Environmental Potentials

Power Quality For The Digital Age

21ST CENTURY PROTECTION

An Environmental Potentials White Paper

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Situation

The modern facility has undergone radical changes in the past 50 years, the biggest change is to equipment. Modern equipment is computerized, digital and electronic. This equipment is nonlinear in nature. Nonlinear loads are designed with fast acting switching devices such as diodes, IGBT's. Switching devices result in non-sinusoidal currents and frequency noise. This frequency noise is also called switching frequency noise (since it's the result of switching devices). Switching frequency noise is neither constant in magnitude nor constant in time intervals. This type of noise is indoor power pollution and constitutes 85% of the total power disturbances threatening a facility.

20th Century Solutions

For the past 50 years design engineers have been comfortable using legacy devices. The most common devices are known as SPD's (surge protective devices), TVSS (transient voltage surge suppressors), isolation transformers and harmonic filters. All of these technologies function similarly and none of these products solve the 21st century problem of indoor power pollution. SPD's and TVSS have limited, if any, filtering capability and merely provide high energy events with a path to ground. This is very harmful to computerized, electronic and digital equipment that reference ground for proper operation. This will result in ground currents circulating throughout the facility. Legacy filters like harmonic filters, use capacitors which create switching noise in the system. Isolation transformers used in the facility add ground loops to the system while amplifying the electrical noise on phases. This high frequency noise is detrimental the sinusoidal nature of the waveform.

The 21st Century Problem: Internal Power Pollution

While the biggest threats to the electrical system in the 20th century may have been extreme events such as lightning, the biggest threat to the electrical system in the 21st century is internal power pollution. Electrical noise and ground loops are examples of internal power pollution. Internal power pollution constitutes approximately 85% of the total power disturbances. Nonlinear loads generate non-sinusoidal current, full of harmonics and frequency noise. Ground loops are generated when there is mismatch in the electrical configurations of load and supply. While many facilities suffer from ground loops, all facilities have nonlinear loads.

Internal power pollution is responsible for equipment malfunction, electrical losses, decreased equipment life cycles, downtime and increased maintenance costs.

All of the available filters in the market today use ground as their termination point for electrical noise. Ground is connected to the other parts of the system such as system casings and motor chassis. Unwanted noise or transients diverted to ground will cause currents to circulate throughout the facility and this can cause equipment malfunctions and shortened equipment lifecycles. This means the filters which are supposed to be protecting facilities are actually responsible for creating ground loops. Environmental Potentials' patented waveform correction technology does not divert energy to the ground instead, EP's patented technology converts internal power pollution into heat within the unit.

Independent Testing

Electrical Systems Analysis (ESA), an independent testing agency, tested EP's waveform correction technology and compared it with two widely used products, Cutler Hammer and Psytronics, to discover which product if any had a solution for internal power pollution.

The results in figure 1 demonstrate that EP substantially lowers and expands peak voltage. This provides sufficient time to dissipate the noise within the unit. Other products in the market such as CH and PSY are not able to lower noise or expand the peak voltage to a permissible limit. The peak voltages are 648V for EP, 1000V for CH and 1350V for PSY respectively. This means CH and PSY offer no significant protection/ filtration for an A1 ring wave. The term "let through voltage" indicates the maximum voltage a device allows to reach your equipment after noise reduction. A low "let through voltage" number indicates a greater level of protection/filtration and vice versa. EP's "let through voltage" is 48V where as it is 388V for CH and 724V for PSY.

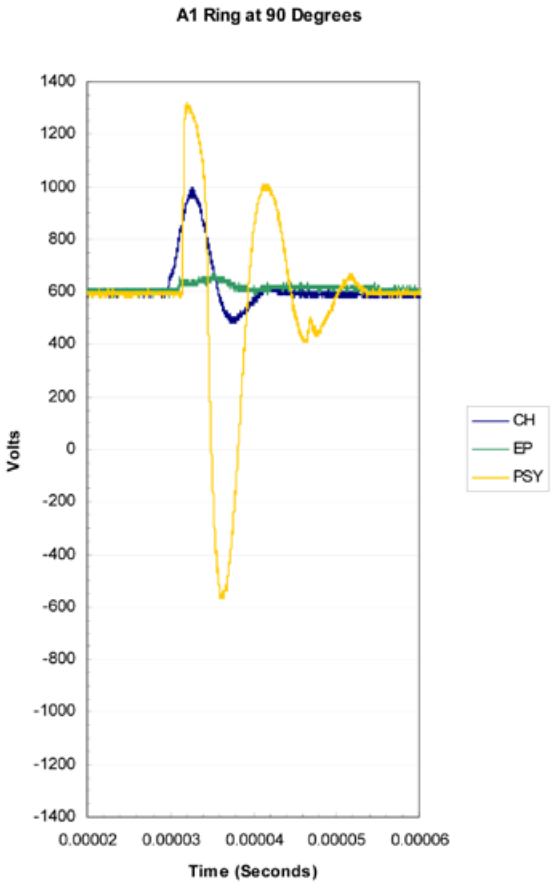

Figure 1: 5uS voltage rise time with 100 kHz ring, a 2kV peak voltage under open circuit, and supplying 70 A under short circuit conditions. This test represents a disturbance waveform that is representative of waveforms generated by non-linear loads and switching.

Compare the let through voltage numbers in figure 2. EP clearly outperforms the competition. CH's let through voltage is approximately 8 times that of EP, while PSY's let through voltage is more than 10 times that of EP.

	Cutler Hammer			EP2000			Psytronics		
Phase	**Baseline**	**Peak**	**Let Through**	**Baseline**	**Peak**	**Let Through**	**Baseline**	**Peak**	**Let Through**
90 degrees	590	996	406	604	668	64	580	1304	**724**
	576	996	420	592	668	76	580	1328	**748**
	580	984	404	580	632	52	568	1320	**752**
	588	980	392	604	656	52	576	1328	**752**
	580	984	404	604	668	64	576	1328	**752**
180 degrees	32	432	400	28	76	48	0	1272	**1272**
	44	444	400	4	64	60	-56	1272	**1328**
	-44	344	388	28	112	84	-48	1272	**1320**
	56	444	388	-56	4	60	16	1272	**1256**
	44	432	388	-4	76	80	-56	1272	**1328**
270 degrees	-632	-212	420	-628	-544	84	-648	1184	**1832**
	-620	-212	408	-628	-544	84	-648	1168	**1816**
	-596	-204	392	-628	-560	68	-632	1168	**1800**
	-620	-212	408	-628	-544	84	-632	1160	**1792**
	-620	-212	408	-620	-544	76	-632	1168	**1800**

Figure 2

Noise between 1-100kHz

EP focuses on removing electrical noise in the 1-100kHz range. This noise range is the most damaging to computer, digital and electronic loads. The noise generated in this region was used to represent noise reflected into the facility power distribution system by facility loads such as AC adjustable frequency drives, DC drives, rectifiers, electronic ballast, switching power supplies and arcing contactors. ESA tested the ability of all three products to remove this noise.

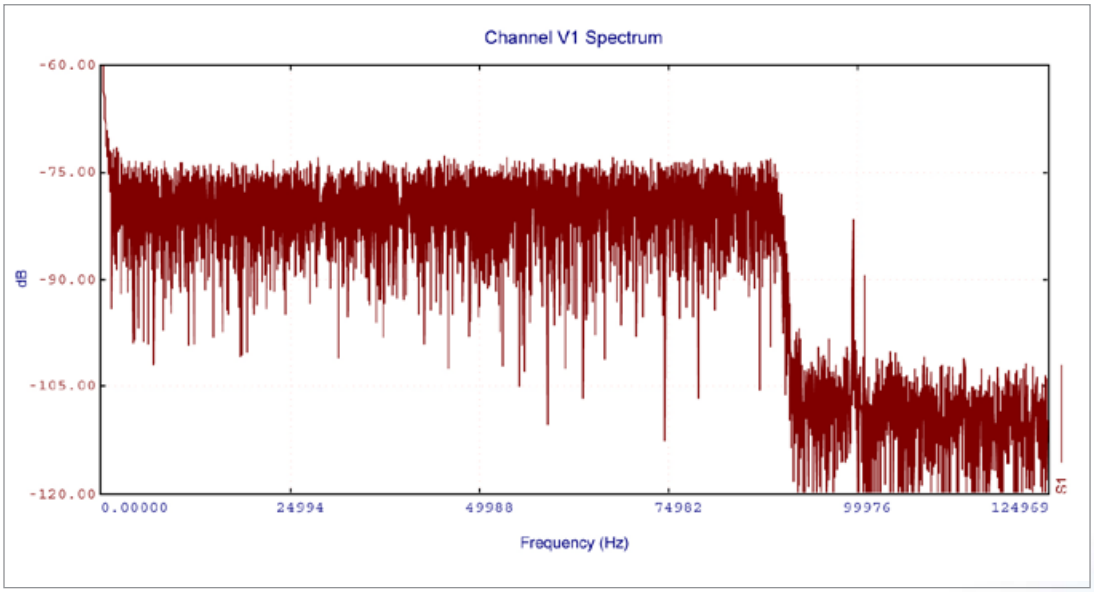

Figure 3: Uniform noise generated from 1kHz to 90 kHz

Figure 3 shows the 1 kHz to 90 kHz uniform random noise spectrum when no device is connected. This noise was superimposed on a 60 Hz fundamental waveform.

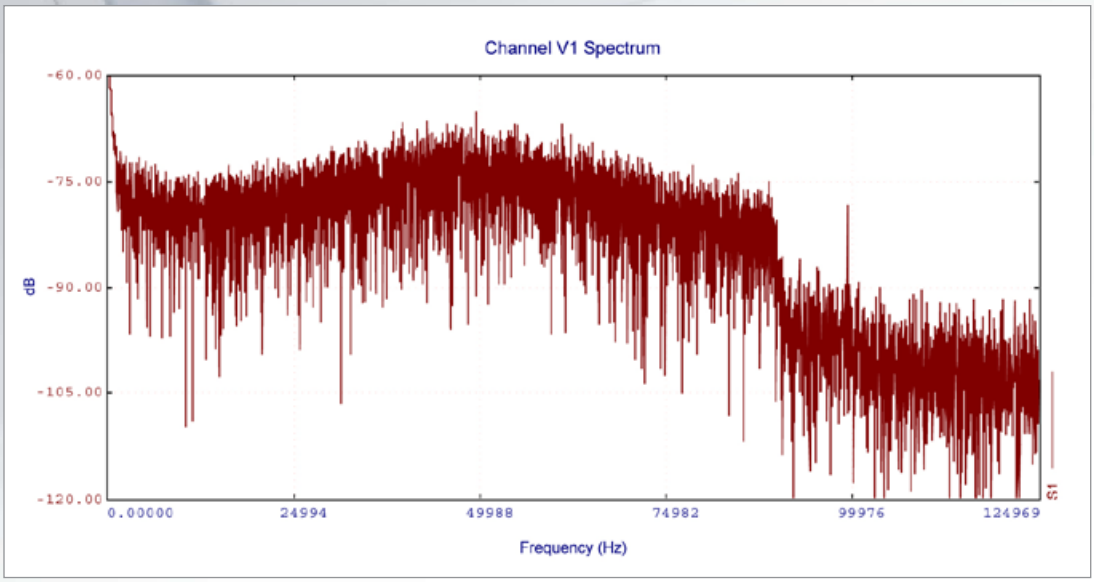

Figure 4: Response of CH for 1-90 kHz uniform noise on sinusoidal wave

Figure 4 shows the response of the CH device. It has a broad resonant peak centering around 48kHz. At its peak, it amplifies the signal about 2 times. The CH device is not performing any filtering action in this range of frequency (typical drive switching frequency and switching frequency harmonics), as there is no drop of the noise significantly below -75dB, or the level of the noise alone with no device connected.

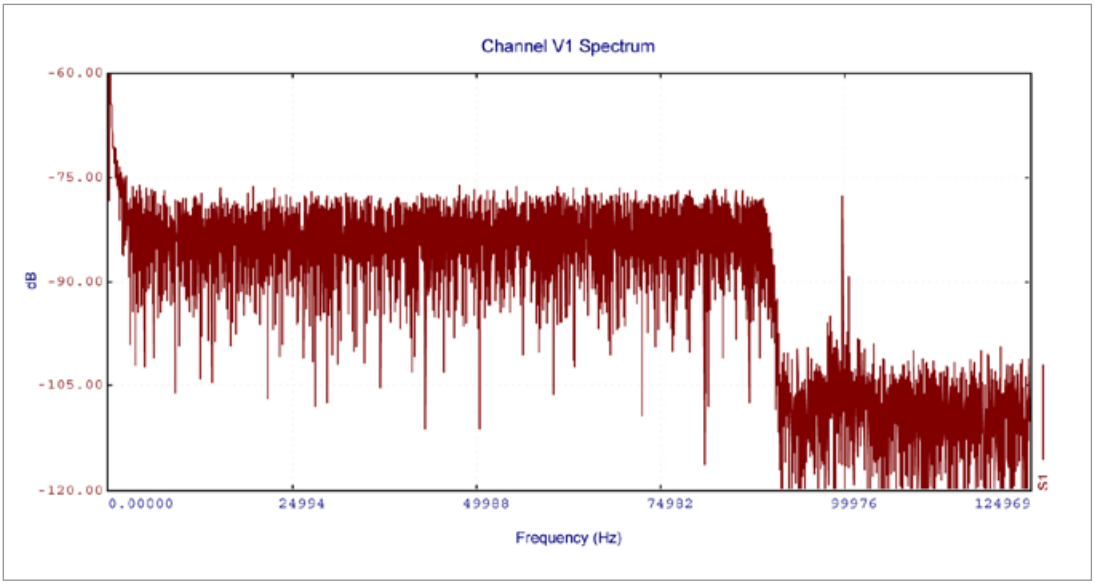

Figure 5: Response of PSY for 1-90 kHz uniform noise on sinusoidal wave

Figure 5 demonstrates that the Psytronics unit offers no filtering and appears as an open circuit in the 1 kHz to 90 kHz range.

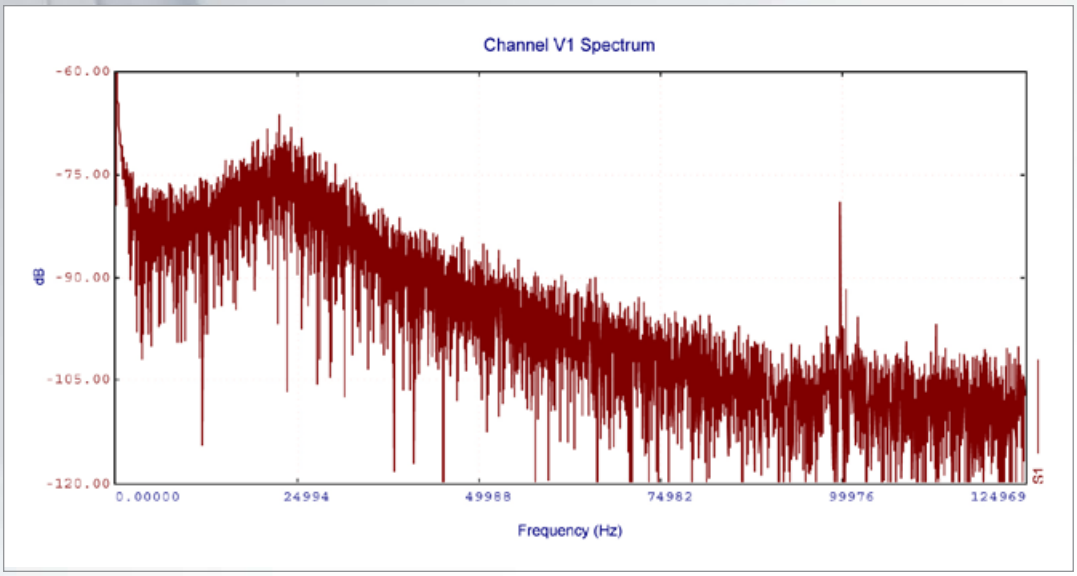

Figure 6: Response of EP for 1-90 kHz uniform noise on sinusoidal wave

EP clearly shows a frequency filtering response. It has a resonant peak centered at about 24kHz, which is much narrower and will cause less amplification of a broad range of frequencies. EP also shows significant filtering as the noise spectrum drops well below the -77 dB point. At 70 kHz EP is 19 dB lower than –77dB and this is nearly a 10 times reduction of noise.

The 21st Century Solution

EP's patented technology is a two part circuit, one being a high frequency low pass filter and the other being a powerful rugged protector in the event of catastrophic events. The protector offers complete protection from catastrophic events. The low pass filter operates 24 hours a day, seven days a week filtering internal power pollution. This is an understated, yet industry changing leap in technology.

EP's protection circuit is completely protected by the filtration circuit which makes the unit durable for all noisy environments. The EP system is the most robust, functional electrical distribution system overlay ever designed. Environmental Potentials bridges the gap between high voltage AC distribution and low voltage DC loads. It is the answer for the damaging, residual "footprint" that each switching cycle leaves behind.

Environmental Potentials' patented waveform correction technology is the only solution for internal power pollution.

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