IEEE Std 1100-2005

From the IEEE Emerald Book: IEEE Recommended Practice for Powering and Grounding Electronic Equipment

3.4.3 Surge protection

Surges can have many effects on equipment, ranging from no detectable effect to complete destruction…electronic devices can have their operation upset before hard failure occurs. The semiconductor junctions of electronic devices are particularly susceptible to progressive deterioration…few solid-state devices can tolerate much more than twice their normal rating. Furthermore, data processing equipment can be affected by fast changes in voltage with relatively small amplitude compared to the hardware-damaging over voltages…For large surge currents; this diversion is best accomplished in several stages. The first diversion should be performed at the entrance to the building with a second protective device at the power panel or at the terminals of a connected load, or both…

8.4.2.5 Surge protective device considerations (*New*)

Recommended practice is that SPD's be applied to service entrance electrical switchboards and panelboards, and panelboards located on the secondary of separately derived systems that support ITE, telephone, telecommunications, signaling, television, or other form of electronic load equipment (refer to 8.6 for further details). These devices may be installed externally or internally to the switchboard or panelboard. Panelboards are available that contain integrally mounted SPD's that minimize the length of the SPD conductors, thus optimizing the effectiveness of the device. However, as pointed out in IEEE PO62.72 (Draft L.1 November 2005) [B-2], when an SPD is located inside switchboards or panelboards, there is a concern that failure of the SPD can cause collateral damage to the switchboard or panelboard, including compromising the insulation system with subsequent L-L and L-G faults.

It is recommended practice that all SPD's have a means to disconnect them for service. Locating the SPD external to the switchboard or panelboard allows the disconnecting means to be located inside the switchboard or panelboard and does not require access to the switchboard or panelboard interior when servicing the SPD.

8.6 Lightning/surge protection considerations

…A listed and properly rated surge protective device should be applied to each individual or set of electrical conductors (e.g., power, voice, and data)…all voice…secondary surge protectors should be coordinated per…UL497A-1998…

8.6.1 Selection

The selection of surge protective devices typically depends on the location of the device. The surge protective devices are recommended to be sized per IEEE Std C62.41-1991 and IEEE Std C62.45-1992 requirements to achieve proper coordination. Surge protective devices should be listed to UL 1449-1996. Surge protective devices used for three-phase, four-wire circuits are generally recommended to be connected in all combinations of line-to-line, line-to-neutral, line-to-ground, and neutral-to-ground. Surge protective devices for three-phase, three-wire circuits are recommended to be attached in both the line-to line and line-to-ground modes. Surge protective devices may also be specified with high-frequency filtering characteristics. Care should be taken to ensure that this filtering does not adversely affect the operation of the power line carrier.

8.6.2 Installation

Surge protective devices may not perform properly under field conditions of use unless installed in a correct manner. Recommended surge protective device installation practice is for all lead lengths to be short and shaped to minimize open loop geometry between the various conductors. This is accomplished by removing excess and unneeded lead lengths to the surge protective devices; by twisting all the phase, neutral, and equipment grounding conductors together; and by avoiding any sharp bends and coils in the conductors. IEEE Std C62.41-1991 and UL 1449-1996 should be used as standard means of verifying performance of surge protective devices.

8.6.3 Service entrance surge protection

Facilities housing electronic load equipment of any type should have service entrances equipped with effective lightning protection in the form of listed Category "C" surge protective devices, as specified in IEEE Std C62.41-1991. Care should be taken to assure that the method used for the installation of surge protective device equipment does not cause a degradation of its current-diverting and voltage-clamping abilities.

8.6.4 Premise electrical system surge protection

In addition to surge protective devices installed in the service entrance equipment, it is recommended that additional surge protective devices of listed Category "B" or Category "A," as specified in IEEE Std C62.41-1991, be applied to downstream electrical switchboards and panel boards, and panel boards on the secondary of separately derived systems if they support communications, information technology equipment, signaling, television, or other form of electronic load equipment.

8.6.5 UPS system surge protection

Lightning and other transient voltage and current-producing phenomena are harmful to most UPS equipment and to its served electronic load equipment. For example, the transient may reach the critical load via an unwanted activation of an unprotected static-switch bypass path around a UPS. Therefore, it is recommended practice that both the input circuit to the UPS and the associated UPS bypass circuits (including the manual maintenance bypass circuit) be equipped with effective Category "B" surge protective device, as specified in IEEE Std C62.41-1991.

8.6.6 Data/communication/telecommunication systems surge suppression

Electronic equipment containing both ac power and data cabling should also be properly protected via surge protective devices on both the ac power and data cables.

4.6.5.1 Type-I, signal-data disruption

Signal-carrying circuits are susceptible to surge interference via conduction, inductive and capacitive coupling, and electromagnetic radiation. Both near-and far-field phenomena affect these circuits as EMI. When surges are actually observed on signal lines, it's often assumed, just because the signal circuits are still working, that the noise is below the circuit's EMI threshold, and things are therefore acceptable. This is not so (see Greason [B18]), as explained in the following paragraphs.

4.6.5.2 Type-II, gradual hardware stress and latent failures

A single lightning or switching surge often causes immediate, but not readily apparent physical damage to semiconductor devices. This damage then finally appears at some late time at which point the failure is obvious. This once controversial, but now accepted condition is called latent semiconductor device failure. For example, a single larger surge or several repetitive exposures to lower magnitude surges often cause a gradual performance deterioration, which may finally be associated with intermittent equipment operation as opposed to immediate catastrophic failure of the semiconductor device. In such cases where the semiconductor itself has had its performance marginalized, it is often difficult to differentiate between software-and hardware-induced errors.

4.6.5.3 Type-III, immediate hardware destruction

The third possible impact of surges is the immediately obvious and total destruction of hardware components in a single incident. Table 4-6 shows the threshold voltages and energy levels for destruction of selected semiconductors that are commonly used in electronic equipment (see Gallace and Pujol [B14] and Greason [B18]). Similarly, larger devices, such as signal and power transformers, and relay coils; and power supply components, such as chokes and capacitors, can be destroyed. Type-III events also include general arc-over damage within equipment.