SATURN ELECTRONICS
CORPORATION

SATURN...
RELIABILITY

PRINTED CIRCUIT BOARDS FOR HIGH-RELIABILITY APPLICATIONS

Printed Circuit Boards ("PCBs") should be viewed as electronic real estate. Essentially, the reliability of the components that, combined with the PCB, make up your product are only as good as the foundation upon which they are assembled.

THE RELIABILITY OF A PCB DEPENDS PRIMARILY ON THE FOLLOWING:

Copper Plating Thickness

Typically, IPC Class II requires a minimum of 0.8 mils copper plating in the holes. However, for high reliability applications that are in the field over the long term, a minimum of 1 mil of copper plating is required. This ensures hole wall integrity throughout the assembly process as well as in continued operation in the field.

Fine Grain Structure Copper Plating

Standard Industry requirements and classifications generally do not refer to fine grain structure copper plating. However, plating fine grain structure copper is the key to withstanding harsh thermo-cycling tests. Essentially, fine grain structure copper allows the copper along the hole wall to expand and contract with various hot and cold environments. Standard plating, while meeting the minimum copper thickness requirements, plates larger grain copper that tends to crack during thermo-cycling testing.

Depending upon the environment, this could create severe reliability issues over the long-term during the product's useful life.

Ionic Contamination

Ionic contamination is not a requirement that is commonly called out in fabrication notes. However, it can pose serious PCB reliability issues over the long term. Ionic contamination is a surface contaminant that will cause dendrite growth across the PCB over time. At some point, these dendrites will connect, causing massive shorting of the PCB and, accordingly, failure of the product.

High reliability applications call for maximum ionic contamination levels of almost half that called out by IPC. Furthermore, many OEMs specify the maximum level of each element of ionic contamination.

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Copper Plating Thickness

The key to ensuring a minimum plating thickness of 1 mil is to reduce plating variability as much as possible. Standard manual plating lines can have variability across a single panel of +/- 40%. Thus, if a certain point on a panel measures 1 mil of copper plating thickness, there is a distinct possibility that other areas can have as low as 0.6 mils of copper plating, thereby affecting the long-term reliability of the PCB.

Saturn has designed and built it's own automatic copper plating line with the intent of minimizing variability by optimizing every parameter there is to copper plating. The primary factors include:

1. We only plate panels one-high, as opposed to 2-3 panels high.
2. Anode-to-anode distance is 28 inches (maximum distance allowable for plating).
3. Water-submerged positive cathode contact.
4. Chemical-submerged anode bars for constant positive contact.
5. Eductor system that utilizes a high-volume chemical flow parallel to the panels instead of air to accomplish chemical agitation.
6. Mechanical agitation to allow chemical to flow through holes.
7. Dual sided rectification to equalize copper plating from one side of the rack to the other.
8. State-of-the-art rectifiers (two per rack) with 0.5% maximum ripple effect.
9. Positive Thumbscrew panel contact to racks.

Fine Grain Structure Copper Plating

Copper plating rates can be calculated through the relation of amps per square foot (ASF) and cycle time. The greater the ASF, the less the cycle time. The industry standard is to plate at 30 ASF so as to minimize the required cycle time to reach 1 mil of copper plating. However, this results in large grain structure copper plating that will not withstand thermocycling tests.

Saturn has set up its lines to plate at 17 ASF, which results in fine grain structure copper plating, albeit at a much lowered production rate. However, fine grain structure copper plating has enhanced contraction and elongation properties that are critical to withstanding constant temperature changes.

Saturn tests the reliability of its product by performing extensive thermocycling tests. Our product is exposed to a 1,000 cycle thermocycling test in which one cycle consists of the following:

1. Room temperature down to -40° C within 5 minutes.
2. Stay at -40° C for 25 minutes.
3. Increase temperature to 125° C within 5 minutes.
4. Stay at 125° C for 25 minutes.
5. Decrease temperature to -40° C within 5 minutes.

After 1,000 cycles are passed, the PCB cannot have a change in resistance of greater than 10%.

Ionic Contamination

Since the industry is set up for 6.4 $\mu g/in^2$, the equipment suppliers design to meet this specification. However, in order to meet stricter high-reliability requirements of 3.8 $\mu g/in^2$ or less, Saturn designed and built its own equipment.

Since the primary cause of ionic contamination is the flux used prior to the Hot Air Solder Leveling (HASL) process, the best way to reduce ionic contamination is to clean the PCBs aggressively. Furthermore, Saturn has worked with its suppliers to develop a flux that reduces the levels of ionic contamination on the PCB.

A brief comparison of our custom post-cleaner to the industry-best is as follows:

INDUSTRY BEST	SATURN
(2) 1/2" wide brushes	(4) 1" wide brushes
1 1/2 H.P. chemical and water pumps	7 1/2 H.P. chemical and water pumps
1/2 gallon per minute nozzles	1 1/2 gallon per minute nozzles
All PVC, allowing maximum constant operating temperature of 120˚ to 130˚C	All stainless steel, allowing maximum constant operating temperature of over 180˚C
3 chambers	4 chambers