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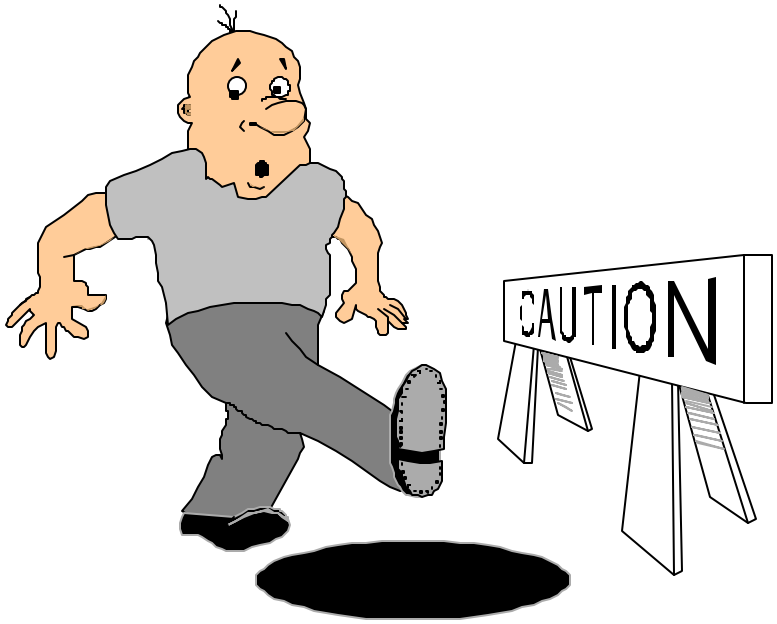

Understanding UL1449

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Introduction

Transient voltage surge suppressors (TVSS) represent the most rudimentary form of power protection available. When properly applied (for example, at the electrical service entrance to a facility) they fulfill an important role in the overall power protection picture.

Since the advent of electronic systems, TVSS have become increasingly popular as a primary defense against catastrophic electrical disturbances such as those defined by ANSI/IEEE C62.41 and discussed in POWERVAR Whitepaper 208. Their use at the end of long branch circuits has increased substantially, due in large part to their low cost and convenient packaging.

The TVSS industry is characterized by a multitude of manufacturers who, in an attempt to differentiate their products from one another, have taken substantial liberties in the use (and sometimes abuse) of not only ANSI/IEEE C62.41 but a newer *safety agency* listing known as UL1449.

The purpose of this whitepaper is to define the intent of UL1449 so that those who specify, purchase, and use power protection devices can make a better informed purchase decision.

Safety First and Foremost

The UL in UL1449, stands for Underwriters Laboratories. UL is a non-profit company located in Northbrook, Illinois. The sole purpose of its existence is to conduct product safety testing.

The UL seal on a product of any kind is the consumer's assurance that the product functions safely and that, if it fails, its failure will not result in fire, electrocution, or other safety hazard.

Nothing in UL's mission is designed to test the suitability of a product for a particular purpose. In fact, UL listing conveys no opinion at all regarding whether a product will perform as advertised or whether it's even appropriate in a given application. A UL listing means only one thing -- the product has been tested and found safe.

Most of us have seen the UL insignia on a variety of everyday items without giving it a second thought. We certainly wouldn't assume, for example, that one restroom lavatory functions better than another on the basis of a UL listing. Why has the TVSS industry adopted UL1449 as a comparison yardstick by which each measures product performance in relation to that of their competitor? How can a safety standard be turned on its head and converted into a competitive selling tool? The explanation is an interesting one and begins with an understanding of what UL1449 is all about.

The Standard Defined

TVSS are designed to reduce transient voltages in the electrical environment. In operation, the individual components that make up the TVSS undergo stress -- some of it immediate and some of it cumulative. Components may fail, and insulation may weaken and break down. The result may be smoke, sparking, and fire.

UL1449 is intended as a guide when testing TVSS units for purposes of insulation coordination. The test procedure breaks no new ground with respect to defining the types of transient voltages that the TVSS may encounter in its actual operating environment. As a matter of fact, the UL1449 test protocol relies on the very same transient voltage waveforms that have been earlier suggested by ANSI/IEEE C62.41. These are the "unipolar wave" and the "100 KHz ringwave."

For cord connected TVSS, UL1449 tests are conducted with the 100 KHz ringwave with a peak short circuit current of 200 amps for Category A and 500 amps for Category B. For permanently connected TVSS, the tests are

conducted using the unipolar combination waveform with a peak short circuit current of 3000 amps for Category B.

Greatly simplified, UL1449 injects each device under test with the appropriate disturbance waveform and measures the voltage that each lets through to its output terminals. The final function of UL1449 is the assignment of a *transient suppression voltage rating* based on the test results. UL1449 assigns the rating by taking the test results and rounding them to the next highest number from the following table:

.33 kV or 330 volts
.40 kV or 400 volts
.50 kV or 500 volts
.60 kV or 600 volts
.80 kV or 800 volts
1.0 kV or 1000 volts
1.2 kV or 1200 volts
1.5 kV or 1500 volts
2.0 kV or 2000 volts
2.5 kV or 2500 volts
3.0 kV or 3000 volts
4.0 kV or 4000 volts
5.0 kV or 5000 volts
6.0 kV or 6000 volts

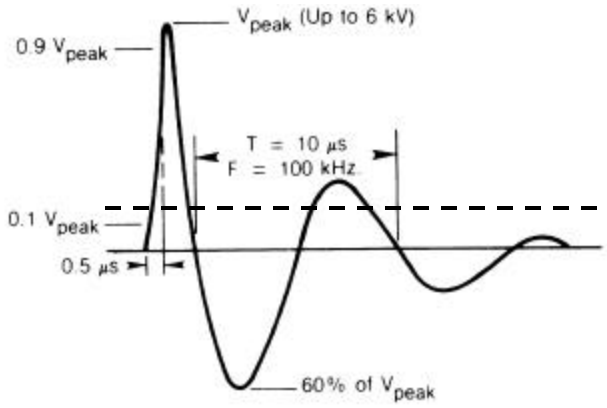
The end result is an indication of the degree to which a TVSS can suppress transient voltages without undergoing insulation or component failure. It's important to recognize, however, that UL1449 was never intended to be a guide for evaluating a TVSS's ability to protect connected electronic equipment. That's why the listing of standard values for UL1449 stops at 330 volts.

Seriously ?

Absolutely. Microelectronics, as everyone knows, function at single digit DC voltage levels -- like 5 volts. If UL1449 was intended to be used as a selection guide for power protection products, doesn't it seem logical that the lowest rating would be something lower than 330 volts? Of course it's logical. And the next logical question is "If UL1449 isn't intended as a performance yardstick, how come so many TVSS manufacturers are advertising their low UL1449 ratings as the reason to buy their product?" And even better, "How did a safety agency listing get turned into a selling tool?" All are excellent questions and we'll try to answer them.

Can't Tell the Players Without a Program

Transient voltage surge suppressors are really a pretty mundane topic of conversation (but you already knew that). The main purpose of a TVSS is to limit the amplitude of a voltage transient. Consider the Category A impulse shown below. The job of a TVSS is to divert a part of the surge away from the load (for example, everything above the dotted line.)



Obviously, the lower a TVSS unit can clamp the transient voltage, the better it can protect the connected equipment. What you may not know, however, is that 300 volts or so is about the best that any TVSS unit can perform, and it isn't that difficult or expensive to build a TVSS that can do that kind of job. In addition, most TVSS technologies share a great deal in common, particularly with regard to the types of components that are used. And that's where the story gets interesting.

Over the years, manufacturers have used the same basic components in TVSS products. These include metal oxide varistors (MOVs), silicon avalanche diodes, gas tubes, inductors, and capacitors. Most technology uses the MOV or the diode as the main functional suppression element. Which element is used is largely a matter of cost and the designer's philosophy.

MOVs and diodes are each the antithesis of the other. Each has strengths and weaknesses. MOV's can handle substantial amounts of energy, but compared to diodes they are slow. In applications where they are used naked on the AC line, MOVs degrade, and their performance may change with time and exposure. Diodes on the other hand are faster and do not degrade. However, compared to an MOV, their individual energy handling is lower, and a transient that only degrades an MOV can destroy a diode. It is the relative differences between these technologies that sets the stage for the commercialization of UL1449.

Manufacturers who use diodes claim that because they are faster they can clamp lower and are therefore superior to devices using MOVs. In addition, they point to their lack of degradation as a major advantage. Manufacturers using MOV's reply that diodes can be "one shot" devices, and that to overcome the problem of low energy handling, multiple diodes often must be used resulting in decreased reliability and increased product cost.

Hidden inside UL1449's test protocol is a procedure that TVSS manufacturers use to defend themselves against the claims of their competitors. UL1449 subjects the TVSS under test to not just one disturbance waveform but to six in a row. The resulting six let-through measurements are averaged and rounded up to the values in the table.

TVSS manufacturers have seized on UL1449's test procedure as a yardstick to prove or disprove degradation. What they ask you to believe is that exposure to six test waveforms in a laboratory is the same as the real world. They have also adopted UL1449's ratings table as a performance standard -- in effect asking customers to purchase TVSS products on the basis of the best available combination of price and UL1449 rating. All this in spite of UL's insistence that they are in the business of safety not performance ratings and that UL1449 was never intended to be applied in such a commercial manner.

Basic Problems

Two basic problems have resulted. Using the ratings in this manner is misleading. The actual test results of one TVSS might be 330 volts and another competing device might average 331 volts. According to the UL1449 ratings table, one TVSS will carry a rating of 330 volts and the other a rating of 400 volts. A one volt difference in actual performance will yield a 70 volt difference in the labeling. Experience has shown that there is also a substantial price difference when the two products reach the store shelf.

Finally, TVSS products are entry level protection for electronic systems. Even 330 volts permits far too much transient energy to reach the system. This might be fine for a toaster, but it's inappropriate for computers. For best protection, low let-through voltage (10 volts or less in normal mode and ½volt or less in common mode) is what's really needed. UL1449 ratings don't tell the whole story.

Choosing TVSS on the basis of test statistics is akin to buying a Renault with cloth seats instead a Renault with vinyl seats. A Renault will always be a Renault -- regardless of the seats. And until someone manufactures an ultra-low let-through TVSS, a surge protector will always be a surge protector and not a low impedance power conditioner.