Process Doctor

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The Key to Success

Examine key parameters for a successful no-clean assembly.

While investigating a medical product sensitive to stray voltage, my company discovered that the original bare hot-air solder level (HASL) boards passed all process validation and accelerated environmental stress screening (ESS) when built up. However, when the full production units were run, they showed early failures in the field and were classified as no trouble found (NTF).

Investigating NTF Failures

The NTF numbers continued to increase and a detailed investigation took place. The units showed failures in boxed assemblies prior to shipment. Three months into product launch, the assemblies were tested for ionic cleanliness. The assemblies showed levels of bromide that were 10-15 times higher than the original qualification data.

All failures showed no visible corrosion or leakage pathways and passed testing when baked for three hours at 85°C. Electrical measures confirmed the failures.

We began a detailed investigation of the bare board and assembly process. With a 9% failure rate—growing every month—understanding what variables affected the circuit performance was important.

A data review shows key differences with the weak organic acid (WOA), bromide, chloride and sulfate levels. The current production data showed these levels to be much higher. What was creating the failures and why is there a difference between the two groups?

all values are µg/in²	----- Ion Chromatography -----				ESS Testing
Sample Description	**Cl-**	**Br^-**	**SO_4^{2-}**	**WOA**	
Original Qualification Boards and Data					65C/85%
Bare HASL Boads Original	0.27	1.36	0.18	0.00	not tested
HASL / SMT No Clean Paste Reflow	0.21	4.36	0.00	9.35	not tested
HASL / SMT Reflow / Selective Soldering No Clean wave	0.24	5.12	0.00	77.37	not tested
HASL / SMT Reflow / Selective Soldering / Hand No Clean	0.19	5.39	0.00	99.36	**Pass**
Current Production Samples					
Bare HASL Boads 3 months later	3.54	14.77	1.54	0.00	not tested
HASL / SMT No Clean Paste Reflow	2.45	18.91	0.00	11.59	not tested
HASL / SMT Reflow / Selective Soldering No Clean Wave	2.27	20.12	0.00	182.36	not tested
HASL / SMT Reflow / Selective Soldering / Hand No Clean	2.05	21.39	0.00	223.74	**Fail**
Assessment of Changes from Current Production					
Cleaned bare HASL boards	0.29	1.08	0.11	0.00	not tested
HASL / SMT Reflow / Soldering / Hand / Current Parameters	0.21	4.57	0.00	208.86	**Fail**
Cleaned bare HASL boards	0.22	1.11	0.09	0.00	not tested
HASL / SMT Reflow / Soldering / Hand / Reduced Parameters	0.20	5.02	0.00	105.36	**Pass**
Bare HASL Boads 3 months later	3.21	16.54	1.33	0.00	not tested
HASL / SMT Reflow / Soldering / Hand / Reduced Parameters	2.15	20.98	0.00	97.48	**Fail**

TABLE 1: ESS testing results highlight the crucial parameters.

Bare Boards

The data from the original group was low in all the anions reported. The current production boards show higher chloride, bromide and sulfate levels, indicating a poor cleaning process and possibly a different line. The boards for production came from a new, high-volume automated process line that was not yet qualified. The level of bromide from the HASL flux can cause the stray voltage leakage problem. The levels of chloride and sulfate are only slightly elevated; when the bromide level is reduced, the other residues will also be reduced.

Surface-Mount Technology/Reflow

The surface-mount technology reflow data show similar results for the reported ionic levels. The levels are typical for the no-clean paste and thickness used. The levels of ionics from the reflow step pose minimal risk for electrical leakage or corrosion problems.

Wave and Hand Soldering

The product passed and performed well when exposed to high humidity. But the current production units show much higher WOA levels that can cause the stray voltage due to excess flux that has not been completely heat-activated.

Since the bromide from the HASL flux can also cause these failures, we must evaluate clean, bare boards with the current parameters and the reduced optimal parameters from applying the flux during wave and hand soldering.

Conclusions

The cleaned bare boards show lower ionic residues when built using the current production specs, but fluxing parameters have little effect on the final performance because they still fail. When we use the current bare boards and reduce the fluxing parameters, the boards still fail testing. Only when the cleaned bare boards are built with optimized flux levels do we see good performance and results similar to the original qualification samples. ■

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