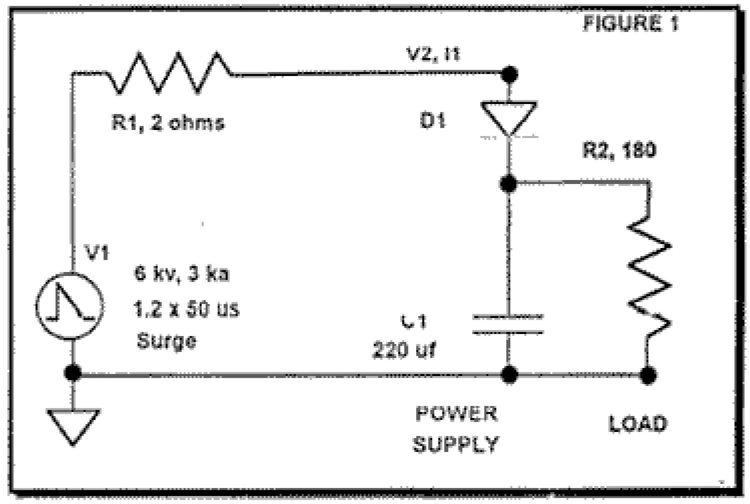
Why Shunt Powerline Surge Suppressors Don't Work

by J. Rudy Harford

A computer simulation study was made of powerline surge suppression configurations to determine the relative importance of the new US Government Suppressed Voltage Rating (SVR) Classifications[1].

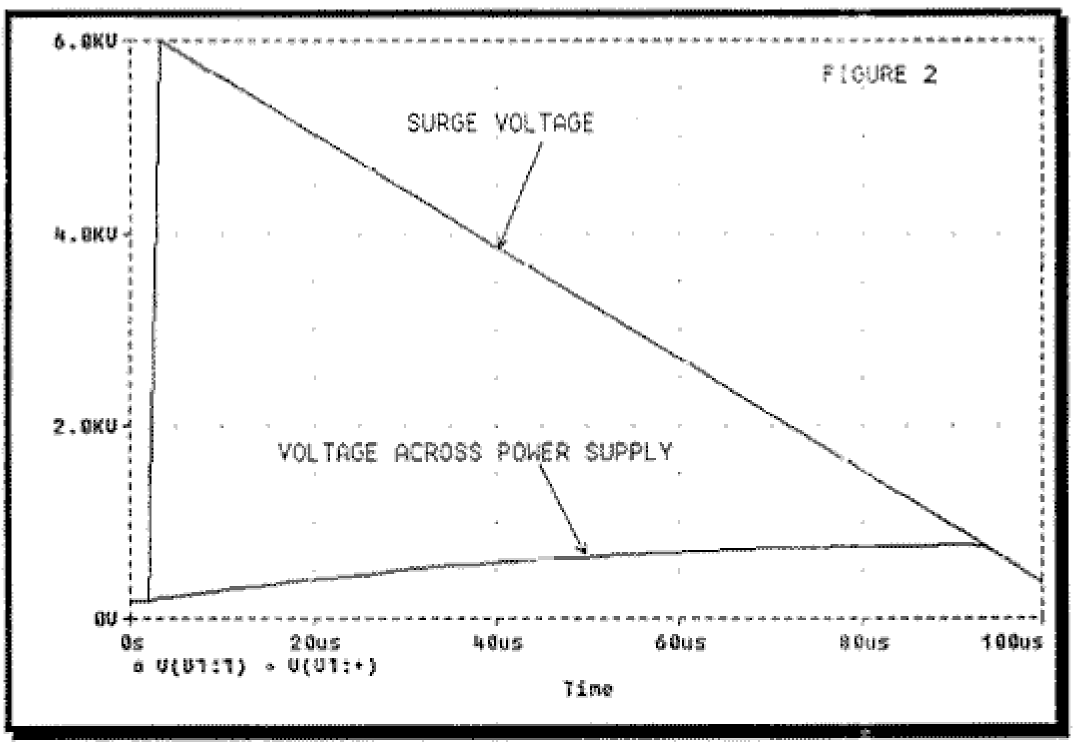


The Class 1 (330 volt SVR), Class 2 (400 volt SVR) and Class 3 (500 volt SVR) performance on the effectiveness of the protection for switch mode power supplies was evaluated. (Most computing equipment being manufactured today uses switch mode power supplies).

The study produced some surprising results. A portion of the study is presented here to reveal the rather surprising findings.

For reference, the industry standard 6,000 volt, 3,000 ampere surge[2] was computer simulated as being applied to an unprotected switch mode power supply, shown simplified in the schematic of figure 1.

The surge voltage and voltage developed across the power supply due to the surge current are shown in Figure 2.



The simulation shows that the voltage across the power supply has risen to about 800 volts due to the surge current charging the power supply capacitor.

This 800 volts is excessive, as the surge voltage rating of typical capacitors for this application is about 350 volts. The breakdown voltage of the typical diode, Dl is about 400 volts, and is being exceeded, necessitating some form of power supply protection.

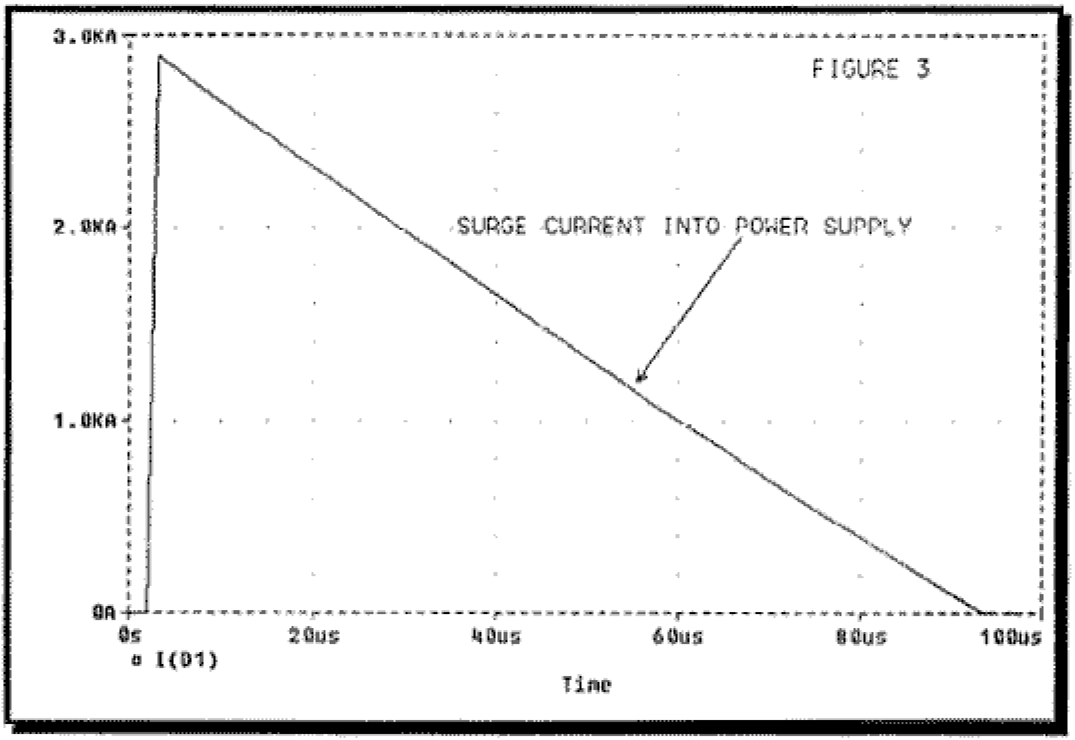
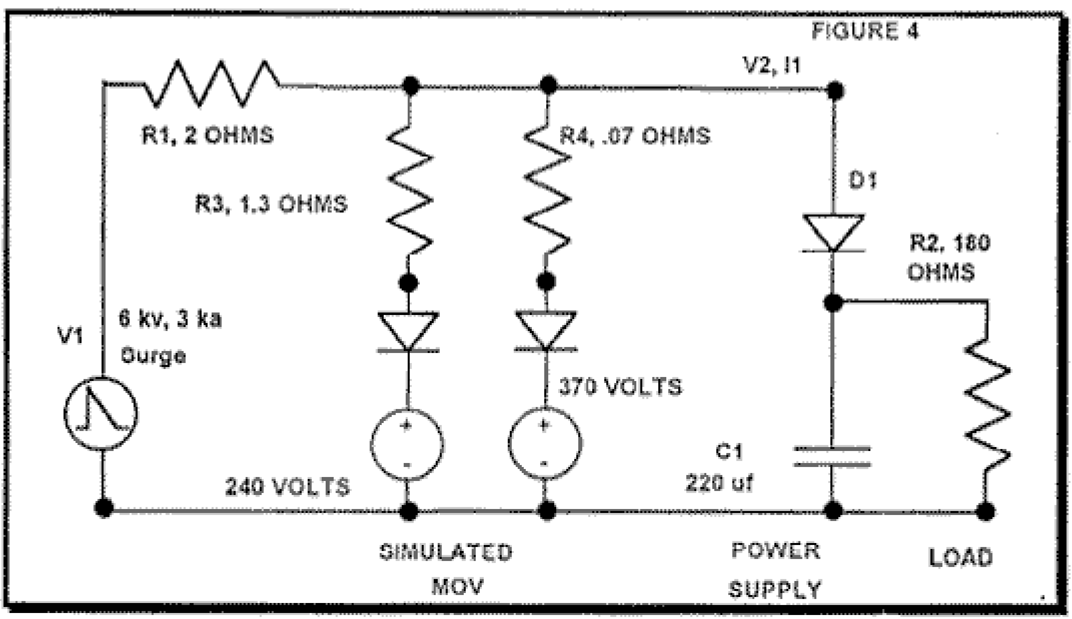
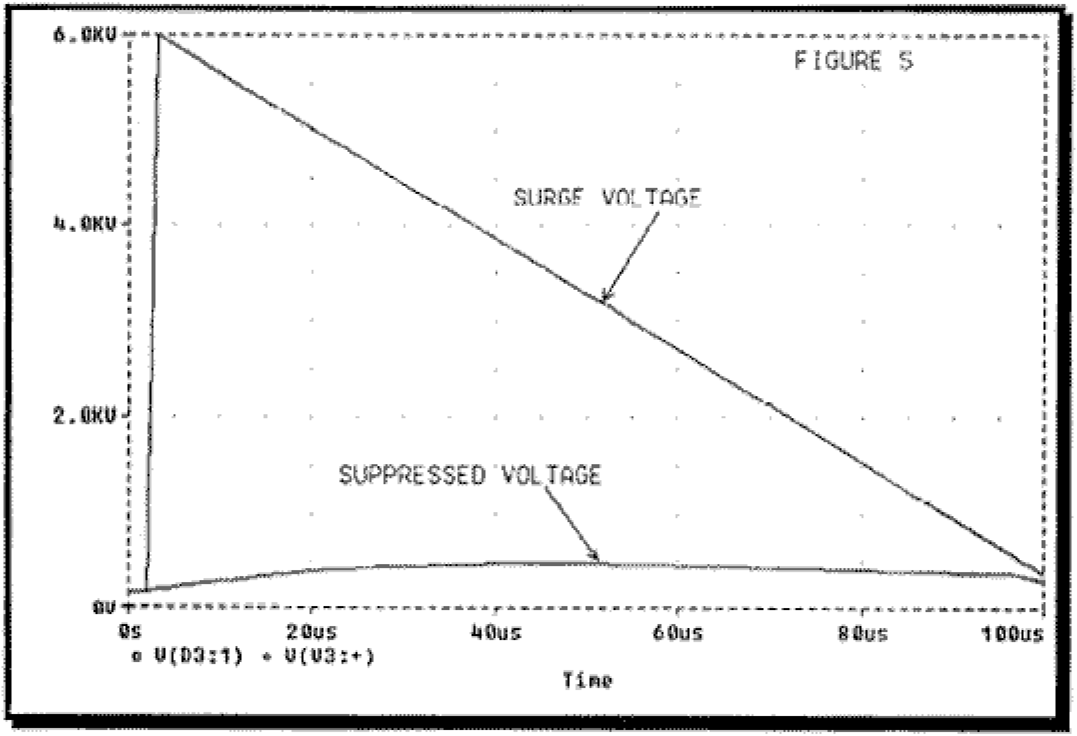


Figure 3 shows, as expected, that the full available surge current of nearly 3,000 amperes flowed into the unprotected power supply.

The diode, Dl, of a typical power supply is probably rated at no more than 3 amperes and 3,000 amperes is likely to be destructive to either the capacitor or the diode or both.



The circuit of figure 4, which includes a model for a typical 150 vac MOV, was then simulated. The MOV model assumed 240 volts clamp level a 1 milliampere of current, 395 volts clamp level at 100 amperes, and 600 volts clamp level at 600 volts. These are design values taken from a manufacturers data sheet for their 20 mm MOVs.



As figure 5 shows, the surge voltage was effectively suppressed to about 500 volts for the 6,000 volt 3,000 ampere surge. So far so good.

Now here comes the surprising part.

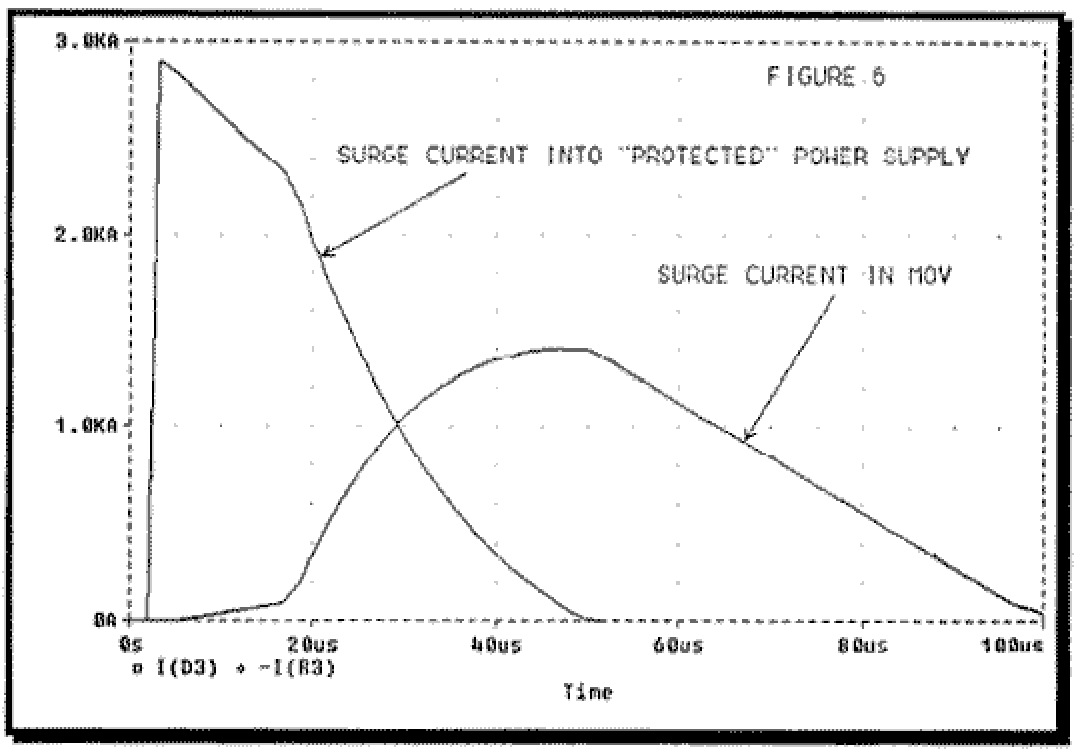
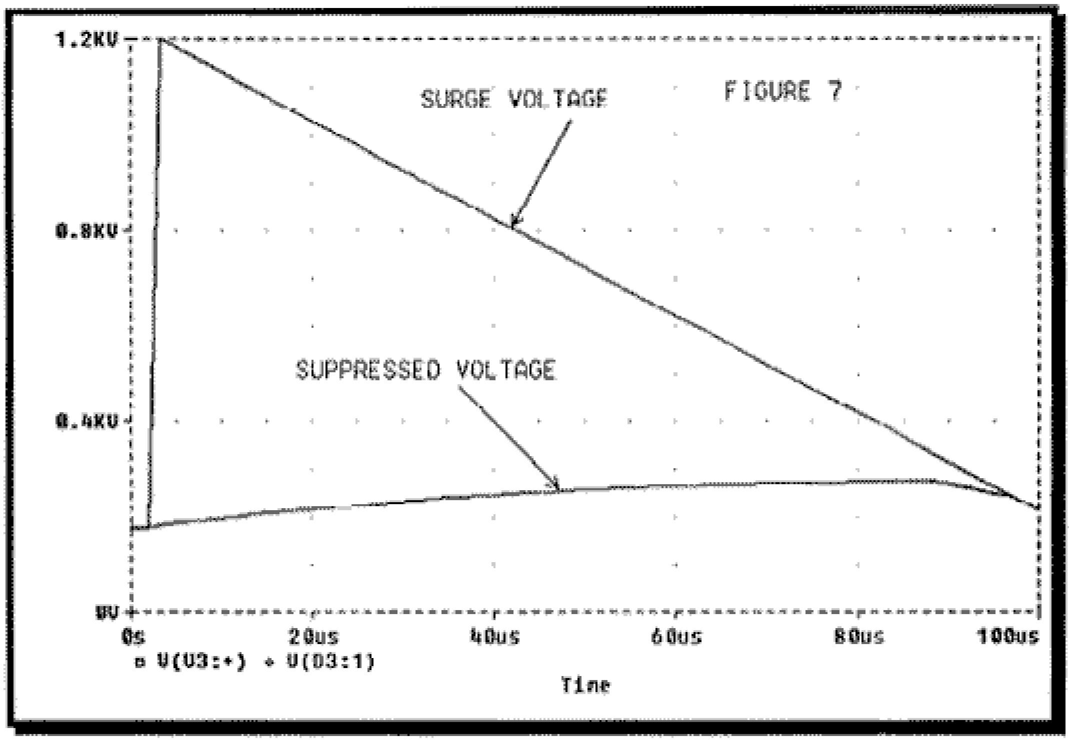


Figure 6 shows that all the available surge current of nearly 3,000 amperes flows into the "protected" power supply, with surge current continuing to flow into the power supply until the power supply voltage rise (caused by the surge current flowing into the power supply) reaches the clamping level of the MOV. The MOV is subjected to only about 1,400 amperes surge current.

In essence, the power supply is protecting the MOV during much of the surge, since MOVs are damaged by current, and nearly 3,000 amperes flows into the power supply, not the MOV!!

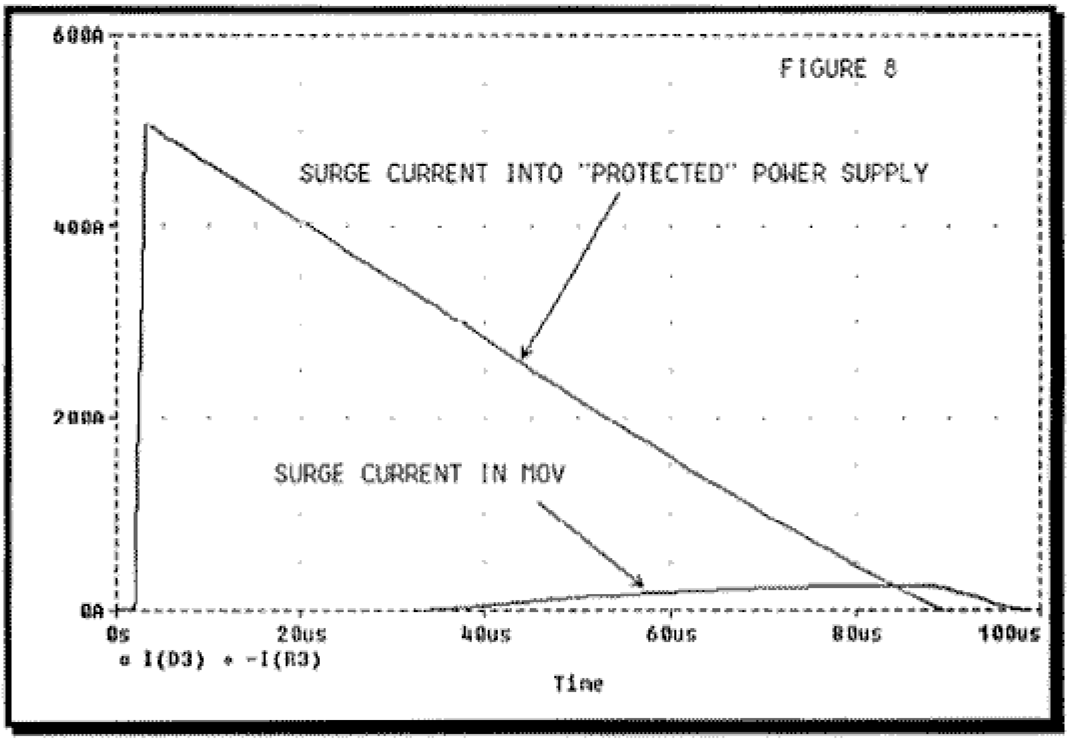
While we knew from field reports that simple MOV suppressors do not work well, this is the first analysis showing the theoretical reasons and how serious the problem can be.

Based on this analysis, it can be seen that the protection afforded by the simple shunt mode approach is virtually useless.



Worse yet, by diverting some of the current to the ground wire, this technology puts audio) video and data ports as well as motherboards of interconnected circuits at risk) as even acknowledged by a manufacturer of MOV products[3]!

In other words, this MOV technology conceivably does more harm than good!



At smaller surges, such as the 1200 volt, 600 ampere surge shown in figures 7 and 8, the protection afforded is even worse, since it takes such a long time for the power supply to charge up to the clamp level of the MOV that the surge is over before the MOV can assist.

References:

1) US Government CID (Commercial Item Description) Number A-A-55818 dated 9 July 1996, titled "Surge Suppressor, Transient Voltage", available from Defense Supply Center Richmond, 8000 Jefferson Davis Highway, Richmond, VA 23297-5610, Tel. # 804-279-5440.
2) ANSI C62.41-1991 Combination Wave voltage waveform, document available from IEEE, tel. # 908-981-0060, Piscataway, NJ.
3) APC technical note #T3, dated 8/91, available from American Power Conversion Corp.