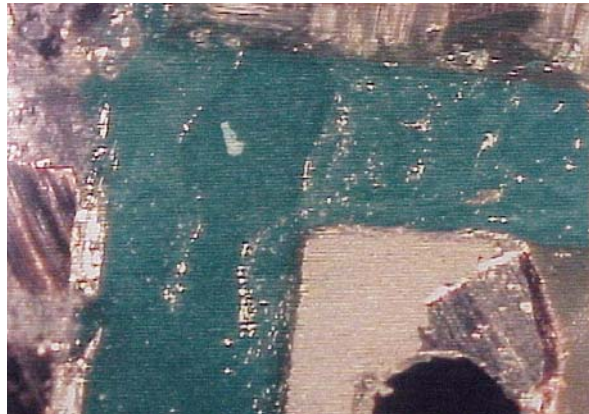


On a Flat Note

Flat leadless PQFN package traps flux from no-clean solder paste
leaving a goeey, conductive residue
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Flux volatilization is a critical factor in maintaining ionic cleanliness levels that lend to reliable performance. In a no-clean process, when the flux is activated and fully volatilizes, it leaves a benign residue carrier or solvent that will not have a negative impact on field performance.

New and compact forms of integrated circuit (IC) packaging, particularly leadless flat PQFN (Power Quad Flat No-Lead) packages, solve spacing issues for power electronics assemblers, but have been shown to entrap flux residues by not allowing a volatilization path. This occurrence causes the entrapment of a high concentration of goeey flux residues that lend to a high propensity for product failures. Though space is saved by a smaller footprint and replacement of axial leads, potential for flux entrapment becomes a huge concern to those using this type of package.



Area under flat leadless PQFN package from a 6 mil stencil with heavy, goeey flux residue

In other words, sometimes space conservation comes at a cost. A recent customer of Foresite's was using a flat, leadless PQFN package in an automotive application, and was experiencing stray voltage failures in the Z15 area where this package was located. This caused LEDs to stay on, and eventually cause failures. Upon removing this package from the assembly, it was found that underneath resided a visible flux residue. This customer sent in several assemblies for us to analyze and determine what the source and type of ionic contamination was.

This was a no-clean process with some selective soldering sites as well. There were visible flux residues on the assembly, and the areas we looked at included the leadless QFN package component as well as several selective soldering sites. We also looked at the cleanliness of incoming bare boards and PQFN packages. The selective sites showed low residue levels indicating that the no clean flux had done its job, and volatilized. The failure area around the flat leadless PQFN package showed only one flux activator group, and gave readings of high weak organic acids (WOA). These residues were coming from marginal cleanliness levels of the bare board and components combined with the flux used in wave solder. All of these elements combined and trapped under the flat PQFN package create a very high risk for conductive pathways to form. In order to investigate this problem and process more fully, I made a site visit to the location assembling the boards with the PQFN. It was found that they used a nominal range profile for the reflow oven used with the no-clean paste. We tried modifying to a higher reflow profile, but there was still goeey, non-complexed flux under the flat leadless PQFN package.



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The reason for this phenomenon is that as the weight of the PQFN package collapses over the molten solder paste during reflow, flux from the outside is sinking over and becoming trapped underneath the package where it cannot be complexed and released. The PQFN, which sits atop solder paste at a 6 mil stencil thickness, is able to drop down to 3-4 mils, thus trapping the flux and blocking the solvent path of volatilization.

To solve this, we suggested to design a 5 mil standoff to fit into the vent pipe vias that would hold the part up physically, and not allow for the column of solder to collapse under the part weight. The part will hold the solder up until it cools. If this were an aluminum part, it would function as a heat sink fin.

We are now working with this customer to enact this corrective design plan, and are also working to develop a remedial cleaning protocol to remove the flux residue from underneath PQFN package. Smaller, more compact technology is always developing at a rapid pace, and sometimes challenging cleanliness issues are discovered with these new, smaller technologies. Though this part is known for its heat dissipation, there needs to be great precautions taken when incorporating PQFN packages into design to prevent flux entrapment with no path of volatilization.

Sample Description	Ion Chromatography						C3 Tester	
	Cl ⁻	Br ⁻	WOA	SO ₄ ⁻	Na+	NH ₄ +	Results	Time(sec)
Board #1 PQFN area	3.42	2.53	114.17	3.25	5.11	3.69	Dirty	33
Board #1 Reference Area	3.09	2.77	16.33	3.69	5.33	3.51	Clean	86
Board #2 PQFN area	3.19	2.62	182.08	3.18	4.12	4.02	Dirty	39
Board #2 Reference Area	3.49	2.44	14.63	3.27	4.32	3.87	Clean	74
Board #3 PQFN area	3.26	3.12	102.82	3.09	4.29	2.94	Dirty	41
Board #3 Reference Area	3.41	3.08	18.37	3.39	4.01	2.88	Clean	82
Board #4 PQFN area	1.08	3.17	92.65	0.27	1.21	0.27	Dirty	56
Board #4 Reference Area	0.89	2.98	11.52	0.23	1.47	0.33	Clean	180
Board #5 PQFN Area (board mfr. 1)	3.78	3.50	59.36	3.21	4.32	3.05	Dirty	59
Board #5 Reference Area	3.62	3.14	18.78	3.09	4.74	3.66	Clean	91
Board #6 PQFN Area (board mfr. 2)	1.67	3.33	71.32	1.21	1.69	1.21	Dirty	51
Board #6 Z107 93ZOOI Ref area	1.23	3.05	14.62	1.11	1.84	1.06	Clean	165
Board #7 PQFN area (board mfr. 1)	3.60	3.27	68.36	3.34	4.69	3.55	Dirty	34
Board #7 Reference Area	3.53	3.44	13.21	3.64	4.41	3.16	Clean	82
PQFN package in tape and reel #1	1.02	0.22	0.00	0.24	0.39	0.15	Clean	180
PQFN package in tape and reel #2	0.89	0.29	0.00	0.15	0.31	0.11	Clean	180

All values in µg / in²