Transients and Switch-mode Power Supplies

Imagine the scene; you have just completed installation of a total cascade of SineTamer® units and everything went absolutely perfect. All the installations look magnificent, all with short straight leads, perfect fit with the panels and all the ST-SPT units are connected in series with the PLC's… and the customer even paid for the units upon completion of the project.

All is well until 9:00 am the next morning when the angry plant manager calls you screaming about an equipment failure that occurred during the second shift the night before! "What went wrong?", "What do I say?", "How do I explain the failure?" … all of these questions are racing through your mind along with many others I am sure. While there is no way to always give a definitive answer to the angry client as to what happened… you can at least calm him down and offer a few possible scenarios to alleviate his high blood pressure and preserve the customer for future orders and referrals.

The first step is to get to the site as quickly as can be arranged, do not put this off, even though you uncertain of what to say to the client. Once onsite do a visual inspection in the area where the failure occurred, checking the units for LED indicators and proper connection. Assuming all of the units are visibly operational – it is 99.99% certain that it was NOT a high voltage transient that came down the line into the area where the damage occurred. The indicators on the SineTamer® units are designed into the protection circuit – meaning if the protection elements are functional – then the LED is lit. Other manufacturers may only connect the LED circuit to the AC or DC power supply that indicates power is applied to the circuit itself.

Fact number one: TVSS devices can not "heal" or reverse damage that has already occurred and resident within microprocessor circuit traces, lighting ballasts or the windings of electric motors. It is obviously unknown to

anyone how close to failure one of these items might actually be. It quite possibly be the next little surge or impulse could be the contributing event leading to the failure of the equipment in question. Unfortunately no one can really ever know. It is worth pointing out that we must be careful in our presentations to avoid the cliché that TVSS will solve and prevent every power quality problem known to mankind! It will NOT. It is a vital asset to prevention of problems and failures, maybe the most important but it is not a panacea, other items such as proper grounding, UPS and Harmonic transformers do have vital roles in improving the power quality of any facility that we survey.

However the comments of this article are more directed to the seeming unexplainable failure of switch mode power supplies. Below are selected comments from various sources about SMPS (Switch Mode Power Supplies).

> Switch Mode Power Supplies are the current state of the art in high efficiency power supplies. Conventional series-regulated linear power supplies maintain a constant voltage by varying their resistance to cope with input voltage changes or load current demand changes. The linear regulator can, therefore, tend to be very inefficient. The switch mode power supply, however, uses a high frequency switch (in practice a transistor) with varying duty cycle to maintain the output voltage. The output voltage variations caused by the switching are filtered out by an LC filter.
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> In all basic switched-mode topologies, the finite duration of the switching transitions will cause a high peak pulse power dissipation in the device. This produces a degradation in converter efficiency and worst of all, can lead to transistor destruction during the turn-off transition due to the inherent BJT (Bipolar Junction Transistors) second-breakdown phenomenon. Therefore the greatest amount of research into alternative switched-mode topologies has been in the field of resonant converters. These converters have tuned circuits as part of the power conversion stage and exhibit sinusoidal voltages and/or currents, so leading to transistor switching transitions at the ideal conditions of zero stress.

One aspect of the SMPS that is currently under re-design consideration is that they can also create transients because of the switching action of loading and unloading of the inductors and capacitors in the circuit. Engineering will follow up with a technical discussion power supplies and their design flaws and proposed changes, a number of papers have been presented in recent Power Quality meetings around the USA.

One of the issues confronting failures of SMPS is also to note that switching power supplies are very susceptible to brown outs, which also raises the need of utilizing UPS/Regulation in areas of critical equipment and processes. When they are turned on (from the off state) they have in-rush current protection. After a few cycles, this in-rush current circuit is removed from the circuit as it makes the circuit less efficient. Then along comes a drop in voltage (brown out, etc). The capacitors in the circuit discharge trying to hold the load up.

When the voltage comes back up, the capacitors "suck up" large amounts of current to charge - effectively creating current surge that can blow the traces, inductors, etc in the circuit. The switch mode power supply creates current surge (not voltage surges) during its operation when brown outs occur.

Unfortunately in these scenarios it is NOT possible to install enough units to prevent power supply failures given the above situations. The power supply is committing suicide due to the electrical environment in which it is placed. However, with the knowledge of this phenomenon at your disposal you will at least be equipped to provide a basic technical account about the seeming un-explainable failures that may occur in brown out/black out scenarios at customer facilities.