

NOTE: All values in $\mu\text{g}/\text{in}^2$, unless otherwise noted.

Process Qualification Of MS2 on Umpire OSP Assemblies Project # 1741-02b

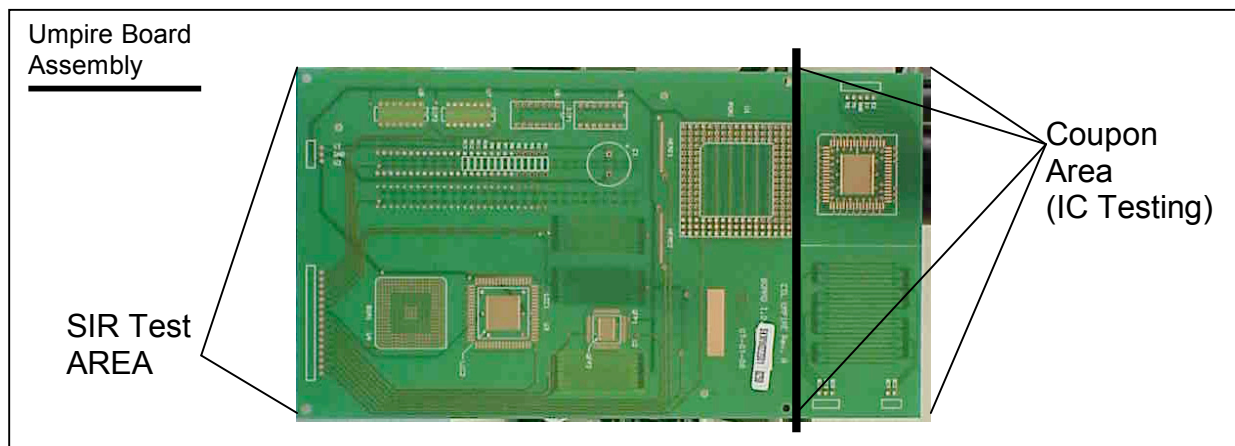
Larry Kay

PROJECT GOAL

The purpose of this project was to qualify the new MS2 Soldering Process (With a lead free soldering process (SnAg (96/4))) using SIR electrical performance and Ion Chromatography testing on the Umpire Test board (Using IPC Class 3 level performance per IPC ANSI J-STD 001 C). Analysis was conducted using Surface Insulation Resistance characterization IPC-TM-650, method 2.6.3.3A

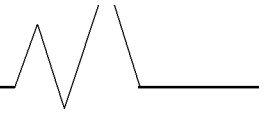
Executive Summary

TEST BOARD - UMPIRE:



SIR Data Summary

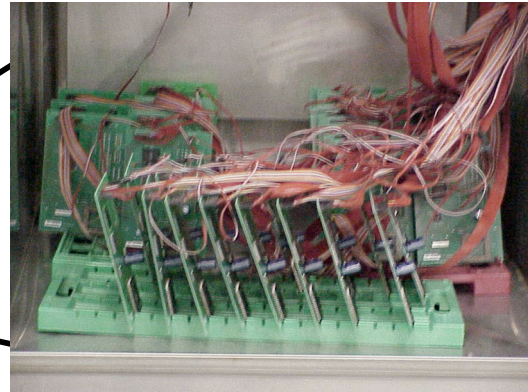
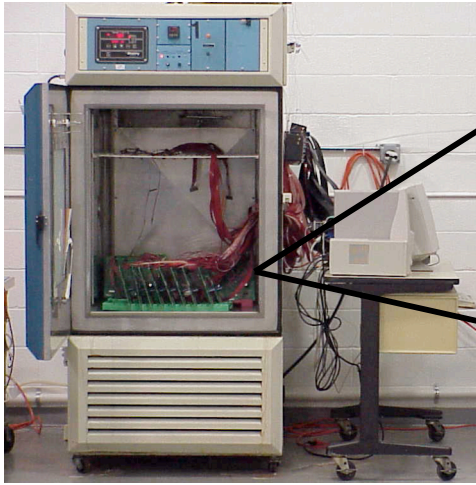
All processed Umpire assemblies of this evaluation for the MS2 process compared to the Air processes, passed the SIR testing with good levels of surface Resistivity. The SIR criteria of J-STD-001C, Appendix B, on all patterns showed levels well above the limits of $1\text{e}8$ ohms of resistance. All processed Umpire assemblies for the Lead Free (SnAg alloy) with a P. Kay no clean VOC free flux (H-9) with and without MS2 processes **pass for class III hardware** the SIR and visual criteria of the J-STD-001C, Appendix B test conditions.



Testing Protocol

SIR testing was conducted on 11 sites on these boards gives an accurate electrical assessment to the condition of the boards.

SIR Chamber



Umpire Boards Wired in SIR Chamber

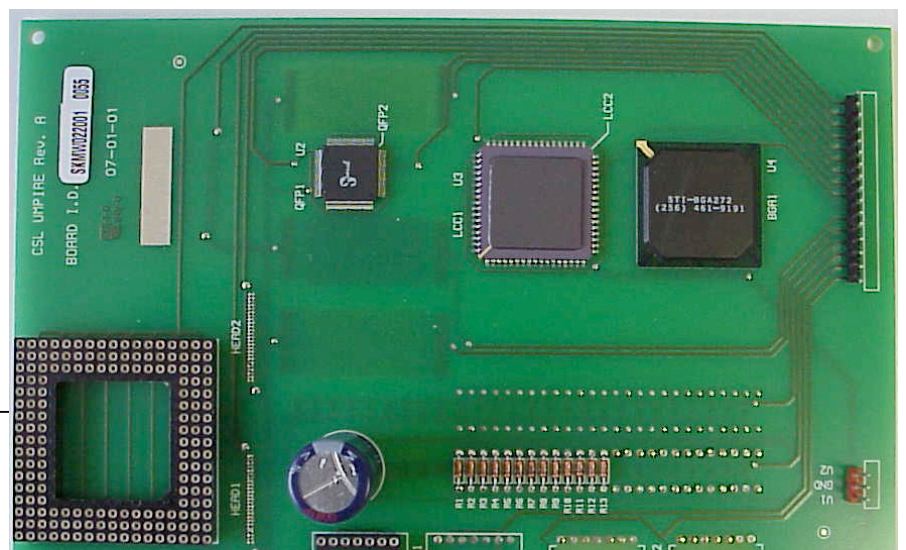
Ion Chromatography was then used to identify and quantify the range of contaminants from the assembly and fabrication process. IC is the only residue assessment tool that directly correlates to electrical performance.

THE PROJECT TEST VEHICLE

The test vehicle used in this evaluation was the Umpire board,

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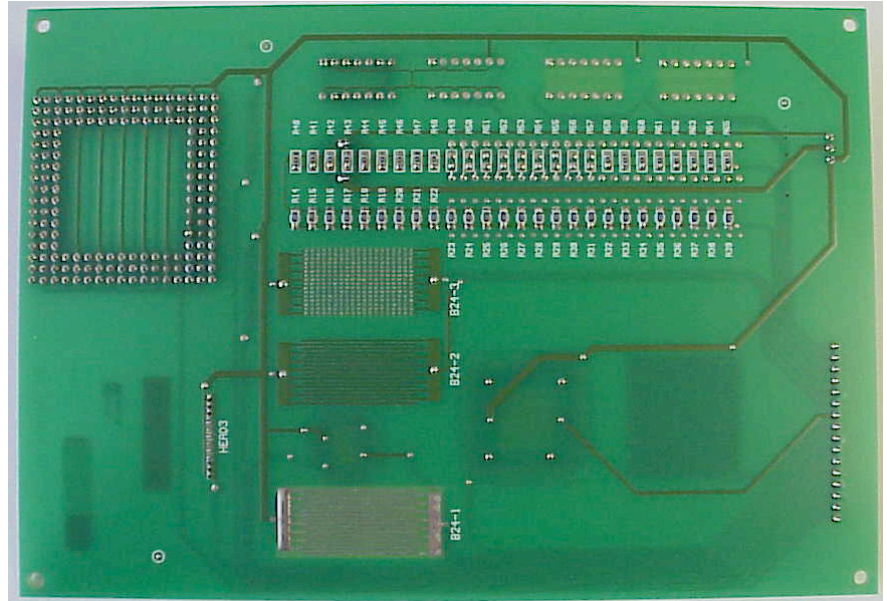
FORESITE

developed by Foresite Inc. (formerly CSL) for use as a process evaluation substrate. This

- A 4-layer MLB with a total of 31 test sites for SIR testing
- IPC B-24 test patterns – no mask, striped mask, full mask
- A row of 0805 chips
- A row of 1206 chips
- BGA, QFP, and LCC test patterns, with and without solder mask
- A row of DIPs for through hole processes

Umpire Board -- Fabrication and Processing Information

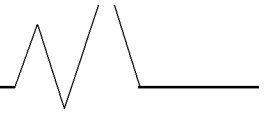
- All fabrication done DSI.
- The base laminate was FR-4 with routed edges
- Solder mask was Electra #2225, light green, extra matte, liquid photoimageable (LPI)
- Solder mask cure was as follows:
 1. 1st side tack bake of 176 degree F for 8 minutes
 2. 2nd side applied and bake of 176 degree F for 50 min
 3. Panels are printed and developed
 4. Final cure of 300 degree F bake for 75 min then UV both sides at 10 feet per min
 5. Surface metallization was OSP from Entek 106A



Test Procedures

PREPARATION AND HANDLING

1. All of the Umpire boards were handled at all times using non-contaminating gloves and then by the edges only. All boards were processed on Foresite's wave solder process using Umpire assemblies and a lead free solder alloy. The solder alloy is 96% Sn and 4% Ag.
2. The boards were separated into coupon boards for ion chromatography (IC) testing and those for surface insulation resistance (SIR) testing.



FORESITE

3. The boards for IC were separated and held for future testing.

4. The unprocessed controls had no connectors on them since they were not part of the assembly process. For these controls, the test connections were made by hand soldering the Teflon coated leads to the circuit boards. During the hand soldering, the remainder of the board was covered with clean aluminum foil to guard the test patterns from flux spattering during soldering. We used Kester 44 RMA cored wire solder with no post-soldering cleaning. Our research has shown that this attachment method does not adversely affect SIR performance. The design of the Umpire board, with the voltage supply and current return portions of the board separated, ensures that there was no electrical leakage due to residual flux.

5. The SIR data acquisition system had a nominal 1 megohm resistor (1.0 E 6) in each circuit pathway. The one megohm value is relatively common in the SIR test field. These current-limiting resistors serve three primary purposes:

- To preserve dendritic formations that grow during the test
- To protect the data acquisition system from large currents
- To prevent a short circuit on one pattern from “robbing” the current from the remainder of the board

6. The test boards were placed – in randomized order -- onto a circuit board rack and fixed in place with Teflon coated wire. The loaded racks were placed into SIR chambers. The racks and the test boards occupied approximately 35 - 40% of the chamber workspace and did not block the flow of air over the control sensors. This was an important element as it allowed the chamber to keep a much tighter control over the test environment, so to avoid condensation from inadequate air flow.

All test wiring was dressed away from the test boards and was passed out of the chamber through a three inch chamber port to a motherboard on the chamber exterior.

SIR Measurements

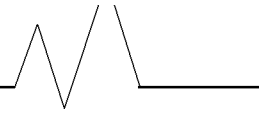
1. The chamber was allowed to equilibrate at 25°C and 50% relative humidity for two hours.
2. Initial measurements were taken at 25°C and 50% RH with a measurement voltage of 100 volts DC and an electrification time of 60 seconds. For the unprocessed controls, because they had no components, all 31 test patterns on the boards were measured. For the processed controls, the four patterns which had a five-bias applied (CHIP1, CHIP2, SOT23, CAP1) were not measured.
3. After the initial measurements were complete, the temperature humidity profile specified below (the hybrid profile) was initiated.

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02/23/06
Page 4 of 20



RESIDUES



4. After 24 hours at 35°C/85% RH, measurements were again taken as outlined above.

5. Following the measurements at 35°C/85% RH, the test profile continued with the exposure to 85°C/85% RH. One hour after the chamber had stabilized at 85°C / 85% RH conditions, a 50 volt DC bias was applied to most of the test patterns. This bias was applied to all patterns whenever measurements were not being made.

6. Measurements were again taken at elevated conditions at 24, 96, and 168 hours. When it was time for these measurements, the electrical bias was removed from all test patterns of all boards. Measurements were made sequentially, board by board, until complete. Each measurement set took approximately 3 hours. Following the completion of the measurements, the electrical bias was reapplied to all test patterns on all boards.

7. Following the final ramp down step, a final measurement set was taken one hour after the chamber stabilized at ambient conditions.

8. Following the SIR test, all test specimens were removed from the chamber and visually examined for signs of corrosion or metal migration using top lighting and back lighting. After an examination of all of the patterns that were not covered, the components were removed from the test boards using a hot air gun. All components, including the 0805 and 1206 chips, as well as the SOT23 devices, were removed. The patterns were again examined for signs of corrosion, metal migration, water droplets, solder splines, etc.

9. All visual phenomena of any relevance were documented with color photography.

SIR Test Environment In This Evaluation



FRESITE

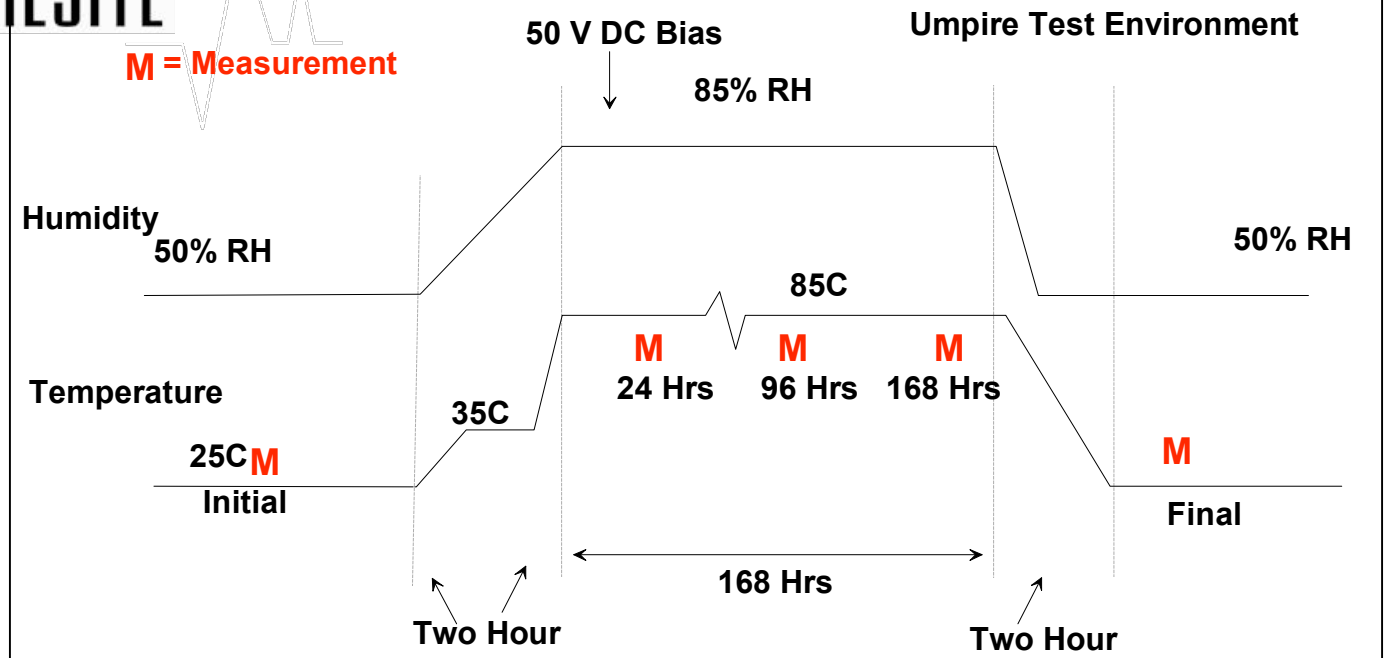


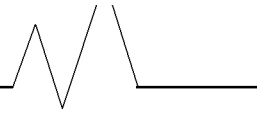
Figure 5: Test Environment

All of the ramp steps were programmed to proceed by first raising temperature to the specified level, while allowing humidity to drop, over the course of a 30 minute period. The final 30 minutes of the ramp were used to slowly bring up the relative humidity to the specified level. In this manner, condensation on the part surface is avoided. In most IPC documentation, this is referred to as a non-condensing SIR test method. For the ramp-down steps, the reverse of the process was performed. These steps were taken because the presence of liquid water on the surface of an energized test pattern violates the intent of SIR testing and invalidates the data for that pattern.

Surface Insulation Resistance

An Overview

Surface insulation resistance (SIR) is a material characteristic of a system of materials, such as laminate, solder mask, and metal conductors. The testing of SIR is generally done under



conditions of high temperature and high humidity, with an applied electrical potential. The specific levels of temperature, humidity and potential chosen depend largely upon what specification is driving the testing, and what the goal of the testing may be. The acceptable levels of resistance demonstrated throughout the testing also depend largely upon what specification or test method is used, along with the geometry of the test patterns.

For a more in-depth understanding of SIR testing in general, and the many factors contain in analyzing SIR data, the reader is referred to IPC-9201, The SIR Handbook. This Handbook is available from the IPC (www.ipc.org).

In general, SIR testing is used to examine a materials system, exposed to one or more fabrication or assembly processes, and determines, in a relatively short period of time, whether the material system under test exhibits a propensity for electrochemical failure mechanisms. The three primary electrochemical failure mechanisms are:

- Excessive electrical leakage between points which should be isolated
- Electrolytic corrosion of metal surfaces
- Electrochemical migration (dendritic growth) of metal between isolated areas

The presence of these mechanisms represents a reliability risk which may take weeks or years of field service to manifest itself, usually with catastrophic consequences.

The tester often has a choice of SIR test pattern, test conditions, duration of testing, the materials of composition, and a degree of control over the processes contacting the test system. These choices vary depending upon what aspect is to be examined. The most common aspects examined are:

- The corrosivity of flux (in various forms) formulations or other benchmarking of flux characteristics
- The materials characteristics of the materials of construction (laminates, metalization, solder mask) before and after various manufacturing processes
- The cleanliness of a fabrication process
- The compatibility of construction materials with fluxes, pastes, or cleaning operations
- The effects of process residues on the electrical characteristics of finished hardware

For the SIR test professional who wishes to test many of these factors, there are several different standards, specifications, and test methods to choose from. In the United States, the three most commonly encountered SIR tests can be found in the following documents:

Control SIR DATA Assembly #C1

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02/23/06
Page 7 of 20

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FORMERLY CSL INC.

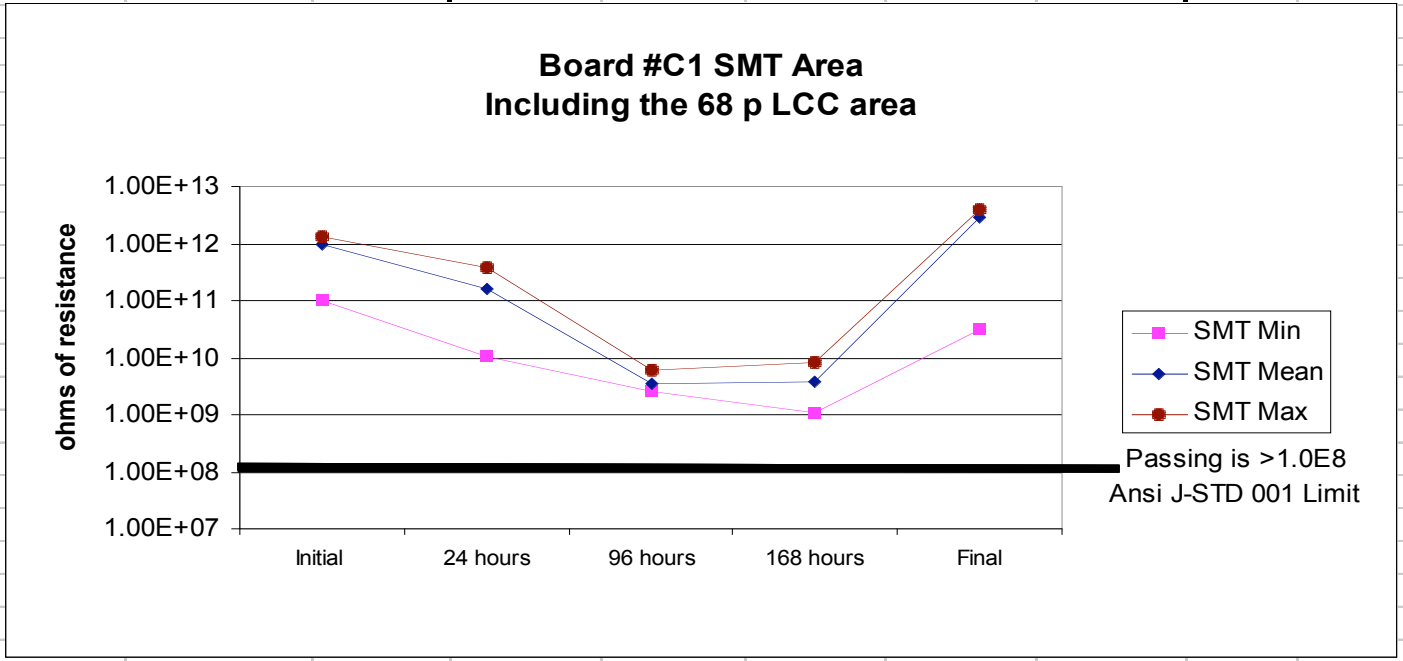


RESITE

Conditions: No MS2 but Soldered in AIR at 500F

Umpire Assembly #C1 SIR DATA

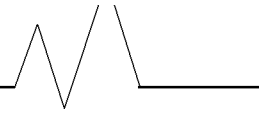
	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		
SMT	LCC	Leads	1.15E+12	1.02E+10	2.45E+09	4.17E+09	3.16E+10	NDS	Pass
	LCC	Comb	1.02E+11	1.66E+11	3.63E+09	1.10E+09	3.47E+12	NDS	Pass
	TQFP	Leads	1.05E+12	9.12E+10	5.89E+09	8.32E+09	3.63E+12	NDS	Pass
	TQFP	Comb	1.12E+12	3.89E+11	2.75E+09	2.29E+09	3.80E+12	NDS	Pass
	BGA	Balls	1.36E+12	1.30E+11	2.77E+09	2.98E+09	2.89E+12	NDS	Pass
PTH	DIP	U6	1.32E+12	1.02E+12	2.46E+09	2.00E+09	3.31E+12	NDS	Pass
	DIP	U7	1.48E+12	1.48E+11	1.22E+09	1.17E+09	8.71E+11	NDS	Pass
	PGA	U1	1.54E+12	4.47E+11	3.09E+09	2.56E+09	1.20E+12	NDS	Pass
Bottom	B-24-1	No mask	3.80E+12	2.82E+11	5.25E+08	8.32E+08	3.24E+12	NDS	Pass
	B-24-2	Masked	3.89E+12	2.82E+12	4.57E+11	3.16E+10	2.69E+12	NDS	Pass
	B-24-3	Crossed	5.75E+11	1.59E+11	8.91E+10	4.90E+09	1.74E+12	NDS	Pass
Header #1	BrBrd Top		3.31E+12	3.80E+11	1.48E+09	2.51E+09	3.80E+12	NDS	Pass
Header #2	Br Brd Top		4.27E+12	3.98E+11	2.19E+09	3.02E+09	3.89E+12	NDS	Pass
Header #3	BrBrd Bottom		1.00E+12	2.69E+11	1.92E+09	4.27E+10	1.05E+12	NDS	Pass



Control SIR DATA Assembly #C2
Conditions: No MS2 but Soldered in AIR at 500F



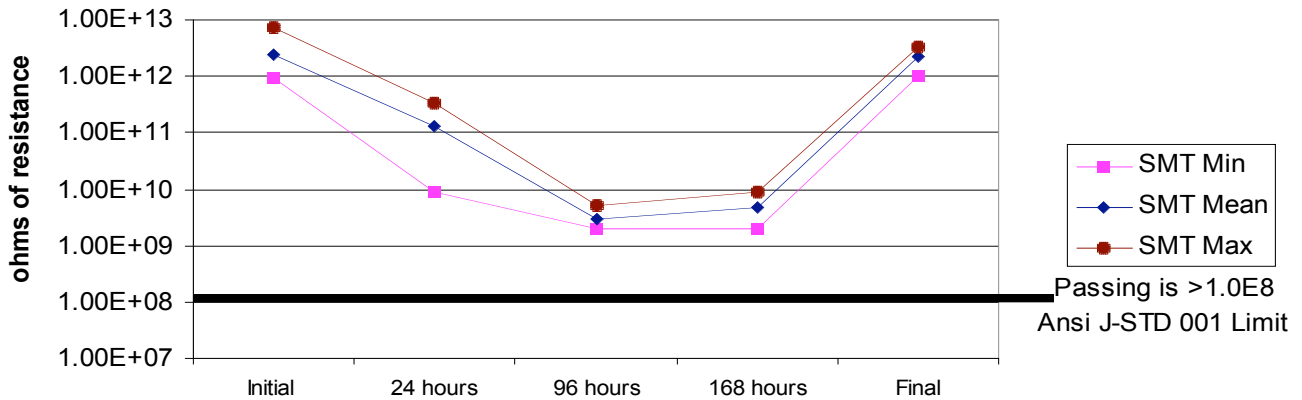
RESIDUES



Umpire Assembly #C2 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		Pass* / Fail**
SMT	LCC	Leads	1.05E+12	8.60E+09	2.06E+09	3.50E+09	2.66E+12	NDS	Pass
	LCC	Comb	1.12E+12	1.39E+11	3.05E+09	9.21E+09	2.91E+12	NDS	Pass
	TQFP	Leads	1.45E+12	7.66E+10	4.95E+09	6.99E+09	1.05E+12	NDS	Pass
	TQFP	Comb	7.42E+12	3.27E+11	2.31E+09	1.92E+09	3.19E+12	NDS	Pass
	BGA	Balls	9.60E+11	1.09E+11	2.33E+09	2.50E+09	1.43E+12	NDS	Pass
PTH	DIP	U6	9.30E+11	8.60E+11	1.33E+08	1.07E+09	2.78E+12	NDS	Pass
	DIP	U7	1.24E+12	1.24E+11	1.08E+09	1.99E+09	7.32E+12	NDS	Pass
	PGA	U1	4.51E+11	3.75E+10	2.60E+09	8.84E+10	1.01E+12	NDS	Pass
Bottom	B-24--1	No mask	3.19E+12	2.37E+10	4.41E+08	6.10E+09	2.72E+12	NDS	Pass
	B-24--2	Masked	3.27E+12	2.37E+11	3.84E+09	2.66E+09	2.26E+12	NDS	Pass
	B-24--3	Crossed	4.83E+11	1.33E+11	7.49E+09	1.41E+09	1.46E+12	NDS	Pass
Header #1	BrBrd Top		2.78E+12	3.19E+11	1.24E+09	2.11E+09	3.19E+12	NDS	Pass
Header #2	Br Brd Top		3.58E+12	3.34E+12	1.84E+09	2.54E+09	3.27E+12	NDS	Pass
Header #3	BrBrd Bottom		8.40E+12	2.26E+12	9.87E+09	3.58E+09	8.80E+11	NDS	Pass

**Board #C2 SMT Area
Including the 68 p LCC area**



Control SIR DATA Assembly #C3



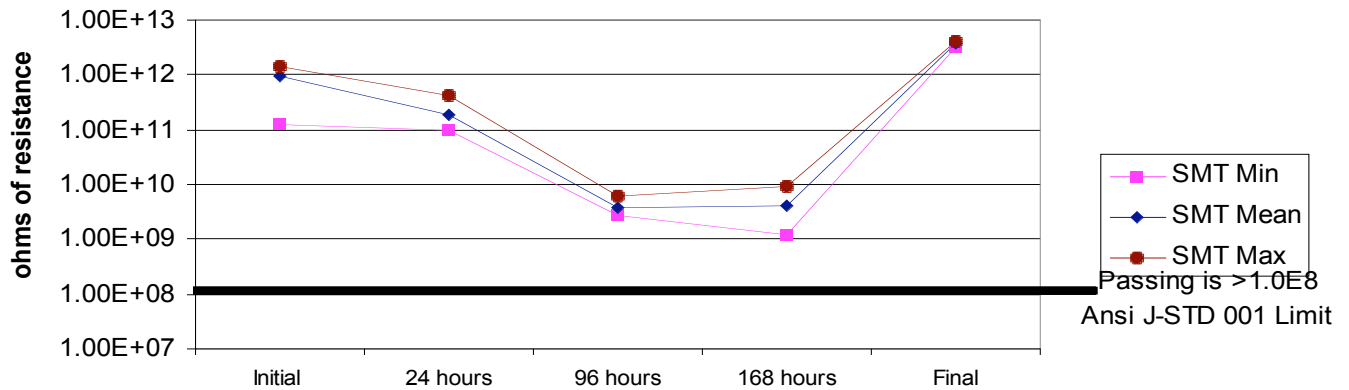
RESIDUE

Conditions: No MS2 but Soldered in AIR at 500F

Umpire Assembly #C3 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grad
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		Pass* / F
SMT	LCC	Leads	1.23E+12	1.01E+11	2.63E+09	4.46E+09	3.98E+12	NDS	Pass
	LCC	Comb	1.26E+11	1.78E+11	3.88E+09	1.17E+09	3.71E+12	NDS	Pass
	TQFP	Leads	5.88E+11	9.76E+10	6.30E+09	8.90E+09	3.88E+12	NDS	Pass
	TQFP	Comb	1.20E+12	4.16E+11	2.95E+09	2.45E+09	4.07E+12	NDS	Pass
	BGA	Balls	1.46E+12	1.39E+11	2.96E+09	3.19E+09	3.09E+12	NDS	Pass
PTH	DIP	U6	1.41E+12	1.09E+12	1.70E+09	2.11E+09	3.54E+12	NDS	Pass
	DIP	U7	1.58E+12	1.58E+12	1.37E+09	1.26E+09	9.32E+11	NDS	Pass
	PGA	U1	5.75E+11	4.78E+11	3.30E+09	1.07E+09	1.29E+12	NDS	Pass
Bottom	B-24--1	No mask	4.07E+12	3.02E+12	5.62E+09	8.90E+09	3.46E+12	NDS	Pass
	B-24--2	Masked	4.16E+12	3.02E+12	4.89E+09	3.38E+09	2.88E+12	NDS	Pass
	B-24--3	Crossed	6.16E+11	1.70E+12	9.54E+09	5.24E+09	1.86E+12	NDS	Pass
Header #1	BrBrd Top		3.54E+12	4.07E+12	1.58E+09	2.69E+09	4.07E+12	NDS	Pass
Header #2	Br Brd Top		4.56E+12	4.26E+12	2.34E+09	3.23E+09	4.16E+12	NDS	Pass
Header #3	BrBrd Bottom		1.07E+12	2.88E+12	1.26E+09	4.56E+09	1.12E+12	NDS	Pass

**Board #C3 SMT Area
Including the 68 p LCC area**





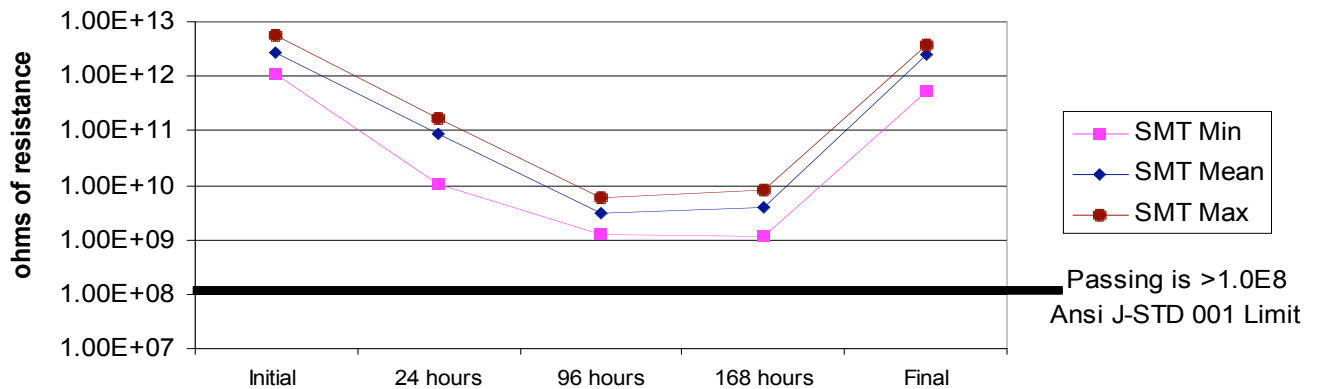
RESIDUE SITE

MS2 SIR DATA Assembly #1 at 480F

Umpire Assembly #1 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		Pass* / Fail*
SMT	LCC	Leads	1.17E+12	1.04E+10	2.50E+09	4.24E+09	5.21E+11	NDS	Pass
	LCC	Comb	4.24E+12	1.69E+11	1.29E+09	1.11E+09	3.52E+12	NDS	Pass
	TQFP	Leads	5.59E+12	9.27E+10	5.99E+09	8.45E+09	3.69E+12	NDS	Pass
	TQFP	Comb	1.14E+12	3.95E+10	2.80E+09	2.33E+09	1.86E+12	NDS	Pass
	BGA	Balls	1.38E+12	1.32E+11	2.84E+09	3.03E+09	2.94E+12	NDS	Pass
PTH	DIP	U6	1.34E+12	1.04E+12	7.16E+09	2.03E+09	3.37E+12	NDS	Pass
	DIP	U7	1.50E+12	1.50E+12	1.31E+09	1.19E+09	8.85E+12	NDS	Pass
	PGA	U1	5.46E+11	4.54E+10	3.14E+09	1.02E+09	1.22E+12	NDS	Pass
Bottom	B-24--1	No mask	3.86E+12	2.86E+12	5.33E+08	8.45E+09	3.29E+11	NDS	Pass
	B-24--2	Masked	3.95E+12	2.86E+12	4.65E+09	3.21E+09	2.74E+12	NDS	Pass
	B-24--3	Crossed	5.85E+11	1.61E+12	9.06E+08	4.98E+09	1.77E+12	NDS	Pass
Header #1	BrBrd Top		4.37E+12	3.86E+12	1.50E+09	2.55E+09	1.86E+12	NDS	Pass
Header #2	Br Brd Top		4.34E+12	4.05E+12	2.22E+09	3.07E+09	3.95E+12	NDS	Pass
Header #3	BrBrd Bottom		6.02E+12	2.74E+12	2.12E+09	4.34E+09	1.06E+12	NDS	Pass

**Board #1 SMT Area
Including the 68 p LCC area**



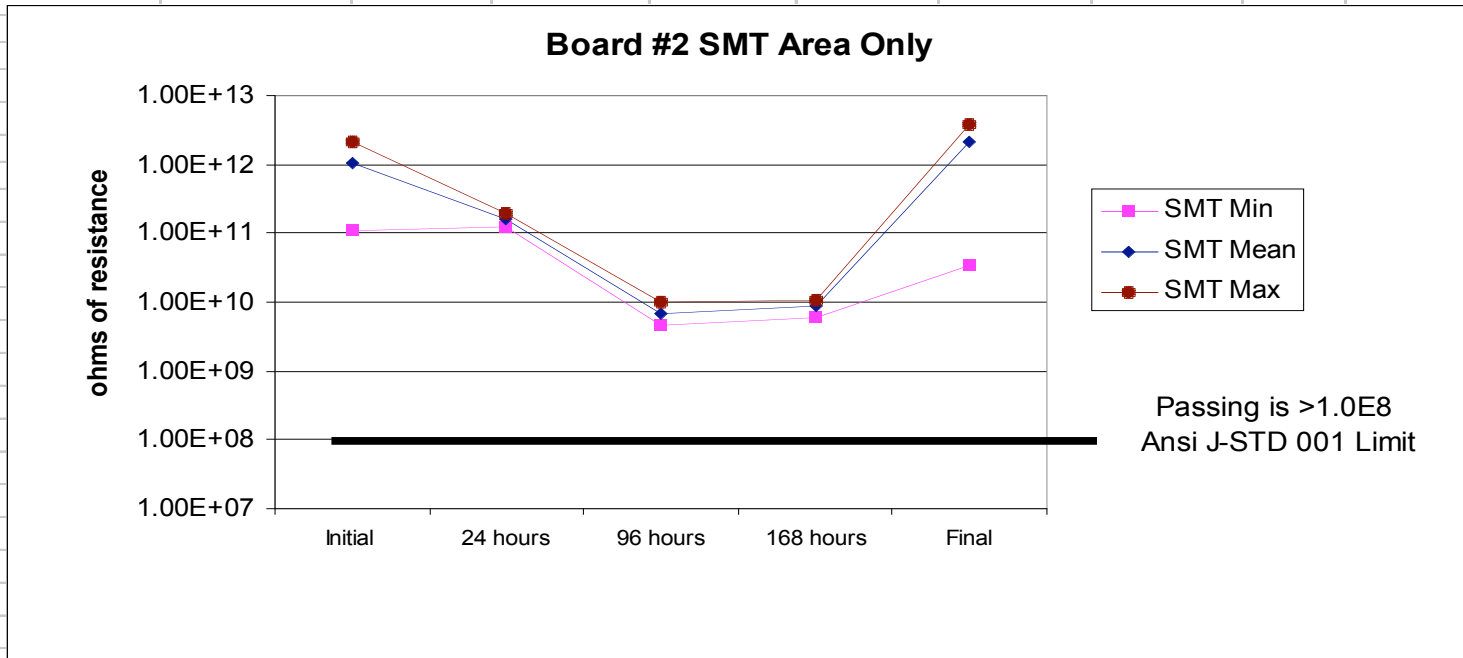


RESIDUE

MS2 SIR DATA Assembly #2 at 480F

Umpire Assembly #2 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		Pass* / Fail
SMT	LCC	Leads	2.14E+12	1.66E+11	4.7E+09	5.9E+09	3.47E+10	NDS	Pass
	LCC	Comb	1.29E+11	1.70E+11	6.5E+09	1.1E+10	1.55E+12	NDS	Pass
	TQFP	Leads	1.68E+12	1.23E+11	1.0E+10	9.1E+09	3.16E+12	NDS	Pass
	TQFP	Comb	1.12E+11	1.91E+11	5.9E+09	9.1E+09	3.89E+12	NDS	Pass
	BGA	Balls	5.12E+11	8.99E+09	9.1E+09	9.1E+10	5.37E+11	NDS	Pass
PTH	DIP	U6	1.05E+12	1.78E+12	2.3E+09	3.5E+09	3.63E+12	NDS	Pass
	DIP	U7	3.24E+11	5.75E+11	1.1E+10	1.0E+10	3.72E+12	NDS	Pass
	PGA	U1	1.07E+12	4.47E+10	3.0E+09	6.5E+10	1.00E+12	NDS	Pass
Bottom	B-24--1	No mask	5.13E+11	2.63E+12	4.0E+09	8.5E+09	3.31E+12	NDS	Pass
	B-24--2	Masked	7.59E+11	1.66E+12	4.0E+09	3.5E+09	3.09E+12	NDS	Pass
	B-24--3	Crossed	2.51E+12	2.69E+12	3.6E+09	6.0E+09	3.02E+12	NDS	Pass
Header #1	BrBrd Top		4.27E+12	4.07E+12	2.1E+10	1.9E+10	3.72E+12	NDS	Pass
Header #2	Br Brd Top		4.07E+12	3.98E+12	2.0E+10	2.3E+10	3.98E+12	NDS	Pass
Header #3	BrBrd Bottom		5.01E+11	3.09E+12	1.0E+09	4.5E+09	3.80E+12	NDS	Pass



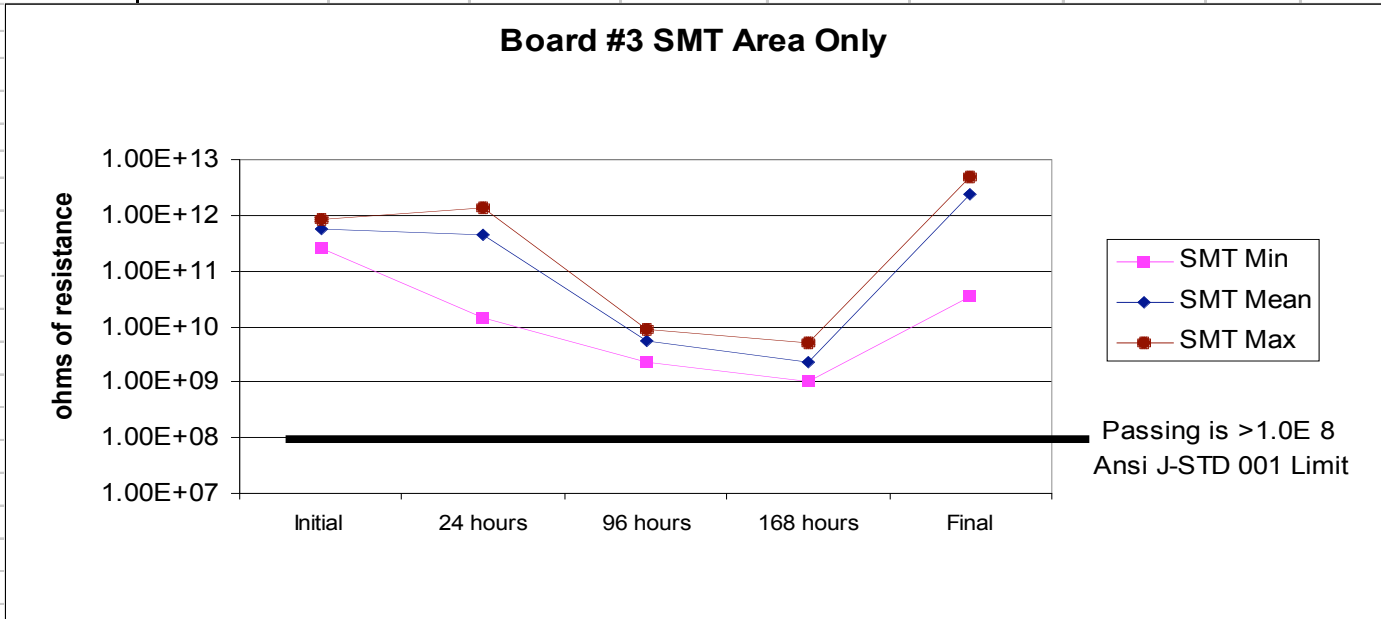


RESIDUE

MS2 SIR DATA Assembly #3 at 480F

Umpire Assembly #3 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		Pass* / Fail**
SMT	LCC	Leads	4.90E+11	7.05E+10	8.19E+09	2.82E+09	3.39E+10	NDS	Pass
	LCC	Comb	8.32E+11	4.17E+11	8.71E+09	1.20E+09	1.62E+12	NDS	Pass
	TQFP	Leads	5.25E+11	2.82E+11	2.88E+09	1.05E+09	1.66E+12	NDS	Pass
	TQFP	Comb	2.45E+11	1.41E+12	4.57E+09	1.07E+09	3.72E+12	NDS	Pass
	BGA	Balls	7.55E+11	1.41E+10	2.36E+09	5.07E+09	4.82E+12	NDS	Pass
PTH	DIP	U6	6.31E+11	1.95E+11	5.62E+09	8.13E+09	7.24E+11	NDS	Pass
	DIP	U7	2.34E+12	1.55E+12	1.35E+09	3.47E+09	3.80E+12	NDS	Pass
	PGA	U1	1.41E+11	3.39E+10	3.24E+09	7.24E+09	1.29E+12	NDS	Pass
Bottom	B-24--1	No mask	3.47E+12	2.95E+12	5.25E+09	8.71E+09	3.63E+12	NDS	Pass
	B-24--2	Masked	1.95E+12	2.82E+12	3.89E+10	3.02E+09	3.16E+12	NDS	Pass
	B-24--3	Crossed	1.74E+12	1.29E+12	2.95E+09	5.13E+09	2.75E+12	NDS	Pass
leader #1	BrBrd Top		3.89E+12	3.39E+12	1.10E+10	2.00E+09	3.98E+12	NDS	Pass
leader #2	Br Brd Top		2.29E+12	1.32E+12	1.86E+10	2.63E+09	3.98E+12	NDS	Pass
leader #3	BrBrd Bottom		6.59E+12	2.46E+12	2.66E+10	1.33E+09	1.18E+12	NDS	Pass



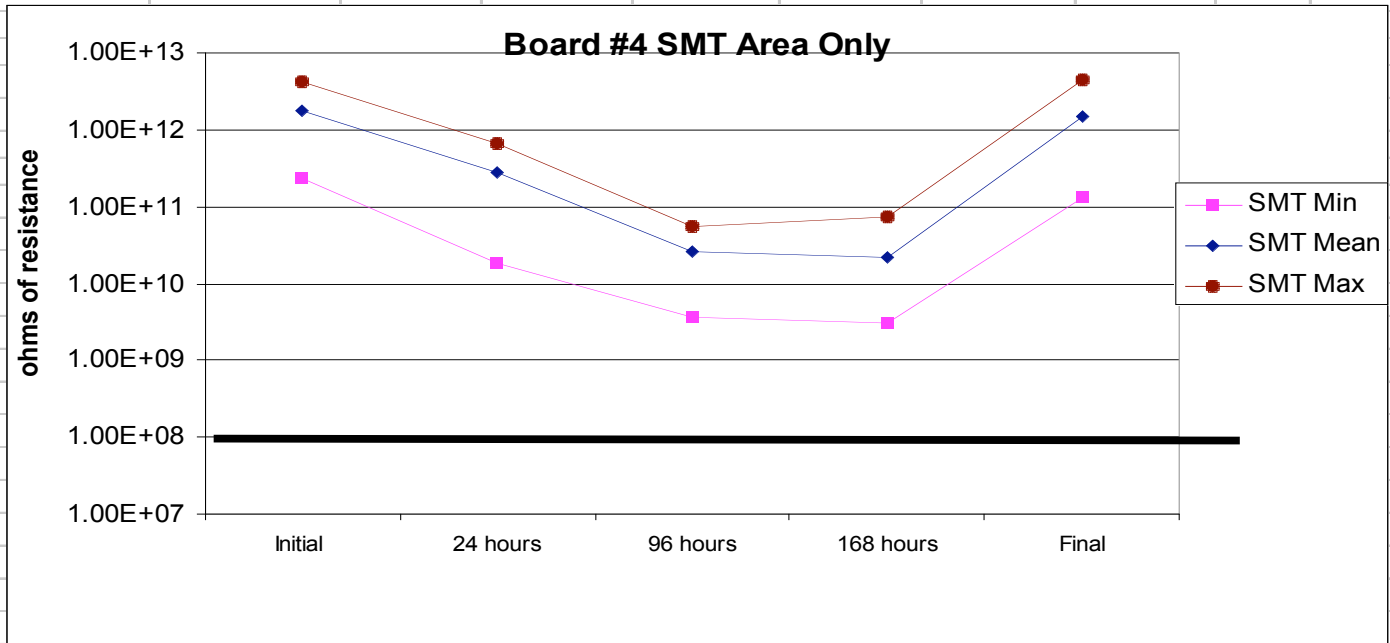


RESIDUE SITE

MS2 SIR DATA Assembly #4 at 480F

Umpire Assembly #4 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		Pass* / Fail**
SMT	LCC	Leads	2.29E+11	8.17E+10	3.7E+09	3.1E+09	1.33E+11	NDS	Pass
	LCC	Comb	2.69E+12	6.76E+11	7.9E+09	1.0E+10	1.48E+12	NDS	Pass
	TQFP	Leads	5.75E+11	4.68E+11	4.9E+10	1.3E+10	2.50E+11	NDS	Pass
	TQFP	Comb	4.27E+12	1.87E+10	1.6E+10	1.2E+10	4.37E+12	NDS	Pass
	BGA	Balls	1.17E+12	1.19E+11	5.6E+10	7.2E+10	1.37E+12	NDS	Pass
PTH	DIP	U6	3.55E+12	6.92E+11	1.4E+09	2.1E+09	1.01E+12	NDS	Pass
	DIP	U7	2.09E+12	5.01E+11	1.5E+09	2.2E+10	1.86E+12	NDS	Pass
	PGA	U1	7.41E+11	5.25E+10	3.6E+09	1.7E+10	1.17E+12	NDS	Pass
Bottom	B-24--1	No mask	1.55E+12	4.79E+11	2.7E+09	3.9E+09	1.45E+12	NDS	Pass
	B-24--2	Masked	4.17E+12	2.69E+12	5.0E+09	1.3E+10	3.24E+12	NDS	Pass
	B-24--3	Crossed	4.27E+12	2.14E+12	2.4E+09	5.1E+09	2.51E+12	NDS	Pass
leader #1	BrBrd Top		3.98E+12	3.31E+12	7.6E+09	1.0E+10	4.47E+12	NDS	Pass
leader #2	Br Brd Top		3.80E+12	3.55E+12	1.4E+10	1.7E+10	4.90E+12	NDS	Pass
leader #3	BrBrd Bottom		1.80E+12	2.74E+11	3.3E+10	2.5E+10	1.18E+12	NDS	Pass



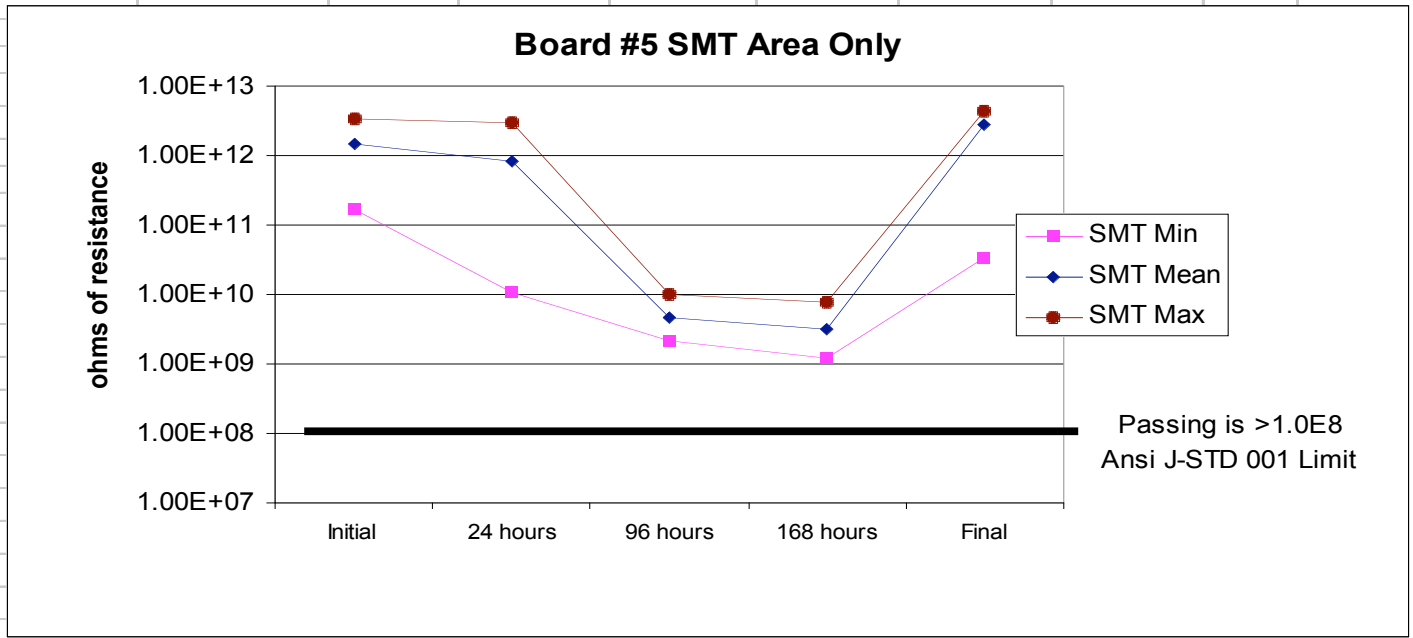


RESIDUE SITE

MS2 SIR DATA Assembly #5 at 480 F

Umpire Assembly #5 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		Pass* / Fail
SMT	LCC	Leads	6.79E+11	1.10E+10	2.19E+09	2.95E+09	3.31E+10	NDS	Pass
	LCC	Comb	2.45E+12	3.02E+10	4.31E+09	7.80E+09	3.80E+12	NDS	Pass
	TQFP	Leads	7.59E+11	9.77E+11	9.77E+09	1.20E+09	4.47E+12	NDS	Pass
	TQFP	Comb	3.47E+12	2.95E+12	3.63E+09	1.55E+09	4.47E+12	NDS	Pass
	BGA	Balls	1.67E+11	9.51E+10	4.03E+09	2.65E+09	1.47E+12	NDS	Pass
PTH	DIP	U6	1.10E+12	1.51E+12	2.04E+08	1.25E+09	3.63E+12	NDS	Pass
	DIP	U7	3.16E+12	3.98E+12	3.98E+09	3.89E+09	4.79E+12	NDS	Pass
	PGA	U1	1.15E+12	6.17E+10	6.46E+08	6.45E+09	1.70E+12	NDS	Pass
Bottom	B-24--1	No mask	2.24E+12	1.74E+12	6.61E+08	8.70E+09	4.27E+12	NDS	Pass
	B-24--2	Masked	3.55E+12	3.02E+12	3.72E+09	2.11E+10	3.55E+12	NDS	Pass
	B-24--3	Crossed	2.24E+12	1.48E+12	4.47E+09	5.82E+09	3.09E+12	NDS	Pass
Header #1	BrBrd Top		1.51E+12	3.72E+12	2.69E+09	3.47E+09	4.37E+12	NDS	Pass
Header #2	Br Brd Top		3.16E+12	3.55E+12	2.82E+09	2.88E+09	4.47E+12	NDS	Pass
Header #3	BrBrd Bottom		1.95E+11	3.16E+12	2.08E+09	3.02E+09	3.98E+12	NDS	Pass



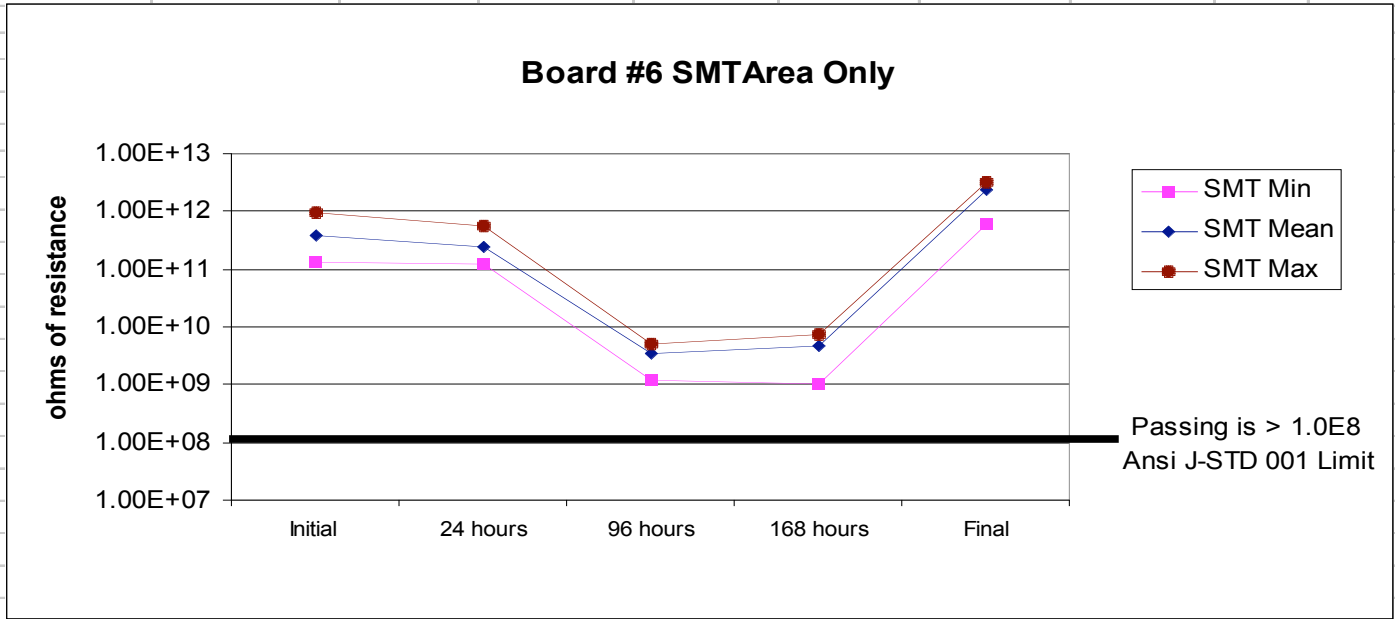


RESIDUE

MS2 SIR DATA Assembly # 6 at 480 F

Umpire Assembly #6 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		
SMT	LCC	Leads	3.09E+11	2.29E+11	3.80E+09	7.08E+09	3.24E+12	NDS	Pass
	LCC	Comb	2.45E+11	1.29E+11	4.17E+09	5.37E+09	2.88E+12	NDS	Pass
	TQFP	Leads	2.57E+11	5.62E+11	5.01E+09	7.41E+09	6.17E+11	NDS	Pass
	TQFP	Comb	9.77E+11	1.59E+11	1.23E+09	1.05E+09	3.24E+12	NDS	Pass
	BGA	Balls	1.27E+11	1.26E+11	3.33E+09	3.25E+09	1.42E+12	NDS	Pass
PTH	DIP	U6	2.40E+12	2.95E+12	2.51E+09	2.63E+09	3.09E+12	NDS	Pass
	DIP	U7	7.24E+11	3.39E+11	3.24E+08	5.75E+09	2.63E+12	NDS	Pass
	PGA	U1	2.45E+11	2.57E+10	3.24E+09	5.25E+09	1.32E+12	NDS	Pass
Bottom	B-24--1	No mask	2.82E+11	2.40E+12	2.40E+09	2.82E+09	1.95E+12	NDS	Pass
	B-24--2	Masked	2.04E+12	1.70E+12	3.80E+09	2.63E+09	2.88E+12	NDS	Pass
	B-24--3	Crossed	1.38E+12	1.86E+12	3.31E+09	6.46E+09	2.75E+12	NDS	Pass
Header #1	BrBrd Top		2.75E+12	1.74E+12	8.31E+09	6.61E+09	3.16E+12	NDS	Pass
Header #2	Br Brd Top		3.39E+12	3.39E+12	1.02E+09	7.76E+09	3.24E+12	NDS	Pass
Header #3	BrBrd Bottom		6.61E+11	5.62E+11	8.70E+09	2.09E+09	2.69E+12	NDS	Pass



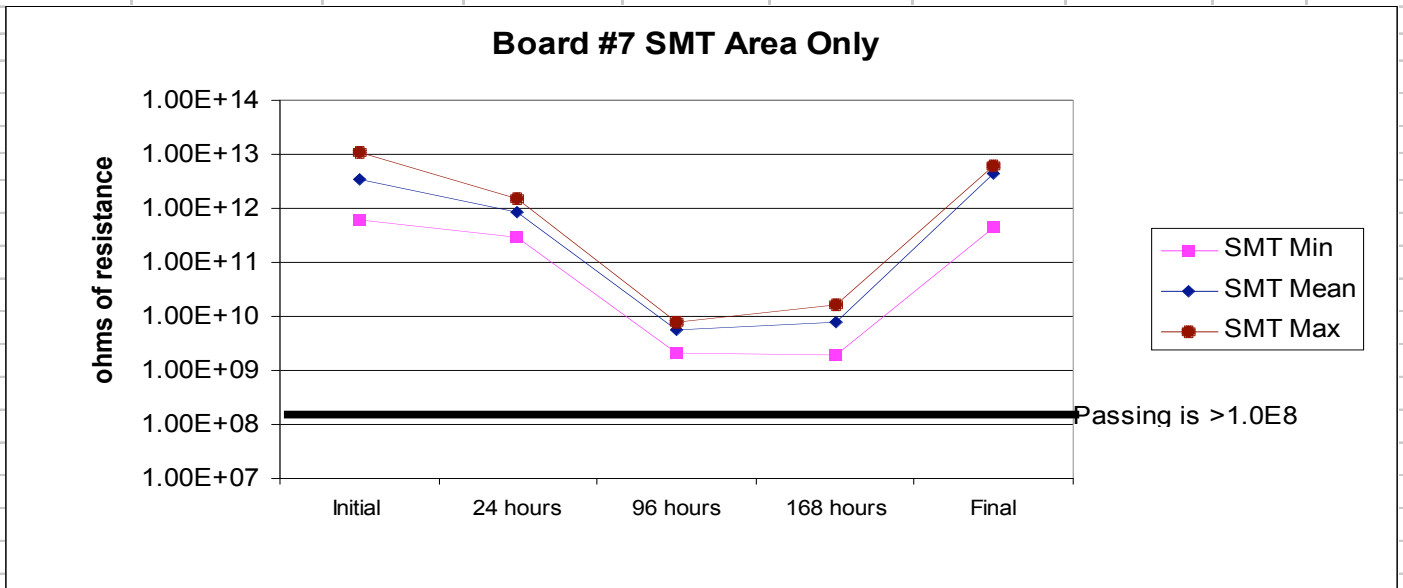


RESIDUE

MS2 SIR DATA Assembly #7 at 480 F

Umpire Assembly #7 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		
SMT	LCC	Leads	2.98E+12	2.91E+11	6.91E+09	8.50E+09	5.62E+12	NDS	Pass
	LCC	Comb	7.15E+11	7.32E+11	7.76E+09	1.58E+10	6.16E+12	NDS	Pass
	TQFP	Leads	1.53E+12	1.26E+12	2.07E+09	6.06E+09	6.16E+12	NDS	Pass
	TQFP	Comb	6.09E+11	4.21E+11	7.94E+09	1.90E+09	4.57E+11	NDS	Pass
	BGA	Balls	1.10E+13	1.57E+12	4.03E+09	6.17E+09	3.25E+12	NDS	Pass
PTH	DIP	U6	3.93E+12	2.37E+12	1.17E+10	2.24E+09	5.75E+12	NDS	Pass
	DIP	U7	3.75E+12	5.95E+11	4.26E+09	4.46E+09	2.14E+12	NDS	Pass
	PGA	U1	3.75E+12	1.01E+11	5.75E+09	9.99E+09	3.89E+12	NDS	Pass
Bottom	B-24--1	No mask	9.01E+12	8.21E+12	5.49E+09	1.17E+10	5.24E+12	NDS	Pass
	B-24--2	Masked	4.73E+12	3.93E+12	5.37E+09	4.68E+09	4.78E+12	NDS	Pass
	B-24--3	Crossed	6.23E+12	7.49E+12	4.26E+09	8.50E+09	3.98E+12	NDS	Pass
Header #1	BrBrd Top		1.36E+12	9.22E+11	4.78E+08	8.90E+09	5.01E+12	NDS	Pass
Header #2	Br Brd Top		7.49E+11	1.08E+12	1.26E+10	1.09E+10	6.45E+12	NDS	Pass
Header #3	BrBrd Bottom		1.11E+12	5.69E+11	2.08E+09	2.93E+09	2.90E+12	NDS	Pass



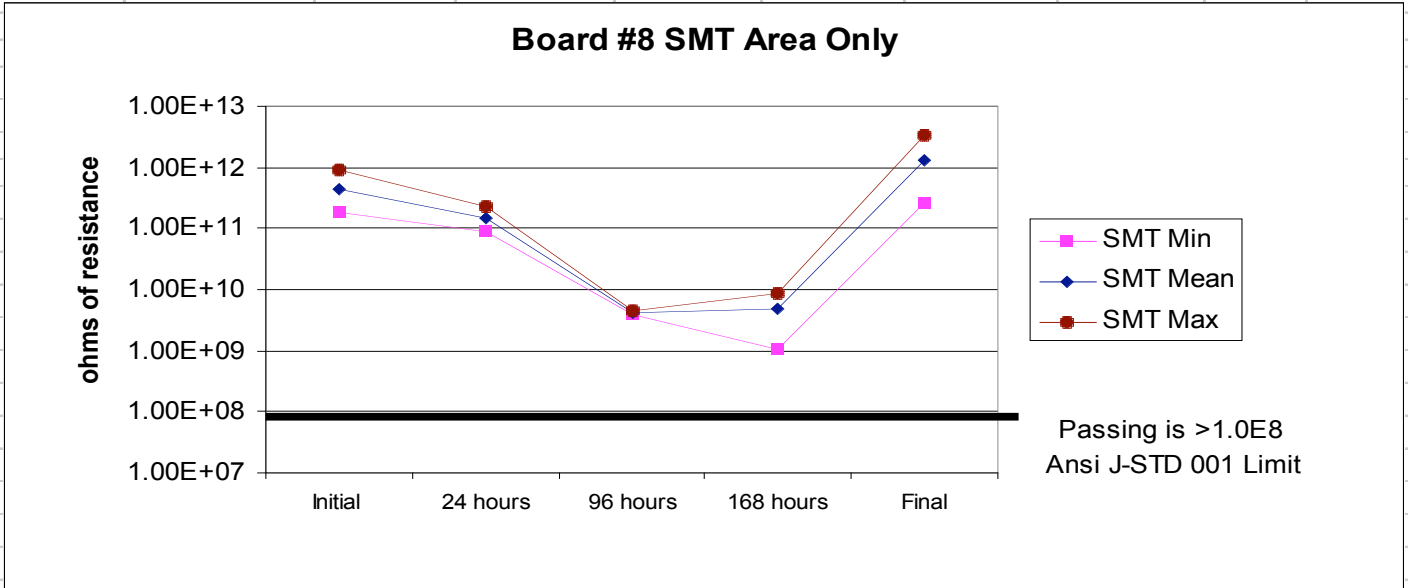


RESIDUE SITE

MS2 SIR DATA Assembly #8 at 480F

Umpire Assembly #8 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		Pass* / Fail**
SMT	LCC	Leads	9.12E+11	8.91E+10	3.89E+09	4.79E+09	3.16E+11	DNS	Pass
	LCC	Comb	2.19E+11	2.24E+11	4.37E+09	8.91E+09	3.47E+12	DNS	Pass
	TQFP	Leads	1.39E+11	4.39E+10	7.37E+09	1.21E+09	5.67E+11	DNS	Pass
	TQFP	Comb	1.86E+11	1.29E+11	4.47E+09	1.07E+09	2.57E+11	DNS	Pass
	BGA	Balls	2.86E+11	3.28E+10	1.15E+09	1.97E+09	3.17E+11	DNS	Pass
TH	DIP	U6	1.20E+12	7.24E+11	6.61E+09	1.26E+09	3.24E+12	DNS	Pass
	DIP	U7	1.15E+12	1.82E+11	2.40E+09	2.51E+09	1.20E+12	DNS	Pass
	PGA	U1	1.15E+12	3.09E+10	3.24E+09	5.62E+09	2.19E+12	DNS	Pass
Bottom	B-24--1	No mask	2.75E+12	2.51E+12	3.09E+09	6.61E+09	2.95E+12	DNS	Pass
	B-24--2	Masked	1.45E+12	1.20E+12	3.02E+09	2.63E+09	2.69E+12	DNS	Pass
	B-24--3	Crossed	1.91E+12	2.29E+12	2.40E+09	4.79E+09	2.24E+12	DNS	Pass
leader #1	BrBrd Top		4.17E+11	2.82E+11	2.69E+09	5.01E+09	2.82E+12	DNS	Pass
leader #2	Br Brd Top		2.29E+11	3.31E+11	7.08E+09	6.17E+09	3.63E+12	DNS	Pass
leader #3	BrBrd Bottom		1.29E+11	7.41E+10	4.51E+09	5.69E+09	1.14E+12	DNS	Pass





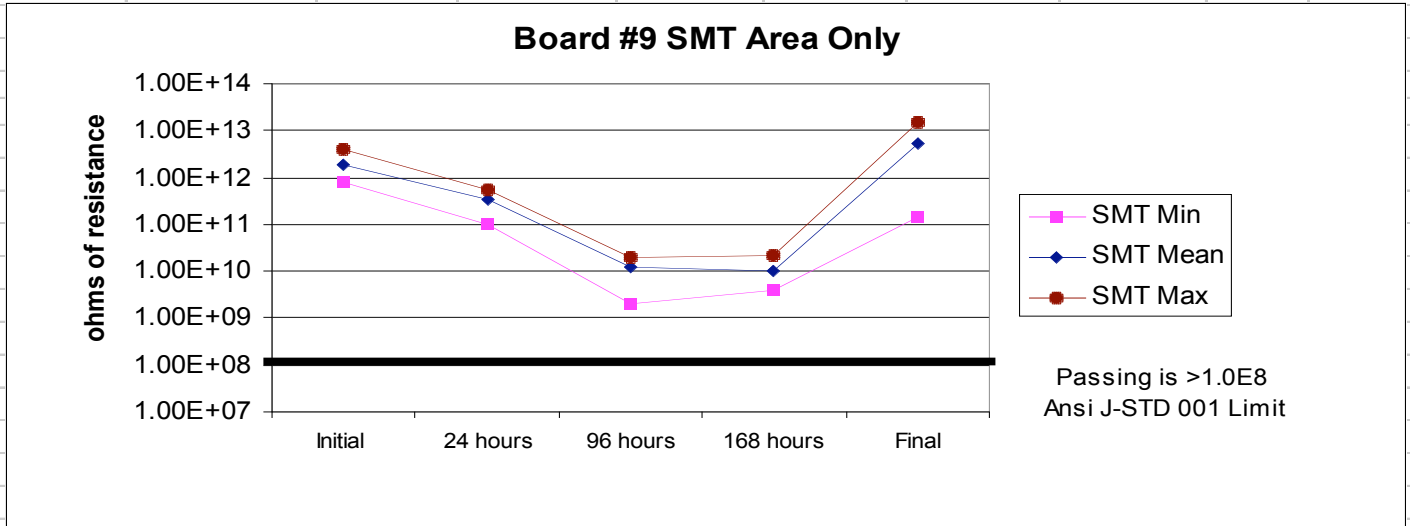
RESIDUE

MS2 SIR DATA Assembly #9 at 480 F

Jmpire Assembly #9 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		
MT	LCC	Leads	3.99E+12	3.90E+11	1.70E+10	2.10E+10	1.38E+11	DNS	Pass
	LCC	Comb	9.58E+11	9.80E+10	1.91E+10	3.90E+09	1.52E+13	DNS	Pass
	TQFP	Leads	6.08E+11	1.92E+11	3.22E+10	5.31E+09	2.48E+12	DNS	Pass
	TQFP	Comb	8.15E+11	5.64E+11	1.96E+09	4.69E+09	1.13E+12	DNS	Pass
	BGA	Balls	1.25E+12	1.44E+11	5.02E+09	8.64E+09	1.39E+12	DNS	Pass
TH	DIP	U6	8.58E+12	5.17E+12	4.72E+09	8.99E+08	2.31E+13	DNS	Pass
	DIP	U7	8.20E+12	1.30E+12	1.71E+09	1.79E+09	8.58E+12	DNS	Pass
	PGA	U1	8.20E+12	2.21E+11	2.31E+09	4.02E+09	1.56E+13	DNS	Pass
Bottom	B-24--1	No mask	1.97E+13	1.79E+13	2.21E+09	4.72E+09	2.11E+13	DNS	Pass
	B-24--2	Masked	1.03E+13	8.58E+12	2.16E+10	1.88E+09	1.92E+13	DNS	Pass
	B-24--3	Crossed	1.36E+13	1.64E+13	1.71E+09	3.42E+09	1.60E+13	DNS	Pass
leader #1	BrBrd Top		2.98E+12	2.01E+12	1.92E+09	3.58E+09	2.01E+13	DNS	Pass
leader #2	Br Brd Top		1.64E+12	2.36E+12	5.05E+09	4.40E+09	2.59E+13	DNS	Pass
leader #3	BrBrd Bottom		9.22E+11	5.29E+11	3.22E+10	4.06E+10	8.16E+12	DNS	Pass

Initial 24 hours 96 hours 168 hours Final





RESIDUE

MS2 SIR DATA Assembly #10 at 480F

Umpire Assembly #10 SIR DATA

	Umpire Board		Initial	24 hours	96 hours	168 hours	Final	Visual	Grade
	Component Area		(ambient)	(85/85)	(85/85)	(85/85)	(ambient)		Pass* / Fail**
SMT	LCC	Leads	1.18E+12	1.16E+11	5.05E+09	6.22E+09	4.11E+10	DNS	Pass
	LCC	Comb	2.84E+11	2.91E+11	5.67E+09	1.16E+09	4.50E+12	DNS	Pass
	TQFP	Leads	1.80E+11	5.70E+10	9.57E+09	1.57E+09	7.37E+11	DNS	Pass
	TQFP	Comb	2.42E+11	1.67E+11	5.80E+09	1.39E+09	3.34E+11	DNS	Pass
	BGA	Balls	3.72E+11	4.26E+10	1.49E+09	2.56E+09	4.12E+11	DNS	Pass
TH	DIP	U6	1.56E+12	9.41E+11	1.11E+09	2.12E+08	4.20E+12	DNS	Pass
	DIP	U7	1.94E+12	3.07E+11	5.25E+08	5.50E+08	2.03E+12	DNS	Pass
	PGA	U1	1.94E+12	5.21E+10	7.09E+08	1.23E+09	3.69E+12	DNS	Pass
Bottom	B-24--1	No mask	4.65E+12	4.24E+12	6.77E+08	1.45E+09	4.98E+12	DNS	Pass
	B-24--2	Masked	2.44E+12	2.03E+12	6.61E+09	5.76E+08	4.54E+12	DNS	Pass
	B-24--3	Crossed	3.21E+12	3.86E+12	5.25E+08	1.05E+09	3.78E+12	DNS	Pass
Leader #1	BrBrd Top		7.03E+11	4.75E+11	5.90E+08	1.10E+09	4.75E+12	DNS	Pass
Leader #2	Br Brd Top		3.86E+11	5.58E+11	1.19E+09	1.04E+09	6.12E+12	DNS	Pass
Leader #3	BrBrd Bottom		2.18E+11	1.25E+11	7.60E+09	9.59E+09	1.93E+12	DNS	Pass

