Converting 10/1000µs Pulse Equivalents to DO-160E Waveforms

By: Ivan Lawson

This brief assists the design engineer that requires protection from DO-160E, Section 22 transients, in selecting the proper transient voltage suppression device that only shows 10/1000µs waveform parameters on the specification. The most common waveforms in question are the Oscillatory Waveform 3 and the Exponential Waveform 6.4/69µs waveform 4, as shown in Figures 1 and 2. Table 1 indicates the voltage and current levels for the various DO-160E waveforms (1 to 5).

TABLE 1 - WAVEFORMS

LEVEL	1 V_T/I_T	2 V_T/I_T	3 V_T/I_T	4 V_T/I_T	5 V_T/I_T
1	50/100	50/100	100/20	50/300	50/300
2	120/250	120/250	250/50	125/800	125/800
3	300/600	300/600	600/120	300/2000	300/2000
4	750/1500	750/1500	1500/300	750/5000	750/5000
5	1600/3200	1600/3200	3200/640	1600/10000	1600/1000

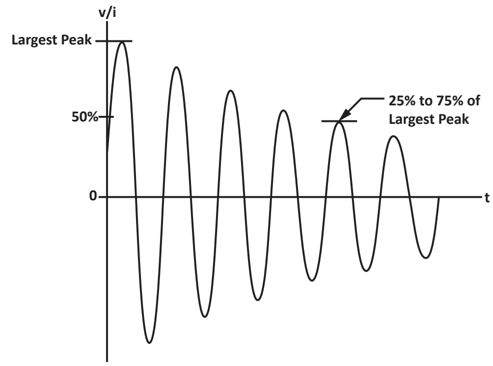

Figure 1. Oscillatory Waveform 3

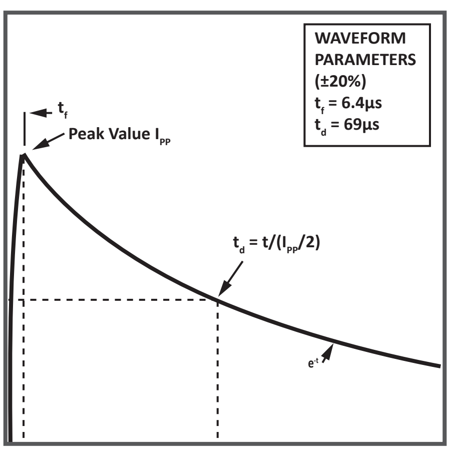

Figure 2. Exponential 6.4/69µs Waveform 4

The Peak Pulse Power (P_{PP}) vs Pulse Time (tp) curve, shown in Figure 3, was developed for a 15kW power TVS device. This power curves covers five decades of time, from 100ns to 10ms and four decades of power from 1kW to 1000kW. For a four decade decrease in pulse width, power is increased by two decades. The slope of the curve is the same for all device power levels, so it can be used for conversion of all TVS power/current levels, from 400W to 30kW.

The oscillatory DO-160E Waveform 3 is conversely equivalent to a 5µs pulse duration. To calculate the equivalent 10/1000µs I_{PP} rating for a 15KP48A silicon TVS for 5µs, use the following method.

Interpolate the P_{PP} vs tp curve and select the P_P value equivalent to 5µs, which is 170kW. Insert that value into the equation below. Insert the I_{PP} value for the closest estimated device fit for your application. For example, if considering the 48 Volt, 15KPA48A for abnormal high-line conditions for a 28V bus:

I_P for 5µs = (P_P @ 5µs/P_{PP} @ 10/1000µs) x I_{PP} of the 15KP48A
= (170kW/15kW) x 193A
= 11.3 x 193A
= 2190A @ 5µs

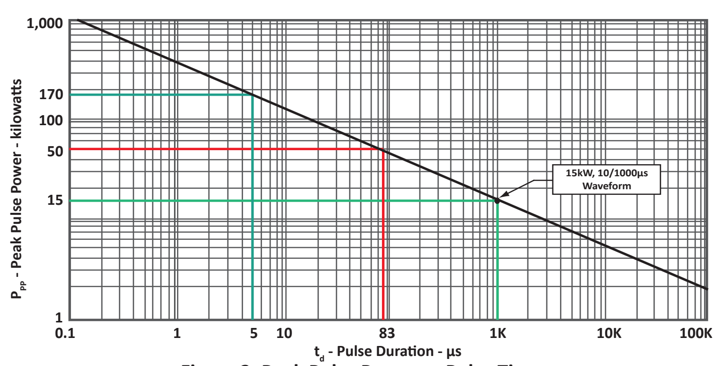

Figure 3. Peak Pulse Power vs Pulse Time

For a 5µs pulse, the increase in I_P capability is 11.3 times the I_{PP} at 10/1000µs for a the DO-160E Waveform 3. Values may vary ±10% depending on small variations in the graph used for interpolation. I_{PP} represents the datasheet specified value, while I_P is the derived value per the above equation. There is also an assumption of constant VC.

Waveform 4 is 6.4/69µs, but using the high side of ±20%, the worst case is 83µs. All values should be adjusted to the high end of a specified tolerance. Continuing to use the parameters of the 15KP48A, the equivalent peak pulse current rating at 6.4/69µs is as follows:

I_P for 6.4/69µs (at adjusted tolerances) = (P_P @ 83µs/P_{PP} @ 10/1000µs) x I_{PP} of the 15KP48A
= (50kW/15kW) x 193A
= 3.33 x 193A
= 643A @ 6.4/69µs

For the adjusted 69µs, the increased I_P capability is 3.3 times the I_{PP} at 10/1000µs for the DO-160E Waveform 4.

The Peak Pulse Power (P_{pp}) v Pulse Time (tp) curve, shown in Figure 4, represents the SM5KW Series. Using the same calculations, the SM5KW series of devices handles less current than the 15KP series of devices.

I_P for 5µs = (P_P @ 5µs/P_{PP} @ 10/1000µs) x I_{PP} of the SM5KW36A
= (50kW/5kW) x 86A
= 10 x 86A
= 860A for 5µs

I_P for 6.4/69µs = (P_P @ 69µs/P_{PP} @ 10/1000µs) x I_{PP} of the SM5KW36A
= (15kW/5kW) x 86A
= 3.0 x 86A
= 258A for 6.4/69µs

For 69µs, the increased I_P capability is 3.0 times the I_{PP} at 10/1000µs for the DO-160E Waveform 4.

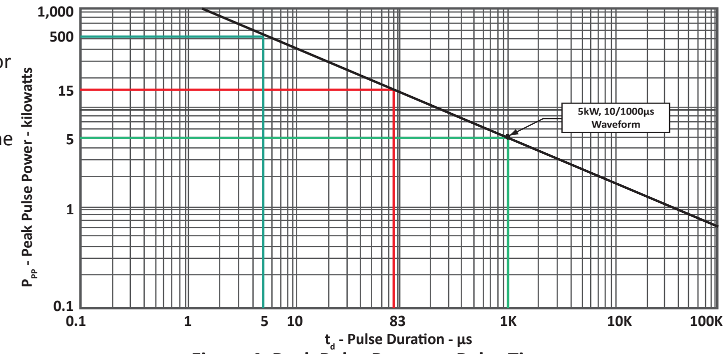

Figure 4. Peak Pulse Power vs Pulse Time

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