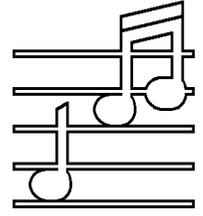


# AUDIO BASICS



A MONTHLY NEWSLETTER OF AUDIO INFORMATION  
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## Yes - New Speaker Wires Can Change The Sound!

I just finished a series of phone calls with a good long term client. One of a pair of B&W 802 loudspeakers I had sold him several years ago had mysteriously started distorting. The client was certain that both the midrange and tweeter were defective and was a bit upset because the system's age was one year past the B&W five year warranty.

Fortunately, it is very easy to swap the complete midrange - tweeter head assembly from speaker to speaker with this model. I told the client to do so.

The problem remained with the same speaker! The tweeter and midrange assembly that had previously been distorting worked fine on the other main woofer assembly, and now the tweeter and midrange head that had been working distorted when connected to the "problem" speaker.

The client now assumed the problem was with the crossover in the speaker. Inasmuch as I have never seen a crossover failure in a B&W loudspeaker - other than the complete destruction of a tiny pair of bookshelf units years ago driven to ruin by a 300 watt per channel bipolar amplifier at a drunken party - I thought not.

The client assured me he had already switched amplifier channels and sources and the problem was isolated to the speakers, not to a component earlier in the chain.

He overlooked one "component."

I asked the client if he had recently changed speaker wires. He had. I asked if these were of fine multi-strand "braided" construction. They were. I suggested that he try different speaker cables. He called back a few minutes later to tell me that he had swapped the speaker wires from channel to channel. The distortion problem followed the speaker cable!

*I should point out that this was not the advised method of locating a defective speaker wire. If the wire was*

*shorted and the amplifier poorly protected, then a shorted wire could damage an amplifier output channel. Moving the wire to the other channel could result in damaging the other channel too - making the repairs twice as expensive. Our October and November, 1982 issues covers this situation in detail.*

Anyway, the speaker problem was not a speaker problem at all. It was a magic speaker wire problem. In fine multi-strand woven cables, the only thing separating you from a short circuit across the output terminals of your amplifier is the baked on lacquer insulation on the tiny wires. A single crack, chip, or flaw anywhere on any of the thousands of feet of hair sized wire in the cable will cause a short circuit. As the wire is flexed, the brittle baked on insulation coating is stressed. Sooner or later it is going to let go - in this case it was sooner. The result was a shorted wire - a hopelessly inappropriate load across the amplifier output terminal.

In this instance, because the client was using a very rugged Audio by Van Alstine power amplifier, the short manifested itself only as a near zero ohm load across the amplifier causing early clipping and distortion. Our amplifier survived the abuse. With a lesser brand, the result would likely have been amplifier output circuit failure and subsequent speaker damage.

In this case the only damage was to the client's pocketbook when he learned the hard way what I have been telling you for years and evidently need to tell you again.

**Exotic high priced speaker wires and cables do change the sound of your audio system. Far too often, they screw the sound up completely when they do damage to the system.**

I am tired of replacing banana jacks broken off by overtightening monster lugs with a pipe wrench. I don't like replacing spec RCA jacks deformed and

broken loose with clamping monster plugs. I don't like replacing amplifier fuses fried by shorted multi-strand speaker wires. I don't like troubleshooting hum caused only by an open ground when an excessively stiff cable popped off. I don't like replacing speaker terminals broken off when the speaker tipped over and the ultra stiff speaker cables broke things before flexing. When is this lunacy going to stop? If you paid more for speaker wires and interconnect cables than you would have needed to at Radio Shack, you most likely screwed yourself.

Interconnect cables and speaker wires are not components. Don't pay component prices for them and believe none of the audiophile claims for their sonic virtues. In any other technical field of endeavor, placebos and double blind tests are used to control variables and sugar pill effects. Not so in audio – the unsubstantiated purple prose of cable virtues goes on and on.

Doesn't anyone understand that the only effect the cable can have on the sound is how its electrical characteristics load the source and affect the frequency response into the load? Doesn't anyone understand that you don't have to pay significantly extra to get a relatively low capacitance, low resistance, and well shielded cable or speaker wire? Why are so many buying bullshit instead of good audio components?

How can reviewers claim they actually like hopelessly inadequate DCC, MiniDisc, and one-bit source players in one breath and spend 20 pages of purple prose nonsense describing their favorite speaker wires and cables in the next. This is like writing about which brand of air to put in your tires while never noticing that the shock absorbers are broken.

If you want a high fidelity audio system, purchase all high fidelity audio components competently engineered to be faithful to the source material, and make sure your listening room is acoustically inert. Don't throw your money away on grossly overpriced and often grossly unreliable cables claiming to be components. They are not.

Read the article on speaker wires in the July, 1993 issue of *Audio* magazine. Notice they found no correlation between price and performance. Our only disagreement with the article is our greater concern with excessive distributed capacitance. Far too many amplifiers ring, overshoot, and start to oscillate internally when even a small capacitive load is attached to their output terminals.

This produces a bright underdamped high frequency peak in the sound that fools mistake for "detail" and "clarity." We would have been happier with the *Audio* tests if they had showed amplifier square wave performance with the various cables attached. We think they would then be less generous with woven cables that trade off inductance for capacitance. We suggest a heavy (12 to 16 gauge) two conductor and flexible cable, twisted about 3 times per foot for good RFI rejection, terminated in banana plugs. It should cost you no more than \$20 per cable, including the banana plugs. Don't pay more.

**Zero Field Failures, Zero Returns, continued.**

or

### **How to Design a Power Amp that Works!**

In the April, 1993 issue of *Audio Basics* we explained the adventure we experienced in designing the "outsides" of a new power amplifier. Now it is time to continue this story and tell you about the design process of the "insides" of the amplifier.

We had several goals:

1. Absolutely unsurpassed state-of-the art musical performance.
2. Absolutely bulletproof reliability and durability.
3. Affordable and rational end retail price.
4. Efficient assembly and efficient future serviceably and upgradeability.

There were several goals we did not consider:

1. We did not design for a "no labor cost" everything on one board machine made layout. This kind of design always compromises future serviceability and durability for short term lower assembly cost expediency. It is OK for throw-away designs and products assumed to be soon obsolete. It is not OK for long term "keeper" audio components.
2. We did not design for short term plastic styling whims. We did not try to cramp the functions into the "shape of the month" to sell to those who buy audio components only to look at. In good design, form follows function. The landfills are full of last year's strange unserviceable shapes. The repair shops are full of electronics with all sorts of dying plastic flex cables, cracked film circuits, inadequate cooling space, and zapped and mashed electronic controls.

3. Quality is good reliable performance for the intended function. The function of high fidelity equipment is to reproduce music with high fidelity to the source, not to make toast. We never forgot the intended function. Most designers are resigned to the fact that the general public assumes that quality is "features." Thus they design only to sell quickly and easily based upon superficial values to those that don't want to think. The quick buck design and marketing approach is tempting and profitable. There are a lot more "thunder lizards" out there thundering away than there are good loudspeakers. It is hard to find high quality goods today in many areas simply because the general public does not care. We still care. We still design for high quality audio performance first even if it makes a harder sell. We did not design superficial features to take the quick buck from the uninformed.

How did we design? Let's take a look at some of the aspects of the process. We will start with reliability and durability first. If it doesn't work well for you it doesn't matter how "good" it sounds. It does not sound good while it is broken.

Note that esoteric performance does not imply fussy, unreliable and high maintenance design. That old chestnut is simply an excuse for foisting off incompetent products upon you and expecting that you will be happy paying unnecessary repair and maintenance costs. You simply don't need to grease the trunnions once a week in an age in which sealed ball joints work well for the life of the unit.

Most consumer electronics are designed and built with the lowest quality, widest tolerance, and lowest voltage rated parts that will make it through the warranty period. Most amplifiers are full of protection circuits to shut them down in case of overload and to protect the speakers from damaging DC when the amplifier turns on or off and for when it blows up. Many amplifiers blow up simply because the designer used parts of too low a rating. As we told you in April, designers assume that voltage ratings that are good enough during normal operation are adequate. But the repair shops are full of power amplifiers that blew up simply because at clipping, the output and driver transistors see the full rail-to-rail power supply voltage – twice what the designer expected or designed for.

We developed a few simple design rules that have served us (and you) well:

1. Build using semiconductors with voltage and current ratings more than the maximums that can be applied to them in circuit, even during hard overload conditions. You cannot over-voltage a device if you specify and use devices with ratings in excess of the circuit's worst case peak voltage. Keep in mind that the worst case voltage might not come during normal operation. For example, your AC power line will have occasional transient spikes of double the normal voltage. What does that tell you about how the designer should specify supply rectifier parts? Do you think that using a computer line filter and transient surge absorber with your audio and video equipment might not be a good idea too?
2. Build using all high reliability, low noise, tight tolerance resistors. Folks, 1% tolerance metal film resistors cost us about 6¢ each in production quantities. In a unit using 100 resistors, that is only \$6.00 worth! Precision resistors do not add significantly to the cost of the product – actually they make our cost lower! Using precision resistors gives us very tight channel to channel and unit to unit repeatability. It gives us very low passive circuit noise. And it gives us very low infant mortality. There is nothing more tedious than searching a circuit for a noisy resistor. You have to replace them one at a time until the noise goes away. By using resistors that simply never go noisy, in house re-works and warranty repairs are greatly reduced. The cost of the precision resistors is much less than the cost of warranty work if they are not used. We don't understand why lesser parts are used by so many, even in much more expensive equipment.
3. Build using high reliability and matched capacitors appropriate for the application. You cannot just look at the capacitance value for a power supply part, for example. You must know its ripple current specification and how that compares to the amount of current you expect to pull from it. If the circuit demands more than the maximum design specification, you will have failures.

You cannot be a silly slave to one kind of capacitor. There are many esoteric designs stuffing giant soft film capacitors (with excess lead inductance, microphonic resonances, and tem-

perature drift) in all the wrong places. We use many types of capacitors, each selected for its suitability for the application.

4. As with transistors, use each passive part well within its rated voltage and current. We have seen many old Dyna St-400 power amplifiers fail simply because the under-rated power resistors in the driver circuit overheated with age and cooked themselves until they broke and fell right off the circuit boards. That was idiotic design. It is easy to determine the power a resistor must handle ( $V^2/R$ ). Provide resistors with at least twice the power capability of what they must handle in circuit and they will last forever. With polarized capacitors, watch out for that reverse voltage too. If the DC bias on a coupling capacitor is not greater than the reverse signal AC voltage swing, for example, then part of the signal duty cycle will cause the polarized capacitor to be reverse biased and it will break down. Distortion and premature parts failure will be the result. The part was fine – inappropriate engineering application of the part is not.
5. Design to eliminate damaging turn-on and turn-off transients. Many amplifier designs generate significant amounts of DC offset voltage and current during turn-on and turn-off. This makes annoying large thumps and pops and can damage loudspeakers. Often inappropriate voltages are applied before the power supply voltage is stabilized so that output transistors are overstressed momentarily during turn-on and turn-off. For good reliability, the circuits and parts must remain within their ratings all the time. If one doesn't consider what is happening during the transition between off and operation, one will likely have unsuspected failure modes. Sometimes the on and off thumps are so bad that mechanical relays must be provided, controlled by additional DC sensing circuits, to keep the amplifier disconnected from the speakers during turn-on and turn-off time. These protection circuits are expensive, unreliable, and simply indicate that the designer didn't get the DC balance right in the design. If one designs for absolute DC stability over a very wide range of power supply voltage, then on or off transients will be minimized, DC drift will never be a problem, and the drop-out prone relay circuits become redundant. Also, if one designs so that resources do not need to be put into protection circuits, the price of the

finished product will be lower and its reliability will be better.

6. Thermal protection is unnecessary if one designs so the circuit will never overheat. This is why we ran sustained FTC preconditioning tests on pre-production heatsinks before finalizing the designs. If it thermally stabilizes and stays within safe temperature limits for hour after hour of testing (and our new heat sink does), it will never overheat in much less demanding home use conditions.
7. VI limiting circuits are unnecessary if one designs output stages so rugged they can withstand any possible signal or source overload. We do not understand why so many amplifiers are built with the lightest duty and cheapest output devices that will kind of make power without blowing up the first time and then the amplifier is filled with protection circuits to keep these minimum standard output devices alive. Good design with rugged parts is less expensive than cheap design and lots of scummy protection circuits.  
Keep in mind that the protection circuits always get into the way of the sound. They cannot work instantly. In order to save things during a hard overload, they have to start ramping on and limiting before the hard overload occurs or they will be too late to save things. Thus the limiting circuits are always starting to cut in and out on transients and are always screwing up the linearity of the amplifier long before its maximum limits are reached.
8. The least expensive and simplest protection circuit is a fuse. Unfortunately, with most bipolar output circuit amplifiers, if the fuse is big enough to provide full power, an overload will take out the output transistors first, protecting the fuse! This is because of an effect called secondary breakdown or thermal runaway. When a bipolar power transistor gets hotter, it conducts harder, which gets it hotter, which causes it to conduct harder, and so on, until it melts. External temperature sensing circuits are necessary in the output bias circuit to turn the current down as the device gets hotter. Unfortunately external sensors are never 100% accurate. They are not inside the transistors and thus sense the output circuit heat late and slow. The result is an approximation, never exactly the bias current the outputs really need under the conditions. During an overload, the

internal die in the power transistor can “hot spot” and melt much quicker than the protect circuits can detect and faster than a fuse can react.

One of the many reasons that we use power v-mos-fet output transistors is because secondary breakdown problems do not exist, thermal bias tracking is unnecessary, and good protection can be provided with a simple fuse. Unlike a bipolar transistor, certain power mos-fet transistors have a negative thermal coefficient – they conduct less as they get hotter rather than conducting more. So when they are correctly set to the manufacturer’s rated bias current setting, they will maintain that current over a wide temperature range. As the devices gets hotter, it conducts less, slightly turning itself off and thus cooling itself. As it gets cooler, it conducts more, keeping the bias current at the proper value. No external temperature circuits required! Because the device cannot “hot spot” internally, it takes much more overload time to destroy it – more than enough time for a fuse to work and prevent the damage. So the audio circuits become simpler, better, and less expensive because they need not accommodate bias tracking circuits. That is the way we like to do things.

9. Design to keep initial and maintenance adjustments to a minimum. Trimpots are occasionally bumped out of adjustment and sometimes fail. A service agency might not know what the correct adjustments are supposed to be. End users sometimes rummage around inside and mess the adjustments up. We see too many components using dozens of adjustable trimmers, many of which have drifted out of specification and can never be put exactly right again because the trimmer action is too crude. If one can design the precision into the circuit in the first place, it is possible to eliminate the trimmers and their problems.

With the  $\Omega$ mega II amplifiers, by designing a critically damped electrically and thermally balanced circuit, the DC balance of the two audio channels is so precisely stable and centered that no DC offset adjustment is required at all. There is no DC centerline adjust pot because the unit self-centers perfectly and never goes offset, not even at clipping. One adjustment per channel remains for initial setup bias current. Because the current requirements of

the mos-fet output devices vary slightly on a sample to sample basis, it is necessary to make one measurement and bias current adjustment the first time the completed circuit is energized on the test bench. This adjustment is permanent and need never be touched again unless output devices are subsequently replaced. (For your information, the proper bias current for all  $\Omega$ mega II amplifiers is 65 milliamperes for the drive board plus 100 milliamperes per standard die v-mos-fet or 75 milliamperes per large die v-mos-fet output). The new Fet-Valve hybrid amplifiers need no DC adjustment either. They are just as stable as the all solid state  $\Omega$ mega II amplifier which is highly unusual and very user friendly for a vacuum tube hybrid design.

10. Design and lay out the PC cards for best possible operation rather than for quick and dirty assembly or impressive looks. We have seen far too many board designs that let the signal, ground, and supply paths ramble all over the place like a herd of drunken goats just to make all the resistors line up on the component side to impress the casual observer. We know to keep ground paths short and heavy, to keep the supply leads away from the signal, to provide low impedance damped decoupling for fast devices, and to provide room for small signal device heatsinks for long term durability. First, the board must work musically and electrically at its best. Second, it must be a rational layout for repeatable and reliable construction, avoiding too tight traces and solder bridge possibilities. Third, the pads and traces must have the mechanical and thermal capability to make sure no part ever breaks loose from stress, vibration, or thermal aging. Fourth, the board should be made as nice and tidy looking as possible without violating the more demanding constraints.

Hey, our amplifier is getting really nice already and we have not even started on the audio circuit design concepts yet. To be continued.

### Hot Flash!

Our long awaited Super Pas 4i kit review has been published in the August, 1993 issue of *Audio* magazine. Buy a copy and turn to page 71. We are pretty happy with the overall comments. Note that the Super Pas 4i and an  $\Omega$ mega II 400 power amp generated the “Goosebumps” editorial on the last page of the most recent issue of *Stereo Review*. We will let you know how much interest the review generates.

## USED EQUIPMENT

**Omega II 150 Power Amplifier** in a good Dyna St-120 chassis. This was a very clean Omega 150 traded in on a Omega II 400. We upgraded the circuits to Omega II to give it brand new performance (75 watts per channel, dead quiet, unbelievably smooth, transparent, and high definition) and a one year parts and labor warranty. The price is \$495 + \$15 USA shipping. We cannot economically build any more of these (the cost of the necessary power transformer to fit this unique chassis has gone way up) so this is your last chance at this great high performance package – the best sounding solid state amplifier ever at such a low price.

**Omega II Pat-4 Preamplifier.** The best brand new AVA solid state circuits installed in a very good used Dyna Pat-4 chassis. You get precision volume and balance controls, useful tone controls, phono and five line level inputs, high and low filters, and great musicality. You pay only for the factory rebuild, \$345.00. The chassis is thrown in at no extra charge. Hurry, we only have one. Two year warranty on our circuits. Shipping is \$10.00 in the continental USA.

**Super Pas Three Preamplifier.** Brand new AVA circuits installed in good used Pas-3 chassis. You pay only \$395 for the complete Super Pas Three circuit set installed (including five new tubes) and we will throw in the nice used Pas chassis we just took in trade for just \$50 extra. You get a two year warranty on our circuits and you get brand new factory performance. Includes new stepped precision volume and balance controls, selector switch rewired to provide phono and five line level inputs, and clean and tidy original Dyna appearance. Add \$10 for shipping in the continental USA.

**Super 70i Power Amplifier.** Complete with “the works” (all new tubes, new AVA power transformer, new AVA input/output jack set, new AVA factory installed circuits) in a clean used St-70 chassis completed with refinished cover cage. This is FVA’s own amplifier - with even more power supply than stock - available now because we have acquired another good St-70 chassis to rebuild. It is yours for \$795 including a two year warranty on our circuits. Most listeners believe this is the best sounding small tube amp ever. Now you can own one too. \$15 shipping in the continental USA.

**Super Pas Three Omega Preamplifier.** This is a superbly wired kit built unit just traded in on a Super Pas 4i because the client needed the headphone amplifier. It has everything – Omega phono and line buffers, gold AVA jack set, ceramic selector switch, black AVA faceplate and knob set, good select Chinese tube set, and very fresh construction (built in 1991). It works and looks like near new. The price is \$495.00 plus \$10 shipping in the continental USA. For just \$50 extra we can upgrade this unit to Omega II standards with all new AD843 buffers and the 8.2 $\mu$ F film capacitor upgrade to the line section previously discussed in Audio Basics. That will give it brand new performance. We will provide a six months parts and labor warranty on all the AVA circuits in this great preamplifier. Call soon, this is as good as they get.

**SPECIAL PACKAGE DEAL - PURCHASE BOTH AN AMPLIFIER AND A PREAMPLIFIER FROM THIS LISTING AND TAKE \$75 OFF ON THE COMBINED PAIR PRICE AND GET FREE SHIPPING IN THE CONTINENTAL USA TOO. CALL US NOW AT 612 890-3517.**

*Frank and Darlene Van Alstine*