What's Your PCB IQ?

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Quiz #5
What the Flux?

It's a fluxing jungle out there! With thousands of different fluxes to choose from, what's an engineer to do? Take the Printed Circuit Girls and Geeks' 10-Question Pop Quiz and clear up your fluxing confusion.

QUESTIONS

Part one: Multiple Choice

1. In the electronics assembly process, does flux:
a) clean oxides from surfaces to prepare them for hot solder to wet to them
b) fight the formation of new oxides under the heat of processing
c) help the tiny spheres in solder paste coalesce into a single mass during SMT reflow
d) help break surface tension, and therefore eliminate solder bridges and balls in wave soldering
e) all of the above
f) none of the above

2. Fluxes are classified according to J-STD-004 using a coding system. The first two letters of a flux's designation can be OR, RO, RE or IN. These represent:
a) basic composition
b) activity level
c) halide content
d) none of the above

3. The next portion of the designation, L, M, or H stands for:
a) basic composition
b) activity level
c) halide content
d) none of the above

4. The final portion of the code is 0 or 1. That stands for
a) basic composition
b) activity level
c) halide content
d) none of the above

Part Two: True or false?

5. Rosin is the same as resin.

6. Halogens and Halides are the same thing.

7. Halogen-free fluxes are not as good as halogen-bearing fluxes.

8. A flux's acid number is an indicator of its performance.

9. Water-soluble fluxes aren't really very soluble in water.

10. Water-soluble fluxes are active at room temperature.

ANSWERS

1. e. All of the above. That was pretty easy.

Flux comes in many forms:

- liquid, for wave or hand soldering
- viscous gel, for solder paste or rework flux
- solid and sticky, inside cored wire
- solid and dry, applied to the outside of solder preforms

Despite the variety of forms and formulations, all fluxes are designed to do pretty much the same job: promote soldering, no matter what's being soldered. Because there are so many different things to be soldered however, there are many different chemical approaches to flux. Hence the labyrinth of flux compositions and chemistries, and our attempt to guide you through it.

2. a. Basic composition. The first two letters of the designation represent one of four main categories into which fluxes are classified based on their composition:

RO = Rosin
RE = Resin
OR = Organic
IN = Inorganic

Rosin and resin fluxes are very similar, and they're good for long term reliability.

Organic acid fluxes don't usually have the same reliability as rosin or resin, so you have to be careful when you use them. Sometimes they must be cleaned off the assemblies after soldering, and you should never use them with paper-based laminates.

We don't use inorganic fluxes in electronics, so let's just say "flux them" for now.

3. b. The second part of the designation, or third letter, represents activity level:

L = Low
M = Medium
H = High

Activity level is determined by several tests, including how much copper the flux can eat through in 24 hours, how corrosive it is, and its halide content.

4. c. Halide content. This is also determined by a couple different tests. The quick-and-dirty spot tests put a drop of flux into certain chemicals to look for a visible reaction. If there's no color change, the flux is considered halide free, and it gets denoted with a 0 in the last position of the designation code. If there is a color change however, it moves to round two of testing, ion chromatography, to quantify the halide content, and it gets assigned a 1 in that last position.

Here's a table reproduced from the J-STD-004 document that sums it up:

Flux Materials of Composition	*Flux/Flux Residue Activity Levels*	*% Halide (by weight)*	*Flux Type*	*Flux Designator*
ROSIN (RO)	**Low**	0.0%*	L0	ROL0
		< 0.5%	L1	ROL1
	Moderate	0.0%	M0	ROM0
		0.5-2.0%	M1	ROM1
	High	0.0%	H0	ROH0
		>2.0%	H1	ROH1
RESIN (RE)	**Low**	0.0%	L0	REL0
		< 0.5%	L1	REL1
	Moderate	0.0%	M0	REM0
		0.5-2.0%	M1	REM1
	High	0.0%	H0	REH0
		>2.0%	H1	REH1
ORGANIC (OR)	**Low**	0.0%	L0	ORL0
		< 0.5%	L1	ORL1
	Moderate	0.0%	M0	ORM0
		0.5-2.0%	M1	ORM1
	High	0.0%	H0	ORH0
		>2.0%	H1	ORH1
INORGANIC (IN)	**Low**	0.0%	L0	INL0
		< 0.5%	L1	INL1
	Moderate	0.0%	M0	INM0
		0.5-2.0%	M1	INM1
	High	0.0%	H0	INH0
		>2.0%	H1	INH1

** 0.0% is defined as <0.05% by weight*

Referencing our decoder table above, an ORL0 flux is rosin-free, low activity, and halide-free. An ROL0 flux contains rosin, has low activity, and is halide-free. An ROL1 flux contains rosin, has low activity, and has less than 0.5% halides.

Congratulations - you have broken the code! If you want to learn a little bit more about how fluxes are tested and classified, *and* how to select them for your application, download this white paper from Chrys' website:

http://sheaengineering.com/Documents/Selection%20of%20Wave%20Soldering%20Fluxes%20for%20Lead%20Free%20Assembly%20APEX%20-%20for%20dist.pdf

If you want a complete understanding all the test methods used and the precise classification criteria, the best reference is the standard itself, which can be purchased from IPC (www.ipc.org).

5. True. While this is not a trick question, it is a tricky one! Rosins are a subset of a larger chemical family of resins. Rosins occur naturally, usually in pine or other evergreen trees. Resins can also occur naturally, but in the context of flux, they are either highly refined rosins, or fully synthesized materials. While the classification system differentiates between the two, most flux formulators and users don't - they just refer to fluxes as rosin (bearing) or rosin-free, regardless of its actual classification. Most of the rosins used in modern fluxes actually are synthetic resins, but we still refer to them as rosins anyway. Old habits die hard…

Far more important than splitting hairs on the rosin-resin thing is what these substances do for you - they're magic! When they're warm, they work as activators and reduce the oxides on the metal surfaces, but when they're cold, their molecules close up and encapsulate all the nasty ionic materials and unreacted acids that might be left behind. That's pretty fluxing nifty, if you ask us.

If rosin helps soldering AND reliability, why doesn't everybody flux with it? That's a sticky subject. If you use a high-rosin formulation, too much flux, or don't put enough heat into it, you're going to have problems with probe penetration at electrical test. Not only does excess rosin residue impede probe contact, it can transfer to the pins of the test fixture. So you get a double whammy – poor contact and fluxed up fixtures – a real clusterflux that most test engineers try to avoid.

6. False. Halides obviously contain halogens, but not all halogens are halides. In the PCB world, halides are usually found in fluxes, because they are great at reducing those pesky oxides – especially helpful for components that have been sitting on the shelf for a long time. The biggest problem halides are blamed for is occasional post-soldering corrosion, but that doesn't happen often, because rosin is always there to encapsulate the chlorides, bromides or fluorides that helped from the solder joint.

On the other hand, halogens are more often found in PCBs and wiring as flame retardants, but there are pinches of them in fluxes and solder pastes. Halogenated materials like PVC can give off several types of dangerous

emissions if they burn at certain temperatures. It's a little ironic, isn't it? Flame retardants burning? Anyway, eliminating them wherever possible sure seems like the smart thing to do. But there's a tiny glitch with the master plan – the test method that measures halogens does so by converting them to halides, so we can't actually tell which is what when we test for them. Therefore, as an industry, we basically have to phase them all out, which is akin to throwing the baby out with the bath water.

While there currently aren't any legislative measures banning halogens like there are for lead, environmentally responsible OEMs are leading the industry in eliminating these substances from electronic products. That's a good thing, because it will drive the development of replacement materials, many of which don't yet exist. So if you can't join the Halogen-Free movement right now, don't worry; you don't have to.

For more on halogens and halides in electronics, go to:
http://circuitsassembly.com/cms/magazine/95/5954

7. False. Mostly false, anyway. While the first generation of materials pretty much sucked, the current offerings are pretty good. Think back to the first lead-free or no-clean products. They sucked, too, but then they got better as product developers climbed the learning curve and suppliers figured out how to deliver what was important to PCB assemblers.

Well, the same thing is happening with the removal of halogens from the flux formulations - each generation performs better than the previous one. Some halogen-free products are actually pretty good these days. Sadly, there are still some sucky fluxes out there, so the user should test a few before settling on a single vendor or formulation.

8. False. While it's perfectly natural to want maximize our flux activity, the reality is that it's more than just a numbers game these days. Since we got the lead out of our assembly processes, flux formulators have produced a number of exceptions to that old acid number rule. Fluxes with high acid numbers may not have the thermal longevity to hold up to a long, hot lead-free soldering process, whereas fluxes with low acid numbers may contain thermal stabilizers that prolong their activity.

9. True! You may have noticed that flux and paste manufacturers often refer to them as "water washable" and "water cleanable." What does this mean? Well, if you have all the time and hot water and fancy spray jets in the world, you will eventually be able to completely remove the flux residues with deionized water alone. But in all practicality, if you are trying to make money when you build your circuit assembly, you will need to add some type of saponifier to your wash process. What's saponifier? Basically a fancy word for soap. So if you want

your boards to come out of that wash cycle clean for sure, add soap to your hot water. The same goes for your laundry, your dishes, even you!

10. True. That's why we keep it in plastic containers instead of metal ones! And that's why you need to clean it from the boards completely. Get it?

Did you ace this quiz or FUBAR it?

Give yourself one point for every correct answer, and deduct one point for every wrong answer.

If you scored 8-10, you are an absolute fluxing genius!
Flux U, ("U" standing for University, what else?) is ***the*** leading academic institution for the world's most talented electronics engineers and manufacturers. A figment of our imaginations, this highly touted center of knowledge and creativity draws students and faculty from all over the universe to experience the finest learning and most collaborative environment ever envisioned. This university's amusement theme park even has unicorn rides and teleporting transportation! Congratulations - you have qualified to serve as Professor Emeritus at our world-renowned think tank.

If you scored 0-6, you are a pretty dumb fluxer.
The time of reckoning is upon you: as it turns out, our quizzes aren't too dumb for you. The fact of the matter is that you are too dumb for them. But don't fret! "90% of being smart is knowing what you're dumb at."

You must rise above your engineering ego and get to learning. Grab your quiz, a couple scrap boards (which we know you've got; don't bother to deny it), some solder and flux, and step up to the challenge. Bring a snack; you might be at it for a while. You CAN be a fluxing rockstar, and that's just as good as being a Flux U graduate…or maybe even better (wink).

If you scored less than zero, you are a fluxing idiot!
You got an "F." And "F" is not for "Flux" or for "Funny"…because we are not amused, and your boss won't be either if he finds out badly you fluxed up this quiz. "F" is purely for failure. You will never get a diploma from Flux U because you will never get accepted into it. And don't even think about wearing one of our collegiate t-shirts while attending your local community college; your colleagues will just mock you behind your back and eventually make it Facebook official for everyone to see. Give up now and go start a google+ circle for other fluxing losers like yourself.