

# ***AVX*TransGuard<sup>®</sup>**

## **SOLDERING – ASSEMBLY GUIDELINES**

## AVX Multilayer Varistors – Assembly Guidelines

### TRANSGUARD® SURFACE MOUNT DEVICES

The move toward SMT assembly of Transient Voltage Suppressors (TVS) will continue accelerating due to improved long-term reliability, more efficient transient voltage attenuation and size/functionality/cost issues.

TransGuards® are uniquely suited for wide-scale usage in SMT applications. TransGuards® exhibit many advantages when used in SMT assemblies. Among them are:

- Available in standard EIA chip sizes 0402/0603/0805/1206/1210.
- Placed with standard equipment (8mm tape and reel).
- Processed with fewer guidelines than either ceramic chip or resistor chip devices.
- Exhibit the highest energy/volume ratio of any EIA size TVS.

This general guideline is aimed at familiarizing users with the characteristics of soldering multilayer SMT ZnO TransGuards®. TransGuards® can be processed on wave or infrared reflow assembly lines. For optimum performance, EIA standard solder pads (land areas) shown in Figure 1 are recommended regardless of the specific attachment method.

#### Dimensions: mm (inches)

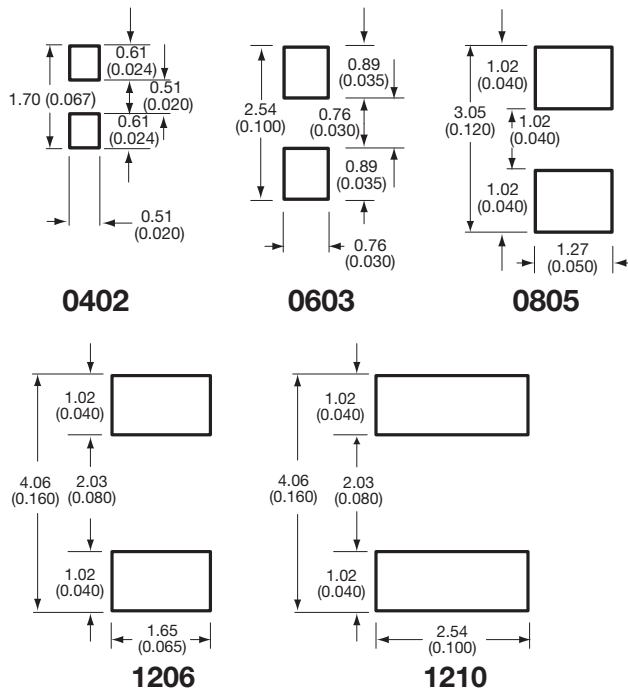


Figure 1: TransGuard® Solder Pad Dimensions

### STORAGE

Good solderability of plated components is maintained for at least twelve months, provided the components are stored in their “as received” packaging at less than 30°C and 85% RH.

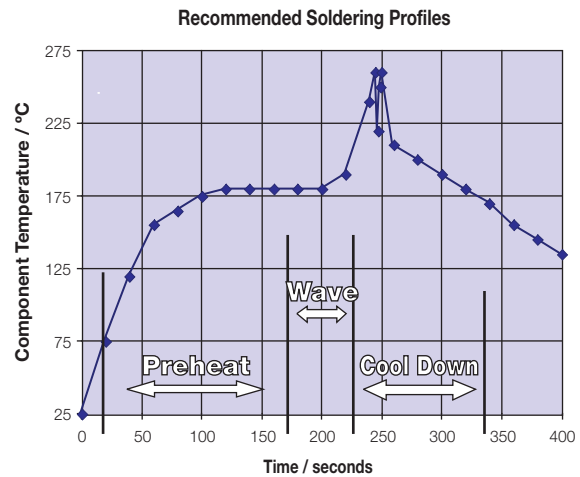
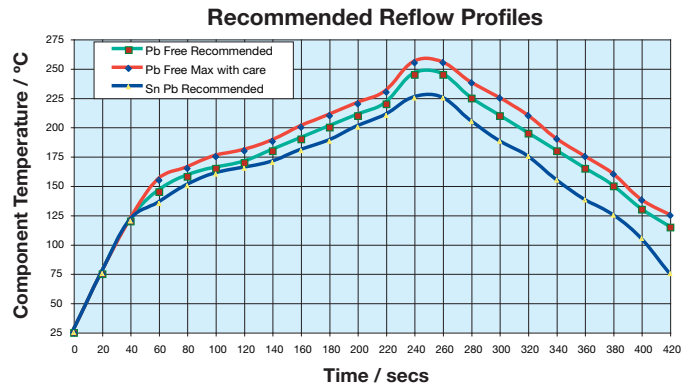
### SOLDERABILITY

Plated terminations will be well soldered after immersion in a 60/40 tin/lead solder bath at 235°C ±5°C for 5 ±1 seconds.

### LEACHING

Plated terminations will resist leaching for at least 30 seconds when immersed in 60/40 tin/lead solder at 260°C ±5°C.

### RECOMMENDED SOLDERING PROFILES



### GENERAL

Surface mount multilayer varistors (MLVs) are designed for soldering to printed circuit boards or other substrates. The construction of the components is such that they will withstand the time/temperature profiles used in both wave and reflow soldering methods.

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### HANDLING

MLVs should be handled with care to avoid damage or contamination from perspiration and skin oils. The use of tweezers or vacuum pickups is strongly recommended for individual components. Bulk handling should ensure that abrasion and mechanical shock are minimized. Taped and reeled components provide the ideal medium for direct presentation to the placement machine.

### PREHEAT

It is important to avoid the possibility of thermal shock during soldering and carefully controlled preheat is therefore required. The rate of preheat should not exceed 4°C/second and a target figure 2°C/second is recommended.

### SOLDERING

Mildly activated rosin fluxes are preferred. The minimum amount of solder to give a good joint should be used. Excessive solder can lead to damage from the stresses caused by the difference in coefficients of expansion between solder, chip and substrate. AVX terminations are suitable for all wave and reflow soldering systems. If hand soldering cannot be avoided, the preferred technique is the utilization of hot air soldering tools.

### COOLING

Natural cooling in air is preferred, as this minimizes stresses within the soldered joint. When forced air cooling is used, cooling rate should not exceed 4°C/second.

### CLEANING

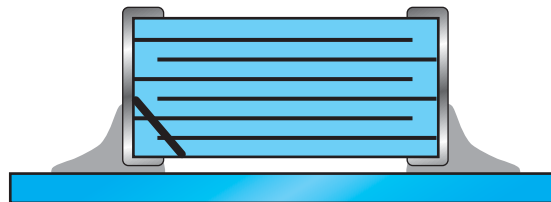
Flux residues may be hygroscopic or acidic and must be removed. AVX MLVs are acceptable for use with all of the solvents described in the specifications MIL-STD-202 and EIA-RS-198. Alcohol-based solvents are acceptable and properly controlled water cleaning systems are also acceptable. Many other solvents have been proven successful, and most solvents that are acceptable to other components on circuit assemblies are equally acceptable for use with MLVs.

### POST SOLDER HANDLING

Once the components are soldered to the board, any bending or flexure of the PCB applies stresses to the soldered joints of the components. For leaded devices, the stresses are absorbed by the compliancy of the metal leads and generally don't result in problems unless the stress is large enough to fracture the soldered connection.

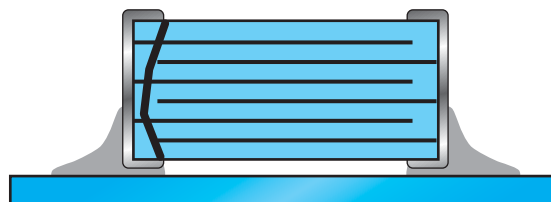
Surface mount devices are more susceptible to such stress because they don't have compliant leads and are brittle in nature. The most frequent failure mode is high leakage current (or low breakdown voltage). Also, a significant loss of capacitance due to severing of contact between sets of internal electrodes may be observed.

Cracks caused by mechanical flexure are very easily identified and generally take one of the following two general forms:



Type A:

*Angled crack between bottom of device to top of solder joint.*



Type B:

*Fracture from top of device to bottom of device.*

Mechanical cracks are often hidden underneath the termination and are difficult to see externally. However, if one end termination falls off during the removal process from PCB, this is one indication that the cause of failure was excessive mechanical stress due to board flexure.

### COMMON CRACKS OF MECHANICAL CRACKING

The most common source for mechanical stress is board depanelization equipment, such as manual breakapart, v-cutters and shear presses. Improperly aligned or dull cutters may cause torquing of the PCB resulting in flex stresses being transmitted to components near the board edge. Another common source of flexural stress is contact during parametric testing when test points are probed. If the PCB is allowed to flex during the test cycle, nearby components may be broken.

A third common source is board-to-board connections at the vertical connectors where cables or other PCBs are connected to the PCB. If the board is not supported during the plug/unplug cycle, it may flex and cause damage to nearby components.

Special care should also be taken when handling large (>6" on a side) PCBs since they more easily flex or warp than smaller boards.

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### REWORKING ASSEMBLIES

Thermal shock is common in MLVs that are manually attached or reworked with a soldering iron. AVX *strongly recommends that any reworking of MLVs be done with hot air reflow rather than soldering irons.*

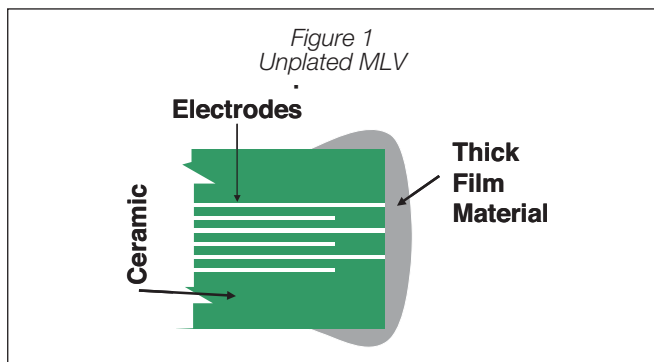
Direct contact by the soldering iron tip often causes thermal cracks that may fail at a later date. If rework by soldering iron is absolutely necessary, it is recommended that the wattage of the iron be less than 30 watts and the tip temperature be <300°C. *Rework should be performed by applying the solder iron tip to the pad and not directly contacting any part of the component.*

### VARISTOR SOLDERABILITY

Historically, the solderability of Multilayer Varistors (MLVs) has been a problem for the electronics manufacturer. He was faced with a device that either did not wet as well as other electronic components, or had its termination material leached away during the assembly process. However, by utilizing proprietary procedures, AVX Corporation provides the market with a MLV that has solderability comparable to that of other electronic components, and resists leaching during assembly.

### BACKGROUND

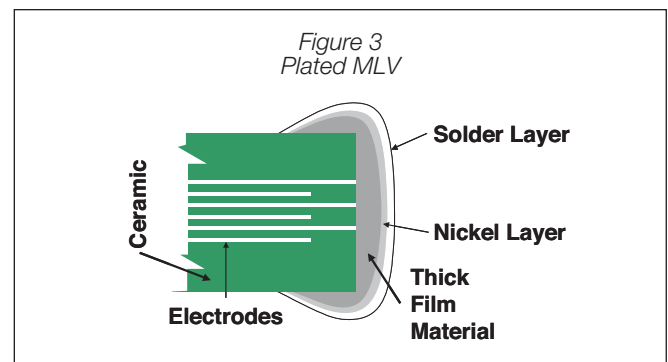
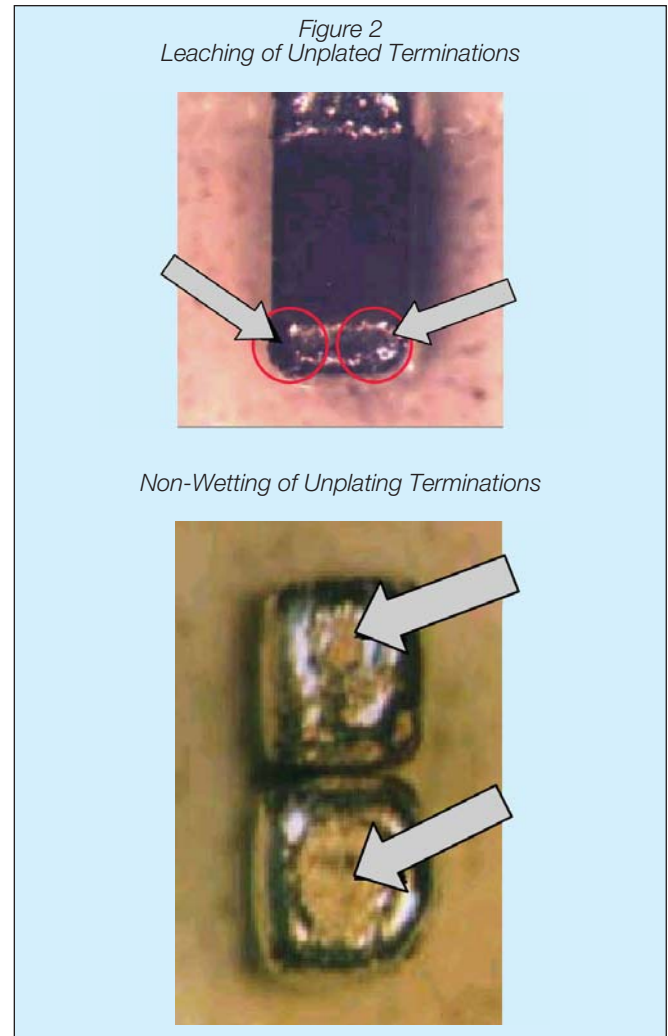
The basic construction of an unplated MLV is presented in Figure 1. The external termination is a metal that connects



the internal electrodes to the circuitry of the assembly using the MLV. The external electrode must accomplish two goals. First, it must be sufficiently solderable to allow the solder used in assembly to wet the end of the chip and make a reliable connection to the traces on the circuit board. Second, it must be robust enough to withstand the assembly process. This is particularly important if wave soldering is used. Unfortunately these two goals are competing. In order to achieve good solderability, an alloy high in silver content is chosen. However, this alloy is prone to leaching during assembly, so an additional metal is added to improve the leach resistance. While this improves the leach resistance, this addition makes the termination less solderable. The results are either terminations that leach away, or do not solder well (see the photographs in Figure

2).

Clearly, a plated termination system (as seen in Figure 3) is desired. This system, which is typical of other electronic components such as capacitors and resistors, produces a



much better assembled product.

In the plated termination, the base termination layer is still used (it provides contact from the electrodes to the circuitry). On top of the base termination is a layer of nickel. This is the surface to which the solder bonds during assembly. It

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must be thick enough to stay intact during IR reflow or wave soldering so that the thick film material does not leach away. It must also be thick enough to prevent the inter-metallic layer between the thick film termination and the nickel layer from affecting the solderability.

In order to protect the nickel (i.e., maintain its solderability), a layer of solder is plated on top of the nickel. The solder preserves the solderability of the nickel layer. It must be thick and dense to keep oxygen and water from reaching the nickel layer.

### THE CHALLENGE

Zinc oxide varistors are semi-conductive in nature – that is what allows them to “turn on” and divert a damaging transient away from sensitive electronic circuitry and safely to ground. This semi-conduction poses a major problem for the manufacturer that wants to plate the terminations – the ceramic plates also! This condition, overplating, must be controlled, as it is cosmetically undesirable and could result in an unwanted path of conduction across the chip.

Early efforts in plating MLVs revolved around limiting the time that the chip was in the plating bath. This helped prevent overplating, but also produced chips with marginal solderability. The photographs in Figure 4 depict the problems that occur when the plated layers are not thick enough.

### THE SOLUTION

AVX has developed a proprietary process that passivates the ceramic surface of the MLV. This allows us to plate the parts for a longer time without getting the overplate. This results in significantly thicker layers of nickel and alloy plated onto the base termination. These thicker layers translate into bond strengths that are typically twice those of our competitors and solder fillets and parts that pass all measured of solderability (as seen in Figure 5).

*AVX: The solution for MLV assembly problems.*

