

Preliminary information  
Subject to change without notice

## Product Information Sheet

### Green-Guard™ 701

**Consumer-electronics-grade protective conformal coating for mitigating tin whisker risk on electronic components with pure-tin-plated surface finishes**

**Rev. 2**  
**15 August 09**

(Revisions underlined)  
(Rev. 2 changed mixing ratio)

#### **Description**

Green-Guard is a clear (transparent green), low-modulus, two-component urethane coating system designed specifically for containing the tin whiskers that grow from pure-tin-plated finishes on ROHS-Compliant components on electronic circuit boards and their components. It has all the normal electrical insulating qualities of conventional printed circuit board conformal coatings. It is repairable.

When the liquid components of Green-Guard are combined, the mixture is a non-Newtonian fluid (meaning has a nonlinear flow/viscosity characteristic known as thixotropy), and is intended to drain to a wet-film thickness of about 2.5 mils. At 40% solids, it is intended to give a nominal dry-film thickness of about one mil on flat surfaces. Due to its nonlinear viscosity properties, it will give much better corner/edge coverage than materials not possessing thixotropy.

Application may be by dip, spray or brushing.

When cured, Green-Guard is specified to contain a three-micron diameter whisker at a 25-micron (one-mil) film thickness. The containment mechanism is that of Euler Buckling.

Green-Guard has excellent reversion resistance, and low outgassing.

Mil-spec approval is neither sought nor expected, as this material is intended only for consumer-grade products. It is not restricted for export, and is suitable for use on Consumer or some Industrial equipment.

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### Typical Properties \*

#### Part A

Viscosity, cPs	400 (agitate well before use)
Specific gravity, g/cm <sup>3</sup>	tbd
Flash point, open cup, °F	45
Percent solids	40-50 tbd
As-supplied form	<u>Green liquid</u>

#### Part B

Viscosity, cPs	80
Specific gravity, g/cm <sup>3</sup>	tbd
Flash point, open cup, °F	45
Percent solids by volume	40-50 tbd
As supplied form	<u>Clear amber liquid</u>

#### Part C

<u>Viscosity, cPs</u>	<u>80</u>
<u>Specific gravity, g/cm<sup>3</sup></u>	<u>tbd</u>
<u>Flash point, open cup, °F</u>	<u>45</u>
<u>Percent solids by volume</u>	<u>40-50 tbd</u>
<u>As supplied form</u>	<u>Clear dark amber liquid</u>

\* Typical properties, not guaranteed limits. Based on Smith & Co. Inc. test methods. Contact for details

### **Packaging & Storage**

Green-Guard A, B and C are flammable liquids. These are moisture-sensitive materials. They should be stored in a dry place and in their original containers, tightly closed, at 20°-35°C. The shelf life under such conditions will be 6 months from the day of shipping. Reseal containers after use, using dry nitrogen or argon to flush air from each container before screwing cap on container. For best results, form a sheet of aluminum foil over the neck of the can before screwing on the metal cap. Wipe any residue of part A or B or C from the threads of the neck of the can and the screw-cap with dry paper towels to minimize likelihood of cap becoming bonded to neck of container as material hardens on air exposure.

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Packaging is in 1.5 quart kits consisting of an 8-oz can of Part A, a 32-oz plastic bottle of Part B and an 16-oz glass bottle of Part C.

### **Surface Preparation**

The surface to be coated should be clean. Green-Guard is compatible with the normal condition of circuit boards after solder reflow, without need for any particular cleaning process, or after any cleaning process as the customer may wish to specify.

Specialized surface preparation may be necessary for many thermoplastic or other materials. Adhesion tests should be conducted by the user if any materials other than the usual components mounted on printed circuit boards such as inductors, capacitors, resistors, diodes, transistors and integrated circuits are being coated.

### **Application methods**

All mixing and application work should be done in a well-ventilated area, such as a hood that draws ALL solvent vapor and chemical vapor away from personnel. This includes the coated boards after the coating process. Curing ovens must have positive air exhaust to the outside, away from personnel areas, or to vapor-oxidation apparatus as may be required under local Air-Quality-Management-District regulations.

Green-Guard may be applied by spray, brush or dip.

Use entire kit at one time so remaining material will not be contaminated by exposure to atmospheric moisture. If not possible, reseal containers after use, using dry nitrogen or argon to flush air from container before screwing cap on can. For best results, form a sheet of aluminum foil over the neck of the metal can of Part C before screwing on the cap. Wipe any residue of any component from the threads of the screw cap with dry paper towels to minimize likelihood of cap becoming bonded to neck of container as some of these materials harden on air exposure. Store at 20-35°C.

### **Portioning**

Mixing ratio by volume: 6:3:1

Mixing ratio by weight: tbd

### **Mixing**

Mixing Container should be polyethylene, polypropylene, Teflon or comparable fluoropolymer labware (not polystyrene!), glass, or metal. Do not use wooden mixing implements or paper containers, as paper and wood have a high moisture content, which will degrade product performance and possibly inhibit cure.

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Material temperature should not be below 60°F (15°C) when mixing.

Mixing and application shall be between 60°F and 95°F.

Weigh Part B into container first. Add Part A to container. Add part C to container.

Measurement may be by volume if delivery accuracy is within two percent. Syringes may thus be used if calibration accuracy is sufficient. This is a preferred method for preparing small quantities (e.g., under 60cc) and minimizing product exposure to ambient air and moisture. Decanting, measuring and mixing may also be done inside an AtmosBag™ glove-bag, available from Sigma-Aldrich [www.sigma-aldrich.com/labware](http://www.sigma-aldrich.com/labware). Green-Guard Urethane Cleanup Solvent (from Smith & Co.) may be used to clean syringes, tools, spray equipment of residue of any individual component or mixed material before it has cured. After it has cured, there is no Cleanup Solvent. DO NOT mix Green-Guard Urethane Cleanup Solvent with coating to be used. Do not use this solvent to clean the neck of any container. Use dry paper towels. Even a small amount of Green-Guard Urethane Cleanup Solvent will chemically destroy the functionality of Green-Guard.

Slow machine mixing or stirring by hand minimizes air entrapment. In order to make it possible to attain thorough mixing of Parts A, B and C, without which optimum end properties cannot be attained, mix all components in one container, transfer entirely to a second container and mix again. This ensures the inevitable small residue of Part B on the first container bottom or sidewalls of that first container does not get applied to a circuit board without being mixed in correct proportions with the rest of the system.

Vacuum degassing is not recommended, due to the excessive solvent-evaporation. Allow the mixed product to stand (covered) a few minutes, and any bubbles from the mixing process will rise and break.

If not mixing an entire kit, flush partially used containers with dry nitrogen or argon before resealing.

Store partial containers as originally supplied. Plastic bottles furnished inside metal cans with covers must be replaced and stored in those same metal cans with covers.

### Mixing ratio

#### Parts by weight

Green-Guard A:       TBD

Green-Guard B:       TBD

Green-Guard C:       TBD

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### Parts by volume

<u>Green-Guard A:</u>	<u>One</u>
<u>Green-Guard B:</u>	<u>Six</u>
<u>Green-Guard C:</u>	<u>Three</u>

Initial Viscosity, cPs 150

Gellation time in a covered dip tank:  
time (hours) 6-10 nominal

Tack-free time (hours at 25C) TBD

Pot life at 25°C (100g), hours 3 minimum

Pot life is defined as the time for the viscosity to increase by thirty percent. Chemical reaction rates roughly double for every ten-centigrade-degree temperature increase. Pot life will vary accordingly. Adjust induction time accordingly.

### Recommended cure time:

24 hours @25C followed by 16 hours @85C, in an atmospheric humidity of [30% minimum to 70% maximum, referred to 25C ambient]

Maximum insulating resistance, interfacial adhesion, and protection from corrosion are obtained with heat curing. If heat curing is not done, allow 1000 hours at 25C.

### Induction time before use:

Allow mixture to stand (covered) 20 minutes (at 68F/20C) before use. Chemical reaction rates roughly double for every ten-centigrade-degree temperature increase. Adjust induction time accordingly. Pot life will vary accordingly.

**Spraying:** Green-Guard Spray Reducer may be added to the mixed Green-Guard as necessary to give a wet-film-thickness of 2.5 mils on the board, if solids content of what arrives and remains on the board after excess drainage is about 40%. This will give a dry film thickness of about 1.0 mils. Other solvents such as Toluene may be used for viscosity reduction, but the pot life will be shortened significantly.

**Dipping:** Green-Guard does not need to be thinned to control coating thickness. To achieve a 2.5 mil wet film thickness coat per dip, apply the mixture as furnished.

The liquid level must be raised slowly enough to not trap bubbles behind fine-pitch parts. Lifting the board slowly (or lowering the liquid-level slowly) also minimizes runoff and

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dripping of excess material. Raising and lowering the liquid level on the board at a 45-degree angle to the part orientations will help to minimize air bubbles being trapped behind fine-pitch parts and attendant incomplete coverage.

### **Induction time before use:**

Allow mixture to stand (covered) 20 minutes before use.

### **Rework procedure:**

Cured Green-Guard may be cut with a sharp knife and removed by scraping or peeling, where adhesion is not excessive. A soldering iron is often used to melt or burn through cured conformal coating as a removal method. This must only be done in a well-ventilated area with positive air exhaust, as toxic gases may be generated by the thermal decomposition of **ANY** polyurethane material.

Suitable swell-to-release Conformal Coating Release products may also be used.

Board cleaning before and after soldering may be done with 99% (anhydrous) Isopropyl alcohol.

### **Physical Properties**

(typical values)

Hardness, Shore A*	TBD
Tensile strength, psi	20,000 at film rupture
Elongation, %	450
Tg, °C	TBD
Fungus resistance	Non-nutrient
Maximum continuous use temperature, 130°C	
Flame resistance	Self-extinguishing
Flexibility	may be folded double without cracking or crazing

\* Cast specimen of 100% solids version of Green-Guard

### **Electrical Properties**

(typical values)

Insulation resistance, $\geq 1.0 \times 10^{15}$
Volume resistivity, ohms-cm
@ 25°C > $10^{15}$
@ 95°C > $10^{13}$
Dielectric strength,
3mil thickness, V/mil > 1,000
Dielectric constant
@ 25°C, 100 KHz 3-5 (tbd)
Dissipation factor
@ 25°C, 100 KHz tbd

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Moisture resistance, tbd

### **Suggested Quality Control procedure on a production line**

This product, as with all two-component chemically cured polyurethane products, contains isocyanates, and such molecular structures are moisture-sensitive. Excessive exposure to atmospheric moisture can in theory deactivate enough of the isocyanate curing agent of this or any similar product as to produce an inadequate degree of cure. Such a failure is permanent, and no amount of post-cure baking will remedy this kind of defect.

It is possible to test on a production basis for such a condition by measuring the film modulus, as with a Nanoindenter. An inadequately cured film will exhibit a modulus of elasticity significantly lower than a properly cured film, and will in addition exhibit a significantly higher degree of plastic flow under applied stress, whereas a properly cured film should not exhibit any plastic flow. Plastic flow means that an applied stress produces a degree of permanent deformation, as with modeling clay.

### **Handling and Safety Precautions**

Read and understand the Material Safety Data Sheet.

Warning! Flammable. All components contain aromatic hydrocarbons, ethers, esters and/or ketones. Part B contains organic isocyanate. Part C contains aromatic and aliphatic amines. Causes severe eye and skin irritation and possible eye burns. Vapor or mist harmful if inhaled. Harmful if swallowed. Will cause allergic respiratory reaction, and may cause allergic dermatitis.

Personnel with any history of chemical sensitivity, whether to epoxy products, urethane products or any other, should not be allowed to use Green-Guard as they may already be “sensitized” to chemical-induced allergic reactions.

All industrial hygiene procedures should be followed whenever Green-Guard is being handled and used. Only personnel trained in good “lab technique” for handling chemicals and solvents should be allowed to use Green-Guard.

All processing shall be conducted inside a fume hood or other work-area that eliminates worker exposure to solvent and organic isocyanate vapors.

Work in a well ventilated area and use clean, dry tools for mixing and applying.

### **First Aid In case of contact:**

Eyes: Immediately flush with water for at least 15 minutes. See a physician.

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Skin: Immediately wash with mild soap and water.

Inhalation: Remove person to fresh air. Administer oxygen or artificial respiration if necessary. See a physician. Some people may exhibit prompt bronchospasm (asthma).

Ingestion: If conscious, give plenty of water to drink. Never give anything by mouth to an unconscious person. See a physician immediately.

Other: contains aromatic hydrocarbons.

If in doubt as to whether a hazardous exposure has occurred, see a physician immediately.

### **NON-WARRANTY**

The following is made in lieu of all warranties, express or implied. We guarantee that the quality and properties of the material supplied conform to our own standards. Since we have no control over the use or application of these products, we assume no responsibility nor make any warranties or guarantee for coverage, patent, trademark or copyright infringement, or injuries resulting from use. Liability, if any, is limited to refund of purchase price or replacement of that portion of the merchandise proven to be defective. Neither seller nor manufacturer shall be liable for any injury, loss, or damage, direct or consequential, arising out of the use or inability to use the product. Before using, user shall determine the suitability of the product for his intended use, and user assumes all risk and liability whatsoever in connection therewith. The foregoing may not be altered except by agreement signed by the buyer, seller, and manufacturer.

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