

## Recommended Audio System "Tweaks"

We have found the following list of "tweaks" or adjustment/ correction techniques to be essential for great sound. Individually and collectively these modifications have improved the sound of our system more than any component upgrades such as new amplifiers, preamps, etc. We believe our findings are applicable and useful to audiophiles in general, but of course we cannot guarantee the same results given the great variation in personal taste and component design.

A prerequisite is that your system already has to be good enough in terms of resolution, imaging, etc. for these techniques to be of benefit. Of course, closed-minded strictly by-the-book meter-reader engineer types who believe that the differences obvious to audiophiles between cables, amplifiers, use of "tweak" accessories, etc. are hype and illusion will not be interested and need read no further.

This is just a partial and evolving list and only touches on a vast subject. One of the fascinations of audio is the complexity of the basic problem - attempting to reproduce recordings as realistically as possible in a home environment. The elements of the problem include electronics, psychoacoustics, acoustical engineering, mechanical engineering, physics (electromagnetics) and many other disciplines.

We believe that theoretically these measures work primarily through two interrelated mechanisms: by increasing the "time coherence" of the system, and by lowering the noise floor. In this context, to "improve time coherence" means to reduce the delay and smearing of sonic energy of a musical event over some period of time following the event. This "time smearing" phenomenon is inherent in the mechanical and electrical systems used for sound reproduction, and the ear-brain system is very sensitive to it. Electrical examples are skin effect or frequency-dependent phase shifting of signal current propagated through the interior of a wire and dielectric absorption in capacitors and cables. Mechanical / electrical examples are the time delayed and resonant behavior of speaker drivers and enclosures, flutter (rapid speed variations) in turntables and CD transports, and time smear induced in the phono cartridge output due to stylus contact-generated energy returned to the stylus after first being propagated into the tonearm and record. Interestingly, timing jitter in the CD playback serial digital data is caused both electrically and mechanically by vibration, and rapid speed variations in the transport drive mechanism.

Another example of vibration feedback-induced time smearing is the vibration of wires in cables due to sound pressures from the speakers and to electromotive forces induced by adjacent current-carrying wires.

Another form of mechanical vibration-induced time smearing is the fore-and-aft vibration of a speaker enclosure in response to forces on the driver voice coil. This is simply due to Newton's law of action and reaction and occurs regardless of the rigidity and degree of damping of the enclosure. Simply placing a 15-20 pound lead weight on the top of the speaker improves clarity of sound considerably by reducing Doppler distortion due to the reactive fore-and-aft motion of the enclosure. Doppler distortion smears sonic energy over a range of frequencies (rather than time) and is inherent in all speaker designs. If a driver diaphragm is moving at both a low and a high frequency at the same time (say 50 and 5000 Hz), the higher frequency is modulated (distorted) by the lower frequency due to the Doppler effect. As the sound source approaches at some velocity its sound is shifted up in frequency proportionately to the speed of approach, and vice versa for the sound source moving away from the listener. This effect "frequency smears" the output of all speakers, with the effect worsening with decreasing efficiency, smaller radiating area and 2-way designs. Of course the weights also improve performance by increasing the damping of cabinet resonances.

The common effect of all these and many other time and frequency smearing mechanisms is a massive perceived blurring, smearing, flattening and veiling of the sonic "picture", along with various tonal imbalances such as overbrightness and bass boominess or looseness.

The items listed below are really more than tweaks - they partially correct fundamental problems such as time smear and RF induced noise that no new improved electronics or speakers can address. As a general observation, each of these techniques achieve unique improvements which cannot be produced by other tweaks.

The following observations are very important and should be kept in mind when considering "tweaks". The less revealing or resolved the system already is, the less impact the addition of a single modification or tweak will make. Of course, "revealing" doesn't mean expensive - the transparency, resolution and musical naturalness of a system are more dependent on the quality of setup and tweaking than expense of components. This means that the first few modifications may only slightly improve the sound, but as the system's resolution gets better and better, subsequent "tweaks" become more and more dramatic in their effect. Basically, the ear/brain system can perceive very small amounts of time smear or incoherence. If a given system mod or "tweak"

reduces time smear by x amount and the system initially has 10x time distortions, there is little improvement. If the system is better, with only 2x distortion, the same tweak transforms the sound because it doubles the resolution by halving the time distortion.

We have found a quick and easy method to instantly tell if your system is fairly time coherent and resolved. While playing a CD quickly select Pause, then Play. This resets the transport mechanism serial digital output circuits and on a good system an instant improvement in smoothness, lack of edge and resolution results. Unfortunately, over a period of 5-10 minutes the serial digital timing drifts off, and the sound slowly reacquires the original slight edginess, hardness and muddiness. As your system improves, the sonic changes in this test become more and more pronounced. This technique is not listed in the tweak list because it has to be periodically repeated, doing insult to the musical continuity each time.

The overall tweak technique list keeps expanding, but this is it for now. It is hard to give a relative ranking of all those items, but we have found that as a group the AC power purification techniques make the greatest improvement. Your comments and questions are welcome!

- 1. Tweaks for the NuForce amplifiers**
- 2. Power line shunt or parallel filters**
- 3. Do-it yourself AC filtering**
- 4. Power conditioners**
- 5. Turn off and unplug**
- 6. EMI filtering for noise-generating appliances**
- 7. Ferrite RFI blockers**
- 8. Dedicated (Supplementary) Earth Ground**
- 9. Other noise and hum reduction techniques**
- 10. Power cables, interconnects and speaker cables**
- 11.Devices designed to correct CD digital errors**
- 12.Devices designed to compensate for inherent acoustical record/playback errors**
- 13.Component support and damping**
- 14.Special component feet**
- 15.Tube dampers**
- 16.Improved passive parts**
- 17.Parallel RFI filtering at speaker input**
- 18.Antistatic sprays**
- 19.CD Treatment products**

## **1. Tweaks for the NuForce amplifiers**

This amplifier was found to be so extraordinarily sensitive to the various kinds of external electrical noise and micro vibration reducing tweak modifications we have already explored in this column, that the mods developed for the interfacing and support of it merited a separate category in the System Tweak pages. This sensitivity and improvability appears to be mainly because this design is unusually good in the time domain (that is, time coherent) in addition to having a flat relative phase characteristic over the audio band, plus the other qualities identified in the various reviews.

Prior to adding the various external tweak modifications detailed here performance with the NuForce Ref. 8.02 amps (with all updates up to the present) was excellent in various areas of performance but still not completely satisfying – especially due to a little electronic hashiness and edginess in the high frequencies. After all of the external tweaks described here were implemented with NuForces, every aspect of the system's sound was unbelievably improved, to a sort of "supernatural naturalism" (someone else coined this phrase). The system now has previously inexperienced (and unimagined) levels of see-through clarity, resolution, dynamics, musicality and holographic imaging. The previous favorite amps, a pair of superb 30w push-pull 2A3 tube monoblocks, have been relegated for use only for occasional experiments. The speakers are 96db sensitive hybrid ribbon designs – the Ambience Reference 1600s (380 Hz crossover), and TBI VIP subwoofers.

It should be pointed out that most of these techniques were also tried out on the tube amps with great results, but coming nowhere near the performance of the NuForces with the same tweaks.

Of course, we have not tried all available kinds of conditioners, filters, equipment supports, vibrational damping, etc., but this particular combination of external mods with the NuForce Ref. 8s has produced dramatic sonic improvements that should be to some extent translatable to other systems.

### Power conditioning :

Dedicated AC conditioning/EMI filtering seems to be essential for the NuForce amps, presumably due to the EMI generated by the 500KHZ switching power supply. Another separate power conditioner also needs to be used for the front end components, to further isolate and reduce interference from the NuForce switching supply EMI. We found the combination of two AC power conditioners in series to be an optimal arrangement for the NuForces. The PS Audio UPC 200 balun-type conditioner works very well – an immediate increase in clarity, lucidity and reduction of a slight “edginess”. An even greater improvement resulted from adding a separate Foundation Research LC-2 power conditioner/power cable for each NuForce monoblock. Since the LC-2 is by design floating (no earth ground connection), an earth ground connection for each amp had to be improvised. Although a supplementary earth ground connection needs to be provided, the Foundation Research LC-2 is the best single power conditioner found yet for use with the NuForces (two required, one for each monoblock). The Brick Wall also works well with the NuForces, but is not as refined, smooth and resolving, and also is incompatible with the Foundation Research units.

### EMI filter at amplifier speaker outputs:

Considerable improvement was obtained from use of Empirical Audio’s ferrite-bead Image Clarifiers, one for the + output and one for the – output. These units have a spade at one end and a banana receptacle at the other.

### EMI absorbing shielding material:

EMI is apparently radiated especially through the ventilation openings in the chassis. A significant improvement is made by taping a couple of two-layer patches of the ERS EMI shielding cloth just over these vents. The amplifier runs so cool there was no concern about sealing these vents off.

### Special Supporting Feet:

With these amplifiers the differences between rigid cone type supports and flexible or spring-like devices were much greater than usual. We found that rigid support feet of all kinds resulted in various degrees of hard, edgy coloration. The best results were with the use of three Hyperion Magnetic Floaters - superb clarity, transparency and smoothness. These devices also had the advantage of relatively low cost, \$90.00 for a set of four. They are made by the manufacturer of the highly regarded Hyperion HPS938 speaker. The Tightrope devices were also excellent with these amplifiers, but they were somewhat too large for the small chassis. The small physical size and weight of these amplifiers evidently makes the transmission of vibrational energy from the supporting rack the dominant mechanism, not direct acoustic pickup. Therefore a premium is put upon using feet that absorb as much of that energy as possible. The feet should be pointing up.

### Damping:

The largest single improvement of all of these tweaks resulted from greatly reducing micro vibration through mechanical damping using special elastomeric materials (along with the special supporting feet). Be warned that damping accomplished this way has a poor WAF rating because it must be done by placing ugly rectangular pieces of damping material all over the amplifier chassis.

This amplifier is so sensitive to vibration that we found that a more sophisticated approach was need for damping. This requires two layers of different materials, where the underlayer is stiffer with a high mechanical impedance to absorb vibrational energy from the chassis surface without reflecting much back into the chassis, and the upper layer is softer but still dense and reduces reflection of vibrational energy from the top surface back through the material to the chassis.

The damping material placed on the chassis should be rectangular patches consisting of 4 layers of EAR Isodamp SD40 placed on the metal surface, followed by 3 layers of Parts Express automotive sound deadening sheet, part no. 268-020. These materials are adhesive backed. There may be better materials for this purpose out there, but for now they are the best I have found. The damping patches I have used in my experimentation have been about 1” x 2”, but presumably larger pieces would be even more effective. The damping material should cover most of the surface area of the top, bottom, sides and front except the ventilation holes and the places where the chassis rests on the 3 upward pointing magnetic feet. The EAR materials are available from Michael Percy Audio, [www.percyaudio.com](http://www.percyaudio.com).

### Weights:

The optimal weight to place on each NuForce amp seems to about 5 pounds. I used a bar of lead babbitt (McMaster-Carr part no. 8899K11), which has a slightly better sound than regular lead, and is easily available in bars of the right weight and shape. Each bar needs to be damped with two layers of EAR SD125 on all four sides - this is necessary because even lead has a slight metallic ring. Addition of the lead weights drastically clarifies, deepens and widens the sonic image by further reducing micro vibration.

### Install Bybee quantum purifiers:

The Bybee filters produce wonderful improvements in see-through clarity, intertransient silence and musicality, with the effects especially pronounced if implemented after controlling microvibration. They should be installed at the interconnect inputs, speaker outputs, and most importantly at the IEC AC power input. The least expensive approach is to get the bare purifiers and solder them into adaptors. For the interconnect inputs and speaker outputs, there should be filter units on both + and -. The small

Purifiers are fine for these applications. For the AC input, the large Purifiers should be used, one on AC (line) and one on neutral. Surprisingly, the Purifiers' sound improves if they are each damped by a 3 or 4 layer piece of EAR SD40.

#### Improve quality of input load impedance:

This last touch is quite amazing in the degree of improvement obtained, after all the previous techniques. This only goes to show how really subtle and complex are the underlying phenomena of high end audio. The standard input impedance of the NuForce is 50,000 ohms (50K). This resistance is certainly of good quality, but improvement of it still makes a big difference. For several reasons this needs to be done externally with an adaptor with a very high quality resistor connected between signal and ground. The RCA to RCA or XLR to XLR adaptor is inserted at the interconnect input.

Certain very high quality resistors have such superbly low noise and high time coherence characteristics that there is an immediate, large sonic improvement of the same type as with the Bybee filters, though considerably less dramatic. The very high quality resistor constitutes a parallel path from input signal to ground, and the noise level and coherence of the signal input to the amplifier (at the junction point of the very high quality resistor and the amp's internal load resistor) is significantly improved. The ear-brain system immediately recognizes this, because of having the ability to detect and fixate upon small improvements in time coherence and noise level. Two ultra-quality resistor types have presently been identified for this purpose: Caddock TF-020 (metal-oxide film), and Mills 1w non-inductive wire wound. These are available from Michael Percy. A value of about 100K ohms has been found to work the best so far, with the best results a parallel combination of one 200K TF-020 and one 200K Mills. The net input impedance of the amplifier is changed a little (reduced from 50K to 33K ohms), but this is unimportant in most systems.

## **2. Power line shunt or parallel filters**

These devices incorporate capacitors connected in parallel across the power line, and reduce noise reaching the equipment without imposing any inductive, maximum-current choking coils or inductors in the line.

Correctly applied, this major system modification or adjustment (really more than a "tweak") dramatically improves digital and to a lesser extent analog playback quality. Digital processing, especially the serial digital, is extremely sensitive to power line noise, probably due to the effect of noise on digital timing jitter.

There are two alternate approaches for this technique: either use commercially available plug-in filters, or build superior-sounding units yourself.

Commercially available parallel-type plug-in AC filters:

Recommended: Audioprism Quiet Line plug-in filters (kit of 8). Audioprism, Inc. Tel. (425) 869-8482, Enacom plug-in power line filter, available from The Tweak Shop (707) 575-8626. The Quiet Line and Enacom filters plug into the A/C socket. The Quiet Line filters produce a large reduction in background noise level, edginess, harshness, etc. The Enacom filter is more expensive, but also improves clarity especially in the midrange, much more than the Quiet Line unit.

These filter types employ small value (0.1 microfarad) capacitors. The Quiet Line units also use resistors in an RC filter configuration with inexpensive, nonaudio-grade capacitors. Neither type filters noise from the neutral line.

Ideally, most of the Quiet Lines should be plugged only into other AC lines than the one used by the system, in the listening room and in other rooms in the house. The Enacom filters incorporate a much higher quality, better sounding capacitor and should be reserved for the outlet(s) powering the system. You need at least 2 to 3 Enacoms for the best performance. A single Enacom improves clarity and resolution over a relatively narrow band from the high frequencies through the upper midrange. Adding one, two, three, etc. Enacoms extends the improvement successively lower in audio frequency. Three together (total .3 microfarad) seem to extend fully through the midrange.

We find that the greatest sonic improvement in our system results from installing a combination of both commercially available types:

- At least 7 Quiet Line filters plugged into other AC lines than the one used for the system, covering all the AC lines in the house if possible.
- Three Enacom line filters plugged into the power conditioner supplying the signal source component (CD player, phono/line stage preamp), or into the wall outlet used if there is no power conditioner.

This may seem excessive, but the effect of all the filters is cumulative. This one combined "tweak" accomplished a wonderful improvement to digital playback quality unobtainable in any other way than AC filtering. Of course, power line quality varies from

location to location and the optimum number of filters certainly also varies with location and with the AC line noise susceptibility of the particular components.

We suggest the common sense approach of starting out with one of each type, increasing numbers of filters until the point of diminishing returns is reached.

### **3. Do-it yourself approach to AC line filtering**

Only for the EXPERIENCED HOBBYIST who is familiar with a soldering iron and basic house electrical wiring practices. Inexpensive and simple AC filter adapters can be made using large-value metallized polypropylene film capacitors. There are no commercially available units equivalent to the designs suggested here. If correctly utilized, such hand-made plug-in filters have a huge, almost unbelievable effect in improving the sound of digital, an order of magnitude more than the commercially available units mentioned previously. Some of the capacitors should be connected from AC line to neutral, and others should be connected from neutral to earth ground. The 120 VAC line to neutral capacitor adapters should of course be carefully insulated using tape and/or shrink tubing to thoroughly insulate the caps and wiring to the 2-prong plugs.

There is no specific optimum number of power line filter capacitors. Even small to moderate amounts of filter capacitance significantly improve the sound. Beyond this, the more capacitance on the more AC receptacles and separate AC lines the better. We have not yet found a point of diminishing sonic returns in increasing total capacitance. Ultimately, increases in total AC to neutral filter capacitance would be limited by buildup of excessive capacitive 60HZ charge/discharge currents in the AC and neutral lines. However, this point is well beyond any practical concern.

A moderate initial filter configuration could consist of 50 microfarads total (AC to neutral) at the system outlet, another 50 microfarads total (AC to neutral) distributed around the house, and 300 microfarads total (neutral to earth ground) distributed around the house. This would greatly improve transparency and lower the noise floor without massively covering every receptacle/line in the house. Later, as you look for more improvement, you can keep increasing the number of caps/adapters as your budget and spouse allow.

Care should be taken when removing one of the 120v AC line-connected capacitor plug-in units from the receptacle since the capacitors may be charged up to over 180 volts at the moment of removal. Always short out the plug prongs before handling. Alternatively, a 100,000 ohm 1/2 watt resistor can be soldered across the caps to automatically discharge the caps rapidly on removal from the receptacle.

The capacitors connected from AC line to neutral should be plugged in as close to the CD player (or DAC and transport) IEC power inlet(s) as possible. The largest improvement in smoothness, transparency, depth of image and lowered noise level is obtained using an adapter allowing the AC line to neutral plug-in caps to be placed near the CD player (DAC/transport IEC input receptacle). This short adapter has a female IEC at one end, then a multiple ungrounded (two wire) AC receptacle for the caps, then a male IEC connector for the power cord.

In addition, more plug-in AC line to neutral-connected capacitors should be placed in the same or adjoining wall receptacle that the system is plugged into. These capacitors drastically improve the sound by greatly reducing digital timing jitter through their AC line noise reducing effect, and also supplement the CD player/DAC/transport power supply capacitors during the short rectifier diode conduction periods (120 times per second) by acting as supplementary instantaneous current sources derived from their stored electrical charge.

The plug-in filter capacitors connected from neutral to earth ground reduce noise on neutral by bypassing or shunting it to earth ground, and improve the sound of digital even more than the AC line-to-neutral connected capacitors. The neutral to earth ground-connected capacitors must be wired to 3-prong AC plugs. For factory-terminated molded plugs, connection is from the white or blue wire (neutral) to green wire (earthground).

These plug-in filters should be inserted in wall AC receptacles wired to each of the AC lines in the house, except the line the stereo system is plugged into. This is necessary because large neutral to earth ground connected capacitors often cause ground loop hum and buzz if plugged into the audio system AC line. Experimentation is suggested here.

For best results, each of the non-audio system-connected power lines should have at least one capacitive filter on neutral because noise induced on the neutral lines by appliances, digital, and RF devices in the house all sums at the common neutral tie point in the breaker box to be transferred to the audio system-connected lines. As many separate receptacles on each line as possible should have plug-in filters.

Recommended capacitor type and values for a single plug-in unit use in AC line to neutral adaptors:

Four 10 microfarad 400-600 volts DC metallized polypropylene film caps, connected in parallel and bypassed by at least one .47 microfarad and one .01 microfarad 400-600 volts metallized polypropylene cap.

The neutral-to-earthground connected capacitors can be much larger (higher capacitance) and lower voltage rating than the AC caps.

Recommended for each neutral to earth ground plug-in adaptor: one 100-220 microfarad, one 10 microfarad, and one 0.47 microfarad metallized polypropylene film cap, connected in parallel (all caps 100 VDC or greater, no resistor needed).

Similar to when connected directly in the audio signal path, the powerline capacitors have different sounds or sonic signatures when connected one way versus reversed. For the absolutely best results, the capacitor types used should be tested to determine the best sounding orientation or polarity, before wiring into the connectors.

Recommended capacitor brands and sources (inexpensive and good-sounding): Xicon .47 and .01/630V metallized polypropylene film capacitors. Source: Mouser (800) 346-6873, part numbers 1429-6474 (.47), 1429-6103 (.01).

.47-220 microfarad/250 VDC and 400 VDC metallized polypropylene film caps manufactured by Solen. Sources: Handmade electronics (610) 432-5732, Michael Percy 530-470-8650 ([www.percyaudio.com](http://www.percyaudio.com)), Solen, Inc. (Canada) (450) 656-2759.

A number of other capacitor manufacturers also make as good or even better-sounding units in the same values. Examples are Reliable and Axon. Reliable: (PPMF type) (562) 946-8577; Axon: recommend only the 20 microfarad/1200v: (602) 272-6696.

#### **4. Power conditioners**

Power conditioners are generally much more expensive than the single parallel (shunt) units recommended above, though the cost of a good power conditioner can be comparable to the total cost of a maxed-out multiple set of parallel AC filters. The sonic improvement gained with most power conditioners is less than from either recommended set of parallel type filters and is therefore not as cost effective. We have found that many high end audio power conditioners are marginal or negative in their effect. This seems to be associated with the current-limiting isolation transformers, coil inductors and bad-sounding types of ferrite cores used in many series-filter type conditioners.

Two different power conditioner-type devices have been found so far which are major exceptions to this: (1) The Foundation Research LCI bi-directional AC noise filter system, and (2) our own Magnan Signature power cable/line conditioner units. Though moderately expensive, they greatly improve the quality of digital and to a lesser extent analog playback in similar but slightly different ways relative to the recommended handmade AC filter approach. Most importantly, these three power conditioners and the plug-in capacitive AC filters do not add any negative sonic effects along with the improvements and also work together extremely well when installed in a single system. The effect of doing this is simply stunning. The effect of series connecting the 3 different power conditioner units (using special male IEC-AC receptacle adaptors) along with using capacitive AC filter plug-ins is clearly greater than simply additive - there is a real synergy operating. The reason for that synergy is that the different filter designs in series simultaneously reduce or eliminate several separate types of noise phenomena affecting AC power.

Recommended: (1) Foundation research LCI and LC-2 AC power line conditioners. This device employs a bi-directional noise filtration system which also stops components from injecting noise back into the power line to adversely affect the system. The LCI will power source components (DACs, transports, preamps, etc.), and low-power amplifiers. The LC-2 will power most power amps up to 200 w.

(2) Magnan Signature power cable/power conditioner. This design combines in one power cable the functions of both a power cable and a power conditioner, with greatly reduced time dispersion/group delay ribbon conductors and built-in passive filtering. There are two basic models: the standard Signature compatible with all components, and the ultra-high performance Signature Bronze for source components only.

Sources: Foundation Research (905) 659-1789

Magnan Cables, Inc. Tel/fax (805) 484-9544, e-mail [jmagnan904@aol.com](mailto:jmagnan904@aol.com).

#### **5. Turn Off and Unplug**

The foregoing techniques clean up AC to some extent depending on how many capacitors and types of filters are used, but do so basically after noise of various kinds has already been injected into the power lines by all the plug-in devices in the house.

Virtually all household appliances, TVs, radios, computers, burglar alarm systems, lawn sprinkler control system, etc., etc., further

pollute the already noisy AC power reaching the system. Many of these devices have power supplies and digital processors running continuously and injecting noise into AC and neutral even with the units switched off. As many of these units as possible should be either switched off or preferably, unplugged for any listening session. Some may think this is ridiculous, but unplugging the TV, lawn sprinkler system and burglar alarm, for instance, makes a really big difference comparable to parallel capacitive AC filtering. Doing this is well worth the inconvenience to an audiophile perfectionist. For more convenience, external power switches and mechanical timers can be added. Such external switches should interrupt both AC and neutral. Of course, this issue is greatly subject to the obvious constraints imposed by practicality and the power of your spouse to impose some degree of sanity.

## **6. EMI Filtering for Noise-Generating Appliances**

It is often not acceptable or feasible to actually unplug household devices which inject a lot of AC noise onto the power line. Commercial EMI filters (normally intended to be installed in computers, etc) can be placed between the wall receptacle and AC cord of the noise-generating device and will operate just as well in reverse, i.e. to filter out much of the appliance self-generated AC noise before it reaches the house power circuits.

These commercial EMI filters typically employ symmetrical pi-type AC filter circuits, and are hermetically sealed in rectangular steel "cans" with external solder terminals. To be utilized in the suggested way, the EMI filter needs to be hard-wired to a wall plug for its "line" input and to a cord receptacle for its "load" output. Of course, the terminals must be well insulated after soldering. These units work well in this application, but are unsuitable to filter AC for most audio components due to use of bad-sounding RF chokes and capacitors.

Examples of devices which generate a lot of power line noise are high tech televisions containing switching power supplies which are constantly on even with the unit switched off, refrigerators, and surprisingly some built-in switching-type subwoofer amplifiers. The 2700-watt Sunfire subwoofer amp seems to generate an especially large amount of noise on power. We have found this to be a superb woofer even with the AC noise. Use of the suggested EMI filtering of self-generated AC power noise dramatically improves the sound of systems using this subwoofer.

There are a lot of brands of EMI filters, and they are all subtly different in their effect on a system. This is probably due to use of various inferior types of capacitors in their internal line filters. The caps in these filters are in parallel across the power line just like the suggested high quality capacitors. The following recommended type has been found to cause only a slight sonic degradation when plugged in with no load, and generally improves the sound to varying degrees when used in series with the power cords of AC noise-generating equipment.

Part Number: #562-864-03/3 (3a), #562-864-06/7 (6a), #562-864-10/11 (10a). Source: Mouser (800) 346-6873

## **7. Ferrite RFI blockers**

These are placed on power cords in the system and also at strategic places throughout the house. Most important places - TV sets, computers, burglar alarm system, refrigerator.

Recommended: Large toroidal cores made by Amidon Associates, Santa Ana, CA. Types F-240-43 (ferrite) and T-300-2 (iron powder material). These are available in electronic parts stores. An alternate mail order and international source is Surplus Sales of Nebraska. E-mail: [grinnell@surplussales.com](mailto:grinnell@surplussales.com) or URL: [www.surplussales.com](http://www.surplussales.com). Catalog part numbers: iron cores (ICH) MM-T157-2 (page 57); ferrite cores (ICH) 57-1465 (page 55). The toroidal cores are partially effective just leaning on a power cord and can be evaluated for system improvement this way. This tweak must be carefully adjusted and evaluated by ear. Just one core too many can tip the balance from smoother with reduced "grundge" to hard and edgy.

## **8. Dedicated (Supplementary) Earth Ground**

In most homes even earth ground is contaminated by noise, and the sound of a system can be greatly improved by installing an additional earth ground as near as possible to the system. The sonic benefits are similar to installing the AC-neutral and neutral-earth ground capacitors.

This is a rather laborious tweak involving driving a long copper-tube ground stake in wet ground, bringing in a heavy grounding wire to the system outlet(s). Having a licensed electrician do this is recommended.

The sonic improvement is somewhat greater if the system-connected dedicated earth ground is isolated from the noisy house earth ground, but this is not recommended by electrical codes because of possible safety problems. If both an equipment fault causing significant ground currents and poor house earth ground connection occur there could be large voltages between the two.

## **9. Other Noise and Hum Reduction Techniques**

First, only one component should be connected to earth ground (three prong AC plug). The other units should be "floating", using only AC and neutral. Typically, the preamplifier, DAC or CD player should be the one earth grounded component. This eliminates local earth ground loops.

Ground loops are formed in a system wherever neutral or earth ground paths are allowed to form a complete circuit. Electromagnetic field-induced currents can then flow around the loop and because of loop resistance cause hum and noise voltages in the local ground used by components.

You can check for neutral ground loops by making sure there are no "sneak paths" connecting the cases of any of the other (floating) components together to form a loop.

If possible, all components should be plugged into the same AC line, and using only one wall receptacle, to eliminate ground potential differences which cause hum and noise.

Also of benefit in noise and hum reduction is to modify components' internal grounding schemes to make sure they are internally star grounded. This means that there is only one common point for grounding for the entire unit including the chassis.

## **10. Power Cables, Interconnects and Speaker Cables**

One of the worst sources of "time smear" (as defined in the Introduction section) is the cables. All audio system cables including the power cords need to be as time coherent as possible. This primarily means reducing skin effect as much as possible using thin ribbon-type conductors; the thinner the better within the other constraints affecting each design application. The skin effect causes so much sonic degradation because it actually spreads all music signal frequency components over time, and the ear-brain system is very sensitive to this subtle "smearing".

Since Magnan manufactures audio cables, the need not to appear self-serving would seemingly require leaving out any recommendations. However, objectivity and completeness require that we point out that unique in the industry, Magnan cables are designed to be as time coherent as possible. The Signature interconnect design, using very thin conductive plastic, reduces skin effect time smear to a vanishingly low level limited only by the electromagnetic laws and the constraints of actual input/output circuits. The Type Vi and Super Bronze interconnects reduce skin effect as much as possible using a metal conductor. These designs reduce the other major source of time smear in cables, dielectric absorption, to a minimum using the best available dielectric system-air space/TFE Teflon.

## **11. Devices designed to correct CD digital errors**

The current 44.1 KHZ sample rate CD digital format inherently results in considerable phase shifts starting in the midrange and increasing to 45 degrees (lag) at 11 KHZ and 90 degrees at 22 KHZ. This is essentially due to the sample rate itself constituting a "brick wall" low-pass filter starting at 1/2 the sampling rate or 22 KHZ. Any such filter results in a large associated phase shift. Secondly, the information above 15 KHZ is degraded because the system has only two 44 KHZ samples per signal cycle.

Almost all CD players and processors fail to correct these inherent problems. The Taddeo Digital Antidote is a patented ingenious solution in the analog domain, which also allows the device to be used between a CD player or DAC and preamp or amp. The device both corrects the phase error and in the process rolls off the degraded highs above 15 KHZ. Fortunately, there is very little musical information above 15 KHZ.

The Digital Antidote is the only analog domain add-on device we know of which addresses this problem, and we have found it to be essential for CD reproduction. The sound becomes more round and "fleshed out", with a considerable reduction in upper midrange hardness and edge. In comparison, even very good uncorrected CD playback is spacially somewhat flat or two-dimensional, edgy and tonally unnatural.

The original Digital Antidote II has been replaced by an improved design (same model no.). The new version is an even greater advance in natural CD reproduction -- much more lucid and extended in the high frequencies than the previous model II.

Matisse Conductor - GT Audio, 011-44-1895-833099 (UK)

This unique product acts as a passive "sink" or absorber of RF noise on the DAC ground plane, thereby improving the sound primarily by reduction of timing jitter. Note that this kind of RF noise is in part generated by the digital switching circuits themselves and cannot be eliminated by AC power filters. The unit plugs into any unused RCA input on a DAC or CD player (connection is only with ground). A switch on the front panel toggles between two different filter circuits. One or the other setting will be sonically optimal depending on the DAC design and other system characteristics. When the device is set up correctly, the sound becomes notably smoother along with more resolving, with a significant reduction in the typical digital "brittle smearing" in the upper mid and high frequencies. This device is expensive, but what it uniquely accomplishes will make it cost-effective to a perfectionist.

## **12. Devices designed to compensate for inherent acoustical record/playback errors**

TDS Harmonic Enhancement System (Passive Audiophile Version) - True Dimensional Sound, Inc. (800) 542-4930, [www.TDSaudio.com](http://www.TDSaudio.com)

When compared with live music, most classical recordings in particular typically seem to be thin and overbright in tonal balance. Many audiophiles strive to tonally adjust their systems to achieve a more naturally rich upper bass - lower midrange "fullness".

One of the most important reasons for this is the dynamic nonlinearity of human hearing, quantified by the well-known Fletcher-Munson curves developed at Bell Labs in the 1930s. The perceived frequency response of human hearing is very different at lower sound pressure levels from the response at higher volume levels. At the lower loudness levels typical of live classical music listening, hearing greatly emphasizes audibility of midrange tones centered at approximately 3KHz, with response way down in the bass and high frequencies. At loud volumes, the normal ear response is relatively flat. Since audiophiles often listen at louder than live levels the tonal balance seems high-frequency and bass-emphasized relative to live - i.e. bass heavy but thin and overbright. Of course, such a tonal balance may also be the deliberate choice of some recording engineers, exacerbated by the close microphone placement usually needed for good dynamic range and clarity. Other contributing factors can be hard, edgy-sounding solid state/digital circuits, and peaky tweeters.

The TDS technology uses a passive tuned inductor (transformer coupled) circuit to reshape the system frequency response during playback as an "average" compensation for these mostly inherent tonal balance errors.

The subjective effect of inserting the TDS Enhancer (typically between preamp and amp) is a satisfying natural richness in the midrange/midbass along with a subtle but striking overall naturalness, palpability and smoothness, as if certain needed upper midrange harmonics are no longer being suppressed. There is also a noticeable increase in volume, probably due to the sensitivity of the ear to midrange frequencies. We noted a slight loss in resolution, but this was only apparent in a very high resolution system. Finally, we recommend the version with a bypass switch, mainly because certain atypical recordings are better flat, without the effect.

## **13. Component support and damping**

This is a complex but very important area because of the almost unbelievable sensitivity of the ear to the effects of minute motions or vibrations in all components including CD transports, DACs, preamps, cables and power conditioners. CD transports, players and turntables are especially sensitive to these effects. Great sonic improvements in clarity, transparency, etc. are achievable by employing a system approach combining, where possible, mass/weight damping on top of the component, adhesive damping sheets on component chassis and support rack surfaces, both coupling and absorbing feet, and a support platform as massive, non-resonant, rigid and hard-surfaced as possible.

Detailed recommendations will not be made except regarding component feet and vibrational damping sheets. The area of component support and damping is mostly a matter of improvisation. Metal (except lead) and granite should be avoided - these materials all "ring" to some extent even when damped by elastomers. Even lead is slightly improved sonically by application of adhesive damping material.

Mail order source for lead bricks: McMaster-Carr (562) 692-5911, catalog numbers 9033K22 (15lb.), 9033KM (26lb.). Another source: 5-lb. deep-sea fishing weights sold in some fishing tackle and sporting good stores.

Adhesive damping sheets:

(1) McMaster-Carr catalog number 9709T18 - this inexpensive high-temp mastic adhesive-backed material is almost totally neutral sonically (no sound of its own) while significantly improving clarity. For best results stack 2-3 layers together. A very similar material, called Dynamat, is available in stores sold for auto chassis damping (doors, hood, floor, etc.). Parts Express #268-020.

(2) EAR Isodamp SD-125 and SD-40 adhesive semi-rigid damping sheets, available from Michael Percy ([www.percyaudio.com](http://www.percyaudio.com)). This tough PVC-based material damps micro-vibration in component chasses and electronic parts much more effectively than the above mastic/bitumen based sheets. The sonic effectiveness is greater because these sheets utilize mostly the principle of constrained-layer damping, where vibrational energy is dissipated as heat in the horizontal (shear) deformation of the adhesive between the vibrating wall and the horizontally rigid damping sheet. Viscoelastic materials such as the sheets described in (1) above less efficiently dissipate vibrational energy mainly in the compression and expansion of the material. The sonic effectiveness of this material is better also because its stiffness is a better mechanical impedance match to chassis walls. The thinner type (SD-40) is best stacked in 5-9 layers, SD-125 in 3-5 layers. Use of patches of this material on even one component will improve clarity considerably in a good system.

(3) Do-it-yourself constrained layer damping sheets. Theoretically, the effectiveness of constrained layer damping should be better if the material is very stiff in the horizontal plane, noncompressible, nonresonating and with a high mechanical impedance approximating a metal chassis wall. A damped thin metal sheet is such a material and would also effectively block external vibration. A number of commercially available damping materials utilize a sheet of aluminum or other metal. with pressure sensitive adhesive and in some cases damping elastomer backing. We found that these materials all exhibited unacceptable metallic ringings even with additional damping layers added to the back of the patches. A simple combination of off-the-shelf materials can produce very much better performance for high end audio systems. The following do-it-yourself damping pads improve resolution, imaging and general sonic clarity considerably more than even the EAR Isodamp materials.

Damping pad construction:

Apply 3M high-shear strength double-stick tape (McM.-Carr part no. 75955A673) to one side of a one to four square inch rectangle of any of the following materials:

- a. 15 mil phosphor bronze sheet (shim stock, McM.-Carr # 9014K33);
- b. 4 mil copper foil (McM.-Carr # 9053K13);
- c. 1 mil brass foil (McM.-Carr # 9504K11);
- d. copper-clad (one side) phenolic circuit board (McM.-Carr # 8521K33).

Add at least 7 layers of the adhesive-backed material to the other side of the sheet. The different materials have subtly different sonic effects, with the best all-around material being the bronze sheet. The double stick tape side of each damping square is applied to the surfaces of a component chassis after peeling off the paper backing.

This particular tape does not have an aggressive adhesive, and as a result the damping pads may not stick well to pebbled or otherwise unsmooth surfaces. It is still recommended because of its sound as a thin layer shear damping elastomer. The tape can be removed and replaced if necessary.

We have found that optimum results are obtained from using a combination of all these materials (1) - (3) essentially "tuning" the vibration reduction by ear.

Sources:

- McMaster-Carr (562) 692-5911;
- Michael Percy 530-470-8650, E-mail [mpercy@pacbell.net](mailto:mpercy@pacbell.net);
- Parts Express (800) 338-0531.

#### 14. Special component feet

The physical problem is that the component needs to be coupled as rigidly as possible to the support platform (limiting any micro-motion of the component) while at the same time any residual mechanical vibrational energy induced in the component needs to be absorbed. We have found that the best sonic results in improved resolution, image focus, transparency, bass quality, etc. results from using a combination of rigid coupling feet with more flexible and lossy energy-absorbing feet.

Recommended: Combine two Black Diamond Racing carbon fiber cones and one DH ceramic cone (large type). Additionally, place at least one Audio Prism iso-bearing and one sorbothane-type foot under the component near each of the rigid feet, in such a way that the component is still holding the rigid feet down. Sources DH Cones: Golden Sound, Tel. (703) 847-2617, Fax (703) 442-7966. Black Diamond Racing, Tel. (414) 747-8733, Fax (414) 747-8734.

## 15. Tube Dampers

All vacuum tubes exhibit microphony to some extent, the generation of spurious sounds in response to mainly airborne vibration. This is usually low in level but mixes with the music signal to add subtle, pervasive "grudge", muddiness and harshness. These effects worsen as the sound pressure level increases. Of course, all electronic components have this general problem to some extent, where platforms, special feet, damping and weighing down the chassis are the curative measures. With tube microphonics, the active devices themselves, the vacuum tubes, need to be separately damped.

Many audiophile accessory tube damping products are being marketed, but most are a kind of negative tradeoff where there is some improvement in apparent clarity, but longer term listening reveals that there is also an unacceptable loss of life and transparency of the overall sound.

Other negative effects of various commercial tube damping devices can include a metallic "ringing" quality and loss of dynamics. The most likely theoretical explanation is that the high frequency resonances of the tubes glass envelope are indeed being damped and other vibrations are being reduced, but the fields surrounding the tube's plate, grid and cathode are also being affected. Introduction of material with poor dielectric properties or metals with remnant magnetic fields and inherent eddy current effects are indirectly affecting the electron flow and therefore the music signal.

We have found only two devices that have almost entirely positive sonic effects in reducing tube microphonics. These are special types of "o"-ring (FEP Teflon-coated silicone) which can be obtained in the right size to fit onto miniature (12 AX-type) tubes, and plain silicone o-rings which much improve other types such as 2A3, 300B and 6SN7. Though certainly not designed for this purpose, these o-rings make amazingly effective damping devices.

Next best, but introducing noticeable muddiness and loss of midrange information, are the 3M elastomeric damping rings.

Sources: FEP Teflon coated silicone o-rings, size 116, fits miniature (12AX7-size) tubes, silicone o-rings, size 133, fits 2A3 and 300B types: McMaster-Carr (562) 692-5911, catalog numbers 9319K26 (#116), 9396K154 (#133); 3M Tube damping rings: Michael Percy, 530-470-8650 ([www.percyaudio.com](http://www.percyaudio.com)).

## 16. Improved passive parts

These replace stock inferior film caps in signal path and power supply positions in components such as amps, preamps, speaker crossovers, CD players, processors, etc.

Recommended: The absolute best found so far by a wide margin, but very expensive: Reliable Exotica Copper Foil Polypropylene Film, PCU capacitors. Reliable: (562) 946-8577. Next best: Reliable aluminum foil/polypropylene Alpha capacitors. Improved resistors should replace inferior metal film, carbon film and carbon composition resistors in at least the signal path and signal-to-ground (shunt) positions. Recommended: Caddock TF020 metal-oxide film resistors (best), then Mills non-inductive wire-wound resistors. Source: Michael Percy, 530-470-8650. Fast recovery diodes should replace stock standard power supply rectifier diodes. Source: Michael Percy ([www.percyaudio.com](http://www.percyaudio.com)). Other parts changes with less effect: electrolytic caps, wiring, sockets, etc.

## 17. Parallel RFI filtering at speaker input

These devices are designed to reduce RFI in the speaker interface and also to reduce "ringing" caused by reactive speaker load impedances. This is a new category of tweak.

Recommended: Enacom audio noise filters (speaker type). These devices connect across the speaker terminals. Background noise is dramatically reduced and overall resolution is greatly increased especially in the upper midrange. Piano recordings in particular are very much more "real". This is a breakthrough product and concept. Manufacturer: Combak Corporation. Source: The Tweak Shop (707) 575-8626 ([www.tweakshop.com](http://www.tweakshop.com)).

## 18. Antistatic sprays

It appears that the electrostatic fields surrounding statically charged surfaces of CDs, CD players, preamps, amps and cables significantly degrade the sound. This must be true because eliminating the static surface charges with an antistatic spray dramatically improves the sound. The effect lasts a couple of days at most, and then must be renewed by respraying. In the case

of CDs, what happens perhaps can be understood as the combined effect of the rotating electrostatic field coupled to the disc. As it rotates, the CD must be slightly vibrated by the repulsive and attractive electrostatic forces induced in reaction to adjacent charged surfaces. Also, the rotating electrostatic field would have some effect on signals being conducted through adjacent circuit board traces, wires, etc. The same mechanism also could explain the lesser improvement resulting from demagnetizing the disc. What is harder to understand is why destaticizing cables, CD players, etc. significantly improves the sound, though we can speculate that it is probably a noise reduction effect.

Recommended: Nordost ECO antistatic spray for all components. Source: Nordost (800) 836-2750. Radio Shack sells a much cheaper antistatic spray which is just as effective sonically on CDs. Caution: the Radio Shack spray has not been evaluated on cables and components. The Nordost product was developed specifically for all audio components and appears to leave no residue. It should be noted that CDs should be sprayed and wiped off only on the printed side.

## 19. CD treatment products

Auric Illuminator - Audience, (800) 565-4390, [www.audience-av.com](http://www.audience-av.com)

CD treatment fluids are attempts to improve laser pickup tracking and serial bit signal discrimination by altering or improving the optical properties of the playback surface.

Most of the CD treatment fluids we have tried are not fully satisfactory. They all certainly change the sound, but often there is some unpleasant sonic side effect such as hardness, edginess, smearing, dullness, etc... Several products do not seem to have any negative sonic effects, but either do not improve the sound much or do really sound good but at the cost of endless mistracking problems. The Auric Illuminator Optical Disk Resolution Enhancement is unique in our experience for the sheer magnitude of the improvement and for the absence of negative trade-offs. The background "grundge" or noise level is greatly decreased, along with a drastic improvement in resolution and clarity without any edginess. Highly recommended.

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