Application and Production Guide for the AR Series EMI/RFI Shielding Coatings

Table of Contents

General Instructions for Use

Shielding Coating Application

Introduction

This guide outlines the equipment and recommended application processes for applying EMI/RFI Shielding conductive coatings in an a professional, industrial, or other high-volume settings. It covers

- product mixing and dilution recommendations
- surface preparation procedures
- spray or brush application methods—including extensive equipment and setting suggestions
- cure schedules
- troubleshooting tips (in the Appendix)

CAUTION! It is the user's responsibility to determine chemical, mechanical, and thermal compatibility of the substrate prior to using any of the methods suggested. The solvents recommended may be too aggressive for some thin plastics. For steps suggesting mechanical forces or heat, do not exceed the amount of mechanical force or temperature limits that can be safely applied to the components.

Product Mixing

MG Chemicals electrically conductive coatings must be mixed carefully before use. If the filler is not evenly mixed, the conductivity, adhesion, and quality of the coating will vary. It is, therefore, critical to ensure complete dispersion of filler by mixing before any product use or transfers to other containers.

MG Chemicals designed its shielding products to be easy to mix with a regular paint stirrer. However, to ensure good mixing—especially for large containers—you should use a mechanical paint shaker or a high-lift propeller mixer. After the coating has been properly mixed, it is suggested that it be kept under agitation during production.

General Prerequisites:

- Metal (stainless steel recommended) stirrer, mixing spatula or paddle
- Cloth or paper towel
- Paint shaker or high-lift propeller mixer

CAUTION! Use non-sparking mixing motors to avoid possible ignition of the solvent system.

Hand Mixing

(Quart to Pail sizes: 1 to 20 L)

1. Use a stirrer to scrape the bottom and sides to break up possible deposits.
2. Stir content until coating is fully smooth and homogeneous.
3. If lumps or deposit of material can be felt or seen, continue mixing.

Paint Shaker Mixing

(Quart to Gallon sizes: 1 L to 4 L)

1. Shake for three to five minutes.
2. Verify that mixture is homogeneous, and check for deposits at bottom or sides with a stirring stick.
3. If lumps or deposit of material can be felt or seen, repeat steps 1 to 3.

NOTE: Over shaking in the paint shaker causes the container to build up pressure and crack.

High Lift Propeller Mixing

(Pail to Drum sizes: >4 L)

1. Set speed to achieve a good vortex. Typically, a speed of 1 200 rpm or more is needed.
2. After 5 min, stop and break up lumps or packed material at the bottom and sides of the container.
3. Stir for another 5 to 10 min until the mixture is homogeneous.

NOTE: Prefer lidded stirrers to avoid solvent loss during stirring.

CAUTION! For non-lidded mixers, ensure there is sufficient headspace to avoid spillage.

Coating Dilution Ratios

MG Chemicals conductive coatings are ready to use, without dilution, for brush applications. You can dilute them, however, to help achieve better coat leveling and easier application in brush applications.

For spray applications, we recommend dilution starting points for our AR series products in the table below. To achieve the best results, adjust this dilution ratio based on the equipment, application requirements, and operator's preferences.

CAUTION! Excessive dilution may affect spray quality and create application and production problems. If the settling rate is too fast, it can result in uneven coats and increased equipment clogging. An overly diluted product can also flow off of the substrate when applied. If you wish to dilute the AR series products more than the initial dilution ratios stated in Table 1, please consult MG Chemicals technical support (1-800-340-0772) prior to doing so.

Table 1. Recommended dilution ratio for AR series spray applications

Cat. No.	*Dilution Ratio (Product:Thinner)*
MG 838AR	2:1
MG 841AR	2:1
MG 842AR	2:1
MG 843AR	Not required. Ready to spray.

Thinner Selection

MG Chemicals has developed two solvent systems for different types of plastic substrates. In general, some etching action is desirable to improve adhesion to smooth plastic surfaces. However, if you are using thin plastic pieces, then you may require a less aggressive, non-etching solvent system.

Table 2. Thinner compatibility and advantages

Cat. No.	*Solvent Compatibility*	*Advantages*
MG 435	General surfaces	Low VOC, fast-drying
MG 4351	Solvent-sensitive surfaces	Moderately fast-drying

You may blend these solvent systems to achieve the degree of etching needed to provide the required adhesion without damaging thin substrates.

Substrate Preparation

Surface preparation depends on the project. Depending on its nature, the surface may also need to be roughened, primed, or masked. Some surfaces may not require any preparation, but at a minimum, we recommend that the surface should be cleaned with 824 Isopropyl Alcohol.

Cleaning

It is highly recommended to ensure the cleanliness and dryness of a surface prior to coating, priming, or masking. Most coating defects result from the presence of moisture, grease, oils, dirt, flux, and other board contaminants. Be particularly careful to clean any mold release agents from the plastic molding process.

Sanding and Etching

Mechanical sanding of plastics is not normally required due to the inclusion of chemical etchants, however, for highly resistant plastics and non-plastics, mechanical sanding or primers may be required. After sanding and etching, the surface should be cleaned with 824 Isopropyl Alcohol.

Prerequisites:

- Soft paint brush or clean cloth
- Soap and water
- Degreasing solvent-based cleaner that dissolves greases type contaminants without leaving residues or attacking the substrate. For example, here are a few suggestions:
  - *Mild*: MG 824 Isopropyl alcohol or MG 4351 Thinner Cleaner Solvent
  - *Strong*: MEK, Acetone, or MG 435 Thinner Cleaner Solvent
- Nitrile or latex disposable gloves (to avoid board contamination during cleaning and to protect hands from the solvents)

To clean the surface

- Wipe with a clean cloth, wash with soap and water, and then rinse and dry.
- Put on disposable gloves and clean with the degreasing type solvent. (The gloves prevent surface contamination from oils on your hands and protect your hands from the solvents in the degreaser.)
- Let the surface dry fully. Using elevated temperatures or a drying cabinet can accelerate drying.

The surface is now ready for masking or priming, if required.

Priming

The primer used depends on the surface. If you are coating etch-resistant plastic materials, consult the manufacturer of the substrate for suggestion on suitable primers that can be over-coated with acrylic-based coatings.

Some metals must be coated with conductive coatings to avoid oxidation that would decrease electrical conductivity. Metals like aluminum often benefit from acid wash primer to ensure good adhesion. Using primers, however, tends to increase resistivity between the conductive coating and the metal substrate.

NOTE: Ensure that new surfaces or primed surfaces are finished out-gassing prior to continuing.

Masking

To save time, mask areas that shouldn't be coated prior to spraying. While the AR series shielding coatings can be removed with the MG 435 Thinner/Cleaner, masking is often more efficient.

NOTE: If a permanent mask (molded form or shielding stencil) is being used, ensure that the fit to the surface is good. When cleaning the mask, we suggest collecting the waste in a container to salvage the metal cost from metals recycling facilities.

Adhesion and Compatibility Testing

Prior to using the product on a new substrate, we always recommend a compatibility and adhesion test. Perform these tests even if the substrate is theoretically compatible because materials belonging to the same class can vary substantially in properties due to fillers and chemistry variations. For the adhesion test, a test similar to the ASTM D3359 Method B cross-hatch tape test is highly recommended.

General Application Instructions

The AR series conductive coatings can be easily applied by spray gun or paint brush methods, but generally not by dipping. For large to moderate scale production runs, spray guns give better coating surfaces. The paint brush method can be used for repairs or for small scale applications but usually doesn't achieve the same level of consistency and electrical conductivity as the spray method. Dipping, while technically possible, generally requires too much effort to maintain consistent results.

Note that the electrical conductivity properties depend on the coat thickness (refer to the MG product technical data sheets for typical conductivity per coat). Typical individual coat thicknesses for each of the AR series conductive coatings can be found in the table below. The values in Table 3 were gathered when using the suggested dilution ratios located in Table 1. For best results, apply many thin coats as opposed to a few very thick coats.

Table 3. Typical coating thickness of AR series

Cat. No.	*Thickness per Coat*	
MG 838AR	1.0 mil	[0.025 mm]
MG 841AR	1.5 mil	[0.038 mm]
MG 842AR	0.75 mil	[0.019 mm]
MG 843AR	2.0 mil	[0.051 mm]

NOTE: In all cases, the mixture should be kept moderately agitated during use to avoid premature settling of the solids.

Prerequisites

- A substrate free of oils, dust, water, solvents, and other contaminants; with a dry surface
- Mixing spatula (preferably made of stainless steel metal)
- Thinner/Cleaner solvent (MG 435 or MG 4351)
- Application device (paint brush ***OR*** spray gun system)
- Personal protection equipment (See the product's safety data sheet for details.)

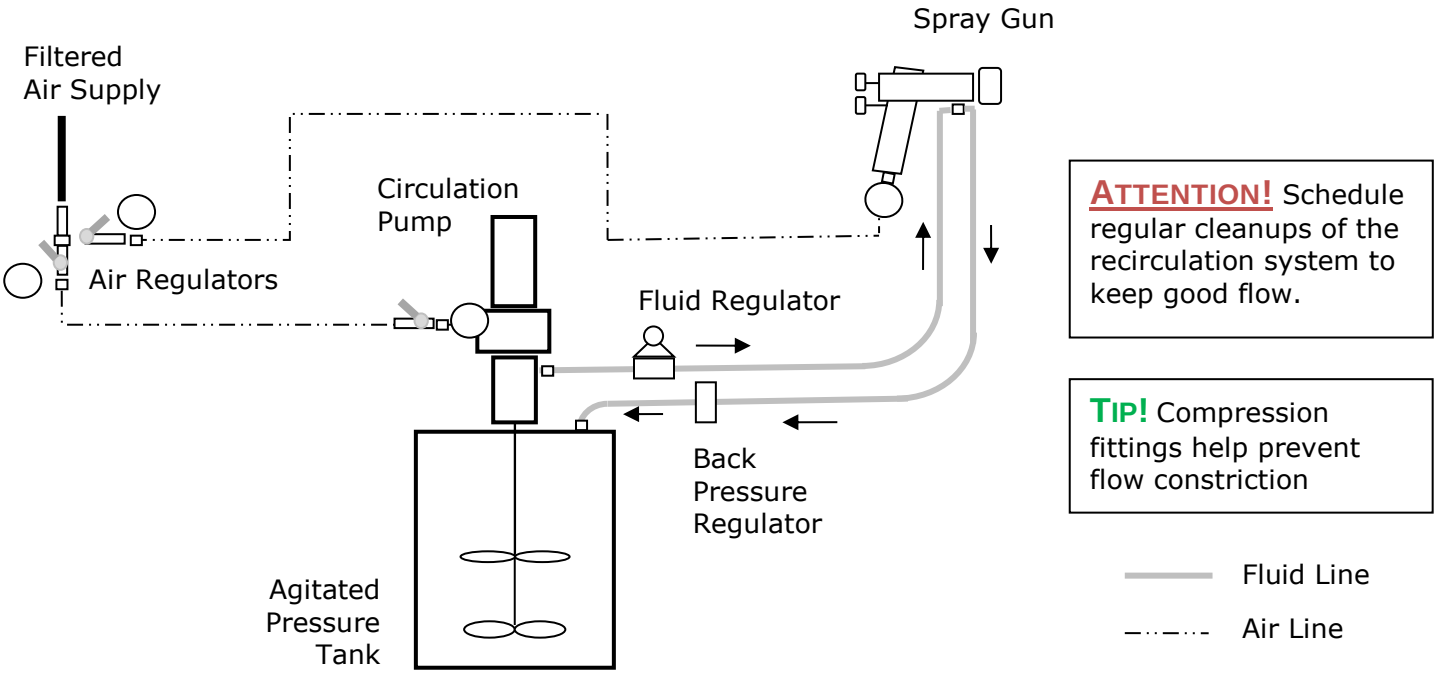
Spray Gun Applications

Read the recommendations in this section, and then select your equipment and adjust these processes to achieve the coat characteristics that best meet your needs.

Agitated Pressure Pots or Cup

Use a recirculation set up with an agitated pressure pot or cup with agitator to prevent filler settlement (See Figure 1). Spray gun manufacturers include Accuspray, Anest Iwata, Bink, DeVilbiss, Graco, Turbo Spray, Sharpe, and others. Since this guide gives generic instructions only, you should follow your manufacturer's guidelines in cases of major discrepancies.

Figure 1: Generic recirculation setup schematic



Equipment parameters

- Gun fluid line
  - Line diameter: 1/4"–3/8"
  - Line length: Minimize length to avoid settling issues (also keep line from kinking)
- Pump fluid line
  - Line diameter: 1/2"–3/4"
- Recirculation pump
  - Pump type: Heavy duty and bottom type
  - Pump pressure: 60–80 psi (lb/in^2)
  - (Recommended) Back pressure regulators or anti surge pipe
- Pressure Tank: Prefer tanks or pots with high abrasion resistance
  - (Optional) Pressure pot liners: Use for quick refill, production line staging, and cleaning ease

Prerequisites

- Thoroughly mix the AR series conductive coating in its original container prior transferring to pressure pot or cup.

To set up the pressure pot or cup

1. Transfer the ***pre-mixed*** and ***diluted*** AR series conductive coating to the pressure pot.
2. Set mixing speed sufficiently high to avoid settling issues, but not so high as it can cause centrifugal effects that collect filler to the sides.
    - Usually, 20 rpm or more is required.
    - Moving the propeller deeper also prevents settling.

NOTE: Preferably, use separate air lines for the air-driven mixer and the air gun. This avoids drop in mixing speed during spraying.

ATTENTION! Ensure that the material is always mixed thoroughly prior to any transfer or spray application.

NOTE: Because this is only meant to maintain the suspension, the speed needs not be as high as in the initial product mixing.

Spray Guns

A partial list of gun manufacturers is given in Table 4. This provides a starting point to evaluate suitable equipment. Not all brands or models are represented, but this table should provide a starting point to select equivalent equipment systems and models.

Table 4. Spray gun selection guide

Pressure Guns	***Gun Name***	***Fluid Tip (Nozzle)***		***Cap #***
3M-Accuspray	Series 10 or 12s (HVLP)		0.042"–0.059" [1.1–1.5 mm]	7 or 9
Anest Iwata	W-101A (agitator cup)		0.039"–0.051" [1.0–1.3 mm]	H4
Binks	Model 2001	*#63B* *#63C*	0.046" [1.2 mm] or 0.052" [1.3 mm]	63PB
	Mach 1SL (HVLP)	*#92*	0.046" [1.2 mm]	95P
DeVilbiss	JGHV 531 (HVLP)	*FF*	0.055" [1.4 mm]	33A or 46MP
	JGA-510 (HVLP)	*FX*	0.042" [1.1 mm] or	43
	DMA-510	*FF*	0.055" [1.4 mm]	
Graco	600		0.051"–0.059" [1.3–1.5 mm]	02 or 21
	700		0.047"–0.055" [1.2–1.4 mm]	03 or 21
	800		0.047"–0.055" [1.2–1.4 mm]	02 or 21
	Optimizer (HVLP)		0.055" [1.4 mm]	H-3

We recommend HVLP (high-volume low pressure) spray guns since this offers greater transfer efficiency, which reduces costs and accidental inhalation of coating solvents and particulates.

Setting Pressures

When it comes to setting pressures, you should start from the low end of the ranges given in Table 5. Use just enough pressure to atomize the material, not more. Excessive pressure may result in overspray, dry spray, bounce back, dripping from nozzle, and sagging, which not only wastes material, but also makes it harder to obtain a good quality coat with consistent thickness.

Table 5. Spray system pressure ranges

Gun Design	*Circulation Pump Pressure*	*Fluid Pressure*	*Inlet/Pot Pressure*
Conventional (Pressure Feed)	60–80 psi	10–15 psi	≥20 psi
HVLP (Pressure Feed)	60–80 psi	10–12 psi	≥20 psi
Conventional (Siphon)	60–80 psi	10–15 psi	—
HVLP (Gravity Feed)	60–80 psi	5–10 psi	—

Once you have established the correct range for your equipment, keep a record of the baseline settings for this particular material and equipment. Using the baseline setting at the beginning of each shift will minimize the amount of adjustments to accommodate operator style and natural material properties fluctuations.

Prerequisites

- Set up a catch basin or bucket on the floor to collect the product.

To adjust the fluid flow

1. Turn fluid adjustment to its manufacturer default start position.
2. Adjust the fluid line pressure at the fluid regulator (See Table 5 or manufacturers suggested settings).
3. Place a wide diameter container on the floor to catch the product.
4. With the gun parallel to the floor, the fluid stream coming out of the tip of the gun should remain straight for the first 2 to 15 cm (1 to 6 in).
5. Use the fluid adjustment knob on the gun to make fine adjustments as needed.

Once the flow is adjusted, it is a good idea to make note of the coating volume being dispensed for a set amount of time. Matching this coating flow volume for other production runs helps ensure better consistency.

To adjust the gun pressure and spray pattern

1. Open the gun's pattern adjustment valve completely.
2. With the air pressure regulator, set the atomizing pressure on at their minimum baseline settings.
3. Increase pressure in small steps to a good atomization and quality finish.
4. Adjust the fan size and spray pattern to best match the size of the surface to be coated.
5. Test spray a pattern at the recommended spray distance (Table 6) and make adjustments if necessary.

Table 6. Spray distances

Gun Design	*Distances (centimeter)*	*Distances (inch)*
Conventional HVLP	23—30 cm 15—20 cm	9—12" 6—8"

Spray Technique

Follow proper techniques as outlined by gun manufacture. For best results, keep the gun-to-surface distance constant. Move the gun in a straight line along the surface, avoiding arcing motions. Use spray-and-release strokes to avoid excess coat in one spot. If possible, start and end each stroke off the surface.

To apply the required thickness

1. At the recommended distance (See Table 6), spray a thin and even coat onto the surface. Overlap the previous stroke by 50% to avoid gaps in coverage. Ensure that the surface has good coverage and wetting.
2. Before spraying another coat, wait 3 to 5 minutes (depending on the product specifications). The delay avoids trapping solvent between coats. The coating should appear dry prior to applying a subsequent coat.
3. Apply additional coats until the desired thickness is achieved. (Go to Step 1.)
4. Let dry for 5 minutes (flash off time) at room temperature.

ATTENTION! Coats that are applied too thick cause runs and hinder solvent evaporation. Prefer the application of many thin coats rather than fewer thicker wet coats.

Cleaning Spray Equipment

At production end or before extended stoppages, clean pot and purge fluid lines.

To empty pressure pot at the end of the production run

1. Shut air supply valve to the tank.
2. Release the air pressure in the tank.
3. Hold a wadded cloth tightly against the nozzle, and press the trigger to force the fluid out of the hose, back into the tank.
4. Empty the tank into its original coating container or in another sealable coating container.

Prerequisites

- Soft bristle brush
- Compatible cleaning solvent

To clean line or guns

1. Relieve the air pressure, remove coating, and rinse pot with solvent.
2. Fill pot with a small amount of clean solvent.
3. Flush a small amount of thinner fluid through the lines and cleaning head.
4. Dis-assemble the nozzle and air cap assembly for cleaning.
5. Brush the gun head with the thinner to clean any residue of particles.
6. Wipe the needle tip and other head parts with a clean cloth.
7. Reassemble the spray gun.

CAUTION! Watch for seals. Do not soak entire gun in solvent.

Brush Applications

Brush application is often used for small cases or features that are difficult to coat selectively using spray equipment.

Brush coating is a semi-skilled technique. Minor brush marks are acceptable. Avoid excessive filets (coat build up between two parts and surface corners). You may add some small amount of thinner to improve the flow and leveling of brush applications. Two coats of the unreduced liquid should be sufficient.

Prerequisites:

- High quality solvent-resistant paint brush with natural or nylon bristles
- Latex gloves (to avoid board contamination during cleaning and to protect hands)
- (Optional) Oven set at 65 °C [149 °F]
- Use a stirring device to keep the filler material suspended.

CAUTION! Do NOT use a magnetic stirrer to keep the MG 841 nickel conductive coating in suspension. Nickel is magnetic, and it will stick to the magnets.

To apply with a brush

1. Wear a new pair of latex gloves to avoid contaminating the board while handling it.
2. Dip a clean brush in coating 1/3 of the bristle length to load it.
3. Tap both sides of the brush lightly against the side of can. This avoids drips and runs.
4. Brush the coating on board using long, smooth strokes. This reduces possible air entrapment, helps create an even coat, and minimizes brush marks.
5. Reload brush as soon as the coating flow starts to break.
6. Keep subsequent brush strokes in same direction; work brush into the edges of previously applied wet coating, but do not coat over wet areas.
7. Before the next coat, rotate the board 90° to ensure good cross-hatched coverage.
8. Wait at least 20 minutes, and apply another coat. Keep brush from curing by dipping it in thinner, and dry brush before reuse.
9. Apply other coats until desired thickness is achieved. (Go to Step 2)

CAUTION! Find and remove any brush hair that comes loose. Non-conductive brush hair creates holes in the

NOTE: Do not paint but flow the coating on. Limit yourself to two strokes

Curing Process

To cure at room temperature (24 hours)

At room temperature, the coat dries to the touch in 5 minutes and is dry enough to handle after 20 minutes. A full cure takes about 24 hours.

To accelerate the curing time

- Let the coating dry at room temperature for 20 minutes: no wet spots should be visible.
- Put in convection oven at 65 °C [149 °F] for 30 minutes.

CAUTION! To avoid blistering, do not heat cure with temperatures above 65 °C [149 °F].

ATTENTION! Heating a fresh coat before flash off can trap solvent in the binder system. This can cause bubbles and blistering, as well as harming the final coat properties and thickness.

Conductivity as the coating cures

MG Chemicals AR series conductive coatings attain conductivity throughout their curing process. Initially, they will be resistive, and the closer they get to the end of the cure schedule, the closer they approach their stated levels of conductivity.

Prior to any quality control conductivity measurements of the coating, please allow for sufficient curing time as well as rest time for the coating to come to room temperature (if performing a heat cure).

MG Chemicals Set Up, Pilot, and Production Services

MG Chemicals recognizes that using and setting up a production process for the first time can be challenging. Our service team offers a wide variety of experience in material production, equipment, and technical issues you may encounter during the planning, pilot studies, and production runs.

To help you overcome these challenges, we offer the following professional services:

- Advice on equipment and material selection
- Assistance for initial set ups and troubleshooting
- Reviews and feedback on your specific application procedures
- Optimization and best practice recommendations
- Training on the proper use of shielding products

Disclaimer

This information is believed to be accurate. It is intended for professional end users having the skills to evaluate and use the data properly. M.G. Chemicals Ltd. does not guarantee the accuracy of the data and assumes no liability in connection with damages incurred while using it.

Conclusion

This application guide presents general instructions on how to apply MG Chemicals product for professional and large scale applications. Adjust the recommendations according to your experience, equipment specifications, environment, and goals.

For clarifications or questions, please contact us.

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Appendix A: Coat quality troubleshooting

Problem	*Cause*	*Remedy*
Blistering, foam	Premature heat cure	Flash off time or dry time not sufficient
	Solvent entrapment	Increase time between coats, apply thinner coats
Blushing	Humidity is too high	Reduce environmental humidity
Cracks in coating	Surface compatibility issue	Apply primer
		Apply a thin coat and allow it to dry before recoating
	Cure temperature too high	Reduce cure temperature
	CTE mismatch too high	Keep thermal variations within tolerance
	Thermal cycling too high	Keep thermal variations within tolerance
Dry Spray	Air pressure too high	Reduce inlet air pressure
	Gun too far	Reduce spray distance to the recommended range
	Gun motion too fast	Slow down
Excessive Fog	Too much atomizing air	Reduce inlet air pressure
Fish Eyes	Surface Contaminants	Clean surface with solvents
	Coating Contamination	Clean system and replace contaminated material
Large Overspray	Gun too far	Reduce spray distance to the recommended range
	Too much atomizing air	Reduce inlet air pressure
	Improper gun motion	Adjust pace and method to match best practices
Orange peel	Gun too far	Reduce spray distance to the recommended range
	Solvent evaporation too fast	Decrease air pressure or change to slower evaporating solvent
	Coat applied too thin	Deposit a thicker coat to encouraging leveling
	Premature heat cure	Let flash off or dry longer before heat cure
	Cure profile is wrong	Adjust cure profile
Pin holes	Trapped solvent	Apply lighter coats, not fewer heavy coats
		Reduce viscosity by increasing dilution
	Air entrapment	Reduce pot pressure
	System contaminated	Clean the system
Runs or Sags	Too much material	Apply lighter coats, not fewer heavy coats
	Gun movement too slow	Speed up
	Too much product	Reduce fluid flow
	Gun to close to target	Increase spray distance to the recommended range
	Gun not at right angle	Keep gun perpendicular to work surface
Thin, Sandy Finish	Gun too far	Reduce spray distance to the recommended range
	Too much atomizing air	Reduce inlet air pressure
	Improper thinner	Change to MG approved thinner systems
Chalking	Gun too far	Reduce spray distance to the recommended range
	Inadequate mixing	Mix coating until it is homogenous
	Humidity is too high	Reduce environmental humidity (50% RH)
	High air pressure	Reduce inlet air pressure
	Overthinning	Reduce amount of thinner
Brush Marks	Inadequate mixing	Mix coating until it is homogenous
	Incorrect application technique	Practice brushing the coating on test coupons

Appendix B: Coat electrical property troubleshooting

Problem	*Cause*	*Remedy*
High resistivity	Low dry film thickness	Apply a greater number of coats to achieve thickness
	Insufficient cure	Let dry longer or heat cure
	Resin rich layer	Apply many thin coats instead of a thick one
	Improper mixing	Ensure thorough mixing prior to transfers and during spraying
	Insufficient leveling	If using brush application, use spray application instead
Conductivity fluctuation	Uneven coating thickness	Apply uniform coating thickness

Appendix C: Poor adhesion troubleshooting

Problem	*Cause*	*Remedy*
Poor adhesion	Dust or dirt contaminants	Wipe with cloth or wash with soap and water if necessary
	Oil or grease contaminants	Clean surface with solvents
	Surface contaminants	Ensure surface is completely dry
	Insufficient flash-off time	Ensure solvent flash-off before applying another coat
	Insufficient solvent volatilization	Ensure solvent is volatilized from the coating into the atmosphere before processing
	Insufficient surface etching	Use primer system
		Sand or mechanically etch the surface
		Use a more aggressive solvent system for the surface