

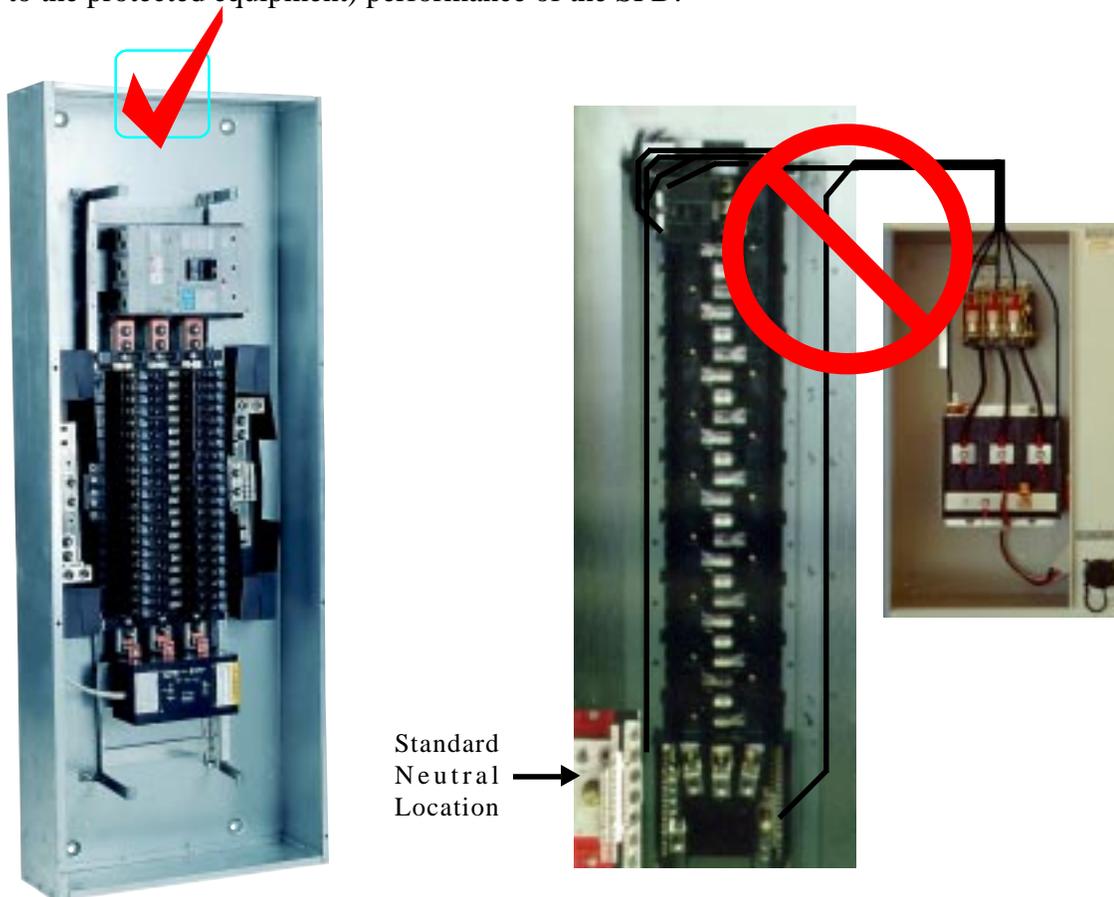
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Integration of TVSS Within Electrical Distribution Equipment

Overview

This paper investigates the benefits of Internally Mounted TVSS (or Integral TVSS). Measurements show that standard #8 stranded wiring adds 165 Volts per foot to the clamp voltage (let-through) at 3kA! When specifying Surge Suppression, consideration should be given to Integral TVSS installed at the factory by the Electrical Distribution Equipment Manufacturer; all major Distribution Equipment Manufacturers offer high quality units. When utilizing the Distribution Equipment Companies' Products, standardized manufacturing procedures *minimize installation costs, insure consistent performance*, and provide the *lowest possible clamp voltage* with optimized lead lengths.

Power quality is a critical issue today due to the increasing abundance of microelectronics which are easily damaged by transients and other power disturbances. The application of TVSS (Transient Voltage Surge Suppression) equipment (also called SPD or Surge Protective Device) is now standard practice in modern facility design. Although extensive research about the design and test of SPDs has been published, the installation has been left up to the electrical contractor. Most installation requirements state: "Install as close as possible to the service being protected." How close is this? Why is this required? This is a subtle problem; installation directly effects the let-through voltage (the voltage that passes through to the protected equipment) performance of the SPD.



Internal Vs. External TVSS

A major benefit of internally mounted TVSS, compared to externally mounted devices, is the performance. During a transient event the SPDs function is to absorb and divert away from the load, the energy from the transient. The performance of the SPD is dramatically impacted by the impedance in the suppression circuit. The largest impedance in the circuit is due to the conductors used to connect the service to the suppressor. Reactance caused by the inductance in the conductors can add 200 volts or more per foot of conductor to the total voltage the load experiences (let-through voltage). An externally mounted device typically requires several feet of conductor to connect to the service adding hundreds of volts to the let-through performance of the suppressor. An internally mounted device reduces this impedance dramatically and maintains SPD design performance.

To demonstrate the effects of lead length, the standard open loop configuration is tested and compared to the UL test data for an Integral Panelboard device. One foot of #8 stranded connecting wire adds 165 Volts/ft. Tests are based on the UL 1449 3kA/6kV Category C1/B3 impulse waveform. The transient impulse is introduced at the panel's connecting lugs, and the let-through voltage measured at each of the 54 breaker positions. The first, last, and four intermediate positions are included to further demonstrate impedance effects of the bus on let-through performance. The SPD is connected to the number 1 breaker.

Connecting wire length is based on the total run of wire for a mode of protection. For the panelboard shown on page 1, with the device located within one foot of the panel, there is at least two feet of wire between the service and the SPD. Using Line-Neutral (L-N) mode as an example (see picture above): 2 feet to connect the Line, and 4 feet to connect the Neutral, equals a total of 6 feet of connecting wire. ***Based on 165 Volts/ft. for #8 stranded wire, this will add 990 Volts to the let-through voltage!*** Table 1 compares the let-through performance for a 3-Phase 120Y/208 Volt Integral TVSS Panelboard, to the performance expected with the SPD mounted externally (open loop, total wire length of 6 feet as described above).

Table 1 - Internal Vs. External Let-Through Voltage Performance

SPD Type	Breaker Pos. 1	Breaker Pos. 12	Breaker Pos. 24	Breaker Pos. 30	Breaker Pos. 42	Breaker Pos. 54
Integral	437 V	491 V	511 V	518 V	530 V	565 V
External	1427 V	1481 V	1501 V	1508 V	1520 V	1555 V

Economics

A misconception about integral mounted suppressors is that they are more expensive than externally mounted devices. This was true several years ago when the TVSS manufacturers first began offering integral mounted SPDs. The TVSS manufacturers would purchase the distribution equipment and have it shipped to their manufacturing plant where the distribution equipment was extensively modified mechanically and electrically and the SPD installed before reshipping to the job site. The uniqueness of the product, extra handling, and special modifications resulted in a higher cost.

Eventually, distribution equipment manufacturers began receiving requests to include the TVSS option at their plant and eliminate the “middleman,” providing a more cost effective product. Initially, the inclusion of the SPD by the distribution equipment manufacturer was treated as a special order and required additional pricing for a non-standard option. Today this is no longer the case. Each manufacturer (Siemens, Square D, Cutler-Hammer, General Electric) offers a standard product that has been fully integrated into their manufacturing process with the resulting price decrease. Additional savings are realized when using Integral TVSS because no additional wall space is required or installation costs incurred as with External SPDs.

Other Considerations

Each of the major distribution equipment manufacturers has modified their equipment to provide maximum performance and, in some cases, has required moving conductor connections or modifying the bus layout. The modifications have been included in the UL procedures for the distribution equipment (whether a panelboard, switchboard, busplug or other equipment.) This UL certified equipment is only available from the distribution equipment supplier with the TVSS option installed. It is not available to other TVSS manufacturers. If a TVSS manufacturer chooses to offer an integral mounted SPD, they must buy a standard product and make their own modifications, and then re-certify the equipment.

When a TVSS manufacturer modifies the distribution equipment to include their SPD, they have voided the original distribution equipment manufacturers certifications and warranty, and must now provide them. This leads to a critical question for the customer. Who has liability for the distribution equipment, the distribution equipment manufacturer or the TVSS manufacturer?

The customer typically assumes that the distribution equipment manufacturer is liable for the service and warranty; when the Consulting Engineer specifies TVSS integral to the distribution equipment as an option from the distribution equipment manufacturer, the customer receives the warranty and service he is entitled to.

When the SPD is installed by the TVSS manufacturer, the warranty and service must be supplied by them - the distribution equipment manufacturer will not assume the liability when the equipment is modified!

Summary

As Consulting Engineers are now aware of the many advantages of installing TVSS internal to the distribution equipment at the electrical distribution equipment factory, their specifications are rapidly reflecting this feature. Integrally mounted TVSS devices offer higher performance at an economical price. For increased performance, smoother installation, and valid certifications from the distribution equipment supplier, integrally mounted devices should always be considered. TVSS should be purchased directly from the distribution equipment suppliers utilizing only their TVSS supplier to maintain the certifications, warranty, and lower the installation cost due to standard procedures.

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