

## MicroNote 108

### Determining Clamping Voltage Levels for a Range of Pulse Currents

 By Mel Clark and Kent Walters

Clamping voltage ( $V_C$ ) is specified only at the maximum limit on most silicon transient voltage suppressor (TVS) datasheets. Often the designer needs to determine the  $V_C$  at some intermediate level between breakdown voltage ( $V_{(BR)}$ ) and maximum  $V_C$ .

The value can be calculated with the datasheet parameters using the following formula:

$$V_C = (I_P/I_{PP})(V_C \text{ max} - V_{(BR)} \text{ max}) + V_{(BR)} \text{ max}$$

Where:

$I_P$  = actual test pulse current

$I_{PP}$  = maximum rated peak pulse current

$V_C$  = clamping voltage at  $I_P$

$V_C \text{ max}$  = maximum specified clamping voltage

$V_{(BR)} \text{ max}$  = upper limit of breakdown voltage

Based on previous data, a linear increase in  $V_C$  can be assumed between  $V_{(BR)}$  and  $V_C \text{ max}$  for this formula. The  $V_C$  versus  $I_P$  relationship of the SMCJ15A for a 1.5 kW TVS between  $V_{(BR)}$  and  $V_C$  as calculated by this method is shown in [Figure 1 \(see page 2\)](#). Results are as expected. This calculation assumes the TVS to be at the upper limit ( $V_{(BR)} \text{ max}$ ), hence it would be conservative for most of the distribution. Note that when  $I_P$  equals  $I_{PP}$ ,  $V_C$  equals  $V_C \text{ max}$ .

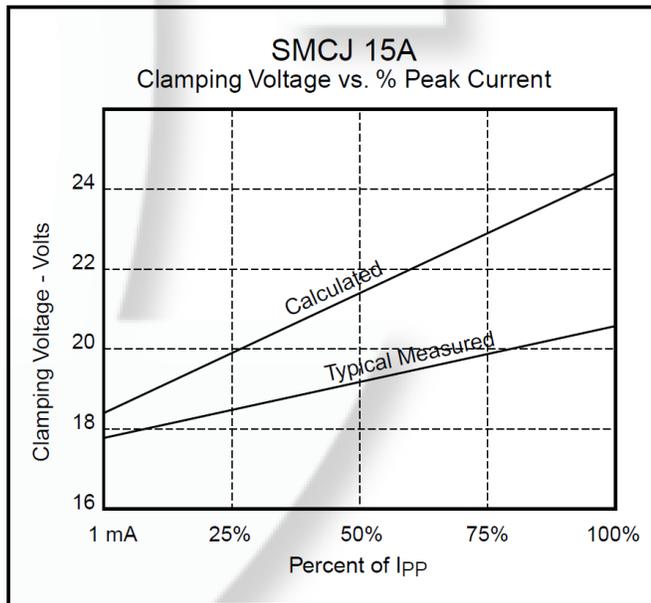
If only  $V_{(BR)} \text{ min}$  is listed on the datasheet,  $V_{(BR)} \text{ max}$  can be approximated. For “A” suffix parts, multiply  $V_{(BR)} \text{ min}$  by 1.2 and for non-suffix parts, multiply by 1.25 to obtain  $V_{(BR)} \text{ max}$ .

An example of a calculated curve compared to one derived from test measurements ([Figure 1 \(see page 2\)](#)) illustrates the feasibility and conservative aspects of this method. Surge tests were performed on a 20 piece sample at 25 °C with a 10/1000  $\mu\text{s}$  waveform.

The curve based on surge test data has a more-shallow slope than the curve interpolated through calculation. This indicates that the devices are conservatively rated, and that the formula given is adequate for interpolating intermediate values of  $V_C$  for a fractional part of  $I_{PP}$ .

The linear relationship between  $I_P$  and  $V_C$  can be applied in determining greater  $I_{PP}$  ratings for applications requiring lower than normal values of  $V_C$ . In the equation above, insert the desired value for  $V_C$  and solve for the higher  $I_{PP}$  value. This often requires upgrading to a higher peak pulse power ( $P_{PP}$ ) rated device.

**Figure 1: SMCJ 15A Clamping Voltage vs. % Peak Current**



## Support

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