AC LINE VOLTAGE PROTECTION & HIGH RELIABILITY with SBT3000 SMART AC SWITCH CONTROLLER

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One issue that can seriously affect a product reliability is AC line voltage surges, or longer-term line voltage swells. Surges are normal shorter duration kilovolt type high voltage spikes, in the order of microseconds. Voltage swells are normally hundreds of volts and can range in duration from milliseconds, to continuous.

Varistors are often used to protect electronic circuits against short duration line voltage surges because they can absorb large amounts of current for a short time. However, the internal damage created by pulse energy absorption in a varistor is cumulative, and each pulse that a varistor absorbs, can shorten its life. Generally, the more energy a varistor absorbs, the shorter its life becomes. Even though varistors can absorb a large amount of energy, they degrade over time and often do not provide reliable long-term overvoltage protection. When a varistor fails, it usually either becomes an open or short circuit, providing no continued equipment protection whatsoever. If a varistor becomes open circuit, it often happens without a customer even knowing that their equipment has no protection whatsoever. If the varistor shorts, it may set on fire.

The following graph from Littelfuse shows how long a typical 20mm “midsized” varistor lasts for short pulse durations.

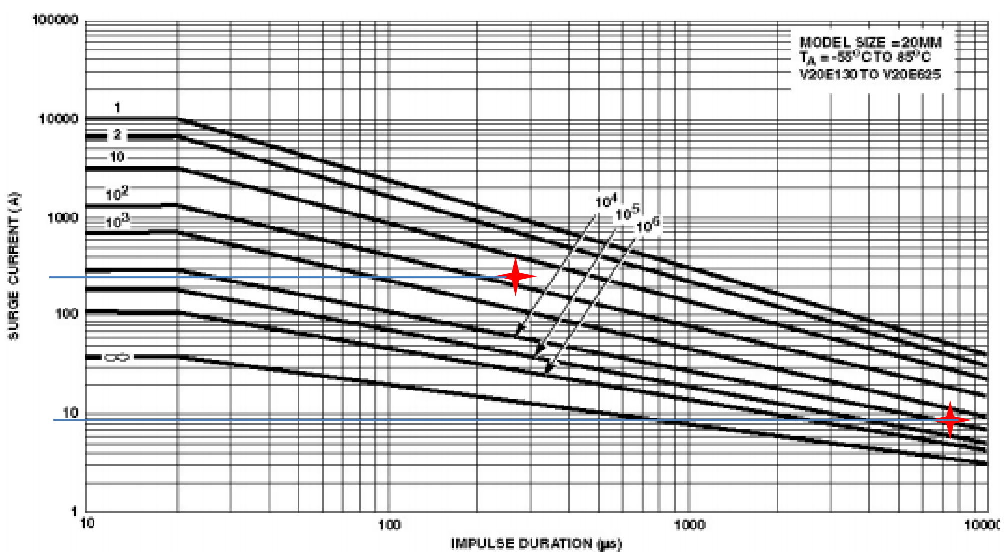

Figure 1: Pulse Life Curve for One Type of 20mm Varistor

From Figure 1 above, it can be seen that this 20mm varistor can only sustain a voltage swell of 40A or 10ms, or using the time data from Figure 4 below, a surge of 800A for 350µs. The varistor will handle these conditions only one time, more occurrences at these energy levels will likely damage the varistor. But are these energy levels and times realistic?

Customers often assume that various transients and surge conditions are isolated and uncommon; however, the reality is that transient and surges happen regularly during the life of a product. Transients and Voltage Swells can have a high current, or high voltage, or both. They can have peak voltages greater than 10kV, and currents greater than 10kA. They are most commonly very short duration (between 10µs and 1ms), and can be caused by lightning, or contactor switching, capacitive or inductive switching circuits. Voltage swells also are common and have different sources. For example, there are often cases of three-phase power system imbalance that cause very large swells for much longer periods of time.

The graph below shows the duration of several surge types. The acceptable duration of voltage swells in power lines, is shown in Figure 2.

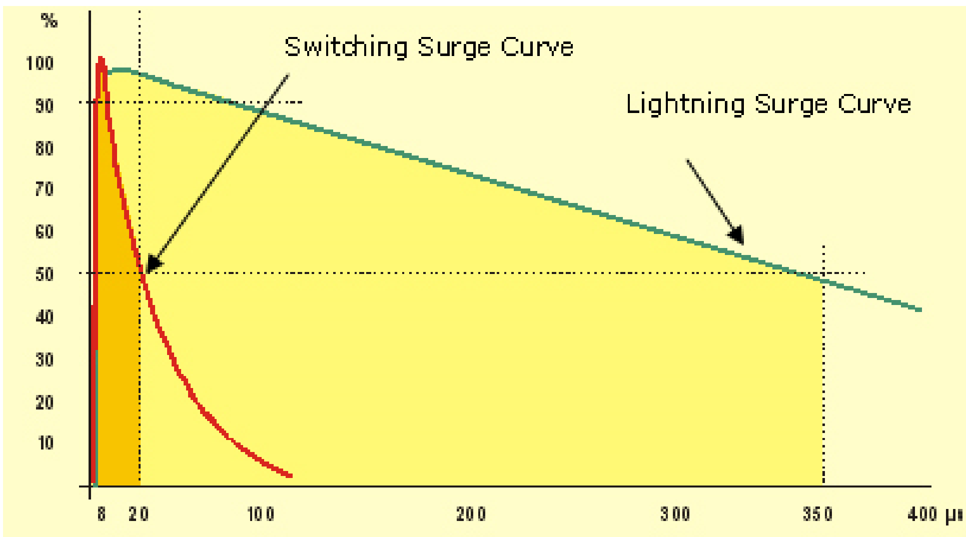

Figure 2: Short Duration Line Voltage Pulse Types, and Two Sources

Power utilities attempt to provide the cleanest AC power to their customers, but how common is a voltage swell, where the line voltage is above normal for more than a few milliseconds? In the USA, there is an organization called the Information Technology Industry Council (ITIC). Amongst other functions, this organization gives recommendations to power utility companies, on how long a “normal” voltage swell can last. The curve provided by them is shown in Figure 3.

Figure 3 shows that it is acceptable for the power line to go up to:

a) 500% of nominal line voltage for 0.01 of a cycle (166µs at 60Hz)
b) 200% of nominal line voltage for about 1ms (or less)
c) 140% of nominal line voltage for about 3ms (or less)

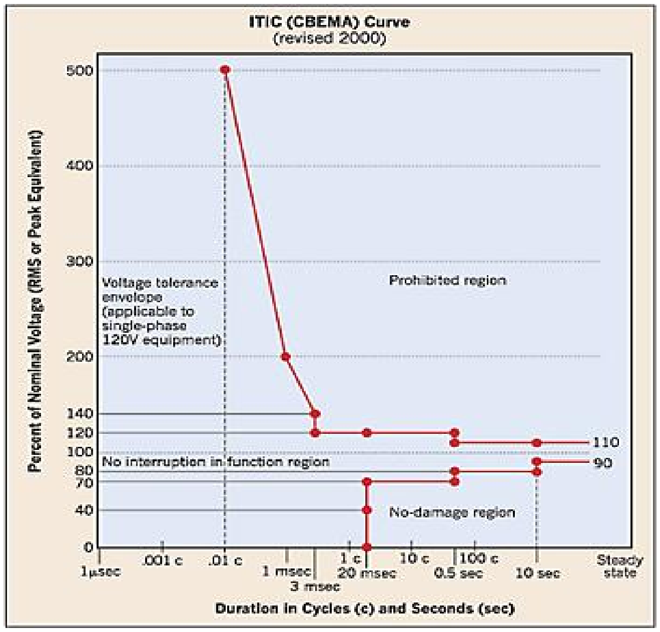

Figure 3: ITIC Curve for Power Line Voltage Swells

Although 166µs is likely within the protection domain of a varistor, 1ms and 3ms are likely not able to be fully protected by a varistor because the energy in these swells exceeds the long-term power dissipation capability of a varistor. Figure 4 below was taken from a Multicomp document which shows the continuous power dissipation capability of various size varistors. Please note that there is a large difference between the short time (shown in Figure 1), and continuous power handling capability (shown in Figure 4), of a varistor. Figure 4 shows that even a large 20mm varistor can only dissipate 1 watt continuously, therefore long-term overvoltage conditions will likely damage a varistor.

Power Dissipation Ratings (P, in-watts)

Disc Size	11V AC to 40V AC	50V AC to 680V AC
5 mm	0.01	0.15
7 mm	0.02	0.25
10 mm	0.05	0.4
14 mm	0.1	0.6
20 mm	0.2	1

Figure 4: Continuous Power Dissipation Capability of Various Size Varistors

So how can a piece of equipment be protected against longer term voltage swells? The Patented SiliconBrite SBT3000 IC detects an overvoltage condition and turns off the downline load for the duration of the overvoltage condition. The SBT3000 can be used in conjunction with a varistor, to provide superior unmatched line voltage protection. Customers will appreciate the additional reliability of the SBT3000 solution which will ensure robust and uninterrupted long-term reliable operation of their product.

For more technical information including product brief, datasheet, application note, product samples, and evaluation demo board please email to:

info@siliconbrite.com

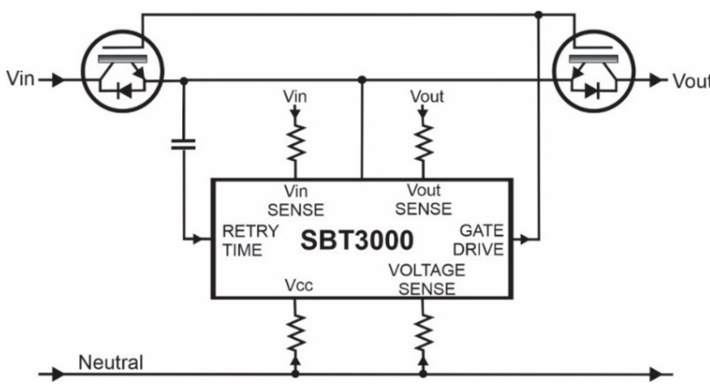

Figure 5: Simplified Electrical Block Diagram of SBT3000

Figure 6: SBT3000 Evaluation Demo Board

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