Discrete All Mode Protection

How does a TVSS control transients?

When transient activity occurs the ideal TVSS instantly bonds every wire combination to the same potential (voltage). By establishing this instantaneous equipotential bond (all of the conductors are held to the same voltage), there is no potential difference between any of the combinations of wires. If there is no potential difference between any of the combinations of wires, there will be no transient current flow and no equipment damage. The flow of current requires that a potential difference (voltage) exist. Eliminate the transient voltage difference between all of the wire combinations and the tendency for transient current flow is also eliminated. The total control of transient voltages and transient currents requires Energy Control Systems' exclusive discrete all mode protection. The discrete all mode protection of the SineTamer® product controls the transient voltages for all conductor combinations (thereby controlling the transient currents), diverts the transient energy away from the protected system, and converts a portion of this energy to heat which is transferred harmlessly into the air.

What is discrete all mode protection and what is reduced mode protection?

Energy Control Systems' unique discrete all mode protection provides dedicated and distinct suppression circuitry for all combinations of conductors (line-to-line, line-to-neutral, line-to-ground, and neutral-to-ground). Typical reduced mode suppressors only provide suppression circuitry from line-to-neutral, or line-to-neutral and neutral-to-ground. For example, a three phase Wye reduced mode suppressor may have only three of four sets of individual and distinct suppression circuits while the discrete all mode SineTamer® product has ten. The reduced mode unit with three or four distinct modes of protection cannot control the transient voltages between all combinations of wires. For example, some suppliers sell three mode line-to-neutral TVSS with no common mode protection for application at the service entrance on a three phase Wye electrical service. When a hit (such as from lightning) comes in on all three phases and the neutral wire from the pole-mounted transformer, some protection is provided by this three mode line-to-neutral only TVSS. Because the vital line-to-ground and neutral-to-ground protection is missing, this reduced mode protection scheme can actually allow equipment to be damaged, which it should have protected. With a hit on all three phases and neutral, the three line-to-neutral protection circuits fire and dump the transient on to the neutral buss. Additionally, the transient on the neutral buss appears with no protection circuitry to control it and heads for the ground rod by passing through the ground-to-neutral jumper in the panel. The transients from the three phases have also been dumped on to the neutral buss and are headed for the ground rod by passing through the neutral buss to the neutral-to-ground panel jumper to the ground buss and out to the ground rod. The net effect of this reduced mode protection scheme is that it creates a ground-to-neutral transient potential shift or ground bounce. This ground bounce can destroy sensitive equipment. The ground bounce is created when the surge currents from the three phases and/or neutral pass through the neutral-to-ground bonding strap in the panel. If a total surge current of 12,000 amps (3,000 amps power phase and 3,000 amps on neutral) and an 8 x 20 Microsecond pulse shape passes through a buss bonding strap with an inductance of 0.1 microhenries (equivalent to about 4 inches of bonding strap length), we have created a ground bounce of:

Ground Bounce = L di/dt, where L = 0.1 x 10-6 henries, di = 12,000 amps,
and dt = 8 x 10-6 seconds
= (0.1 x 10-6 henries)(12,000 amps)(8 x 10-6 seconds)
=150 volts

This 150 volts between ground and neutral is more than enough to destroy sensitive low voltage integrated circuits which are frequently referenced to the ground buss.

Reduced mode TVSS designs, which provide only line-to-neutral protection, are also capable of producing line-to-line transients while operating. Suppose that lightning induces 10,000-volt transients on all three incoming phase wires of a three phase Wye system. Since it is impossible to guarantee that all three of these incoming transients will arrive at exactly the same time and in phase and since it is impossible to guarantee that all three phase-to-neutral suppression circuits will activate simultaneously, one phase-to-neutral suppression circuit will activate before the other two. Thus, if phase A activates first, it will reduce the transient voltage from phase A to neutral to its let-through voltage. For example, we'll assume this let-through is 1,000 volts. Now, the voltage disposition on the three phases is:

1. Phase A to neutral (at let-through voltage) - 1,000 volts
2. Phase B to neutral (hasn't activated yet) = 10,000 volts
3. Phase C to neutral (hasn't activated yet) - 10,000 volts

This reduced mode TVSS has created new transient voltages shown below:

4. Phase A to Phase B (10,000 V - 1,000 V = 9,000 V) = 9,000 V
5. Phase A to Phase C (10,000 V - 1,000 V = 9,000 V) = 9,000 V

Additionally, as the surge currents from phases A, B, and C flow from the phases to neutral and through the neutral-to-ground bonding strap, they create ground bounce transient problems as explained above.

Many other reduced mode TVSS designs include independent and discrete suppression circuitry from neutral-to-ground This design provides four modes of distinct and independent protection circuitry for a three phase Wye service. While the addition of the ground-to-neutral suppression circuitry improves performance by reducing ground bounce to the let-through level of the circuitry it does not control it. Additionally, this neutral-to-ground suppression circuitry is subject to increased wear and tear. The neutral-to-ground transients will use this circuitry exclusively. The phase-to-neutral transient currents will divide depending upon the surge impedance or high frequency impedance they see looking back toward to the ground-to-neutral bonding strap in the panel. It is to be expected that a portion of the neutral-to-ground transient current will flow through the neutral-to-ground protection circuitry. Thus, this leg is often the weakest link in this type of suppressor design.

Consider a discrete all mode SineTamer® product for a three phase Wye service. This SineTamer® product provides 10 individual and distinct sets of suppression circuitry between all combinations of the conductors. Line-to-neutral, line-to-ground, line-to-line, and neutral-to-ground protection is provided. If 10,000 volt transients appear on phases A, B, and C the line-to-neutral and line-to-ground circuitry activate bonding neutral and ground to the let-through voltage of the circuitry. Neutral and ground are now at the same potential so the potential difference between them is 0 volts which means no ground bounce and no transient current flow causing damage. Additionally, the surge current divides between the discrete and independent circuitry from line-to-neutral and line-to-ground. Roughly half the surge currents (it divides between the line-to-neutral and line-to-ground protection circuitry) flow through the line-to-neutral and line-to-ground suppression circuits which means approximately half of the heat is generated in the line-to-neutral and line-to-ground suppression circuitry instead of all of it in a reduced mode TVSS.

With a reduced mode TVSS, all of the heat and wear and tear appears in the line-to-neutral circuitry. With discrete all mode protection, the work is spread around for greater reliability, less heating per mode, built in redundancy, and exceptional life. And with discrete all mode protection the neutral-to-ground protection will control any transients which appear in this mode. Suppose the suppression circuitry for phase A activates first. This will cause the line-to-line protection circuitry to activate controlling the line-to-line transient voltages while the other protection modes activate as required to totally control the transient activity. Only discrete all mode protection is capable of providing the protection today's sensitive and vital electronic systems need.

When a vendor provides let-through voltages for all mode on a data sheet, does this mean the unit is a discrete all mode design?

No, and this causes a lot of confusion among engineers and buyers. For a three phase Wye system, the minimum number of discrete protection circuits to produce all mode let-through voltages is four. For example, Brand X provides protection from line-to-neutral (three modes) and neutral-to-ground (one mode) for a total of four modes. Brand X has the unit tested line-to-neutral and reports the let-through for this mode. The let-through results from the surge current pulse passing through the discrete line-to-neutral circuitry. Brand X has the unit tested for line-to-line let-through. This time the test pulse travels from phase A to neutral and back to phase B. Note that there is no direct, distinct and independent line-to-line protection. Thus, for a line-to-line hit, suppression circuitry must do double duty. Brand X gets a number to report in their marketing literature but the public isn't told what happened. Next, Brand X has the unit tested line-to-ground. This time the test pulse travels through the line-to-neutral suppression circuit and then through the neutral-to-ground suppression circuit. Again, Brand X gets a number for the marketing literature, but won't tell you how. Just as four gallons of gasoline won't do the work of l0. Four modes of protection won't do the work of 10 modes. Four is not equal to 10. Since by industry standards we only test one mode at a time, it is relatively easy for a TVSS manufacturer to confuse the public by providing data which seems to indicate the presence of true all mode protection.

What are the benefits of discrete all mode protection? Why choose discrete all mode protection?

· Discrete all mode protection is the only thing that works
· Discrete all mode protection is mandatory at panels and branch panels serving sensitive or vital electronic systems and should be used in conjunction with the Total Protection NetworkÔ. This is the only protection method that can control transient voltages (and their transient currents) no matter what mode, or modes, they occur on. And, do it without making matters worse by creating ground bounce or allowing large transient voltage differentials to occur on the modes which are not directly protected with individual and discrete protection circuitry.

Because there is no substitute for doing it right, there is no substitute for discrete all mode protection. And, most people find they really don't need to pay more to get the kind of protection that works. Do it right with SineTamer®.