

Power Quality in Cinemas

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The modern projection booth is one of the most "hostile" electrical power quality environments you will find in businesses around the world. With a lamphouse that contains line operated relays, igniter, solid state rectifiers, motors, fans, along with platter motors, a "dowser" or "zipper" solenoid, projector motor and automation relays, a great deal of electrical pollution can be reflected back on the AC line to other components. Electrical spikes, transient peaks, and DC components can be generated by this equipment that can affect the operation or longevity of booth equipment. Add SCR or Triac house light dimmers, a slide projector with solenoid advance, and an air conditioning system that cycles on and off, the amount of "garbage" on the line can cause operation problems or interruption. Microprocessor automation systems, DSP sound components, audio amplifiers that use switching type supplies, and digital stereo processors can fail or become intermittent for no apparent reason. Multiply the problems by 12 if you are running a 12-plex and you have some pretty nasty AC service inside the building that can affect even the ticketing computers downstairs.



The vast majority of power quality problems in a building originate within the same building. The Institute of Electrical Engineers (IEEE), various government agencies in the U.S. and Europe, and other organizations have been studying these problems and effects for several years. As a result, they have issued design guidelines and recommended practices that are known to greatly reduce, if not eliminate, the incidence and severity of power related problems. We did not see these problems in the good old days when theatres had vacuum tube mono sound systems and carbon arc lamps. The more precise, sophisticated, and delicate the equipment, the more important it is to have clean AC powering the equipment.

An industry of Power Quality consultants has sprung up in the past few years to diagnose and recommend corrections where mysterious symptoms and premature failure of equipment repeatedly occurs. Many power companies hire these consultants when their troubleshooters cannot find the problem. Most of the problems are noticed in businesses that have a high concentration of computers, servers, monitors and related equipment. A state-of-the art movie theatre is moving more and more into microcontroller based equipment and with the interest in future D-cinema installations the problem of power quality can become a big issue.

More important than the physical effect on the equipment is the loss of productivity resulting from equipment failure, miscalculation of ticketing and office computers and downtime or lost shows (due to premature burnout of critical equipment). A recent survey by E-Source indicated that, while most respondents did not calculate the cost of their annual losses due to power quality (or even erroneously attribute power quality glitches to software or hardware causes), roughly a third of those that did respond report a loss figure in excess of \$1 million per year.

In many cases, simply installing enhanced electrical systems and better grounding systems will prevent (or cure) the problem. Many simple techniques are relatively inexpensive to install during construction, or during a major building renovation. Infrastructure improvements in the power quality will make the cinema ready for new technologies that may appear in future years. A proper, dedicated grounding system will often prevent many problems before they start. Unfortunately a true earth ground may be several hundred feet from "earth" in a multiplex cinema. Electrical code dictates that earth ground, the neutral circuit, and building steel be bonded at the first point

of disconnect, usually the electrical entrance service box. The neutral and ground are then run separately to each "branch" breaker box for each booth. The booth farthest from the electrical entrance could be several ohms above real earth.

I have talked with several expert cinema equipment installers that have had problems with digital stereo systems repeatedly reverting to backup for no apparent reason. Even though the installation met high standards and was correctly wired and grounded, the equipment did not perform the same as other similar installations. In desperation, one installer told me he added a product called a "power line conditioner" and all the problems disappeared. It is now his practice to add these components to ALL digital systems he installs. Many other installers have adopted the same practice.

Electrical systems need not to be grounded to function, and indeed not all electrical systems are grounded. But the voltages referred to when talking about electrical systems are usually voltages with respect to ground. Ground, therefore refers to the reference point, or zero potential point, to which all voltages refer. Indeed, with sensitive equipment, a zero reference voltage is critical for proper and reliable operation. The projection and sound equipment (other than the lamphouse) runs on 120 VAC in North America, and 230 VAC (average) in most of the world. Australia's official line voltage is 240 VAC but often runs higher in some areas of the country. This power is unbalanced. That is; there is a HOT wire, a NEUTRAL wire and a GROUND wire to each component. This long run of unbalanced power throughout a complex can act as a nice antenna for local broadcast or TV stations, EMI from electrical discharges (lightning), and a conductor of spikes and transient overvoltages reflected by all equipment connected to the power line (mains).

The use of line conditioner products is becoming more popular in high end audio and video installations like screening rooms, recording studios, and expensive home theatre systems where low noise playback is imperative. Often these type systems are in extremely quiet rooms where hums, buzzes, and clicks from power line problems are very apparent. With hundreds of line conditioner products on the market, only a few are suitable for professional installations. Many of the products contain simple inductors that "absorb" spikes and transients or have surge suppressor components that are ineffective in producing pure electrical power to the system. The description of "conditioner" is a loose term that can mean many things and provide various levels of performance. Often a manufacturer will not disclose how it works, or what components are used, but simply claim what it supposedly will do to help power line problems.

The more professional products are not line conditioners at all, but line balancing systems. There are several well accepted products from various manufacturers that convert the unbalanced AC line to a fully balanced system that removes much of the AC line garbage through common mode rejection. This is done by using a huge AC line balancing transformer with a center tapped secondary. The center tap becomes the new zero reference point so ground loops between components is minimized. In effect, the equipment is no longer connected to the original grounded line source. A new isolated ground system is created, reducing line noise and improving performance in audio and video systems.

Some products go beyond simply balancing the AC line. Low pass filters at the input reduce incoming RF signals, harmonics, and "HF hash" on the AC line. A technique of winding a copper band between the primary and secondary of the transformer further reduces the likelihood of passing HF content from one winding to the other. The product may also contain an additional filter to reduce "clock" pulses from digital processors from backing into the unit and being distributed to other components connected to the power conditioner. The power duplex outlets on the back have isolated ground connections.

Almost all the line conditions contain transient surge suppression circuits to handle overvoltage transients that may be present on the power line. Cheaper products use MOV (metal oxide varistors) that are effective when they are new. The more "hits" taken by the MOV, the less effective it becomes until there is no protection at all. Unfortunately, there is no warning that the device is no longer protecting your components. These type suppressors are commonly found in power strips available at computer stores to "protect" your computer. The professional products use industrial surge suppressor systems that have a long life. One such device is are heavy duty "avalanche" diodes that takes a spike directly to ground to protect the equipment.

Professional grade products are manufactured by SMART, Equi=Tech, Alpha Core, Furman, and several others. SMART prefers to describe their product as a Line Purifier. The analogy is a filter you connect to your water faucet to produce pure drinking water. In this case the product removes contaminates and produces pure AC power. Models can vary in size, capacity, and price. Some can handle several kilowatts of load, while others are for protecting only sensitive equipment like digital processors, DSP audio components, video projectors, and servers. None of the line balancing systems will correct for low voltage or "brown-outs".

You will find a great deal of information on power quality on the Internet from manufacturers of line conditioners, professional electrical societies, and consulting groups. It is a topic that was long overlooked as a source for problems associated with equipment failures and poor performance of sensitive electronic equipment.

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