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Using CleanSweep® AC EMI Filters in Hi-Fi and Pro Audio

Patented CleanSweep® filters provide high-level of EMI attenuation in all modes—common, differential, and, uniquely, in ground. CleanSweep filters are designed to reduce industrial-level EMI down to negligible levels—in residential or studio environment they simply render remaining EMI unmeasurable.

Filters or Power Conditioners?

Debates about the need and the benefits of "power conditioners" in audio applications are very much alive. On the subjective side, their benefits are "in the ear of a beholder." Here we address just the engineering side—something we can measure.

First, the term "power conditioner" is so wide that even a lowly surge protector may claim it. On the opposite end, a complete power conditioner would use incoming AC power to generate its own sinewave, ostensibly with constant voltage and frequency, with absence of any surges or transients, plus with added battery-backed operation in case of power sags or blackouts — a vey expensive and bulky approach suited for life- or mission- critical applications. Plus, such power conditioners employ at least two switched mode power supplies (SMPS) inside—one to convert AC voltage to DC, and another—DC voltage back to AC. These are sources of EMI themselves. In many cases in the audiophile lingo "power conditioner" simply means EMI filter, perhaps with added helping of a transient surge protector.

CleanSweep® AC EMI filters satisfy these requirements. They provide exceptional attenuation of EMI from AC power line and ground in all modes. For the technically-minded please see our web page on how CleanSweep technology offers unique advantages over conventional filters: https://www.onfilter.com/real-life-filtering

Besides EMI suppression, CleanSweep® filters also provide highly effective power line transient surge protection. Conventional MOV-based surge protectors are amplitude-based, allowing spikes up to 440V (in 120VAC regions) and up to 900V (in 240VAC regions) to pass through to your equipment. If you are curious, look at the specification of any professional-grade surge protectors. CleanSweep® EMI filters instead treat such power line transient surges as EMI regardless of amplitude, and effectively suppress them down to significantly lower levels—typically below 10V. See details here: https://www.onfilter.com/protection-from-transients It is still a good idea to use a professional-grade surge protector **before** the filter to mitigate long-term surges, however rare they may be.

What Makes CleanSweep® Filters Well-Suited for Audio?

Which specific parameters may be important for audio?

- Significant EMI suppression in all modes—the "prime directive"
- No injection of its self-generated noise
- No degradation of the sound—no one wants a cure that is worse than the problem itself.

Let's examine these criteria on the next pages.

EMI Suppression

This is the reason you would need an EMI filter to begin with. EMI is unwanted high-frequency signals on power lines and ground. There are plenty of various EMI filters on the market—just about every electrical equipment has at least one inside. Why then there is still EMI present? The problem is that all these filters are designed only to meet government regulations on EMI in very specific test setups which have nothing to do with the reality. Patented CleanSweep® filters, on the other hand, are designed to provide maximum EMI suppression in real-life applications, such as yours.

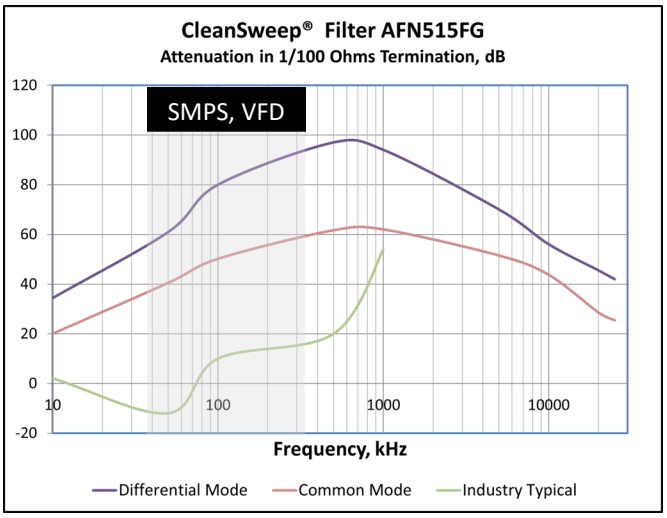

Figure 1. EMI Attenuation of CleanSweep® EMI filters vs. typical EMI filters on the market

What are the typical EMI signals in most environments? The biggest noise pollutants are omnipresent switched-mode power supplies (SMPS) in phone chargers, LED lighting, solar panel inverters, and in every other piece of electronics in your home or office; pulse-driven motors—VFD— present in many appliances—refrigerators, HVAC pumps, washers, dryers, and alike. The spectrum of pulses in SMPS typically lies anywhere between 40kHz and 150kHz; in VFD—from a few kHz to tens of kHz. Figure 1 shows attenuation of CleanSweep filters in real-life environment vs. quality regular filters. The shaded area indicates the critical area of EMI sources.

CleanSweep filters are used in the most critical environments where it is most important to establish "no EMI" environment rather than just to be able to apply FCC and CE labels for electromagnetic compliance. NASA, quantum computers, research institutions, virtually all major U.S. universities, factories and utilities like our CleanSweep filters.

No Degradation of Sound

Why would an AC power line filter affect sound quality? Normally, it shouldn't at all. There are a couple of reasons, though, why some filters/conditioners might. First, as we mentioned on the first page, regenerative power conditioners and UPS have at least two SMPS inside, raising the possibility of EMI at the output.

Another reason is increased output impedance of such power conditioner/filter. How would output impedance of AC power line be of importance? In simple terms, reduction of dynamic range and distortion.

Harmonic distortion (i.e. multiples of the signal frequencies) can be caused by signal clipping, which by itself is often caused by high impedance of the power supply. During sound peaks, especially at lower frequencies, the amplifier draws the most current from its power supply, and, correspondingly, from the AC mains. What happens if the output impedance of your entire AC power chain is too high? The higher the supply current, the bigger the voltage drop on that power chain, and the lower the AC voltage supplied to your amplifier. These current consumption variations occur at sound frequencies— higher than that of the AC mains. Voltage regulators in the amplifier's power supplies or in regenerative mower conditioner cannot respond fast enough at this rate. The result is "starving" of the amplifier at loud signals, resulting clipping and harmonic distortion of the signal (Fig. 2). In case of high output impedance of your AC supply the waveform of that bass sound would be distorted, creating a lot of harmonics.

What else would be distorted? All other sounds during such overload—consider **intermodulation distortion.** During the overload the amplifier circuit becomes non-linear, meaning that the output signal level is not exactly proportional to the input. In such non-linear situation two signals at different frequencies produce new signals—the sum and the

difference between these frequencies, and, of course, their harmonics. This phenomenon is used in AM and FM radios (remember the word "superheterodyne"?). In audio this is very much unwanted. Figure 3 provides the illustration.

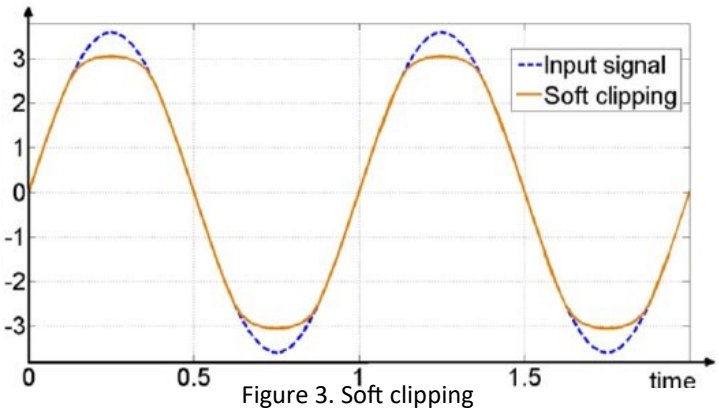

Figure 3. Soft clipping
Source: Journal of Low Power Electronics

Why would your incoming AC power have high output impedance? The usual suspect is too thin wires in the wall from the distribution box to your outlet, and don't forget the resistance of all the twist-cap connections in the electric boxes on the way—every connection eventually oxidizes and adds resistance.

If you add a filter or a transformer, depending on their construction this may add significant impedance. Many filters use less-costly underrated inductors which present higher-than-necessary impedance. Transformers inherently have high impedance as a result of magnetic coupling, unless they use substantial core and large-gauge wire which makes them quite large and very expensive. Both of the above may introduce core saturation at current peaks since their design is often defined by cost constraints.

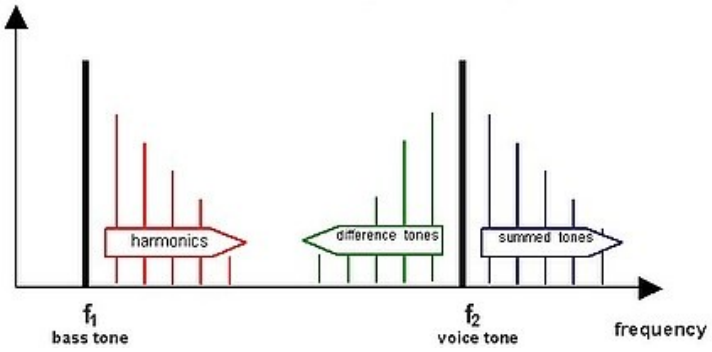

Figure 3. Intermodulation Distortion
Source: Klippel

CleanSweep® filters, on the contrary, are not transformer-based. The cores of Its inductors are large enough not to saturate, and the thick gage employed in the filter's construction offers very low resistance. Patented and proprietary architecture and know-how provide buffering for current peaks—all resulting in low impedance.

CleanSweep filters are completely passive—they are incapable of generating any signal on their own. This also improves their reliability—active components present in regenerative power conditioners are inherently less reliable than purely passive parts.

A note on the power connections: for the audio application in U.S. configuration we use hospital-grade or industrial-grade outlets and power cables. An opinion among audiophiles is that one must have an "audiophile-grade" outlets that rarely offer any specification. We would challenge anyone to prove that such "audiophile" interconnects can meet tough requirements for hospital-grade or industrial-grade parts. If this is good enough for intensive-care unit at a hospital, it is certainly good enough for any sound system.

Ground Noise

Ground connects all equipment in the building, propagating EMI leaked by noisy equipment throughout the entire premises. Patented CleanSweep® AC EMI filters and PDUs uniquely include highly-effective ground filtering blocking EMI on the overall ground circuit from reaching your setup.

This has certain importance in connecting CleanSweep filter to your setup: in order to take full advantage of ground filtering all your components must be connected AFTER the filter, otherwise just one stray component bypassing the filter may bring EMI pollution on ground to the filtered ground of your setup. AC power filtering won't be affected.

Connecting the Filter

EMI filter for audio is supposed to protect the entire setup from noise on power line and ground. It is a given that none of your components are noise generators by themselves—there is no need to protect, say, a CD player from EMI coming from a turntable. CleanSweep® filters have just one heavy-rated filter for your entire setup. Dual outlet in case of U.S. NEMA type is just a matter of convenience—it does not indicate that there are two filters inside. Both outlets are connected.

Figure 4. Connecting CleanSweep® Filter

Figures 4 shows Connection of AF series CleanSweep® filter in a typical audio setup containing an amplifier, and a number of components. Our recommendation is to plug your power amplifier in one of the outlets, and a quality power strip in another outlet. Make sure that that power strip does not have any filtering as it may interfere with CleanSweep® performance. Connect all your components into that power strip.

Figure 5 shows connection of AR series filtered PDU in the same setup. It has enough outlets to power your components. AR series PDU has removable mounting ears for a 19” rack and is supplied with the rubber feet in case of table-top installation.

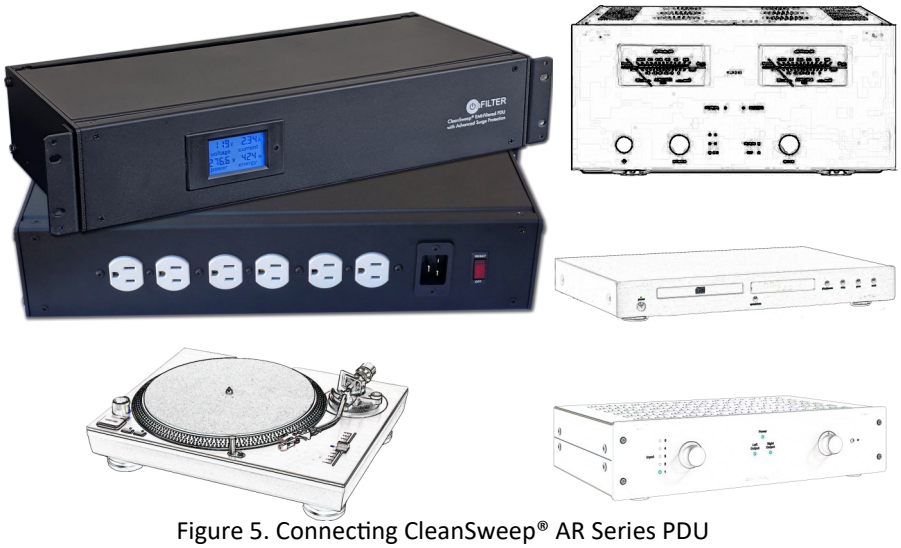

Figure 5. Connecting CleanSweep® AR Series PDU

"I tried a number of power conditioners, filters and EMI/RFI reducing products marketed to audiophiles. None of them had much effect reducing EMI/RFI. The only devices that performed as promised and significantly reduced EMI were CleanSweep filters made by OnFilter." https://www.whatsbestforum.com

About OnFILTER

OnFILTER, a California-based company, was started in 2010 with the goal of addressing a growing issue of electromagnetic interference in industrial, scientific, and medical environments. Increased level of automation brings in more sources of EMI into environment, while similarly growing use of sensitive electronics is accompanied by its malfunction due to EMI. OnFILTER manufactures a broad line of EMI control products: AC EMI filters, DC EMI filters, ground EMI filters, servo motor and variable frequency drive (VFD) filters, data filters and others. Company provides filters to large and small companies, government entities, and, as it happens, Hi-Fi enthusiasts. OnFILTER designs and manufacturers all of its products in USA and ships them around the world where we have international distributors to support our products locally. You can reach us at info@onfilter.com

All OnFILTER products are made in the U.S.

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