laboratory. The test file numbers for this testing are TR-60193-E ,TR-60134-E, TR-60185-E and EA20090495T, These documentations are on file at and available from the Engineering Assurance Product Testing Laboratory
For 80A additional testing items please refer to test report 502-128105.
For Orthogonal testing items please refer to test report 502-128124.

1.3. Conclusion

The Multi-beam XLE Power Distribution Connector System conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-2292, Revision B

1.4. Test Specimens

The specimens were representative of normal production lots, Specimens identified with the following part numbers were used for test.

Part Number	Description
6450860-2	Vertical receptacle,4ACP + 48S + 12HDP
6450880-3	Right angle receptacle,4ACP + 48S + 12HDP
6450840-4	Right angle plug,4ACP + 48S + 12HDP
6450860-3	Vertical receptacle, 12P + 48S + 8LP
6450880-4	Right angle receptacle,12P + 48S + 8LP
6450840-3	Right angle plug,12P + 48S + 8LP
6450860-2	Vertical receptacle,4ACP + 48S + 12HDP
6450880-3	Right angle receptacle,4ACP + 48S + 12HDP
60-1042491	Multi-beam XLE 2 Layered PCB for 6450880-3
60-1042492	Multi-beam XLE 2 Layered PCB for 6450840-4
60-1042497	Multi-beam XLE 2 Layered PCB for 6450880-4
60-1042498	Multi-beam XLE 2 Layered PCB for 6450840-3
60-1042493	Multi-beam XLE10 Layered PCB for 6450880-3
60-1042494	Multi-beam XLE10 Layered PCB for 6450840-4
60-1042499	Multi-beam XLE10 Layered PCB for 6450880-3
60-1042500	Multi-beam XLE 10 Layered PCB for 6450840-3

Figure 1

1.5. Environmental Conditions

Unless otherwise stated. The following environmental conditions prevailed during testing

Temperature: 25°C
Relative Humidity: 50%

1.6. Product Qualification and Requalification Test Sequence

Test or Examination	Test Group (a)							
	1	2	3	4	5	6(b)	7(b)	8
	Test Sequence (c)							
Initial examination of product	1	1	1	1	1	1	1	1
Low level contact resistance, signal and power contacts	2,5	3,7		2,4				
Low level contact resistance, power contacts only					2,6,8,10			
Contact resistance at rated current, power contacts					12			
Insulation resistance			2,6					
Withstanding voltage			3,7					
Temperature rise vs. current					4,11			
Vibration, random		5			9(d)			
Mechanical shock		6						
Durability	3(e)	4			3(f)			
Mating force		2(g)						
Unmating force		8(g)						
Compliant pin insertion							2	2
Radial hole distortion							3	3
Compliant pin retention							4	5
Component heat resistance to wave soldering						2		
Solderability dip test						3		
Thermal shock			4					
Humidity-temperature cycling			5					
Temperature life				3	7			4
Mixed flowing gas	4				5			
Final examination of product	6	9	8	5	13	4	5	6

NOTE

(a) See paragraph 1.4.
(b) Split into subgroups as needed for on and off board tests.
(c) Numbers indicate sequence in which tests are performed.
(d) Energize at current for 18°C temperature rise.
(e) Precondition specimens with 5 durability cycles.
(f) Precondition specimens with 25 durability cycles.
(g) Power only in housing, signal with gage as shown in 108-2157.

Figure 2

2. SUMMARY OF TESTING

2.1. Initial Examination of Product – All Test Groups

All specimens submitted for testing were representative of normal production lots. A Certificate Conformance (C of C) was issued by Product Assurance. Specimens were visually examined and no evidence of physical damage detrimental to product performance was observed.

2.2. Low Level Contact Resistance, Signal and Power Contacts - Test Groups 1, 2 and 4

All low level contact resistance measurements, taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage were less than 10 milliohms initially and 20 milliohms after testing for power contacts and low power contacts and less than 15 milliohms initially and 20 milliohms after testing for signal contacts.

Test Group	Number of Data points	Condition	LLCR(milliohms)		
			Minimum	Maximum	Average
1	Signal Contacts				
	240	Initial (actual)	4.08	9.96	6.83
	240	After mated mixed flowing gas	4.10	12.59	6.92
	Low power Contacts				
	40	Initial (actual)	0.47	0.87	0.65
		After mated mixed flowing gas	0.59	0.98	0.72
	High Power Contacts				
	120	Initial (actual)	0.23	0.51	0.32
	120	After mated mixed flowing gas	0.23	0.49	0.33
2	Low power Contacts				
	40	Initial (actual)	0.56	0.90	0.73
	40	After mechanical shock	0.58	1.39	0.82
	High Power Contacts				
	80	Initial (actual)	0.24	0.54	0.34
	80	After mechanical shock	0.20	0.52	0.30
4	Signal Contacts				
	240	Initial (actual)	4.25	9.52	6.86
	240	After temperature life	3.73	9.89	6.89
	Low Power Contacts				
	40	Initial (actual)	0.53	0.88	0.71
	40	After temperature life	0.48	1.04	0.79
	High Power Contacts				
	120	Initial (actual)	0.21	0.44	0.31
	120	After temperature life	0.20	0.71	0.37

Figure 3

2.3 Low Level Contact Resistance, Power Contacts Only - Test Group 5

All low level contact resistance measurements, taken at 100 milliamperes maximum and 20 millivolts maximum open circuit voltage were less than 15 milliohms initially and 20 milliohms after testing.

Test Group	Number of Data points	Condition	LLCR(milliohms)		
			Minimum	Maximum	Average
	High Power contact				
5	60	Initial (actual)------2Layer	0.21	0.42	0.31
	60	After Mix Flowing gas ------2Layer	0.26	0.41	0.34
	60	After temperature life ------2Layer	0.28	0.43	0.34
	60	After vibration ------2Layer	0.31	0.41	0.33
	60	Initial (actual)------10Layer	0.24	0.31	0.27
	60	After Mix Flowing gas ------10Layer	0.30	0.52	0.36
	60	After temperature life ------10Layer	0.25	0.55	0.36
	60	After vibration ------10Layer	0.27	0.41	0.33
	Low Power contact				
	32	Initial (actual)------2Layer	0.69	0.87	0.75
	32	After Mix Flowing gas ------2Layer	0.78	2.01	1.01
	32	After temperature life ------2Layer	0.72	1.44	0.86
	32	After vibration ------2Layer	0.73	0.9	0.82
	32	Initial (actual)------10Layer	0.65	0.79	0.72
	32	After Mix Flowing gas ------10Layer	0.67	1.14	0.77
	32	After temperature life ------10Layer	0.63	0.86	0.7
	32	After vibration ------10Layer	0.82	1.1	0.94

Figure 4

2.4 Contact Resistance at Rated Current- Test Group 5

Contact resistance measurements for 0.300, 0.250, and 0.200 pitch power contacts were less than the maximum requirement of 0.7 milliohms and low power contacts were less than the maximum requirement of 1.5 milliohms. All data was taken from specimens on 2 ounce copper 2 layer printed circuit boards and 2 ounce copper 10 layer printed circuit boards. Values were measured per individual contacts.

		2 layer board			10 layer board		
High Power Contact	Contact Type	0.300 pitch	0.200 pitch	0.250 pitch	0.300 pitch	0.200 pitch	0.250 pitch
	Requirement	0.7 mΩ max	0.7 mΩ max	0.7 mΩ max	0.7 mΩ max	0.7 mΩ max	0.7 mΩ max
	Current	44 Amps	35 Amps	35 Amps	67 Amps	52 Amps	54 Amps
	N=	4	12	12	4	12	12
	Min	0.329	0.316	0.309	0.28	0.262	0.310
	Max	0.431	0.460	0.427	0.335	0.396	0.452
	Average	0.379	0.343	0.349	0.312	0.306	0.363
Low Power Contact	Requirement	1.5 mΩ max			1.5 mΩ max		
	Current	23 Amps			22 Amps		
	N=	8			8		
	Min	0.790			0.782		
	Max	1.020			0.983		
	Average	0.913			0.893		

Figure 5

2.5 Insulation Resistance – Test Group 3

All insulation resistance measurements were greater than 500 megohms for signal contacts and greater than 1000 megohms for power and low power contacts.

2.6 Withstanding Voltage – Test Group 3

No dielectric breakdown or flashover occurred

2.7 Temperature Rise vs. Current – Test Group 5

Current listed in Figure 6 are for 30°C temperature rise at end of life., All data was taken from specimens on 2 ounce copper 2 layer printed circuit boards and 2 ounce copper 10 layer printed circuit boards. Detailed T-rise graphs in Appendix 1 (The graphs have been curve fitted from the actual data).

Connector Pitch Inch	PCB	Number of Contacts Current (DC amperes)			
		1	4	8	12
0.200	2- oz 2-layer	50	36.5	33	28
	2- oz 10-layer	75	58	48	44.5
0.250	2- oz 2-layer	50.5	38.5	35	30
	2- oz 10-layer	75	63	49.5	46
0.300	2- oz 2-layer	52	43		
	2- oz 10-layer	85	67		
Low Power	2- oz 2-layer	30.5	19	16	
	2- oz 10-layer	49	28	27	

Figure 6

2.8 Random Vibration – Test Group 2 and 5

No discontinuities were detected during vibration testing. Flowing vibration test. No cracks, breaks, or loose parts on the specimens were visible.

2.9 Mechanical Shock – Test Group 2

No discontinuities were detected during mechanical shock testing. Following mechanical shock testing, no cracks, breaks, or loose parts on the specimens were visible.

2.10 Durability – Test Group1, 2 and 5

No physical damage occurred as a result of mating and unmating the specimens 500 cycles.

2.11 Mating Force – Test Group 2

All mating force measurements for power contacts were less than 5 N per contact.

2.12 Unmating Force – Test Group 2

All unmating force measurements for power contacts were greater than 1.8 N per contact; all unmating force measurements for low power contacts were greater than 0.5 N per contact;

2.13 Compliant Pin Insertion – Test Group 7

All compliant pin insertion force measurements were less than 111.2 N per pin

2.14 Radial hole distortion – Test Group7 and 8

All radial hole distortion measurements were less than 0.070 mm with a minimum of 0.008 mm copper wall remaining.

2.15 Compliant Pin Retention – Test Group 7 and 8

All compliant pin retention measurements were greater than 6.7 N per pin.

2.16 Component Heat Resistance to Wave Soldering – Test Group 6

No evidence of physical damage was visible as a result of subjecting the specimens to wave soldering.

2.17 Solderablity dip test – Test Group 6

All solderable areas had a minimum of 95% solder coverage.

2.18 Thermal Shock – Test Group 3

No evidence of physical damage was visible as a result of thermal shock testing

2.19 Humidity/temperature cycling – Test Group 3

No evidence of physical damage was visible as a result of humidity/temperature cycling.

2.20 Temperature life – Test Group 4 and 5

No evidence of physical damage was visible as a result of temperature life testing.

2.21 Mixed Flowing Gas – Test Group 1 and 5

No evidence of physical damage was visible as a result of exposure to the pollutants of mixed flowing gas

2.22 Final Examination of Product – All Test Groups

Specimens were visually examined and no evidence of physical damage detrimental no product performance was observed.

3. TEST METHODS

3.1. Initial Examination of Product

A C of C was issued stating that all specimens in the test package were produced, inspected, and accepted as conforming to product drawing requirements, and manufactured using the same core manufacturing processes and technologies as production parts.

3.2. Low Level Contact Resistance, Signal and Power Contacts

LLCR measurements at low level current were made using a four terminal measuring technique. The test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage. Measurements were taken by applying current through the series wired boards via the plated ring holes. Voltage measurements were taken by applying voltage to each contact's plated via hole.

3.3 Low Level Contact Resistance, Power Contacts Only

LLCR measurements at low level current were made using a four terminal measuring technique. The test current was maintained at 100 milliamperes maximum with a 20 millivolt maximum open circuit voltage. Measurements were taken by applying current through the series wired boards via the plated ring holes. Voltage measurements were taken by applying voltage to each contact's plated via hole.

3.4 Contact Resistance at Rated Current

Specimens were subjected to contact resistance testing in accordance with Design Specification 108-2292. and EIA –364-06. Specimens were energized at the current levels listed in paragraph 2.3 and resistance measurements were recorded.

3.5 Insulation Resistance

Insulation resistance was measured between adjacent signal and power contacts of mated specimens. A test voltage of 500 volts DC was applied for 2 minutes before the resistance was measured, in accordance with EIA–364-21C

3.6 Withstanding Voltage

A test potential of 1000 volts DC was applied between the adjacent signal and low power contacts of mated specimens. This potential was applied for 1 minute and then returned to zero. A test potential of 2500 volts DC was applied between the adjacent power contacts of mated specimens. This potential was applied for 2 minute and then returned to zero. In accordance with EIA–364-20B Condition I

3.7 Temperature Rise vs. Current

Infrared temperature measurement points, i.e. exposed contacts, were coated with Micatin powder which is used as an emissivity correction coating. This emissivity correction coating has a know value of 0.93 emittance. Raising and knowing the emittance value allows for accurate temperature measurements. The infrared camera was used with the build in standard optics (24°lens) to image the test specimens. ThermaCAM Researcher 2001 thermal imaging process system was used for data analysis. The area tool software feature was used to determine maximum temperature of the exposed contacts. The area tool software feature allows a shape, which can be sized, to be placed on an area of interest. The pixels inside the shape are analyzed giving minimum, maximum, average, and standard deviation measurements of that targeted temperature.

3.8 Random Vibration

Mated specimens were subjected to a random vibration test, specified by a random vibration spectrum with excitation frequency bounds of 20 and 500 Hz. The spectrum remained flat at 0.05 G^2/Hz from 20Hz to upper bound frequency of 500Hz. The root-mean square amplitude of excitation was 4.90 GRMS. The specimens were subjected to this test time of 45 minutes per specimen. Specimens were monitored for discontinuities of microsecond or greater using an energizing current of 100 milliamperes. In accordance with EIA–364-28D Condition Ⅶ

3.9 Mechanical Shock

Mated specimens were subjected to a mechanical shock test having s half – sine waveform of 50 gravity units (g peak) and duration of 11 milliseconds. Three shocks in each direction were applied along the 3 mutually perpendicular planes for a total of 18 shocks. Specimens were monitored for discontinuities of one microsecond or greater using a current of 100 milliamperes DC. In accordance with EIA–364-27B Method A

3.10 Durability

Specimens were mated and unmated 250 cycles at a maximum rate of 500 cycles per hour. In accordance with EIA–364-09

3.11 Mating force

The force required to mate individual specimens was measured using a tensile/compression device with a free floating fixture and a rate of travel of 12.7 mm per minute. The maximum average force per power contact was 5N. In accordance with EIA–364-13B

3.12 Unmating force

The force required to mate individual specimens was measured using a tensile/compression device with a free floating fixture and a rate of travel of 12.7 mm per minute. The minimum average force per power contact was 1.8N and per low power contact was 0.5N. In accordance with EIA–364-13B

3.13 Compliant Pin insertion

The force required to apply the specimens to a PCB was measured using a tensile / compression device with a rate of travel of 12.7 mm per minute. A flat rock technique was used to press the connectors off the PCB. In accordance with EIA–364-05

3.14 Radial Hole Distortion

A total of 10 randomly picked pin/holes from 1 specimen were cross-sectioned horizontally as close as possible to the area of maximum deformation. These cross-sections were used to determine mean and maximum radial deformation/distortion as follows: Using an optical video probe with variable magnification of 100 to 300X, measurements were made using a round template affixed to the screen of the video monitor. The lines were matched to the radius of the plated thru-holes by adjusting the magnification of the probe. This line was placed on the original hole radius, and the difference between the original radius and the maximum and minimum deformation/distorted radius was measured for each of the 10 pin/holes. The same 10 pin/holes that were cross sectioned to measure hole deformation were also used to determine hole damage and minimum copper thickness between the pin and the PCB laminate. The holes were also examined for any evidence of cracks or breaks in the copper wall.

3.15 Compliant Pin Retention

The force required to remove a correctly applied specimen from a printed circuit board was measured using a tensile/compression device with a free floating fixture and a rate of travel of 12.7 mm [.5 in] per minute.

3.16 Component Heat Resistance to Wave Soldering - Test Group 6

All specimens were checked dimensionally before and after exposure to heat. The solderable areas of the specimens were immersed in Kester 145 type ROL0 flux for 5 to 10 seconds. This flux is a non-activated rosin flux having a nominal composition of 25% by weight of water white gum rosin in a solvent of 99% isopropyl alcohol. The specific gravity of the flux was between 0.838 and 0.858. The flux was maintained at room temperature. The specimens were then removed from the flux and the excess was allowed to drain off for 5 to 20 seconds. The specimens were attached to a dipping machine and immersed at a maximum rate of 25.4 mm [1 in] per second into a soldering bath filled with melted lead free solder (96.5% Sn, 3.0% Ag and 0.5% Cu) controlled at 265 ± 5/C [509/F] until the solderable surface was coated. The specimens were held in the solder bath for 10 seconds. The specimens were then removed from the solder bath at a maximum rate of 25.4 mm [1 in] per second and subjected to a 5 minute cleaning in isopropyl alcohol. The specimens were then given a visual examination using 30X magnification.

3.17 Solderability Dip Test - Test Group 6

The solderable areas of the specimens were immersed in Kester 145 type ROL0 flux for 5 to 10 seconds. This flux is a non-activated rosin flux having a nominal composition of 25% by weight of water white gum rosin in a solvent of 99% isopropyl alcohol. The specific gravity of the flux was between 0.838 and 0.858. The flux was maintained at room temperature. The specimens were then removed from the flux and the excess was allowed to drain off for 5 to 20 seconds. The specimens were immersed at a maximum rate of 25.4 mm [1 in] per second into a soldering bath filled with melted lead free solder (96.5% Sn, 3.0% Ag and 0.5% Cu) controlled at 245 ± 5°C [473/F] until the solderable surface was coated. The specimens were held in the solder bath for 4 to 5 seconds. The specimens were then removed from the solder bath at a maximum rate of 25.4 mm [1 in] per second and subjected to a 5 minute cleaning in isopropyl alcohol. The specimens were then given a visual examination using 30X magnification.

3.18 Thermal Shock

Mated specimens were subjected to 36 cycles of thermal shock with each cycle consisting of 30 minute dwells at -40° and 125°C. The transition between temperatures was less than 1 minute. In accordance with EIA–364-32C

3.19 Humidity-temperature Cycling

Mated specimens were exposed to 10 cycles of humidity-temperature cycling. Each cycle lasted 24 hours and consisted of cycling the temperature between 25 and 40°C at 80 to 100 %RH. In accordance with EIA–364-31B Method Ⅲ

3.20 Temperature Life

Mated specimens were exposed to a temperature of 125/C for 504 hours (21 days). In accordance with EIA–364-17B Method A

3.21 Mixed Flowing Gas

Mated specimens were exposed for 14 days to a mixed flowing gas Class IIA exposure. Class IIA exposure is defined as a temperature of 30/C and a relative humidity of 70% with the pollutants of Cl_2 at 10 ppb, NO_2 at 200 ppb, H_2S at 10 ppb and SO_2 at 100 ppb. In accordance with EIA–364-65 Class IIA

3.22 Final Examination of Product

Specimens were visually examined for evidence of physical damage detrimental to product performance.

Appendix-1

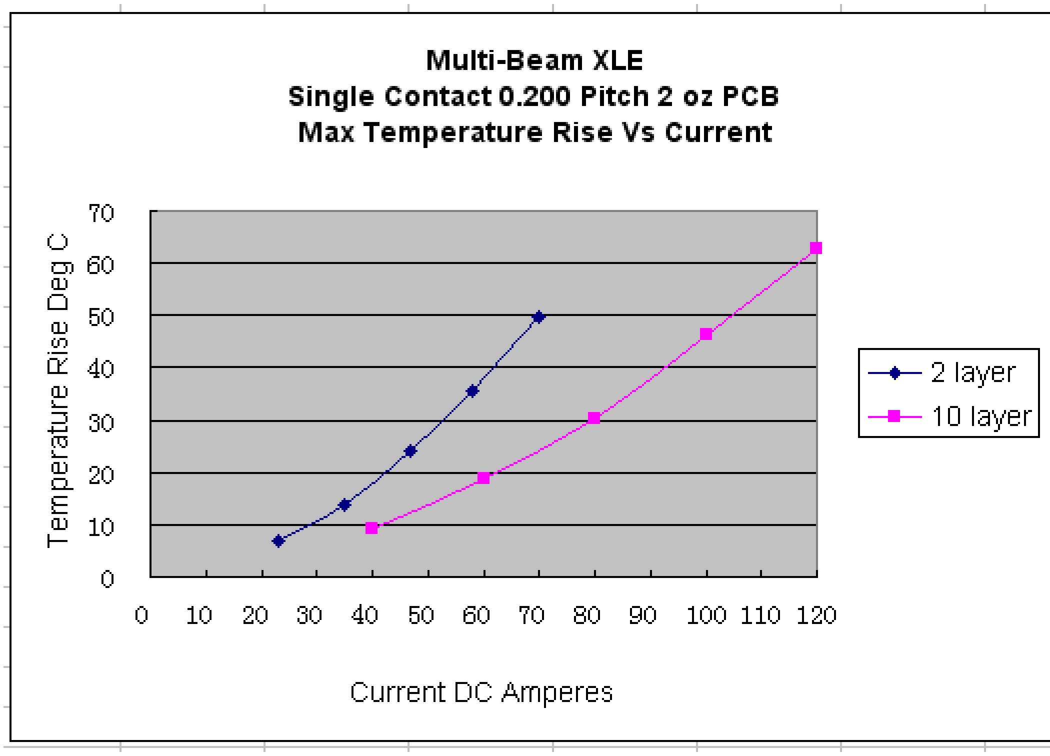

Figure 1---- Single Contact 0.2 Pitch 2 oz PCB Temperature Rise Plot (2 layer vs 10 layer)

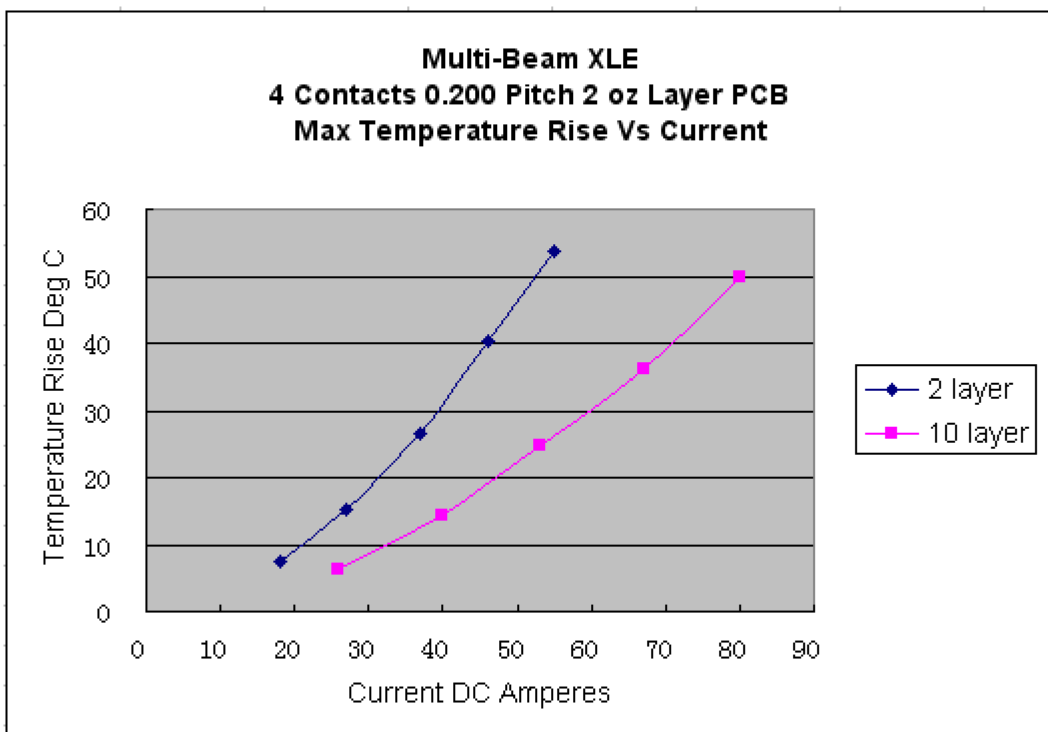

Figure 2---- 4 Contacts 0.2 Pitch 2 oz PCB Temperature Rise Plot (2 layer vs 10 layer)

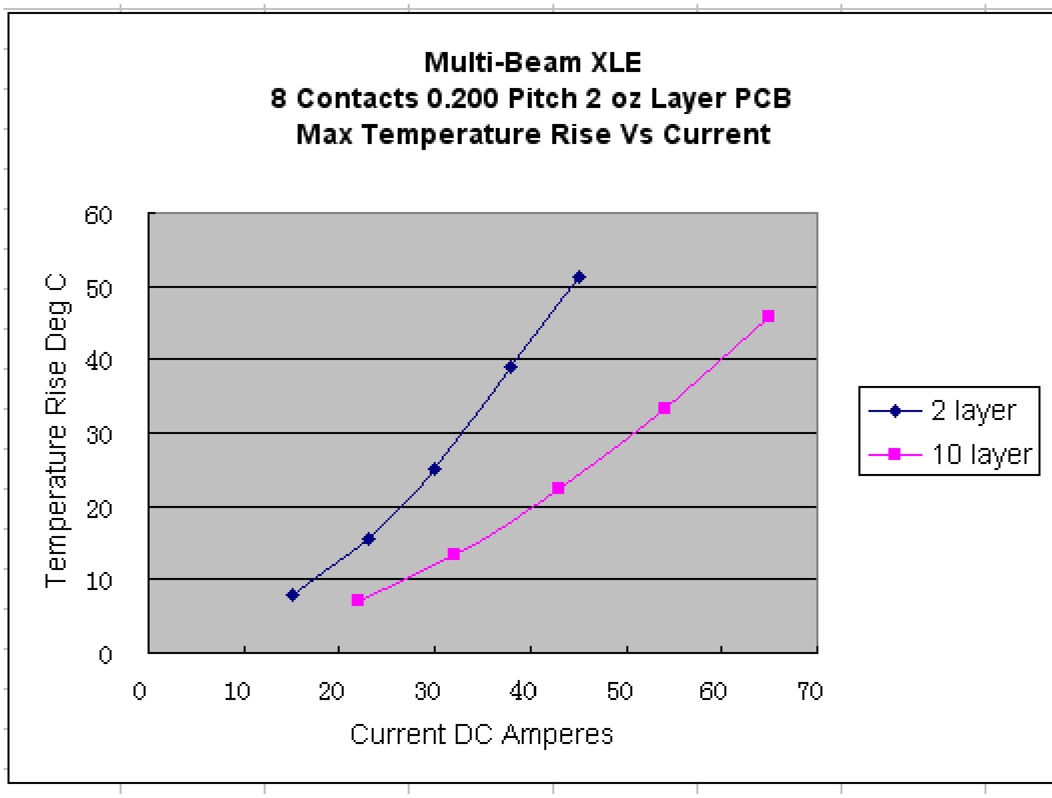

Figure 3---- 8 Contacts 0.2 Pitch 2 oz PCB Temperature Rise Plot (2 layer vs 10 layer)

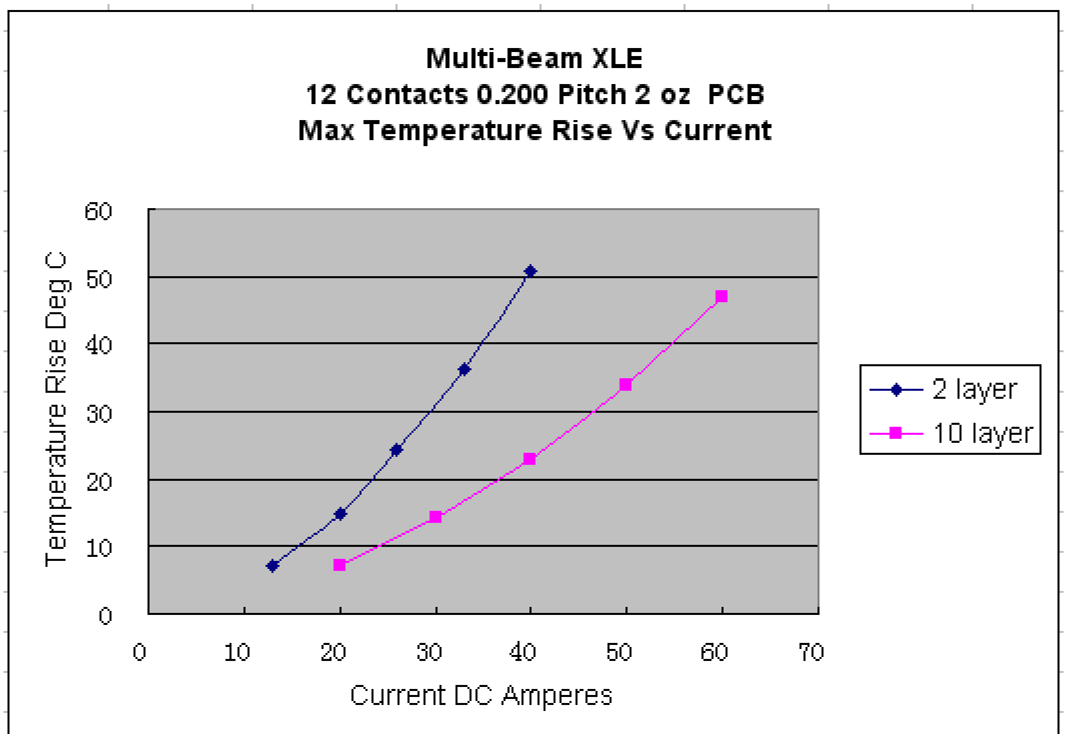

Figure 4---- 12 Contacts 0.2 Pitch 2 oz.2 Layer PCB Temperature Rise Plot (2 layer vs 10 layer)

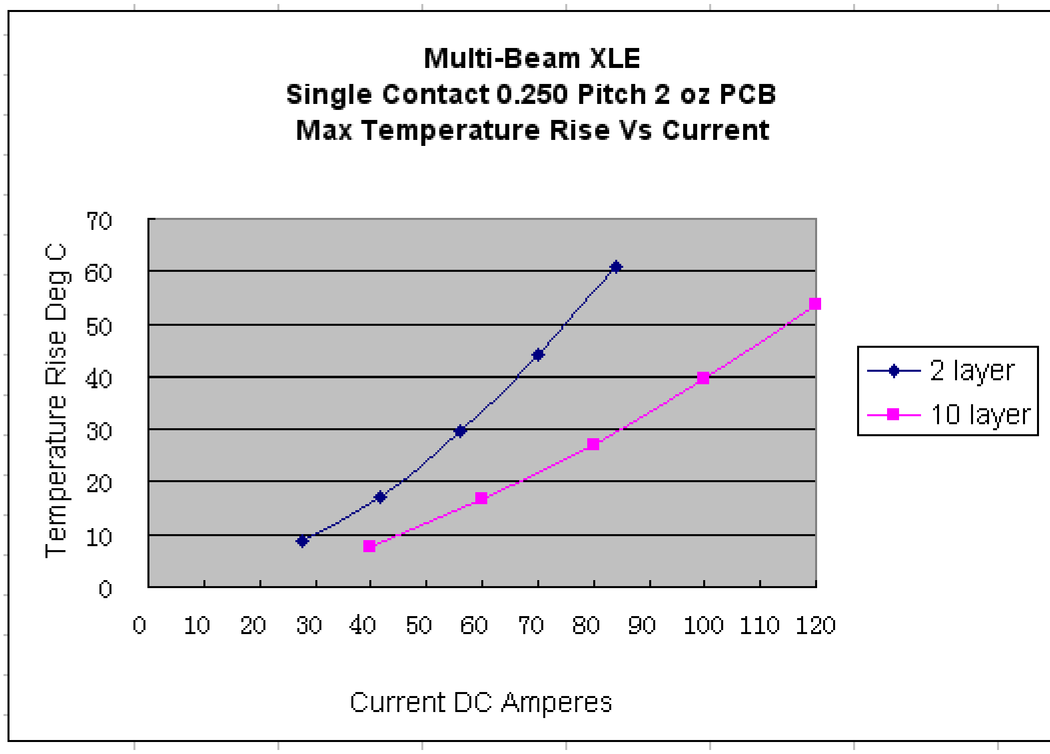

Figure 5---- Single Contact 0.25 Pitch 2 oz PCB Temperature Rise Plot (2 layer vs 10 layer)

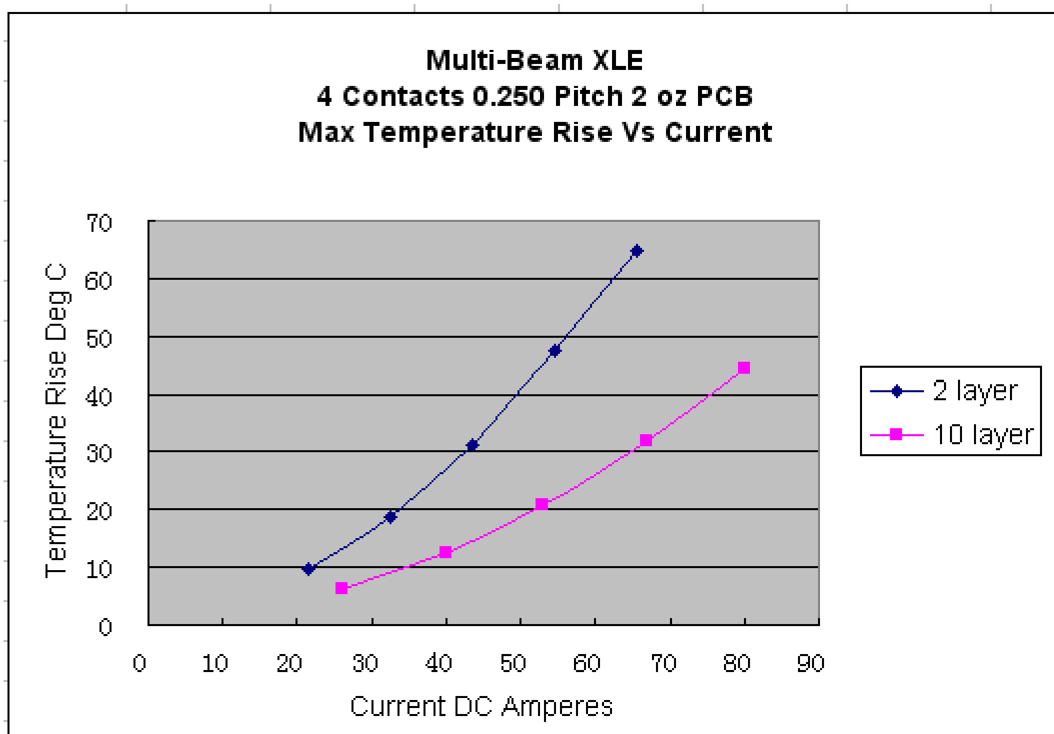

Figure 6---- 4 Contacts 0.25 Pitch 2 oz PCB Temperature Rise Plot (2 layer vs 10 layer)

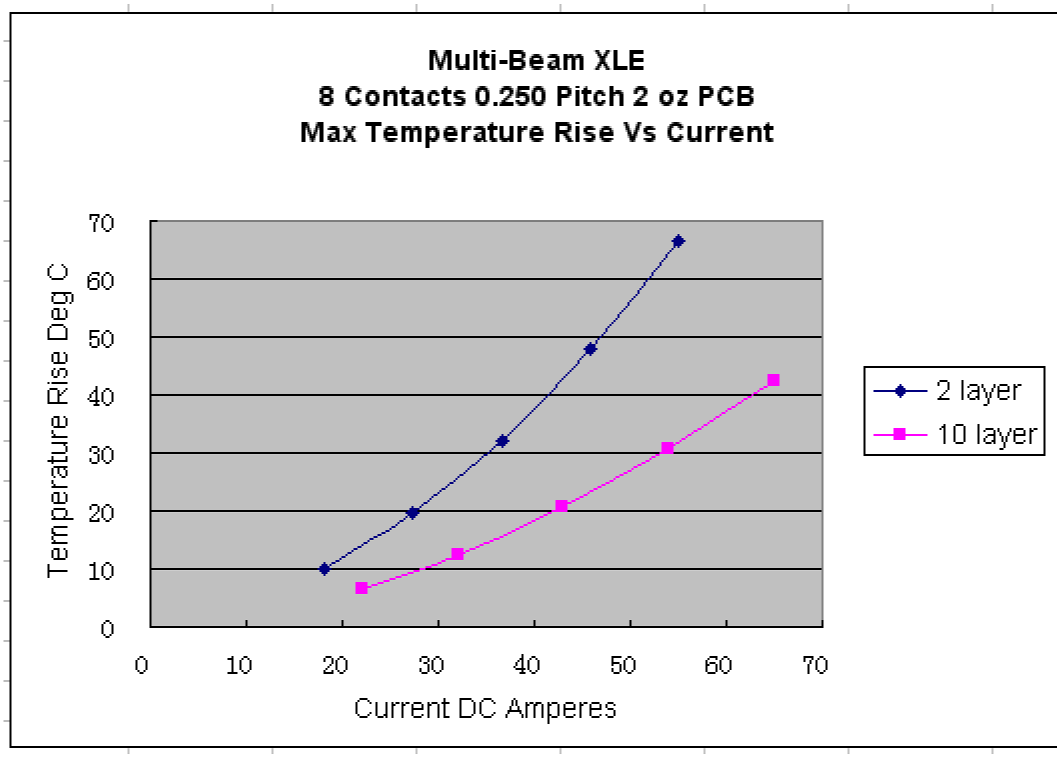

Figure 7---- 8 Contacts 0.25 Pitch 2 oz PCB Temperature Rise Plot (2 layer vs 10 layer)

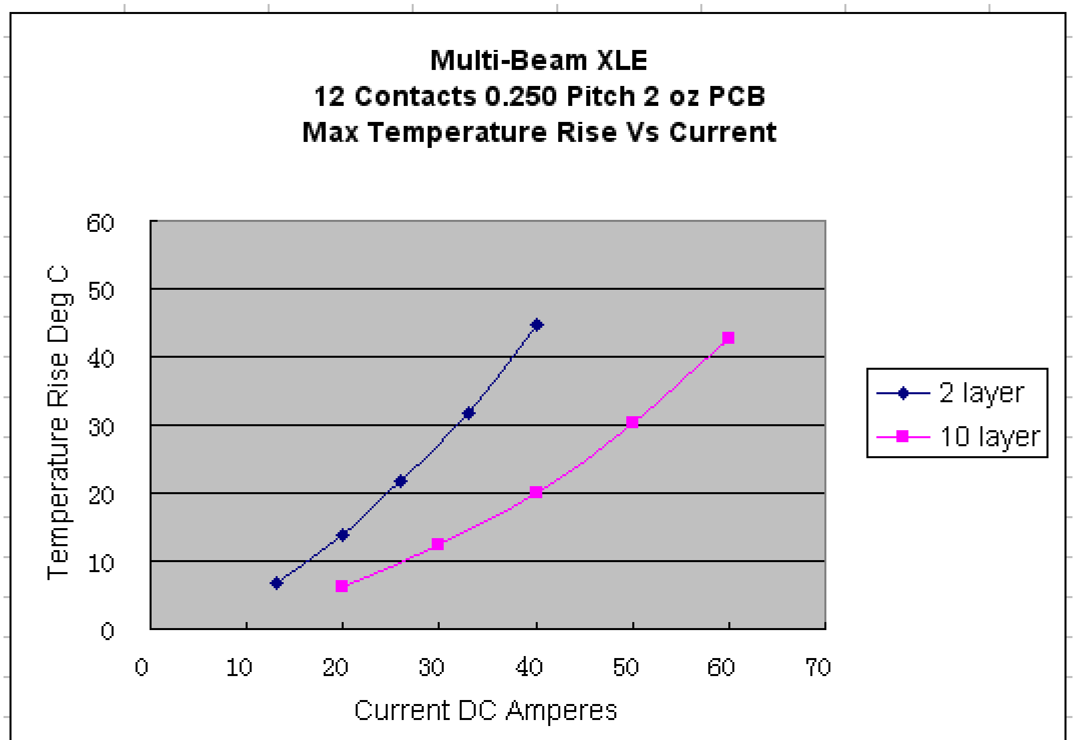

Figure 8---- 12 Contacts 0.25 Pitch 2 oz PCB Temperature Rise Plot (2 layer vs 10 layer)

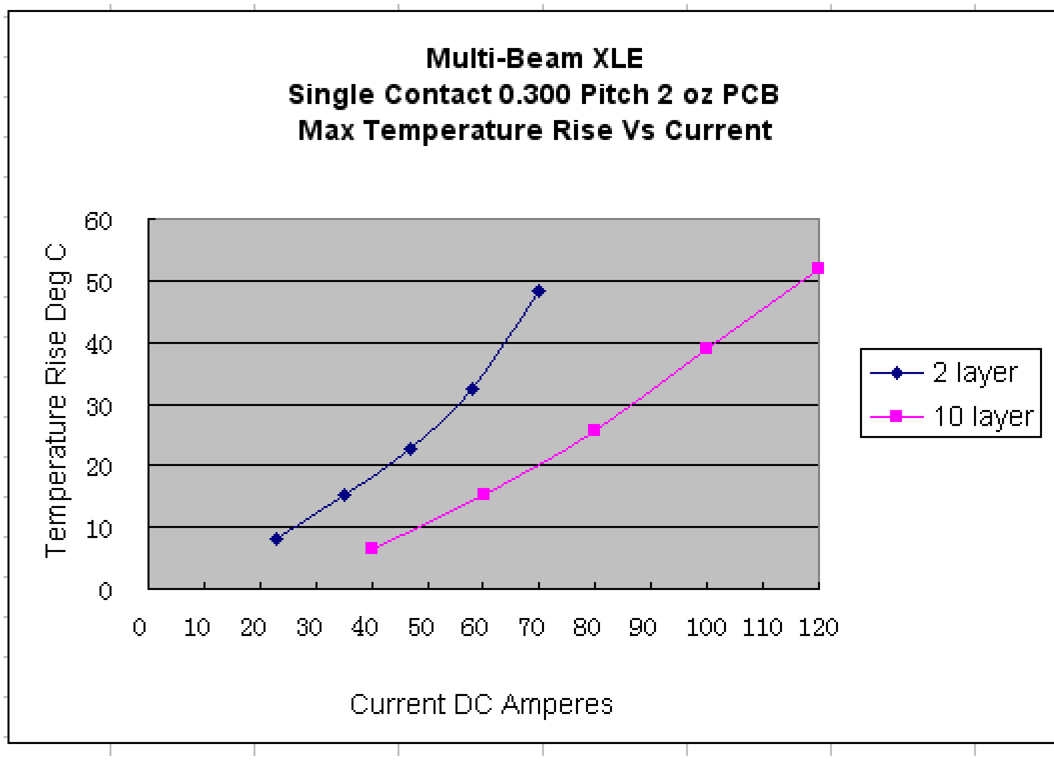

Figure 9---- Single Contact 0.30 Pitch 2 oz PCB Temperature Rise Plot (2 layer vs 10 layer)

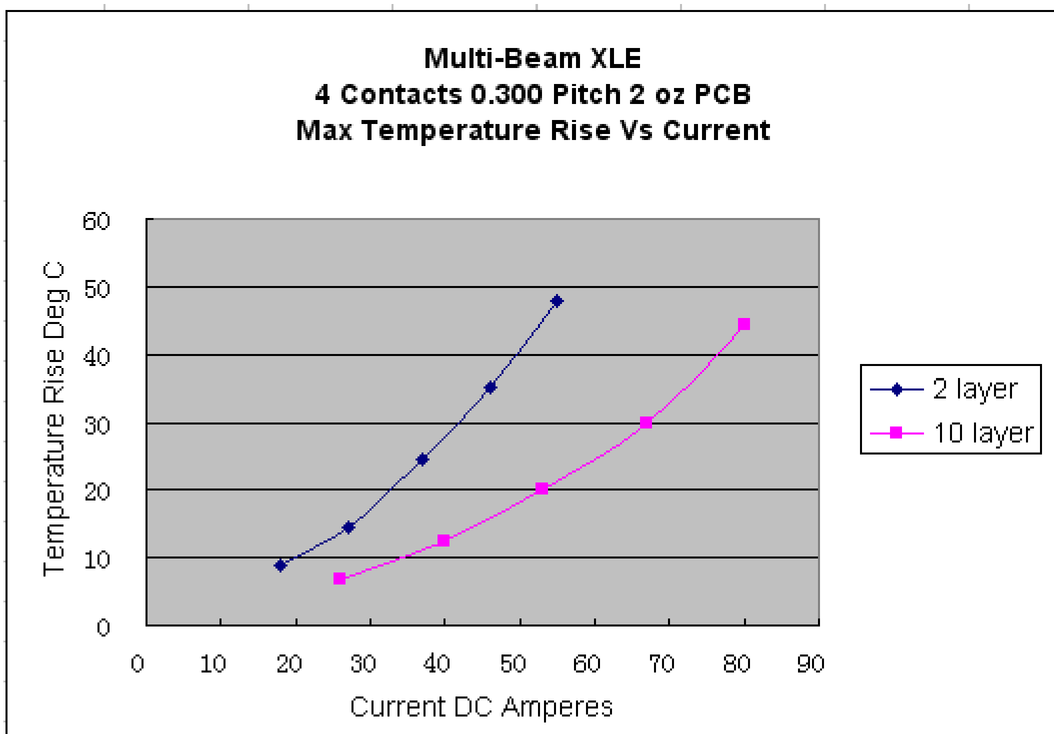

Figure 10---- 4 Contacts 0.30 Pitch 2 oz. PCB Temperature Rise Plot (2 layer vs 10 layer)

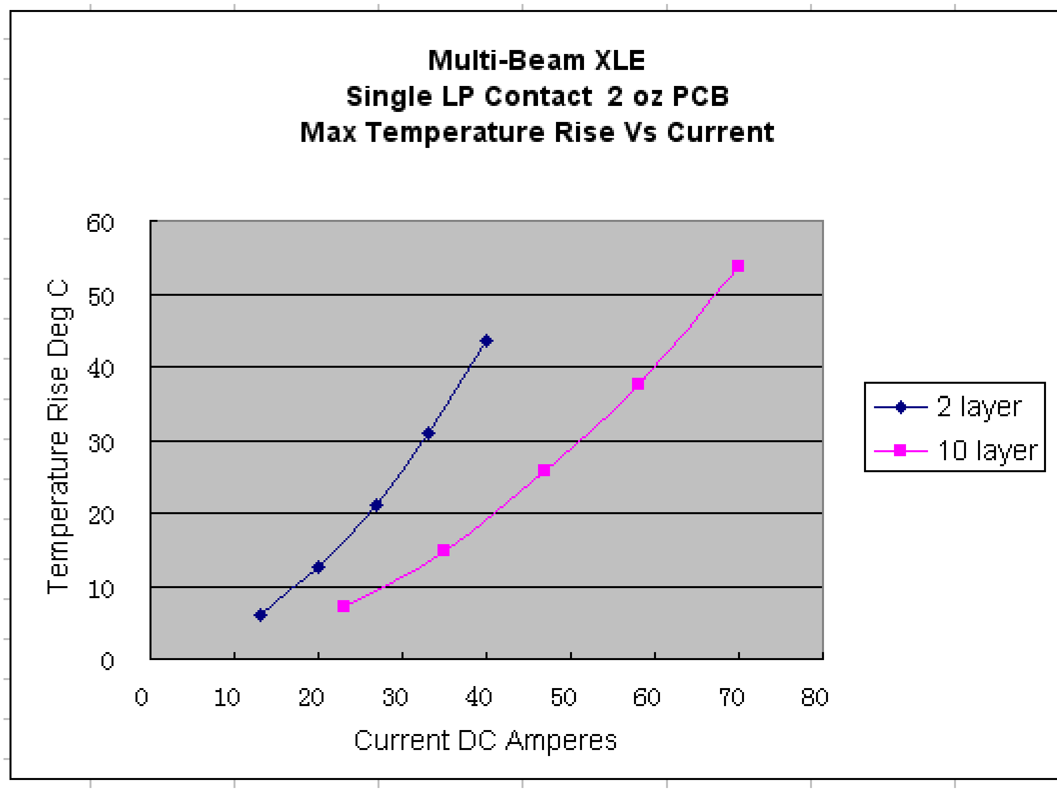

Figure 11---- Single LP Contact 2 oz. PCB Temperature Rise Plot (2 layer vs 10 layer)

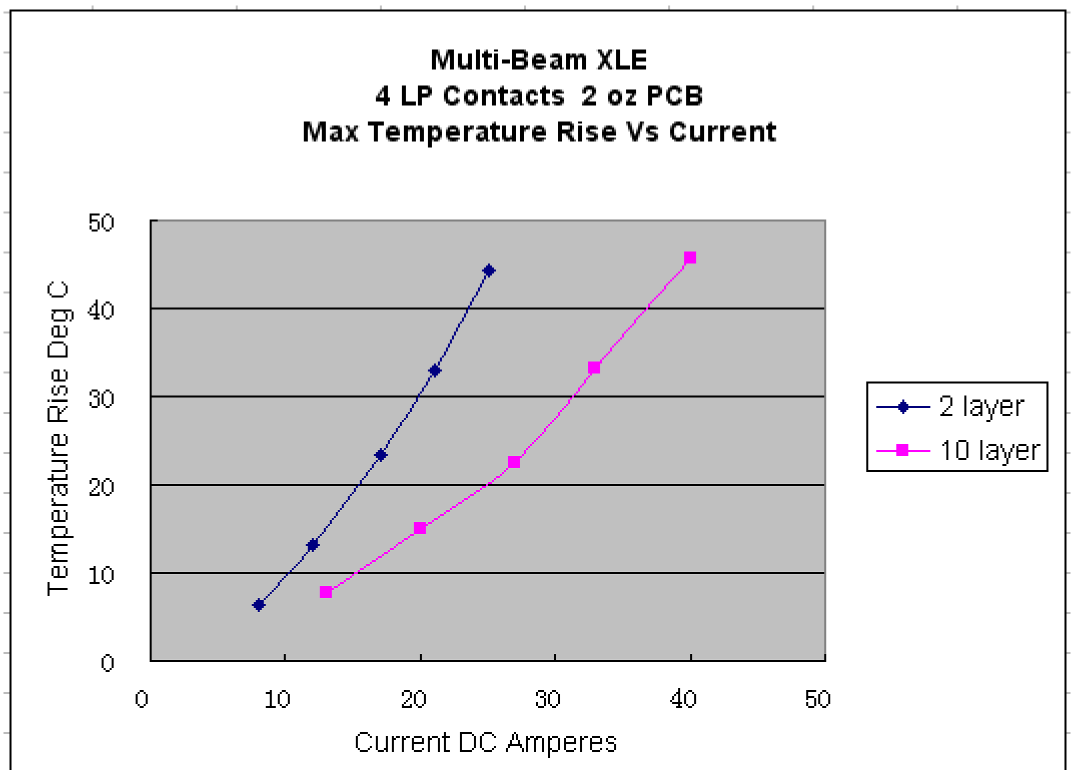

Figure 12---- 4 LP Contacts 2 oz. PCB Temperature Rise Plot (2 layer vs 10 layer)

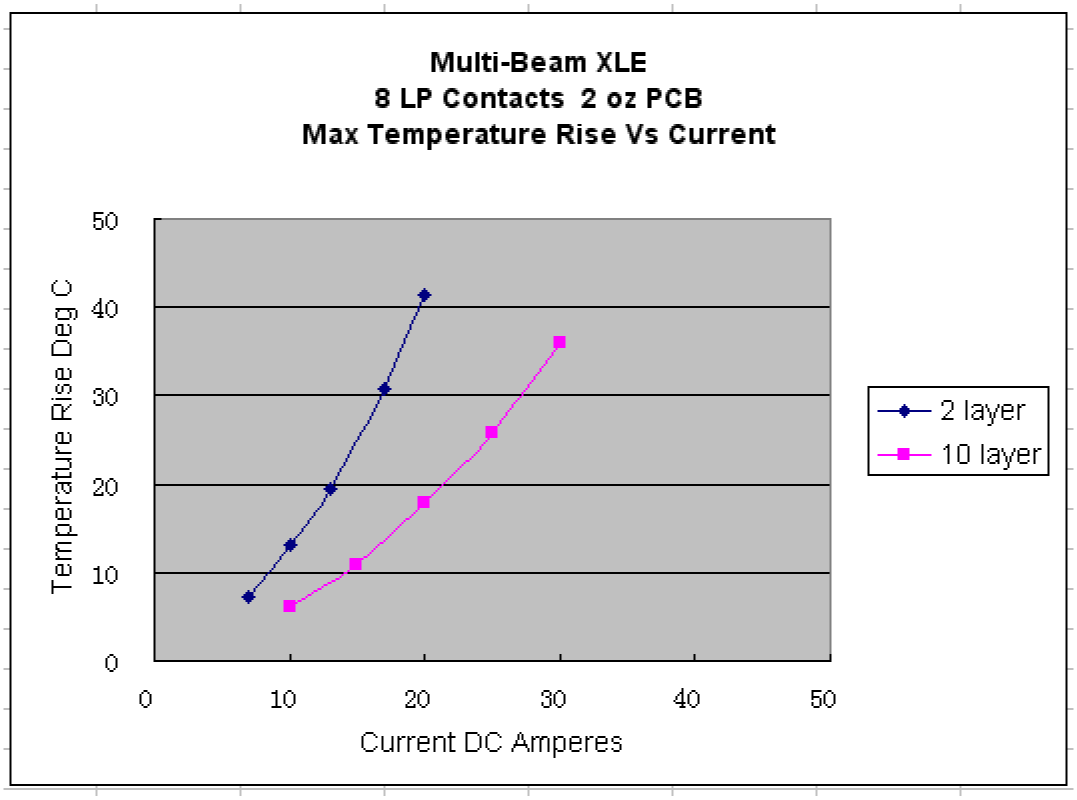

Figure 13---- 8 LP Contacts 2 oz. PCB Temperature Rise Plot (2 layer vs 10 layer)