

Conformal Coating

Z-World has started to apply conformal coating to high-impedance circuits such as the 32 kHz oscillator on Rabbit-based boards to protect them from moisture and contaminants. This Technical Note explains the purpose, types, and application procedures for the conformal coatings used to protect these sensitive circuits.

Conformal coatings are protective materials that are designed to conform to the surface of printed circuit boards for the purpose of providing a durable barrier against environmental contaminants. A conformal coating is typically applied as a thin film with a thickness of 3–8 mil (0.075–0.2 mm).

The physical and chemical compositions of various coatings differ, and thereby offer varying degrees of protection. However, all conformal coatings possess certain characteristics:

1. Conformal coatings prevent short circuits and corrosion of conductors and solder joints by providing a barrier against moisture, dust, and chemical contaminants.
2. The coatings provide durable insulation to help components tolerate shock and resist abrasion. The coatings also serve to reduce mechanical and thermal stresses on the components.

Types of Coatings Available

Conformal coatings can be classified into five major groups based on their chemical composition: acrylic, epoxy, urethane, silicone, and paraxylylene. We will only look at the first four groups since paraxylylene is applied by vacuum deposition, and requires the pre-processing of boards and very expensive specialized equipment.

- Acrylics (type AR) are easy to apply and easy to remove. These types of coatings do not demonstrate resistance to either abrasion or to chemicals.
- Polyurethanes (type UR) are fairly easy to apply, but very difficult to remove. Spot repairability by thermal means (i.e., a soldering iron) is not recommended because toxic gasses (isocyanate) will be produced. UR coatings offer excellent protection against the effects of humidity, chemicals, and abrasion.
- Epoxy (type ER) offers excellent resistance to moisture and solvents. Epoxy is usually available as a two-component thermosetting mixture. Epoxy is fairly easy to apply, but is nearly impossible to remove without damaging components.
- Silicones (type SR) are typically used in high-temperature environments. Silicone coatings are easy to apply, have low toxicity, offer good resistance to moisture, abrasion, and humidity, and are useful over a wide temperature range. Although their dielectric strength is less than other types of coatings, the ease of application and excellent adhesion to previously applied coatings allows for the buildup of a thicker film and improved dielectric strength.

Table 1 provides a simple rating system that can be used as a general guide for selecting the best coating for a particular application.

Table 1. Quick-Reference Guide to Conformal Coatings

Characteristic	Acrylic (AR)	Polyurethane (UR)	Epoxy (ER)	Silicone (SR)
Humidity Resistance	Excellent	Excellent	Good	Excellent
Humidity Resistance (Extended Periods)	Good	Excellent	Fair	Good
Abrasion Resistance	Fair	Good	Excellent	Good
Mechanical Strength	Fair	Excellent	Excellent	Good
Stress on Coated Components Resulting from Temperature Variation	High	High	High	Low
Temperature Resistance	Good	Fair	Fair	Excellent
Acid Resistance	Good	Excellent	Excellent	Good
Alkali Resistance	Fair	Excellent	Excellent	Good
Organic Solvent Resistance	Poor	Excellent	Excellent	Good
Dielectric Constant @ 23°C, 1 MHz	2.2–3.2	4.2–5.2	3.3–4.0	2.6–2.7
Repairability	Difficult	Difficult	Difficult	Easy

Rabbit-Based Boards

Rabbit Semiconductor recommends the application of some type of conformal coating to protect the high-impedance circuitry on Rabbit-based boards against moisture, dust, and chemical contaminants.

High-impedance circuits on Rabbit-based boards manufactured at Z-World are coated with a layer of silicone-based conformal coating that is 8–12 mil (0.2–0.3 mm) thick. The coating covers the 32 kHz oscillator circuitry and the section of the battery backup circuit that regulates the lithium battery voltage down to 2.2 V. These circuits are shown in Figure 1.

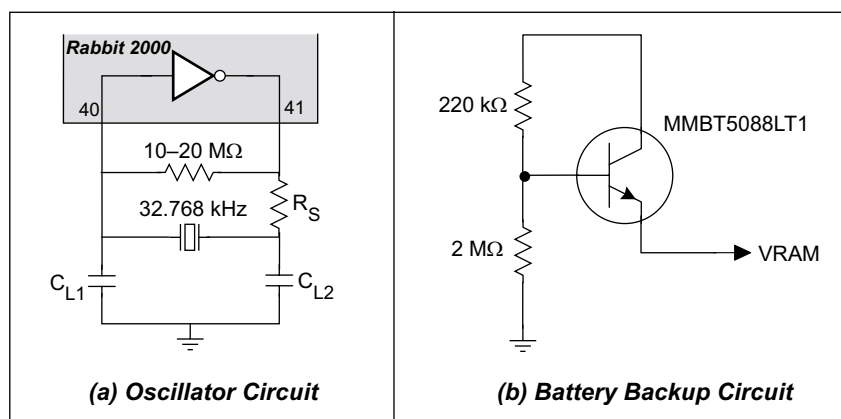


Figure 1. High-Impedance Circuits Recommended for Conformal Coating

Silicone-Based Coatings

Z-World selected the Dow Corning silicone-based 1-2620 Low VOC RTV conformal coating for coating the Rabbit based boards. 1-2620 is the low-viscosity version of the Dow Corning 1-2577 family of silicone-based conformal coatings.

Low VOC stands for Low Volatile Organic Compound. This means that the product contains a lower concentration of volatile organic compounds such as solvents, and that the product is ozone safe and environmentally friendly. RTV in the product name refers to the fact the 1-2620 is a Room-Temperature Vulcanizing compound, which means it cures at room temperature.

As with all types of conformal coatings, 1-2620 contains various hazardous substances. Therefore, it is recommended that the Material Safety Data Sheet for the product be referred to and followed.

1-2620 is a one-part elastoplastic (tough abrasion resistant) coating that is easy to apply and repair. Conformally coated areas can be reworked with a soldering iron, or the coating can be removed with a solvent. 1-2620 contains additives that allow easy UV inspection to ensure complete coverage on the circuit board. An off-the-shelf black light can be used to inspect the coverage of the conformally coated board.

1-2620 is suitable for the Z-World manufacturing environment. A 3 mil (0.075 mm) 1-2620 coating is typically tack-free in 10 min at room temperature. The full cure takes 72 h at room temperature. Cure times can be accelerated significantly by placing boards in a circulating-heat oven once the solvent has evaporated (the evaporation typically takes 10 min).

Applying Conformal Coatings to Selected Regions on a PCB

Customers may elect to use any type or brand of conformal coating that they feel would be appropriate for their manufacturing environment. Several manufacturers supply conformal coating in aerosol or bulk liquid form.

Conformal coatings can be applied by spray, brush, flow, or dip.

Specialized equipment manufacturers sell programmable automated conformal coating systems for high-volume applications. A list of equipment manufacturers is included at the end of this Technical Note.

The spray or brush methods are likely to be the most convenient for low-volume applications. Applying conformal coating using a brush is fairly simple. Certain types of RTV coatings such as 1-2620 also use

the moisture in the air to cure. Therefore, it is important to be aware that these coatings will begin to cure as soon as their container is opened.

Applying conformal coatings with a spray is a bit trickier. Electrical conductors such as headers, connectors, field wiring terminals, and jumpers need to be masked to preserve their conductivity after the coating is applied. There are a variety of ways to mask selected areas on a PCB to keep them from being sprayed.

NOTE: Use adequate ventilation when applying any type of conformal coating. Refer to the Product Material Safety Data Sheet for handling and exposure guidelines.

In this section we'll look at conformally coating the 32 kHz oscillator section on a Jackrabbit board using an aerosol-based silicone coating. All areas that do not require coating are covered with a manually cut and molded piece of anti-static packaging foam that is readily available through computer and/or electronics suppliers. The conformal coating was an aerosol version of the Dow Corning silicone-based 1-2577 supplied through the Miller-Stephenson Chemical Company.

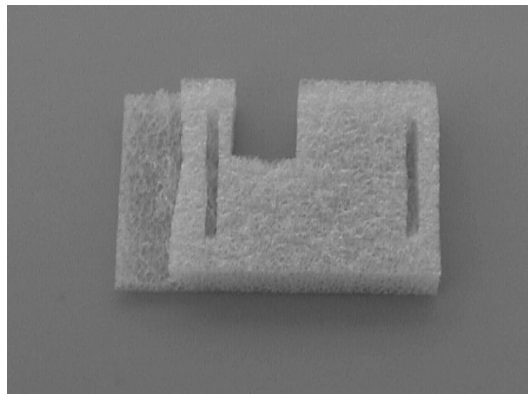


Figure 2. Mask Made from Anti-Static Packaging Foam

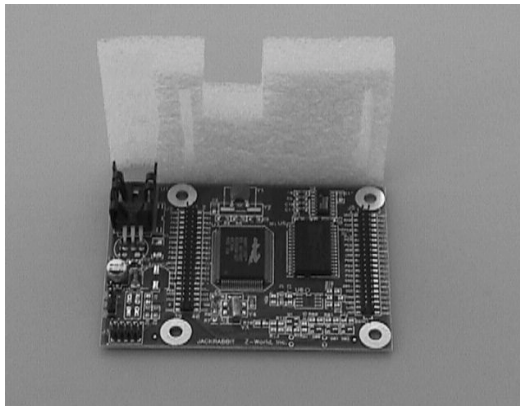


Figure 3. How Mask Fits over Jackrabbit Board

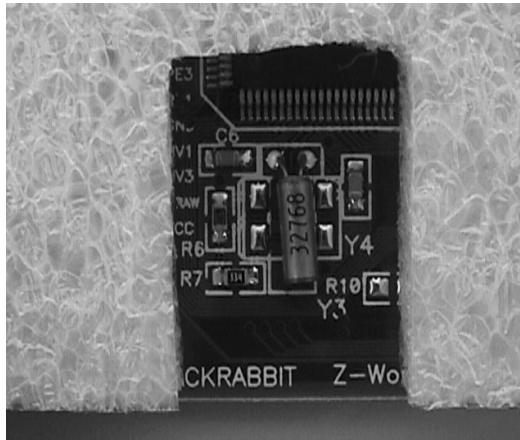


Figure 4. Entire Board is Masked Except for 32 kHz Circuitry

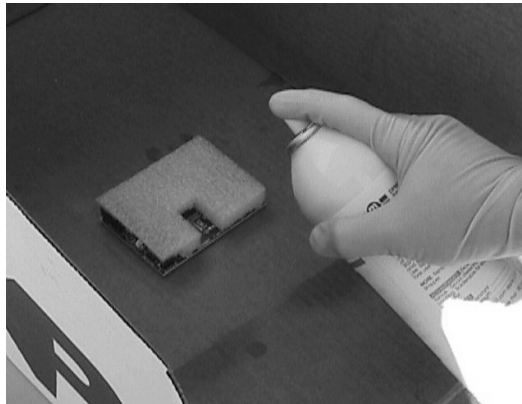


Figure 5. Applying Coating to Masked Board

Conformal Coating Suppliers

The following list is a small sample of the many suppliers that sell or produce conformal coating products. Neither Rabbit Semiconductor nor Z-World is affiliated with any of the listed suppliers or manufacturers.

Name	Phone	Web Site
Chemtronics	800-645-5244	http://www.chemtronics.com
Cytec Corportion	716-376-7804	http://www.conap.com
Dow Corning	517-496-6000	http://www.dowcorning.com
Dymax Corporation	860-482-1010	http://www.dymax.com
Humiseal	718-932-0800	http://www.humiseal.com
Loctite Electronics	800-562-8483	http://www.loctite.com
M.G. Chemicals	800-201-8822	http://www.mgchemicals.com
Miller Stephenson	818-896-4714	http://www.miller-stephenson.com
Mouser Electronics	800-346-6873	http://www.mouser.com
Techspray, Inc.	800-858-4043	http://www.techspray.com

Equipment Manufacturers

The following specialize in the manufacture of conformal coating systems.

Name	Phone	Web Site
Nordson	877-374-6673	http://www.nordson.com/electronics
Precision Valve & Automation	518-371-2684	http://www.pvalve.com

References

- Bennington, Lester D., "Conformal Coating Overview," Loctite Electronics.
- "Conformal Coating Handbook: A Guide for the Selection and Use of Conformal Coatings for Printed Circuit Assemblies," Humiseal Div. of Chase Corp., Woodside NY, 1997.
- "Conformal Coating Selection Guide," Plasma Systems Inc., San Jose, CA, 2000.
- Horrocks, Hal, "Conformal Coating Removal Techniques," CCRCo, Presented at NEPCON West '97.
- "Information About Dow Corning® Brand Conformal Coatings," Dow Corning, Midland, MI, 2000.

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