elenoiseappnotes
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Electrical Noise Attenuation

General

Critical medical imaging and treatment equipment requires clean, noise-free power to perform optimally. Unfortunately, electrical noise or "surge voltages" are a daily reality and must be addressed. Surge voltages originate from two major sources, defined as lightning effects (direct or indirect) on the power system and switching transients. While both may originate outside of the medical facility, switching transients most often originate within the facility itself. These surge voltages may be produced by variable speed drives, elevators, contactors, chillers and even other medical equipment on the same power source. For AC (alternating current) systems, electrical noise is a distortion of the normal sine wave. The effect that noise has on medical imaging systems may include artifacts in the digital image, random error codes, system lock-ups and over time, component failure. Electrical noise attenuation devices such as TVSS (Transient Voltage Surge Suppression) or an SPD (Surge Protection Device), noise filters, and shielded isolation transformers reduce electrical noise to safe levels. Although it is impossible to totally eliminate electrical noise, it is possible to drastically reduce it to tolerable levels. Noise attenuation is expressed as a ratio of the input transient voltage (Vti) to the output transient voltage (Vto), or by decibels (dB). Table 1 (below) shows the relationship of this ratio to decibels. Most electrical systems are provided with 40 to 60 dB attenuation, which is barely adequate, whereas attenuation of 120 dB or greater is required for sensitive systems. There are two main types of noise, common mode and normal mode (also known as transverse mode).

V_{ti}	V_{to}	Ratio	Decibel (dB)
100	1	100:1	40
1000	1	1000:1	60
1,000,000	1	1,000,000:1	120
10,000,000	1	10,000,000:1	140

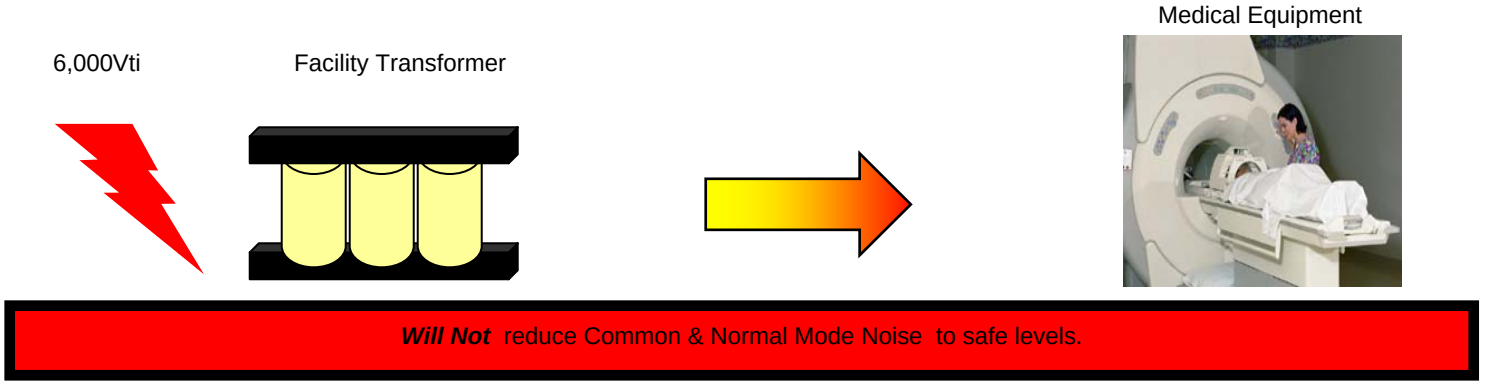
Table 1

Common Mode Noise

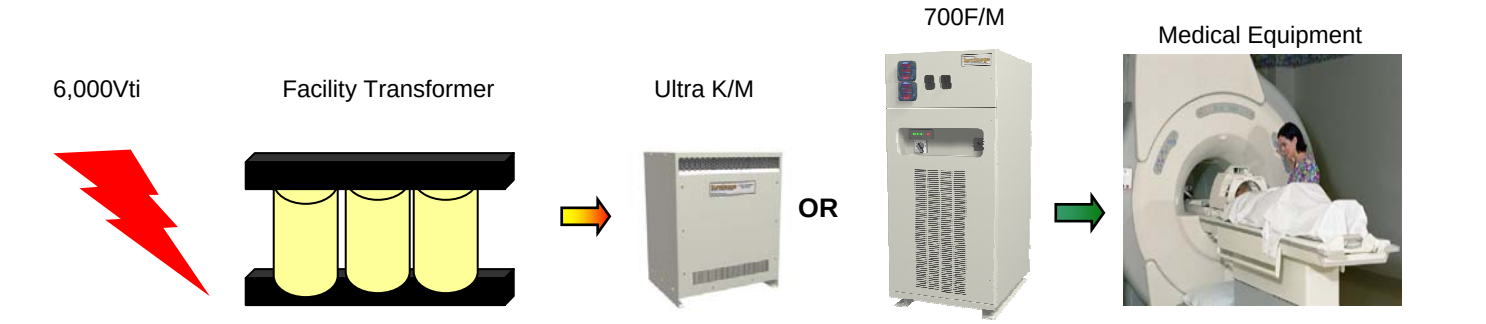
For AC power systems, the term "common mode" refers to electrical noise or surge voltage disturbances that occur between the line and ground conductors, or the neutral and the ground conductors. Ideally, common mode noise should not exist between the neutral and ground conductors since they are connected. However, common mode noise is often injected into the neutral or ground conductors, resulting from overloaded power circuits, wiring faults, and other equipment sharing the same electrical power source. Common mode noise can bypass medical equipment power supply filters and penetrate sensitive electronic grounding systems. This often directly affects digital signal levels critical to proper equipment operation. It is important to note that medical equipment can be exposed to impulses on ground in excess of 6000 Vti. High magnitude impulses of this nature will destroy or render any electronic circuit useless.

Normal Mode Noise (Transverse Mode Noise)

The term “normal mode” refers to electrical noise or surge voltage disturbances that occur between the hot and neutral conductors, or between the line conductors. Most normal mode disturbances result from load switching within the facility (motor type loads being a major contributor). On occasion, surge voltages that come from outside of the building (i.e. lightning effects) enter on the hot conductor and are primarily considered “normal mode” since the neutral conductor is at ground voltage. Surge suppressors only limit surges and may limit normal mode noise to a certain extent, but offer minimal protection “downstream”. By attenuating normal mode noise, electrical circuits will not feel the direct surge from the power line. This attenuation assures proper operation and no stress to the electrical components. This translates to more operational uptime, as well as less maintenance and repairs.



Will Not reduce Common & Normal Mode Noise to safe levels.



Will Easily reduce Common & Normal Mode Noise to safe levels.

The Controlled Power Company Solution

The Controlled Power Company *SureImage* Model Ultra-K/M Power Conditioning Transformer and Model 700F/M Voltage Regulator with Power Conditioning offer the perfect solution for common mode and transverse mode noise. Both models have an integral triple-shielded isolation transformer and output filtering designed to attenuate disruptive and damaging surge voltages, transients, and electrical noise at or near the load. The triple shielding technique delivers maximum common mode noise attenuation (146dB) by minimizing the coupling capacitance between the primary and secondary windings. In addition, the transformer’s leakage inductance and output high frequency noise filter work in concert to provide normal (transverse) mode noise attenuation of 3 dB at 1000 Hertz and 40 dB per decade thereafter. This “one-two punch” and the use of high energy MOVs provide the spike-free, noise-free power required by today’s sensitive medical electronic equipment. Medical imaging and treatment modalities in particular need to receive a clean, stable sine wave to deliver the highest level of image quality and diagnostic reliability.

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