# MicroNote 100

## MicroNote Index and Summary

This MicroNote contains the titles, numbers and a summary of the subject matter for quick reference to the items of interest.

### MicroNote 101

#### A Primer on Transient Voltages

Threats originating from lighting inductive load switching and electrostatic discharge are reviewed and defined along with their damaging effects on microchips.

### MicroNote 102

#### An Introduction to Transient Voltage Suppressor Devices

Describes and illustrates the performance of the basic types of transient voltage suppressors (TVSs), including gas discharge tubes, metal oxide varistors (MOVs), silicon pn junction TVSs, and thyristors.

### MicroNote 103

#### What Is a Silicon Transient Voltage Suppressor?

Illustrates why a silicon TVS is needed, how it diverts transient current away from vulnerable circuitry, and reviews device pulse power ratings.

### MicroNote 104

#### Using the Power vs. Time Curve

Guides the reader in determining peak pulse power and peak pulse current for pulse widths of different values than those specified for a given device.

### MicroNote 105

#### What Is a Thyristor Surge Protector Device?

Reviews the basics of an avalanche voltage triggered thyristor designed for transient voltage protection, used largely for telecom signal lines.

### MicroNote 106

#### Crowbars and Clamps

Reviews the major differences including the low on-state voltage of the crowbar and the ease of transition from conduction to non-conduction for the clamp. Trade-offs and applications are discussed.

## MicroNote 107

### Cross Referencing TVS Devices

Accentuates the electrical parameters to be compared when replacing an axial leaded device with an equivalent surface mount component. Illustrations are given in making selections.

## MicroNote 108

### Determining a Range of Clamping Voltages for a Range of Pulse Currents

Provides a formula for calculating the clamping voltage for values of surge current at lower values than the peak rating. Sample calculation depicts simplicity of concept.

## MicroNote 109

### Protecting from Electrostatic Discharge

Emphasizes the fast, sub-nanosecond rise-time of static discharge and the need for low parasitic inductance in protective devices and requirements for shielding where applicable.

## MicroNote 110

### Parasitic Capacitance in Transient Voltage Suppressors

Illustrates the inherence capacitance values in a silicon TVS and how to minimize this effect with low-capacitance silicon diode elements where required.

## MicroNote 111

### Parasitic Lead Inductance on Transient Voltage Suppressors

Reduced protection offered by a TVS results when longer than tolerable component lead lengths produce overshoot voltages resulting from L(di/dt) effects.

## MicroNote 112

### Series Stacking of Silicon TVSs for Higher Surge Current

Series stacking of TVSs can be employed to increase peak pulse power and surge current since power is additive for parts in series. Practical applications are illustrated.

## MicroNote 113

### Parallel Stacking of Silicon TVSs for Higher Surge Current

For lower voltage applications, higher voltage surge capability can be achieved by parallel stacking. Devices must be matched very closely for load sharing, within 50 mV for an 8 V requirement and within 200 mV for 30 V. Examples are shown.

## MicroNote 114

### Derating of Silicon TVSs for Higher Junction Temperature

Most silicon TVSs are derated linearly from maximum rating at 25 °C down to zero at 175 °C. This note shows the reader how to use the derating curve for assigning the maximum surge rating for a device at any point between 25 °C and 175 °C.

## MicroNote 115

### Derating Transient Voltage Suppressors at Elevated Temperatures for Varying Pulse Widths

This note combines the information in MicroNotes 114 and 104 above to accommodate those conditions in which temperature is above 25 °C and pulse width varies significantly from specified conditions.

## MicroNote 116

### Protection at a Transformer Input

Illustrates the chief advantage, which is higher surge rating, of placing the TVS on the low-voltage secondary output. A case history is used in depicting this advantage.

## MicroNote 117

### Protecting USB Data Ports

Illustrates specific TVS devices for protection and also placement for optimum protection.

## MicroNote 118

### TVS Chip/Cell Product Overview

Reviews TVS chip and cell (disk-die-disk) configurations available for high-density packaging, such as in medical implant circuits.

## MicroNote 120

### Selecting TVS Devices with Rated Ppp and Waveform Considerations

This note reviews electrical parameters of TVS devices and how to apply them to protection from transient voltage threats.

## MicroNote 121

### Protecting I/O Ports

Illustrates the use of a broad selection of TVS array devices for protecting data lines from ESD and low-level induced lightning threats.

## MicroNote 122

### Protection Across High Data Rate Lines

Ultra-low-capacitance TVS devices in array packages are illustrated in high-data-rate applications for protection from ESD and low-level induced lightning threats.

## MicroNote 123

### Effective Use of Space Saving TVS Arrays

Reviews TVS arrays for protecting from ESD with one up through eight single lines per package. Multiple configurations are available to optimize board layout.

## MicroNote 125

### Selecting a TVS

This note reviews all TVS parameters and illustrates how to accurately select the optimum TVS device to provide necessary transient voltage protection.

## MicroNote 126

### Lightning Protection for Aircraft Signal Lines

Defines lightning threats per RTCA/DO-160 and illustrates protection methods for AIRINC 429 signal lines.

## MicroNote 127

### Lightning Protection for Aircraft Electrical Power and Data Communication Systems

Includes a detailed review of all aircraft lightning threats per RTCA/DO-160 and how to effectively use TVS devices for providing required protection. Illustrates how peak surge current values of the datasheet are converted to equivalents of aircraft waveforms with examples of selecting devices for specific applications.

## MicroNote 128

### Unidirectional/Bidirectional TVS Differences

Thoroughly illustrates differences in electrical parameters and includes applications unique to each type.

## MicroNote 129

### Up-Screening Commercial TVS Diodes for Avionics and Other Robust Applications

Defines the electrical and environmental tests for screening components to higher reliability levels, similar to JAN, JANTX, and JANTXV types. These devices are assigned “MQ," "MX," and other prefixes for applicable up-screening to denote level of qualification.

## MicroNote 130

### Overall Selection of TVS Part Numbers for RTCA/DO-160

Calculations have been made to fit all of Microsemi’s TVSs to the waveform and threat levels specified in RTCA/DO-160. All TVS devices are listed by power rating and in columns from Levels 1 through 5 and summarized in two tables for Waveforms 4 and 5.

## MicroNote 132

### Aircraft Lightning Protection — DIRECTselect™ Method

Selection graphs are provided for each of the many types of Microsemi’s TVS offerings, for Waveforms 4 and 5 and Threat Levels 1 through 5. The text provides examples of selecting TVS devices for a broad range of applications, including power and data lines. This method eliminates calculations and allows TVS selections directly from the graphs.

## MicroNote 133

### Repetitive Surge on Transient Voltage Suppressors

The peak pulse power (PPP) ratings provided in datasheets for transient voltage suppressors (TVSs) are primarily for individual impulses with sufficient time to allow cooling before the next transient. These are also known as “random recurring” impulses from external causes where their effects have completely disappeared before the next transient arrives. Rapidly occurring repetitive surges generate cumulative heating (heat soak) effects that need further considerations as also found in the RTCA/DO-160 specification for aircraft in Section 22 (such as “multiple stroke” and “multiple burst” threat level applications). Further TVS device comparisons are made, including mounting or heat sinking for such applications

## MicroNote 134

### Zeners and Transient Voltage Suppressors: Can Either Be Used for the Same Application?

This MicroNote will review the differences of Zeners and Transient Voltage Suppressors (TVSs) for a better understanding of each device and if there are any applications where they can be combined without serious compromise.

## MicroNote 135

### Failure Mechanism for Transient Voltage Suppressors

This MicroNote will review the failure mechanisms of Transient Voltage Suppressors when excessive surges occur beyond their Peak Pulse Power ($P_{PP}$) or Peak Pulse Current ($I_{PP}$) ratings at a specified pulse width. This includes considerations for variations in pulse width and the primary failure mechanisms associated with excessive p-n junction temperatures.

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