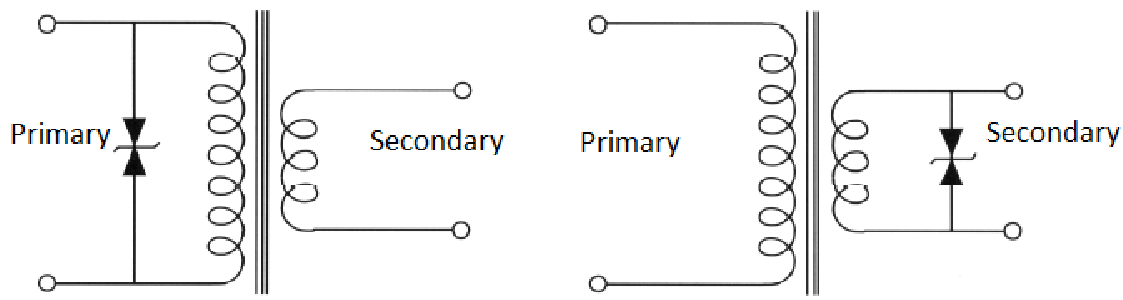
MicroNote 116

Transformer Protection Across Primary and Secondary

By Mel Clark and Kent Walters



a. Protection across primary b. Protection across secondary

Most designers are occasionally confronted with protecting a small circuit powered by a step-down transformer converting 120 V_{AC} to a level between 10 V_{AC} and 15 V_{AC}. The question arises: where is the most effective location for the transient voltage suppressor (TVS)?

The first impulse is to add protection across the primary. However, good design practice has shown that placement should be across the low voltage secondary. Reducing the operating voltage will increase the TVS rated peak pulse current (I_{PP}) in the same proportion as illustrated in the example above.

Protection across the 120 V_{AC} primary requires a device to have a working voltage level of at least 185 V, like that provided by a 1.5KE220CA 1.5 kW TVS. This device is rated at an I_{PP} of 4.6 A for 10/1000 µs. In contrast, the TVS chosen for the 12 V_{AC} secondary would be a 1.5KE22CA with an I_{PP} rating of 49 A for 10/1000 µs—over ten times greater than the 1.5KE220CA.

Severe power line surges originating from lightning are characterized by IEEE specs with a 20-µs duration. For this shorter pulse width, the device has six times more surge current capability, or 294 A total. The effect of increasing current with shorter pulse widths is illustrated in MicroNote 104.

In practice, a more cost-effective P6KE or SMBJ 600 W rated device is often used on the transformer secondary, which will protect from a 140-A, 20-µs surge. This I_{PP} rating is sufficient for most threats. This is further complemented by the power supply filter capacitor, which helps provide protection from voltage spikes. The impedance of the transformer will also contribute a measure of added protection on the secondary side.

This method offers protection with the TVS in optimal placement. Transformer input wires should be dressed for the shortest possible length to minimize radiation. TVS leads require minimum length to reduce parasitic impedance, as illustrated in MicroNote 111. Silicon pn junction devices clamp very close to the operating voltage. Metal oxide varistors (MOVs) typically clamp at much higher voltages, offering less protection to vulnerable, sub-micron geometry microchips.

It is seldom necessary to protect transformer primary windings from transient voltages, as most 120-V transformers designed to operate across utility power will withstand short duration spikes ranging up to 6 kV.

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

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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