UPSCREENING COMMERCIAL TVS DIODES FOR AVIONICS AND ROBUST ENVIRONMENTS OR APPLICATIONS

The features and benefits of silicon TVS diodes are well understood by a broad user community of such devices. 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 40,000 watts (10/1000 µs) for high energy industrial and telecommunications applications, and 100,000 watts (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, particularly as the junction area is expanded to withstand transient surges greater than 2,000 watts (10/1000 µs).

Microsemi's extensive screening history confirms that the anticipated yield loss from device infant mortality increases 1) with the power level of the TVS being specified and 2) 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 I** reviews infant mortality causes in larger TVS devices.

To address this concern, Microsemi has introduced 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 Avionics" grade component upscreening, is recommended for all robust or harsh environmental applications, particularly for power levels greater than 2 kW. The specific screening flow for **MA™** upscreening includes the following process steps on the finished assembly:

Temperature Cycling:	10 cycles, -55 to +150 deg 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 which provide JANTX (MX) and JANTX Lite (MXL) equivalent screening and conformance inspection for Military applications. The JANTX Lite (MXL) option mirrors JANTX (MX) version, except only Group A conformance inspection is required. **Table II** compares the various upscreen flows available and their associated product assurance level.

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.

Microsemi
Scottsdale Division
8700 East Thomas Road - Scottsdale, AZ 85252 - (480) 941-6300 - fax: (480) 947-1503

Copyright 2009

TABLE I: 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 a single chip. 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).

- The assembly of TVS diodes (excluding ESD protection devices supplied in SOD, SOT, and SOIC configurations) is accomplished using high temperature solders. Further, as power levels increase, the junction area must increase accordingly. At the more extreme power levels (>5 kW @ 10/1000 μs), TVS diodes require the matching and stacking of several die in series prior to the final assembly. Low Capacitance and higher voltage ratings (>250V) 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 the various die-to-die and die-to-header interfaces, and assembly stresses have no visual inspection criteria at all.

TABLE II: MATRIX of UPSCREEN OPTIONS and PRODUCT ASSURANCE LEVELS

Process, Screen or Test Description	Product Assurance Level Requirement					
Plastic Part Prefix:	MA		MX	MXL		
Glass or Metal Part Prefix		MQ	MX	MXL	MV	MSP/SP
JAN Equivalent:	"AVIONICS"	(JAN)	(JANTX)	(TX Lite)	(JANTXV)	(JANS)
Military Requirements Wafer Fab *		R	R	R	R	R
S' Level Wafer Lot Acceptance						R
100% Wafer Probe	R	R	R	R	R	R
100% Die Visual						R
Assembly	R	R	R	R	R	R
PreCap or Internal Visual					R	R
Temperature Cycle - 20 Cycles	10 cycles	R	R	R	R	R
Hermetic Seal ****		Sample	****	****	****	****
100% Thermal Impedance **	R	R	R	R	R	R
FIST **						R
BIST **						R
PIND **						R
Constant Acceleration **						R
Surge Test (TVS diodes)	3x		10x	10x	10x	10x
Initial Electrical Test, Read & Record		go/no-go	R	R	R	R
HTRB ***	24 hours		48 hours	48 hours	48 hours	48 hours
Interim Electrical Test, R & R			R	R	R	R
Burn-in (HTRB for TVS) *****	24 hours		96 hours	96 hours	96 hours	240 hours
Final Electrical Test, R & R	go/no-go		R	R	R	R
Delta Calculations			R	R	R	R
PDA Evaluation			R	R	R	R
Radiographic Inspection **					R	R
Hermetic Seal ****						R
Mechanical and Visual Inspection						100%
Group A		R	R	R	R	R
Group B		R	R		R	R
Group C		R	R		R	R

* Not required for plastic package devices
** As required by package type
*** For Zeners > 10 V and Rectifiers
**** Hermetic parts receive fine & gross leak
***** Bidirectional TVS performed in both directions

R - Required and performed per 19500 for conditions and limits

Microsemi
Scottsdale Division
8700 East Thomas Road - Scottsdale, AZ 85252 - (480) 941-6300 - fax: (480) 947-1503
Copyright 2009