MicroNote 113

Parallel Stacking of Silicon TVSs for Higher Surge Current

By Kent Walters and Mel Clark

For any given application, surge current ratings can be increased by series stacking parts—as illustrated in MicroNote 112. However, there are limitations when the desired operating voltage (V_{WM}) is relatively low. For example, a silicon transient voltage suppressor (TVS) rated at 15 kW (10/1000 µs) for a 36 V working voltage dc aircraft bus can be attained only by placing TVSs in parallel. In this example, there are no 3.6 V TVS 1.5 kW devices available for an additive series stack of 10 units for a total of 36 V.

It is also impractical to just make one large pn junction, as there are practical upper limits on manufacturing costs, packaging, and market demand. Economics dictates a suitable alternative to a single chip for protecting low-voltage circuits from high surge current stress.

One exception is the load dump suppressor for automotive and heavy vehicle applications. However, its availability is limited to only a few voltage offerings (primarily in TO-3 and button packages).

Device surge current ratings are additive when placed in parallel. For example, five SMCJ16A devices (each rated at 26 A for 10/1000 µs) would have a combined maximum surge capability of 130 A. The major condition is that all parts must be closely matched in voltage to assure near-equal current sharing at peak pulse current (I_{PP}). When parts are mismatched, the lowest voltage device will carry the heaviest load and will be the first to fail.

Matching is typically performed under surge conditions of at least 3 A (or up to the rated I_{PP} value) to assure maximum performance of the finished product. Optimally matched parts are usually within ±0.25% in voltage at the matching pulse current (I_P). Matching must be done under pulse conditions to assure equal loading under surge stress.

Since it is impractical to manufacture large quantities of a give TVS to a tolerance of less than ±5%, it becomes necessary to select the wider spectrum of parts into smaller increments of ±25% for the final product.

It is important to have control of the ambient temperature during matching, because TVSs have a positive temperature coefficient of voltage (ranging from .06% to .1% per °C). This parameter is found on the datasheets and is the same for both zeners and TVSs of the same breakdown voltage. Poor ambient control will result in greater voltage mismatch and subsequent lower IPP failure levels.

When properly selected and assembled, parallel devices have been a proven alternative for high I_{PP}-rated TVS assemblies for 50 V and below. Many military and aerospace applications use the parallel TVS technology with overwhelmingly successful results.

When using the parallel loading method, there is virtually unlimited surge capability available to the designer. However, where possible, the writers recommend placing TVSs in series to increase I_{PP} capability because of the simplicity of this method compared to configuring devices in parallel.

Matching and assembling parallel configurations requires more technical skill and a higher level of test capability when compared to series stacking. Overall reliability will be questionable if the end user is ill-equipped to perform all functions, adequately match parts for parallel assemblies, and verify performance.

For those who prefer products built to specs, assemblies can be supplied by TVS manufacturers that specialize in design, construction, and test of custom assembly products.

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