Data Sheet

Broadcom PCB Soldering/Assembly Best Practices

Application Note 5578

Introduction

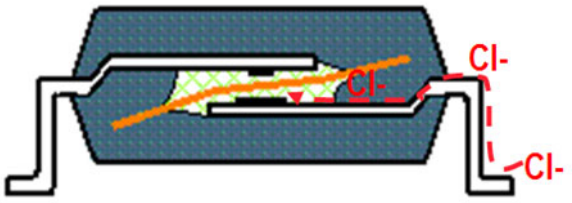
In the printed circuit board (PCB) assembly industry, flux is commonly used—from cleaning component leads to reflow and wave soldering. Using halide and non-halide flux have their own individual challenges. Halide flux always faces the issue of corrosion on the components during post-assembly processes.

This application note highlights the effect of halide content in PCBs, and Broadcom® recommended guidelines for PCB assembly operations, including surface mount assembly.

Definition of Halide-Free and Classification

By definition, halide-free means that a product does not contain any halogenated compounds. Halogenated compounds are mostly found in PCBs, solder masks, mold compounds, connectors, cable insulation, and wiring conduit. In broad terms, halides are associated with soldering operations, while halogens are associated with Printed Wiring Board (PWB) or components. Hydrolizable Chlorine, also known as brominated chlorine retardants, is a common halogen (different from halide) found in mold compounds for their flame retarding properties.

Figure 1: Mechanism for Chlorine to Corrode the Bondpad



IPC J-STD-004B (designed around soldering fluxes) defines halide-free as the following:

> < 500 ppm of a flux's solids content, as chloride (fluoride and bromide are adjusted for the molecular weight difference and calculated as chloride).

The International Electrochemical Commission, IEC 61249-2-21 (designed around PCBs) defines halogen-free as the following:

- < 900 ppm Cl, chlorine
- < 900 ppm Br, bromine
- <1500 ppm total halogens.

Halides are detected using simple spot tests, as described in IPC J-STD-004B. Halide containing halogens are highly reactive. They are used in the board assembly process to aid in soldering performance by providing oxide-removal capabilities to enhance wetting, but they can be harmful or lethal in sufficient quantities. A flux that is classified as halide-free by IPC J-STD-004B is actually only free of ionic halides. IPC has classified electronic soldering fluxes to determine their potential corrosives if left unclean on an electronic assembly. The classification method categorizes fluxes as L, M, or H (Low, Medium, or High) based on their level of corrosiveness. In addition, the fluxes are rated for halide content as 0 or 1 (0 as absence of halide content, and 1 as presence of halide content). This is shown in Table 1 (reference to IPC J-STD-004B).

Effects of Halides to the PCB Assembly

Halides are ionic and have a charge; for example, Cl–, Br–, and F–. Chlorine is the most electronegative ion, and the species migrates into the package through electrical field drifts due to Vcc (power supply) potential. The Vcc (power supply) pad is typically the first pad to be “attacked” by chlorine-related issues. Generally, the GND (ground) pad is normally not corroded, because this pad is generally at ground potential or lowest potential. This indicates that it is unnecessary to de-laminate the lead mold interface for the ionic contaminants to ingress. The mere presence of ionic species, in the presence of acceleration factors such as moisture and potential differences, is sufficient to initiate the ionic contamination process. The mechanism of how the chlorine ions from the environment can be brought into the package and corrode the bondpad is shown in Figure 1. Figure 2 shows that chlorine is found at the interface between the leadframe to mold compound (non-delaminated), and Figure 3 shows bondpad corrosion resulting from using halide flux.

Figure 2: Leadframe to Mold Compound Interface at Power Supply Pin. Chlorine is detected in the green box as indicated from the EDX shown.

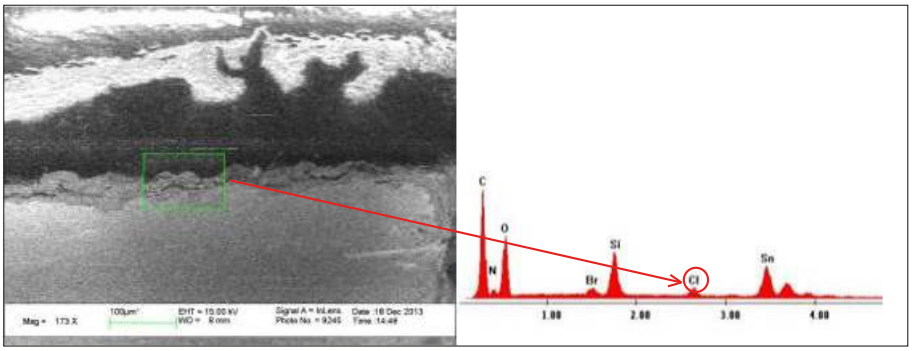
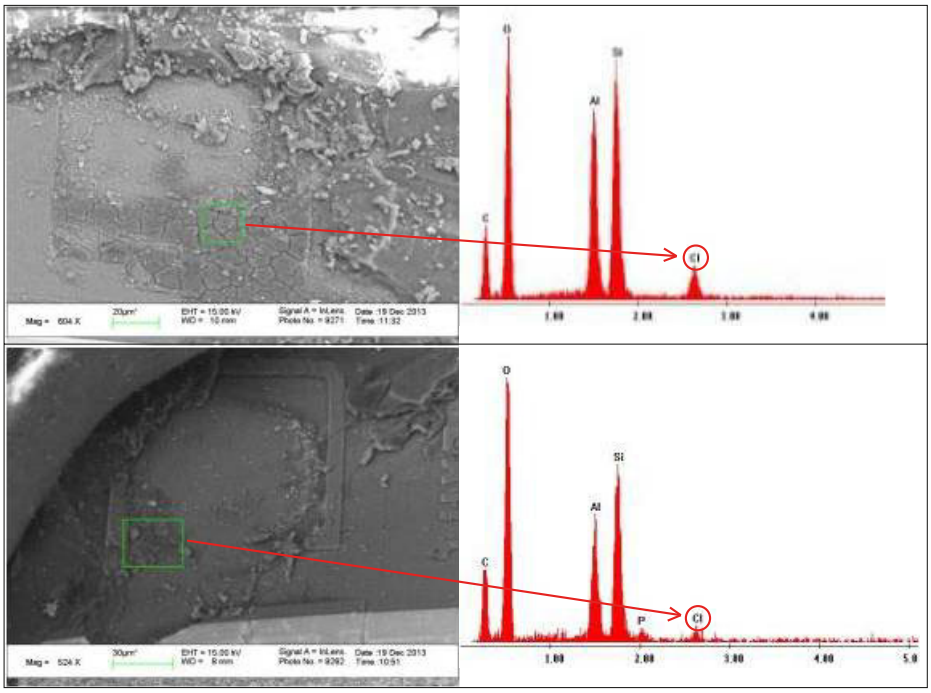


Figure 3: Corroded Bondpads. Chlorine detected in the green boxes as indicated from the EDX shown.



Broadcom Plastic Optocouplers Certified to MSL1

Moisture sensitivity level (MSL) relates to the packaging and handling precautions for some semiconductor devices. It indicates the maximum time period in which a moisture-sensitive device can be exposed to ambient room conditions (approximately 30°C/60% RH). If not adhered to, expansion of the trapped moisture within the devices and exposure to solder reflow temperatures may result in wire bond damage, die damage, and internal cracks, affecting the yield and reliability degradation.

For moisture-sensitive devices, these are packaged in a moisture barrier antistatic bag with a desiccant and a sealed moisture indicator card. The moisture sensitivity levels are classified according to IPC J-STD-020D guidelines. For MSL 1, the floor life is unlimited under condition ≤ 30°C/85% RH environment. For subsequent MSL levels, there is a maximum allowable period of time in which the devices need to be mounted and undergo reflow when removed from the moisture barrier bag (MBB). Usage of moisture-sensitive devices can also be referenced from IPC J-STD-033.

Unless otherwise stated, all Broadcom plastic optocouplers are classified as MSL1. This is stated in the Broadcom reliability data sheets.

Broadcom Soldering/Assembly Best Practices

In PCB assembly, Broadcom recommends that the solder paste/flux and cleaning solvents must not contain any halide (this includes chlorine, bromine, and iodine) in them. Halide flux is known to cause contamination and corrosion and, therefore, reliability issue concerns.

Thermal shock can cause the expansion and contraction of the molding compound and silicone, which causes possible ingress of moisture, chemicals, and cleaning agents into the package.

To reduce the chance of moisture ingress, avoid a direct high-pressure wash on the parts.

The deionized water wash is acceptable, but perform it with the following guidelines in mind.

1. Any soldering flux or cleaning solvents associated with an optocoupler must be “halide-free”. Halide (chlorine, bromine, or iodine, if present in the fluxes) can ingress the package under water wash and initiate the ionic corrosion process, corroding bondpads and wires, and ultimately lead to “catastrophic” failures. This provision of using non-halide flux is indicated in every data sheet for Broadcom plastic optocouplers, under the Soldering Profile section.
2. After soldering is performed on the PCBs, which are generally at an elevated temperature, allow the boards some time to cool off before they are immersed in the deionized water wash to prevent any thermal shock-related issues.
3. The pressure of the deionized wash is kept at reasonably low levels, such as 50 psi or lower, to prevent pressure-induced moisture ingress into the package. Also, keep the duration of any deionized wash to a minimum—no more than 3 minutes.
4. After the deionized water wash, the boards undergo dry heat so that any remaining moisture is evaporated. This can probably be done within several hours of drying at 125°C ambient storage.

The following are Broadcom recommendations for automatic PCB assembly operations, including surface mount assembly guidelines to ensure proper operation and long-term reliability of Broadcom optocouplers.

Solder Reflow Process

- Use only one soldering operation within the thermal profile (see Figure 4 for the thermal profile, guidelines for the time and temperature are indicated in Table 2, Table 3, and Table 4, with reference to IPC J-STD-020D).
- With infrared lamp heating, use precautions to avoid localized temperature rise in the resin.
- Do not immerse the resin in the solder.

Wave Soldering

Allow for a maximum solder temperature of 260°C for 10s, with the solder 1.6 mm below the seating plane.

Solvent Cleaning

- Ensure that the solvent temperature and immersion time do not exceed 45°C and 3 minutes, respectively.
- For ultrasonic cleaning, use environmentally safe solvents, such as ethyl and methyl alcohol.

Staging Time

- Staging time is the maximum time allowable for PCBAs between soldering and cleaning.
- The longer the staging time, the higher the chance of organic contaminants creeping into the package, so washing is not effective.
- For the recommended staging time, consult with the respective vendor for the flux.

ESD Precautions

To prevent damage or degradation of the device, take standard electrostatic discharge precautions in handling and assembly of the optocouplers.

Figure 4: Solder IR Profile (reference to JEDEC J-STD-020D)

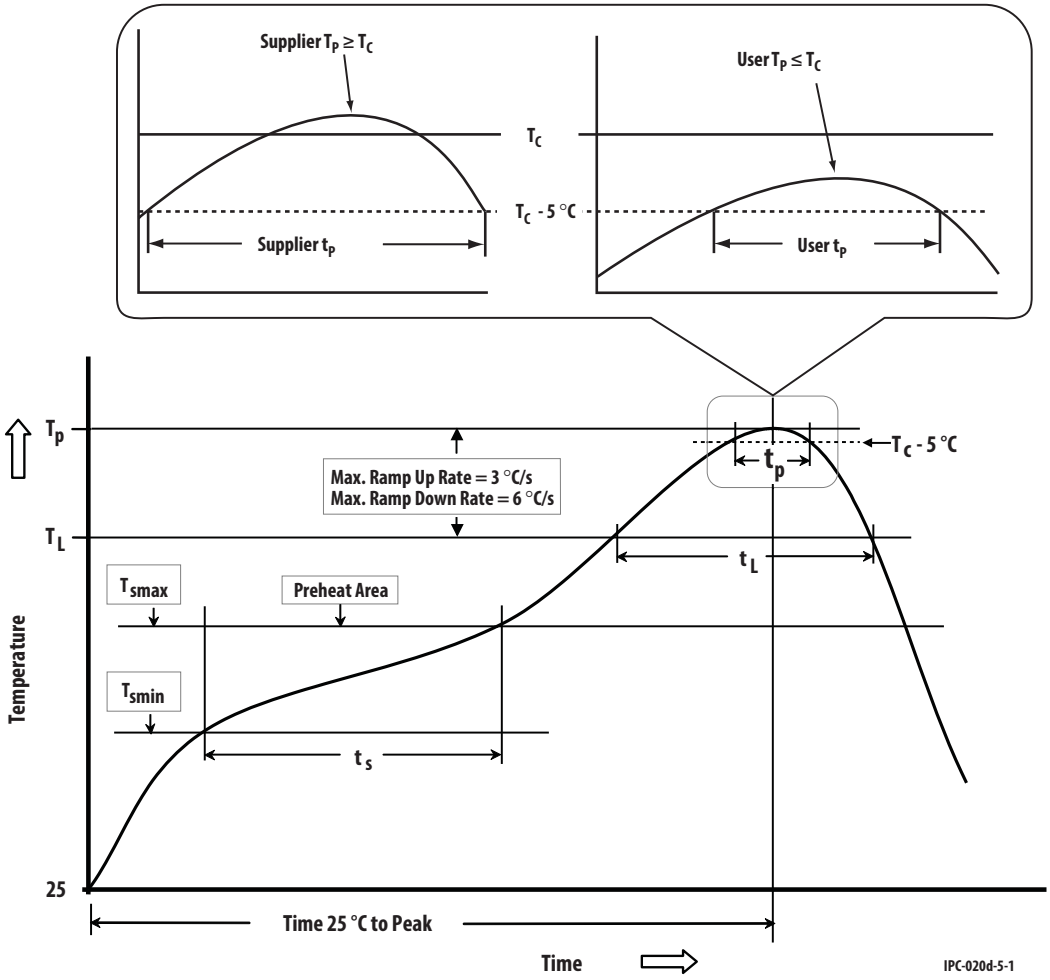


Table 1: Flux Identification System (Reference to Table 1-1 of IPC J-STD-004B)

Flux Composition	Flux/Flux Residue Activity Levels	%Halide (by Weight)	Flux Type	Flux Designator
Rosin (RO)	Low	<0.05%	L0	ROL0
		<0.5%	L1	ROL1
	Moderate	<0.05%	M0	ROM0
		0.5–2.0%	M1	ROM1
	High	<0.05%	H0	ROH0
		>2.0%	H1	ROH1
Resin (RE)	Low	<0.05%	L0	REL0
		<0.5%	L1	REL1
	Moderate	<0.05%	M0	REM0
		0.5–2.0%	M1	REM1
	High	<0.05%	H0	REH0
		>2.0%	H1	REH1
Organic (OR)	Low	<0.05%	L0	ORL0
		<0.5%	L1	ORL1
	Moderate	<0.05%	M0	ORM0
		0.5–2.0%	M1	ORM1
	High	<0.05%	H0	ORH0
		>2.0%	H1	ORH1
Inorganic (IN)	Low	<0.05%	L0	INL0
		<0.5%	L1	INL1
	Moderate	<0.05%	M0	INM0
		0.5–2.0%	M1	INM1
	High	<0.05%	H0	INH0
		>2.0%	H1	INH1

Table 2: Classification Reflow Profiles (Reference to Table 5-2 of IPC J-STD-020D)

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat/Soak		
Temperature Min. (T_{smin})	100°C	150°C
Temperature Max. (T_{smax})	150°C	200°C
Time (t_S) from T_{smin} to T_{smin}	60 to 120 seconds	60 to 120 seconds
Ramp-uprate (T_L to T_P)	3°C/second max.	30°C/second max.
Liquidous temperature (T_L)	183°C	217°C
Time (T_L) maintained above T_L	60 to 150 seconds	60 to 150 seconds
Peak package body temperature (T^P)	For users, T_P must not exceed the Classification temperature in Table 4-1. For suppliers, T_P must equal or exceed the Classification temperature in Table 4-1.	For users, T_P must not exceed the Classification temperature in Table 4-2. For suppliers, T_P must equal or exceed the Classification temperature in Table 4-2.
Time (t_P) within 5°C of the specified classification temperature (T_C), see Figure 5-1	20[a] seconds	30[a] seconds
Ramp-down rate (T_P to T_L)	6°C/second max.	6°C/second max.
Time 25°C to peak temperature	6 minutes max.	8 minutes max.

a. Tolerance for peak profile temperature (T_P) is defined as a supplier minimum and a user maximum.

Table 3: SnPb Eutectic Process – Classification Temperatures (Tc) (Reference to Table 4-1 from IPC J-STD-020D)

Package Thickness	Volume mm^3 < 350	Volume mm^3 ≥ 350
< 2.5 mm	235°C	220°C
≥ 2.5 mm	220°C	220°C

Table 4: Pb-Free Process – Classification Temperatures (Tc) (Reference to Table 4-2 from IPC J-STD-020D)

Package Thickness	Volume mm^3 < 350	Volume mm^3 350 to 2000	Volume mm^3 > 2000
< 1.6 mm	260°C	260°C	260°C
1.6 mm to 2.5 mm	260°C	250°C	245°C
> 2.5 mm	250°C	245°C	245°C

Summary

Broadcom does not use any halide content in its optocoupler manufacturing processes. The effects of halides to the PCB assembly result in corrosion and impact the reliability of the optocouplers. Based on Broadcom's experience, the majority of the failures encountered by customers out in the field are corrosion-related issues, a result of exposure to halide-based fluxes.

Customers should adhere to the Broadcom soldering/assembly practices as detailed in this application note.

References

1. Requirement for Solder Fluxes, IPC J-STD-004B, January 2004.
2. Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices, IPC J-STD-020D, March 2008.
3. Halogens and Halides, Chrys Shea, Circuit Assembly, The Journal for Surface Mount and Electronics Assembly, December 31, 2007.
4. Designer Guide, Data Sheets, 5989-0802EN, Broadcom, June 01, 2006.
5. Plastic Optocoupler Products ESD and Moisture Sensitivity, Reliability Data Sheet, AV02-0310EN, Broadcom, September 18, 2013.