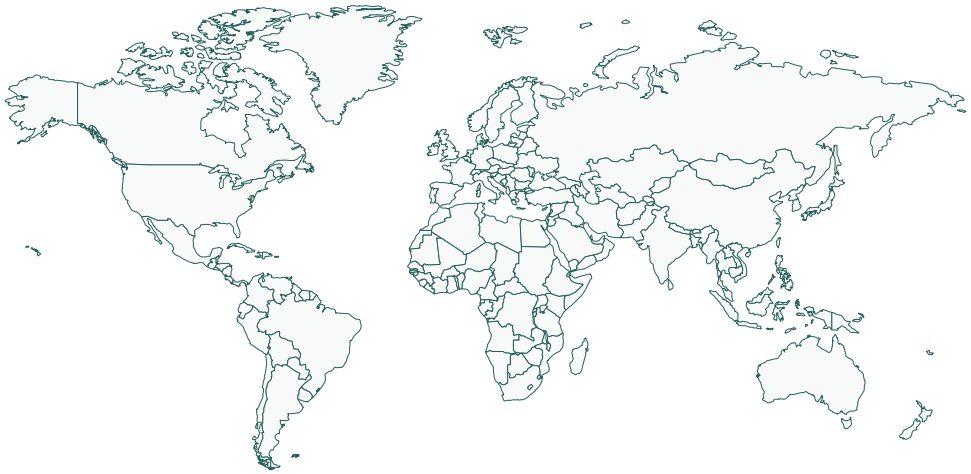
TSi Power

Authors
Peter Nystrom
President
TSi Power Corp.

Why Power Supplies and Semiconductors Fail:



Causes and Results of Power Disturbances

Abstract

Power quality around the world varies significantly from one area to another. Some countries have very stable power grids while others are extremely short on capacity. This paper looks at power supplies and power disturbances — and the effect that power disturbances have on semiconductor failure.

A power disturbance can be defined as unwanted excess energy that is presented to the load. They are caused by the generation, distribution and use of power. Lightning is another cause.

A power disturbance can be defined as unwanted excess energy that is presented to the load.

Causes of power disturbances

- **Power disturbances** originating both outside and inside customer facilities.
- **Load switching** causes surges because of collapsing fields (-e = L * di/dt).
- **Overloaded power distribution systems** can cause significant voltage variations between peak and off-peak hours.
- **Significant momentary load changes**, such as heavy inrush currents, can cause severe voltage variations.
- **Black-outs** can cause severe voltage surges, both on the loss and return of power.
- **Circuit-breaker tripping and fuse blowing** can cause severe surge voltages.
- **Large UPS and variable-speed drives** can cause various surge voltages inside buildings.

Results of power disturbances

- **Sags and undervoltages** can cause component overheating or destruction.
- **Surges and overvoltages** can cause component overheating and destruction or trigger other electronic components such as silicon-controlled rectifiers (SCRs).
- **Component overheating** reduces the life and deteriorates the real reliability as opposed to the estimated reliability based on steady-state conditions of the product.
- **False triggering** of other components can create nuisance alarm tripping or, worse, can cause overheating or destruction of other electronic components.

Why semiconductors fail

Most semiconductor devices are intolerant to surge voltages in excess of their voltage ratings. Even a fast surge of a few microseconds can cause the semiconductor to fail catastrophically or cause enough degradation to shorten its useful life. Damage occurs when a high reverse voltage is applied to a non-conducting p-n junction.

The junction may avalanche at a small point due to the non-uniformity of the electric field. In this case, thermal runaway can occur because of localized heat buildup, causing a melt-through which destroys the junction.

Problems with current solutions

Common-mode voltage disturbances can be amplified in non-TN-S AC distribution systems. In addition, typical electromagnetic interference (EMI) filters are not well damped. This has a dramatic effect on any voltage disturbances, resulting in oscillations inside the EMI filter under any transitional conditions. Severe voltage surges may result from fly-back from saturated inductors looking for a path to release energy.

Boost converters can also be destroyed by surges that cause increased energy storage in input filter. When this happens, the output capacitor (C) is charged to an unsafe level, depending on capacitance value and load levels for the DC-DC converter connected to the output of the boost.

Limitations of commercial UPS equipment

- The industry is driven by lowest cost.
- Most UPS don't have quality battery chargers and aren't designed for long-term back-up.
- With a few exceptions, most UPS equipment does not provide real power conditioning.
- Some UPS equipment is poorly protected against surge voltages.
- Extended back-up requires the addition of expensive rectifier/chargers and battery packs.

About the author

Peter Nystrom is the president of TSi Power Corporation and has been in the power protection industry for over 30 years. He can be reached at: peter@tsipower.com.

TSi Power specializes in manufacturing indoor and outdoor UPS, line conditioners, precision automatic voltage regulators, automatic transfer switches and DC–AC inverter systems designed to meet the challenging international power conditions.

TSi Power Corporation
1103 W Pierce Avenue
Antigo, WI 54409 USA
Tel: +1-715-623-0636
Fax: +1-715-623-2426
Email: sales@tsipower.com
Toll free: 1-800-874-3160
Web: www.tsipower.com

This page intentionally left blank.