MicroNote 129

Upscreening Commercial TVS Diodes for Aviation and Robust Environments or Applications

The features and benefits of silicon TVS diodes are well understood by a broad community of TVS device users. Microsemi Corporation is a world leader in the design, fabrication, and supply of these silicon-based transient protection devices in both hermetic and non-hermetic configurations. The company offers a broad portfolio of TVS devices at all power levels, including single devices which dissipate 36,000 W (10/1000 µs) for high-energy industrial and telecommunications applications, and 100,000 W (6.4/69 µs) for avionics applications. Qualification test plans and reliability monitoring provided for all these products are in line with the best industry standard practices.

However, it is the position of Microsemi Corporation that such programs, while effective in reducing the incidence of device infant mortality in general, are inadequate when applied to larger TVS diodes relative to eliminating infant mortality during in-circuit operation, as the junction area is expanded to withstand higher transient power surges.

Microsemi's extensive screening history confirms that the anticipated yield loss from device infant mortality increases with the power level of the TVS being specified and with the complexity of the assembly required to meet the threat. Device mortality varies from nearly negligible for ESD protection to significant levels for lightning protection products. Table 1 (see page 2) reviews infant mortality causes in larger TVS devices.

To address this concern, Microsemi has also included an exclusive MA™ upscreening flow, which offers a cost-effective solution to infant mortality for more robust applications such as avionics flight hardware where even a very low level of device mortality is unacceptable. MA, which stands for "Microsemi Aviation" grade component upscreening, is recommended for all robust or harsh environmental applications. The specific screening flow for MA upscreening includes the following process steps on the finished assembly:

Temperature cycling:	10 cycles, 55 °C to 150 ° C
100% surge testing:	3 times (each direction for bidirectional)
High temp reverse bias:	24 hours (each direction for bidirectional)

A further extension of commercial off-the-shelf (COTS) upscreening includes screening flows that provide JANTX (MX) and JANTX Lite (MXL) equivalent screening and conformance inspection for military applications. The JANTX Lite (MXL) option mirrors the JANTX (MX) version, except only Group A conformance inspection is required. Table 2 (see page 3) compares the various upscreen flows available and their associated product assurance level where applicable.

Microsemi customers do not need to create source control drawings, nor define screening flows, to specify these upscreening options. Simply add the appropriate prefix to a generic part number, and the Microsemi system automatically responds to the upscreening requirement.

Examples: MART100KP48CA or MXSMLJ43CA

Custom flows are always available from Microsemi to support application specific requirements.

Table 1: Causes of Infant Mortality in Larger TVS Diodes

• TVS die are fabricated in voltage ranges from 3 V to 200 V, each requiring a unique starting material and diffusion profile. Each of these voltages are available as either unidirectional (with a single junction) or bidirectional (having two junctions in series). This creates a vast matrix of combinations in continuous production, each with a specific process yield and defect density.
• TVS diodes are expected to operate from an “OFF” condition to an immediate “ON” condition across the entire junction when hit by a transient event. Even a slight defect in the junction can cause a hot spot that can lead to device degradation (leakage) and ultimate failure (short). Also see MicroNote 135.
• The assembly of TVS diodes (excluding ESD protection devices supplied in SOD, SOT, and SOIC configurations) is accomplished using high temperature solders. Furthermore, as power levels increase, the junction area must increase accordingly. At the more extreme power levels (>5 kW at 10/1000 µs), TVS diodes may require several die in series or parallel prior to final assembly. Low capacitance and higher voltage ratings (>250 V) are also achieved by the stacking of die prior to final assembly. It is both impractical and cost-prohibitive to perform 100% inspection for solder filets on various die-to-die and die-to-header interfaces, and assembly stresses have no visual inspection criteria at all.

Table 2: Matrix of Upscreen Options and Product Assurance Levels /3

Process, Screen, or Test Description	Product Assurance Level					
Part Prefix:	**MA**	**MQ /5**	**MX**	**MXL**	**MV /5**	**MS /5**
JAN Equivalent:	**AVIATION**	**(JAN)**	**(JANTX)**	**(TX LITE)**	**(JANTXV)**	**(JANS)**
Wafer fab lot traceability	R	R	R	R	R	R
S level wafer lot acceptance						R
100% wafer or die probe	R	R	R	R	R	R
100% die visual						R
Assembly	R	R	R	R	R	R
Pre-cap / internal visual inspection					R	R
100% Screening Requirements:						
Temperature cycle - 20 cycles	10	R	R	R	R	R
Constant acceleration 1/						R
PIND 1/						R
Instability shock test - FIST 1/						R
Instability shock test - BIST 1/						R
Serialization						R
Initial electrical test	R	R	R	R	R	R
Peak pulse test	R (3X)	R (3X)	R (10X)	R (10X)	R (10X)	R (10X)
Interim electrical test			R	R	R	R
Burn-in (HTRB) 4/	24 hours		96 hours	96 hours	96 hours	240 hours
Final electrical test	R	R	R	R	R	R
Delta calculations			R	R	R	R
PDA			R	R	R	R
Radiographic inspection 1/						R
Hermetic seal 2/	R	R	R	R	R	R
External visual inspection						R
Case isolation 1/	R		R	R	R	R
Conformance Inspection Tests:						
Group A		R	R	R	R	R
Group B		R	R		R	R
Group C		R	R		R	R
Certificate of conformance	R	R	R	R	R	R

R = Required
Blank = Not Required

1/ As applicable, based on package type.
2/ Not required for plastic products.
3/ The above process flow represents the typical requirements for devices in this category. Specific exceptions to this flow may be necessary based on specific part types within this grouping.
4/ For bidirectional devices, HTRB = 24 hrs in each direction for avionics levels, 48 hrs in each direction for TX/TXV level, and 120 hours in each direction for S level.
5/ Plastic products are not available as a standard product to this screening level. Consult factory.

Support

For additional technical information, please contact Design Support at:
http://www.microsemi.com/designsupport
or
Kent Walters (kwalters@microsemi.com) at 480-302-1144

Microsemi
Power Matters.

Microsemi Corporate Headquarters
One Enterprise, Aliso Viejo,
CA 92656 USA
Within the USA: +1 (800) 713-4113
Outside the USA: +1 (949) 380-6100
Fax: +1 (949) 215-4996
Email: sales.support@microsemi.com
www.microsemi.com