Understanding Peak Pulse Power (P_{PP})

By: Dave Hutchins

Transient Voltage Suppressors(TVS) are categorized according to their maximum peak pulse power rating (P_{PP}) for a specific pulse waveshape. The power rating of a specific TVS is indicated as a curve representing a derating in power (P_{PP}) over a given pulse duration (td). Peak pulse power ratings are typically double exponential waveforms (i.e., 8/20µs or 10/1000µs). However, sometimes square waves are given on TVS product specifications.

Figure 1 shows a 30 kilowatt peak pulse power curve over a 1 millisecond duration. A pulse duration (t_d) is defined as the front time plus fall time. Front time is characterized by the length of time needed for the peak pulse current (I_{PP}) to reach its peak value, as shown in Figure 2. The fall time is characterized as the length of time needed for the pulse to reach 50% of its peak value.

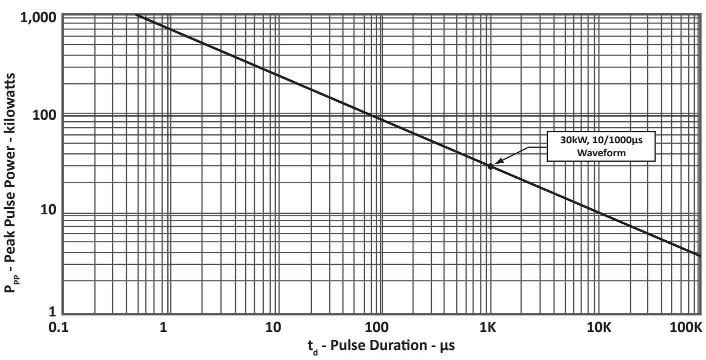

Figure 1. Peak Pulse Power vs Pulse Time

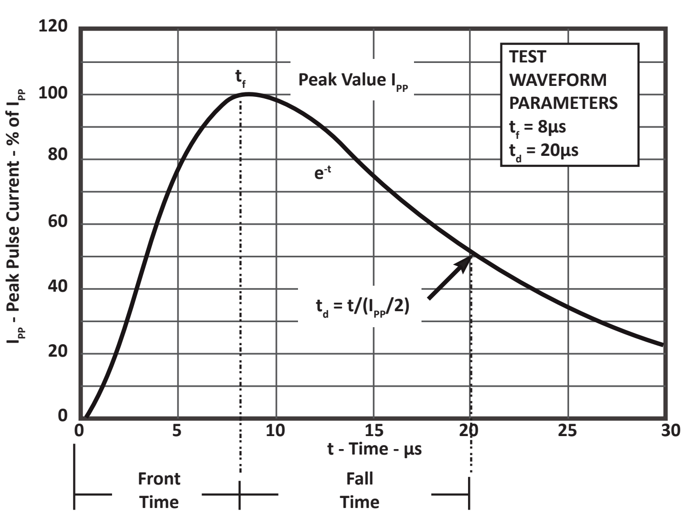

Figure 2. 8/20µs Pulse Waveshape

The maximum peak pulse current rating (I_{PP}) of a TVS device parallels the peak pulse power curve. The maximum peak pulse power (P_{PP}) is equal to the maximum clamping voltage (V_C) multiplied by the maximum peak pulse current (I_{PP}), where the maximum clamping voltage is considered a constant independent of time. Typically, the maximum clamping voltage is called a failure threshold voltage for a given silicon P/N junction diode. Considering this voltage a constant over time, then the power curve represents the current rating over time.

There are two methods that can be used to calculate the maximum peak pulse current (I_{PP}) of a TVS for a pulse duration.

Method One

Calculate the maximum current rating of a specific device type at a given pulse duration, by using the slope of the power curve. To determine the slope of the power curve per decade, that is from 1000µs to 100µs, find the ratio for that given decade. For example, Figure 1 shows a peak pulse power rating of approximately 85 kilowatts at 100µs and 30 kilowatts at 1000µs making the slope 3 for that decade.

The second step in the calculation is to multiply the slope by the devices' maximum peak pulse current (I_{PP}) rating. For example, if a device has a maximum peak pulse current rating of 24.4 Amps for a pulse duration of 1000µs. Given the peak pulse current rating for a specific pulse duration such as 1000µs, the peak pulse current for a short pulse duration of 100µs can be calculated. Multiply the 24.4 Amps by a ratio of 3, then the maximum peak pulse current rating for 100µs is 68.32 Amps.

Method Two

Unlike the first method, the second method does not use the slope of the peak pulse power curve. To determine the peak pulse current rating (I_{PP}) at a given pulse duration, divide the peak pulse power rating (P_{PP}) by the maximum clamping voltage (V_C). For example, if a device has a maximum clamping voltage of 20.6 Volts and a peak pulse power rating of 1400 Watts, the maximum peak pulse current rating (I_{PP}) is 67.96 Amps (1400 divided by 20.6).

It is important to note that for the purpose of calculating the maximum peak pulse current rating for smaller pulse durations, it is recommended that the maximum clamping voltage be increased by 5% per decade in order to acheive a more accurate reading.

As the pulse duration gets smaller (< 0.100µs), the apparent failure threshold becomes larger for two reasons. First, the higher peak pulse currents cause the voltage to increase due to series resistance of the silicon material. Second, the temperature of the device will increase due to the high current causing the voltage to be somewhat higher in proportion to the temperature coefficient of the voltage type. Typically, the increase in clamping voltage attributed to these two factors is approximately 5 to 10 percent per decade.

COMPANY INFORMATION

COMPANY PROFILE

ProTek Devices, based in Tempe, Arizona USA, is a manufacturer of Transient Voltage Suppression (TVS) products designed specifically for the protection of electronic systems from the effects of lightning, Electrostatic Discharge (ESD), Nuclear Electromagnetic Pulse (NEMP), inductive switching and EMI/RFI. With over 25 years of engineering and manufacturing experience, ProTek designs TVS devices that provide application specific protection solutions for all electronic equipment/systems.

ProTek Devices Analog Products Division, also manufactures analog interface, control, RF and power management products.

CONTACT US

Corporate Headquarters
2929 South Fair Lane
Tempe, Arizona 85282
USA

By Telephone
General: 602-431-8101
Sales: 602-414-5109
Customer Service: 602-414-5114

By Fax
General: 602-431-2288

By E-mail:
Sales: sales@protekdevices.com
Customer Service: service@protekdevices.com
Technical Support: support@protekdevices.com

Web
www.protekdevices.com
www.protekanalog.com