MIT Filterpole™ Technology Explained

Q: What are MIT Filterpoles™?

A: Poles of Attenuation

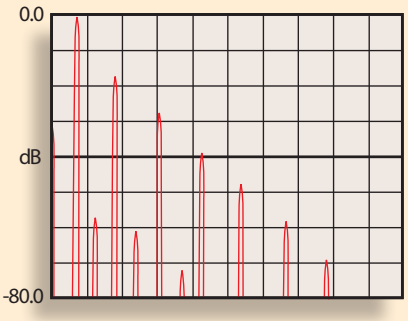
*(as referenced in The Impedance Domain)**

A properly built AC filter will not only attenuate unwanted noise on the AC power line, but it will also optimize the power factor.

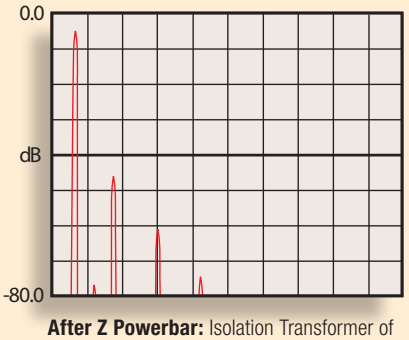
The best way to attenuate unwanted noise is to create a very low impedance (a zero of impedance across the load which acts as an attenuation pole to the noise) surrounding the frequency (or frequencies) of the undesirable noise. In the case of audio, that would be at any frequency other than the power line frequency. **This is best accomplished by placing a tuned circuit in parallel, around the load. MIT was awarded this patent in November 9, 1993: number 5,260,862.**

Also important is the **Power Factor** which is a (dimensionless) number between 0 and 1. When power factor is equal to 0, the energy flow is entirely reactive, and stored energy in the load returns to the source on each cycle. When the power factor is 1, all the energy supplied by the source is consumed by the load and nothing is reflected back to the source. **MIT was awarded a patent on this technology regarding audio in July 13, 1993: number 5,227,962.**

Harmonics Reduction of the Z Powerbar



Before Z Powerbar: Power spectral density of the harmonics produced by a well known isolation transformer.



After Z Powerbar: Isolation Transformer of Figure above with Z Powerbar, which provides greatly lowered harmonic levels.

Q: What problems are associated with typical series filters?

A: Unlike MIT parallel filters, series filters:

- are ineffective at removing noise
- have inductors that create distortion "products" at audible frequencies
- reflect noise back into the circuit rather than directing it to "ground" for removal
- cause resonances that actually create noise at audible frequencies

A series filter operates by blocking, or rejecting certain types of noise. Imagine a series filter working by 'shutting a door' in the face of noisy pollutants. What happens to the noise after the door is closed? Since noise is energy, it cannot be destroyed; it must be consumed to be removed. So, when a series filter blocks or rejects unwanted noise, it simply reflects the noise right back to the source. The noise has not been removed, only reflected. This type of filter cannot rid itself of noise, as the noise is continually reflected between the series filter and the source, again and again. This is yet another source of audible noise, inserted by the very device called upon to eliminate it!

The Solution: Parallel AC filtering.

The Z Series of power products from MIT uses patented parallel "AC Filterpoles"™; a tuned LCR technology. MIT Filterpole technology eliminates reflections by efficiently absorbing all forms of AC noise from the mains, and then converting it into harmless thermal heat.

The result? Once the Z circuitry is working to clean, condition and protect your AV system, you will instantly enjoy "blacker" blacks, better color saturation, and increased shadow detail; movie sound tracks will deliver dialog, Foley sounds and background music with theater-like quality. Because your audio system now has a lowered noise floor, you will have pinpoint audio image placement within a lifelike soundstage, all with clear and authoritative bass.

...continued next page

**for additional in-depth information, please refer to MIT Technical Note 101: "Transportable Power in Audio Cables: Energy Storage Elements and the Power Factor", available in PDF format on the MIT website reference library at www.mitcables.com.*

MIT Filterpole™ Technology Explained *continued*

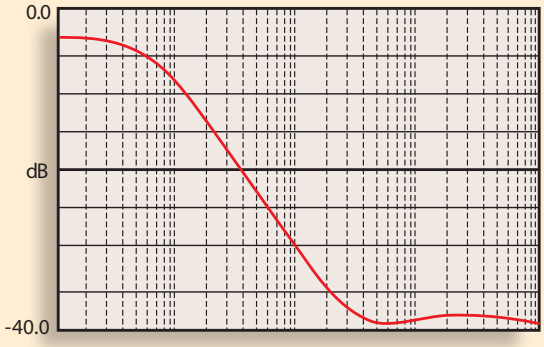
Power Factor Correction: Stops Energy Waste

MIT's Z Stabilizer circuitry also provides "**PFC**" (Power Factor Correction), by controlling the phase angle of the inbound AC sine wave for maximum efficiency.

With PFC you will:

- use less energy for the same work
- prolong the life span of most electronic components
- never limit your current flow

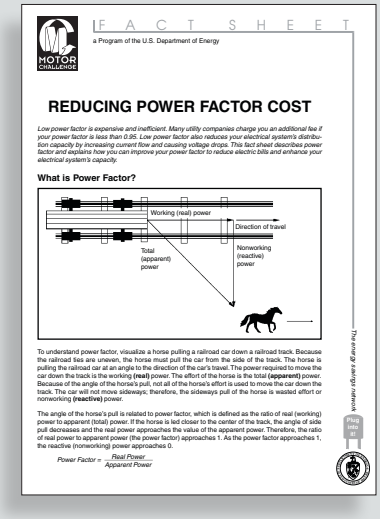
Distortion Reduction Curve



Z Series distortion reduction.

Related Reading

Reducing Power Factor Cost



FACTSHEET

a Program of the U.S. Department of Energy

REDUCING POWER FACTOR COST

Low power factor is expensive and inefficient. Many utility companies charge you an additional fee if your power factor is less than 0.95. Low power factor also reduces your electrical system's distribution capacity by increasing current flow and causing voltage drops. This fact sheet describes power factor and explains how you can improve your power factor to reduce electric bills and enhance your electrical system's capacity.

What is Power Factor?

Working (real) power
Direction of travel
Total (apparent) power
Nonworking (reactive) power

To understand power factor, visualize a horse pulling a railroad car down a railroad track. Because the railroad ties are uneven, the horse must pull the car from the side of the track. The horse is pulling the railroad car at an angle to the direction of the car's travel. The power required to move the car down the track is the working **(real)** power. The effort of the horse is the total **(apparent)** power. Because of the angle of the horse's pull, not all of the horse's effort is used to move the car down the track. This car will not move sideways; therefore, the sideways pull of the horse is wasted effort or nonworking **(reactive)** power.

The angle of the horse's pull is related to power factor, which is defined as the ratio of real (working) power to apparent (total) power. If the horse is led closer to the center of the track, the angle of side pull decreases and the real power approaches the value of the apparent power. Therefore, the ratio of real power to apparent power (the power factor) approaches 1. As the power factor approaches 1, the reactive (nonworking) power approaches 0.

$$\text{Power Factor} = \frac{\text{Real Power}}{\text{Apparent Power}}$$

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Power-line Noise: How Series Filters Work—

Power-line Noise: How Series Filters Work—

(AND WHY THEY DON'T ALWAYS)

Most power-line treatment products depend upon series filters to correct AC line noise problems in the audio/video system. However, these series filters, unlike MIT's parallel filter system, have inherent flaws that make them ineffective at many vital frequencies in A/V use, and cause them to add more noise and distortions than they remove. In this paper, we will explain how:

- series-filter noise rejection is ineffective in real-world systems
- series inductors create distortion products at audible frequencies
- noise that is supposed to go to "ground" is fed back into the circuit
- safety issues require the use of inadequate capacitance to reduce noise
- series-filter resonances actually create noise at audible frequencies

Utility power-line related noise, as most of us know, affects the audible performance of our audio & video systems. The primary means of reducing noise in the audio equipment's circuits is passive AC line filtering placed in series with the AC utility line. Over the years, increased use of electronic filtering and regulation of DC power supplies have also helped isolate the power-line noise from amplifying circuits. Improved grounding techniques within the chassis (e.g., "star grounding" - please see Glossary, page 6) and from chassis to chassis have improved audio system noise performance.

These "line" filters are composed of inductor (L) and capacitor (C) networks placed in series between the AC line and the audio equipment. However, depending on how the noise is coupled to the power line, a great deal remains to be done to remove its effects from our systems.

Hey! Where Does This Utility Line Noise Come From, Anyway?

Power-line noise can come from a number of sources. These sources determine the type of noise and ultimately how it is removed. Noise that is coupled directly through the power-line conductors or wires by other equipment on the line is known as conduction-mode noise coupling. This mode is caused by equipment such as electric motors, arc welders, power supply switching circuits (found in computers,

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All products using Z circuitry are protected by US Patents: 5, 227,962, 5,260,862 and 5,920,468. Other patents pending.
MIT Z Series™ products are manufactured and sold by CVTL, Inc.

MIT® Music Interface Technologies™

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