MicroNote 115

Derating Transient Voltage Suppressors At Elevated Temperatures for Varying Pulse Widths

By Kent Walters

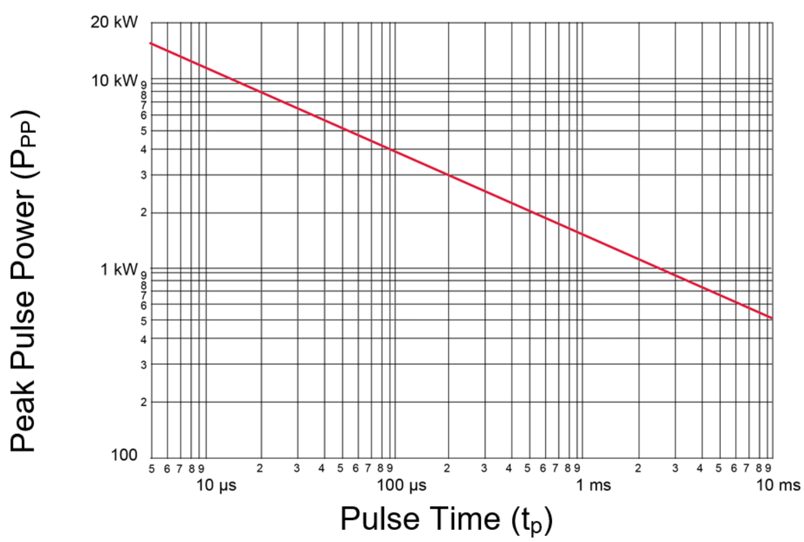
Previous MicroNotes have addressed surge capability at varying pulse widths (MicroNote 104) and derating at elevated temperatures (MicroNote 114). The two concepts will now be combined in illustrating a case history where the performance conditions include a reduced pulse width compared to typical datasheet ratings at 10/1000 µs for peak pulse power (P_{PP}).

The case history example is a sensor in an aircraft vertical stabilizer on a 15 V power bus that is to be protected from a double exponential 40/120 µs induced lightning pulse of 600 V with a peak current of 90 A. The maximum ambient temperature is 70 °C. The package size of the transient voltage suppressor (TVS) must be small for integration into a connector.

Based on the electrical requirements and mechanical configuration, the 1500 W glass body 1N6138A through 1N6173A series has been selected as a starting point. The 1N6149A is chosen as a trial fit with its operating voltage of 15.2 V, and a 10/1000 µs peak pulse current (I_{PP}) rating of 54.2 A.

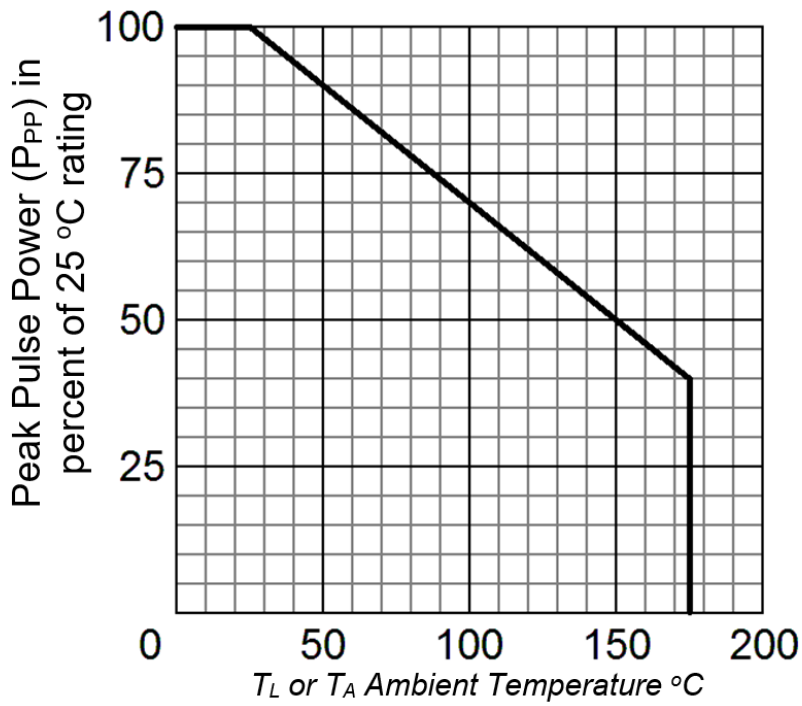
The P_{PP} rating at 1 ms is 1500 W. However, at the shorter 40/120 µs, the P_{PP} capability is much higher with 3500 W as determined from the P_{PP} vs pulse time curve in Figure 1 (see page 1) of the 1N6138A to 1N6173A datasheet series of bidirectional TVSs. This represents an increase in P_{PP} by a factor of 2.33 that would also apply to the peak pulse current (I_{PP}) where clamping voltage (V_C) does not change significantly for the shorter pulse durations on the P_{PP} curve in the following graph. This provides an I_{PP} of 2.33 × 54.2 = 126 A.

Figure 1: Peak Pulse Power vs. Pulse Time



With the required maximum ambient temperature of 70 °C by the user in this case history example, the derating curve at elevated temperature for this device in Figure 2 (see page 2) indicates the I_{PP} must be reduced to 82% of the maximum rating at 25 °C. This yields a net surge rating of 103 A with a margin of 13 A compared to the 90 A requirement. This method of temperature derating is also the same as shown in MicroNote 114.

Figure 2: Peak Pulse Power vs. Temperature



The illustrations given above apply to nonrepetitive impulse waveforms having an exponential rise and exponential decay. Sine-wave and square-wave impulses require further derating that is specified on many TVS datasheets or as described in MicroNote 120 for different waveforms.

Not all TVS selections are as simple as this one example. Occasionally it becomes necessary to stack two or more lower voltage devices in series (or parallel) to increase the I_{PP} capability and/or increase operating voltage up to required levels. In one example, an instrumentation manufacturer stacked five parts in series for protection across an aircraft 270 V dc bus.

There are many options in using standard product for unique applications. This is further explored in MicroNote 132 for various temperature deratings and waveforms as also found in aircraft applications for lightning protection as defined in the RTCA/DO-160 specification.

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 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