



September 2008

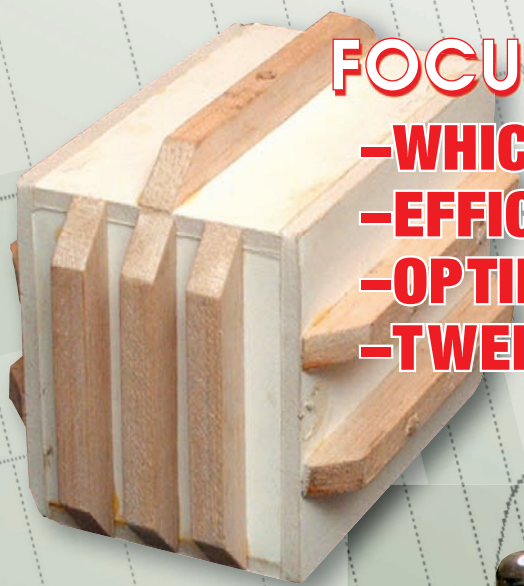
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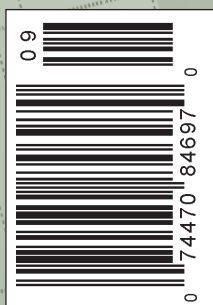
DIY TUBE STEREO AMP PROJECT

FILTER CIRCUIT TO CLEAN AC POWER LINES



REVIEWS

- COMPONENT DATABASE CD
- DISC ENHANCING CREAM
- SUPER AUDIO SELECTIONS



A \$450 Triode/Ultralinear Integrated Stereo Amp

This push-pull, self-bias, class AB1 amp performs well in both the ultralinear and triode modes.

The sensitivity of this amp is 0.4V RMS for 28W triode or 0.48V RMS for 50W ultralinear (UL) output. It has 12dB of loop feedback. The distortion at 1kHz is 0.5% for the 28W triode amp and 0.8% for the 50W ultralinear amp. The noise measured at the 8 Ω output of the amp is 0.003V with the input open and the volume control full-on. The damping and square waves are excellent. Only a driver and inverter stage is required to drive the power output stage, and this reduces the components and the clutter usually associated with typical power amps.

Important: The two amps and power supply are constructed on three 13 $\times$ 5 $\times$ 2" aluminum boxes (Photo 1). This simplifies the wiring and layout because the power supply and amps have a unique construction process. Do not use steel

boxes, because grounds require stripping the painted steel boxes to bare metal. Also, drilling and punching holes are much more difficult with a steel chassis. The front of the power amp chassis has a heater and high voltage on-off switch. The rear of the power supply chassis has two power connectors, power cord and fuse. The rear of the amp chassis has three speaker terminals and an RCA connector. I recommend you use an 80-cfm fan, located directly behind the filament and plate transformer.

AUDIO SWITCH BOX

A commercial audio switching device is required to permit the two separate amps to function as integrated amps. You can purchase a \$27.50 (Recoton) 4-position A/V selector switch from Parts Express or you can build your own switch using double pole, 6-position ro-

tary switch PN 275-1836 from Radio Shack with appropriate box and RCA connectors. I used a commercial unit to avoid unnecessary work. I drilled two holes at the edges/center of the box, so I could mount the box to the side of my cabinet using wood screws.

FIRST STAGE AMP

The first stage amp (Fig. 1) is a paralleled 12AT7 with a flat frequency response of 20Hz to 18kHz and a distortion of 0.7% with a 5V RMS output. The plate impedance is 5k Ω , and the paralleled sections have a voltage gain of 36. The 5V output is the value required for full power output from the amp. The DC supply is +318V DC, and 80V DC is provided to the plate via a 47k Ω resistor. The cathode voltage is 0.8V DC.

An input signal of 0.4V AC (triode-connected output stage) and 0.48V AC (UL-connected output stage) is required to obtain circa 5V AC output from the first stage amp and a maximum output from the power amp.

Note: When making the stage gain and distortion measurements of the first stage and inverter stage, loop feedback is not applied.

PHASE INVERTER

The phase inverter is a 5687 long-tail inverter with a flat frequency response of 20Hz to 20kHz. It uses a 33k Ω plate resistor on the grid-driven side and a 47k Ω plate resistor on the cathode-driven side to obtain equal output voltages from the inverter. The cathodes have a resistor of 8.2k Ω and operate at 87V DC. The DC supply is +472V DC.

The plate voltage via the 33K plate

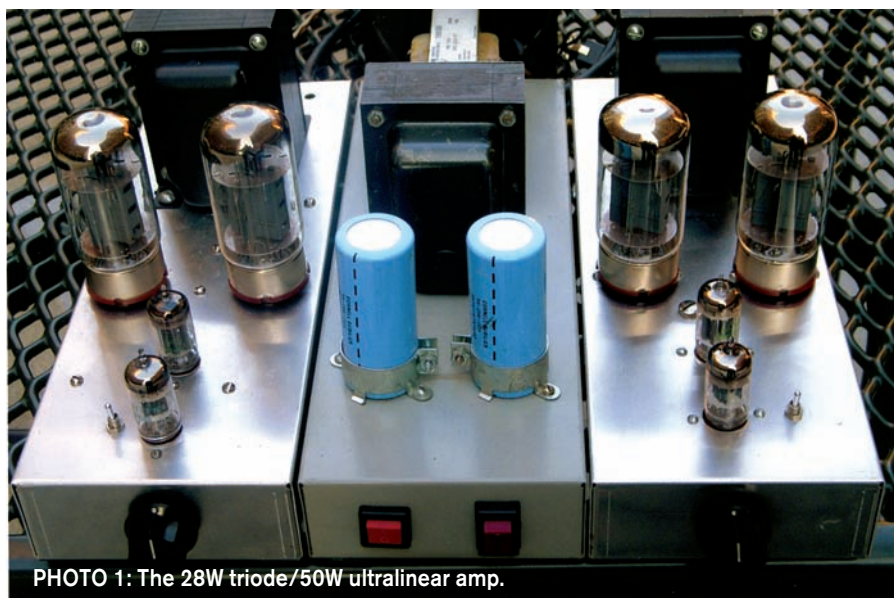


PHOTO 1: The 28W triode/50W ultralinear amp.

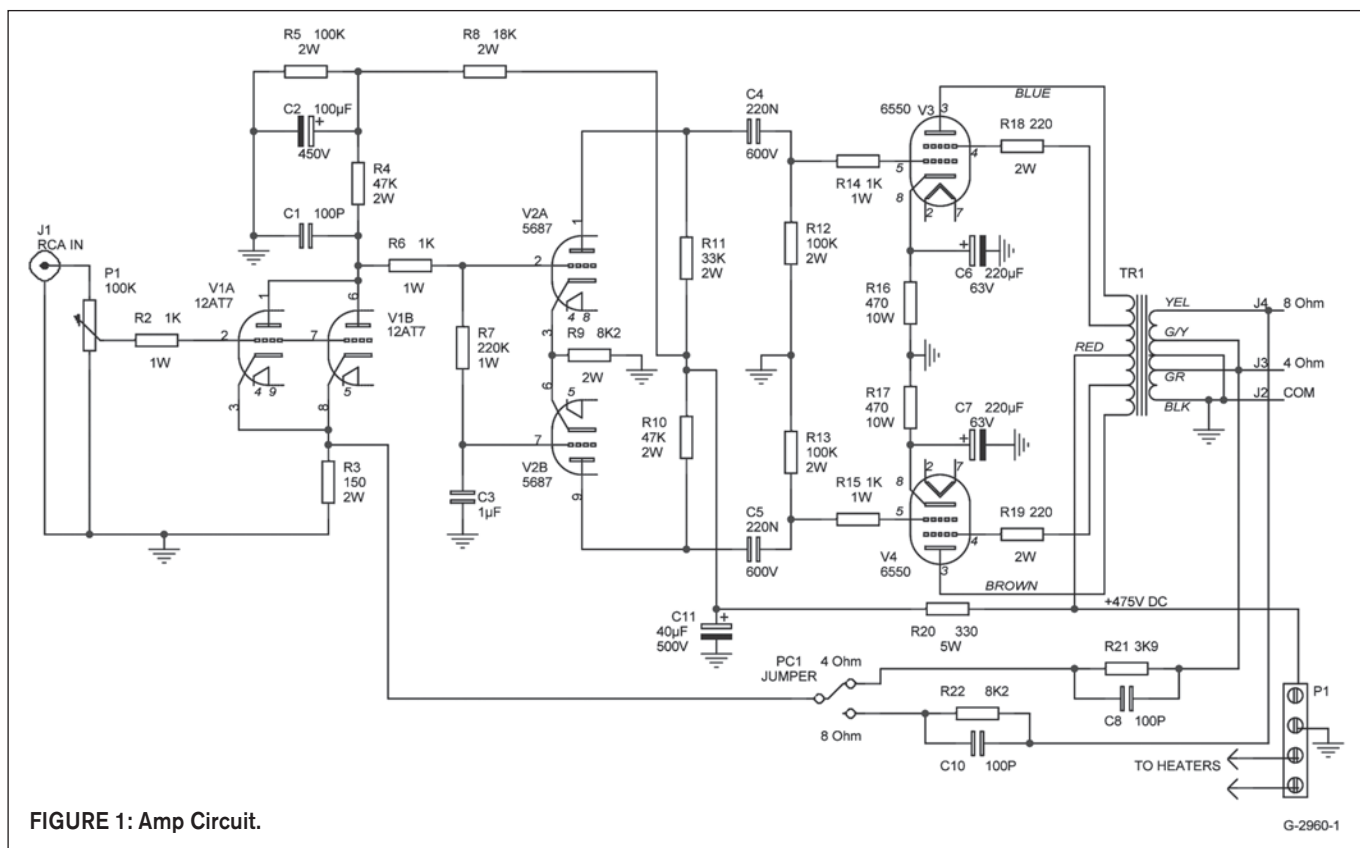


FIGURE 1: Amp Circuit.

load resistor is +268V DC, and plate voltage via the 47kΩ load resistor is 250V DC. The plate impedance at these operating parameters is 4000Ω. The input signal to the inverter is 5.0V RMS to obtain 36V RMS at the 6550 grids.

Inverter stage distortion is 0.5% (grid-driven side) and 0.85% (cathode-driven side) at an output signal of 36V AC.

Note: I recommend you connect the amp in either triode or UL mode and leave it in that mode. It has been my experience that listening establishes a preference.

28W TRIODE POWER OUTPUT STAGE

The power amp stage includes 6550s connected in a push-pull triode configuration. The 6550 output stage requires 36V RMS signal drive for the grids of 6550s to obtain a 28W output. The 6550s employ isolation resistors on the grid and screen to ensure the tubes are free of unwanted signals. The screen grid is connected to the plate via a 220Ω, 2W metal oxide resistor for triode operation. A 470Ω 10W resistor is connected to each 6550 cathode to provide a +50V DC bias voltage. The Ebb is +475V DC and the Eb (plate to cathode) is 430V

DC. See **Table 1** for plate dissipation and plate current information.

Operating at this level, the sonics of the sound are greatly improved; this is commonly referred to as the “sweet spot” and occurs circa the design center maximum level, and no color of the plates is observed. The distortion of the amp without feedback is 1.6% at 1kHz-28W. With 12dB of loop negative feedback at 1kHz, the distortion at 28W is 0.5%.

TABLE 1: TRIODE TUBE DATA

6550 CLASS AB1 (PUSH-PULL-TRIODE)	
Ebb	475V
Eb*	430V
Ek	44.7 to 46V
Rk (each tube)	470Ω
Audio Signal Drive (maximum)	36V RMS
Load Resistance (plate-to-plate)	4300Ω
Ib (zero signal)	188mA
Ib (maximum signal)	194mA
Power Output	28W
Plate + Screen Dissipation (per tube)	40W (no signal)
Plate + Screen Dissipation (per tube)	28W (maximum signal)
Harmonic distortion at 1kHz, no feedback	1.6%
* Plate to cathode voltage	

The damping is excellent, as 2.8V AC at the 8Ω secondary increases to only 3.1V AC when the 8Ω load is removed.

The negative feedback loop of the 8Ω secondary winding uses an 8.2kΩ resistor, and the 4Ω tap uses a 3.9kΩ resistor. For proper operation of the feedback loop, select the 4 or 8Ω secondary outputs.

Comment: The triode power amp shows no sign of ringing with a 10kHz square wave when a 0.1μF capacitor is placed across the secondary winding of the output transformer.

Caution: Before applying power to the amp, make certain the 100K grid resistors are connected between the 6550s grids and ground. This precaution will prevent catastrophic failure of the 6550s output tubes.

50W ULTRALINEAR POWER OUTPUT STAGE

The power amp stage includes 6550s connected in a push-pull UL configuration. The 6550 output stage requires 36V RMS signal drive to obtain a 50W output. As in the triode mode, the 6550s employ isolation resistors on the grid and screen to ensure the tubes are free of unwanted signals. The screen grid is

connected to the UL winding via a 220Ω , 2W metal oxide resistor for UL operation. A 470Ω 10W resistor is connected to each 6550 cathode to provide a +45V DC bias voltage. Also as in the triode mode, the Ebb is +475V DC and the Eb (plate to cathode) is 430V DC. See **Table 2** for plate dissipation and plate current information.

The distortion of the amp without feedback is 3% at 1kHz-50W. With 12dB of loop negative feedback at 1kHz, the distortion at 50W is 0.8%. The damping is excellent, because the measured 2.8V AC at the 8Ω secondary increases only to 3.2V AC when you remove the 8Ω load.

As in the triode mode, the negative feedback loop of the 8Ω secondary winding uses an $8.2k\Omega$ resistor and the 4Ω tap uses a $3.9k\Omega$ resistor. For proper operation of the feedback loop, select the 4 or 8Ω secondary outputs.

Like the triode amp, the UL amp is free of ringing at 10kHz when a $0.1\mu\text{F}$ capacitor is placed across the 8Ω secondary. And the same caution before applying power to the triode amp also applies to the UL amp.

TABLE 2: UL TUBE DATA

6550 CLASS AB1 (PUSH-PULL-UL)	
Ebb	475V
Eb*	430V
Ek	45 to 52V
Rk (each tube)	470Ω
Audio Signal Drive (maximum)	36V RMS
Load Resistance (plate-to-plate)	4300Ω
Ib (zero signal)	190mA
Ib (maximum signal)	220mA
Power Output	50W
Plate + Screen Dissipation (per tube)	41W (no signal)
Plate + Screen Dissipation (per tube)	22W (maximum signal)
Harmonic distortion at 1kHz, no feedback	3.0%

* Plate to cathode voltage

OUTPUT TRANSFORMER

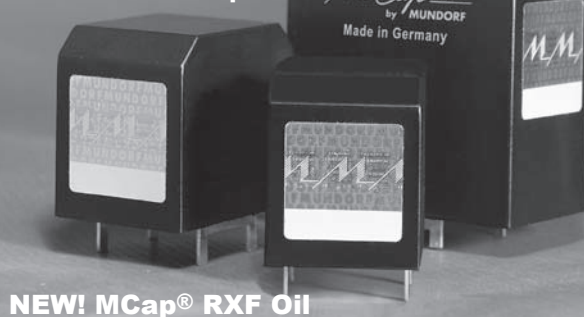
The 1650N-output transformer is rated for an output of 60W. The transformer has a 40% tap on the secondary winding to permit UL operation. The transformer provides excellent fidelity and required a well-thought-out design to operate over a frequency range of 30Hz to 20kHz. To obtain this frequency range from a (\$79) transformer (weight 6.8 lbs) with such a large amount of iron and large circumference coil is indeed commendable. This transformer also measured well in square wave testing.

Comment: My philosophy is to design affordable hi-fi equipment for the audiophile, and Hammond transformers met that requirement.

POWER SUPPLY

The power supply contains the power transformer, heater transformer, capacitors/resistors, switches, and a low noise 80cfm blower fan (cools the power transformer and output tubes). The front of the chassis has separate heater and high voltage switches to permit applying heater power prior to applying high voltage. The rear of the chassis has a power connector, power cord, and fuse. The power supply provides power for two push-pull power amps described in this article. The 80cfm fan is located directly behind the filament and power transformer.

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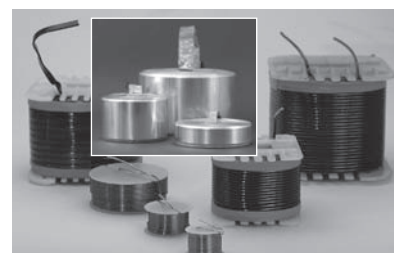
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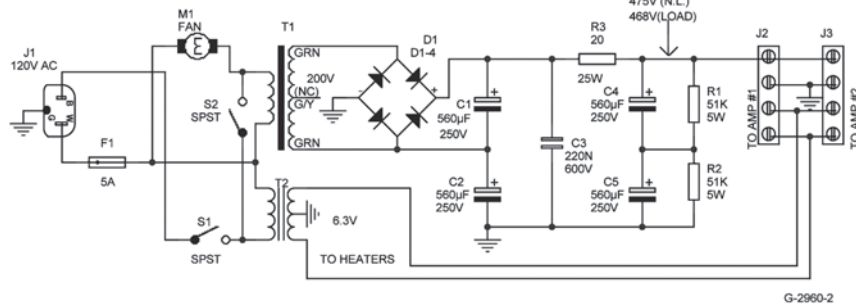


FIGURE 2: Power supply.

TABLE 3: TRIODE POWER AMP DISTORTION WITH 12DB FEEDBACK

Triode Operation				
	5W	10W	20W	28W
35Hz	0.18%	0.22	0.66	0.84
100Hz	0.13	0.15	0.55	0.68
1kHz	0.08	0.10	0.4	0.5
10kHz	0.09	0.15	0.45	0.6
15kHz	0.12	0.20	0.5	0.65

Parts List of Power Supply (do not double parts)

Part	Source
M1, Fan, 80 cfm, 4.7 in ² × 1" thick, "low noise" (Specifications Typical)	—
D1-4, Diode Rectifier, 1A, 1000V, P-Q1N4700 (4)	AE
S1-S2, Switch, Rocker, 6A at 250V, SPST, .71" hole (2) 112-R13-130A	Mouser
220N, 600V, C-RD22-600	AE
560µF 250V 5985-380-250V561 (4)	Mouser
20Ω 25W wire wound 280-CR25-20	Mouser
51kΩ 5W metal oxide 286-51K-RC (2)	Mouser
T1, Heater transformer, 120V to 6.3V center-tapped, 10A, Hamm. P-T166S6	AE
T2, Plate transformer, 120V to 200V, 870mA, Hamm. P-T167H200	AE
J2-J3, Socket Jones, Female, 538-23041 (2)	Mouser
Five Lug Tie Points, 4 per pack (also for amps) (5)	RS
Chassis box, aluminum, 17 × 10 × 3", P-H1444-32 (3) (also for amps)	AE
Fuse holder	—
F1, Fuse, slow blow, 250V 5A	—
J1, Line cord (3 wires, 14 AWG, 6'S-W206	AE

Parts List of Amp (double for stereo)

Part	Source
220Ω 2W metal oxide 262-220 (2)	Mouser
330Ω 5W wire-wound 280-CR5-330	Mouser
470Ω 10W wire-wound 280-CR10-470 (2)	Mouser
1000Ω 1W carbon film 294-1K (4)	Mouser
150Ω 2W metal oxide 262-150	Mouser
3.9kΩ 1W metal oxide, 261-3.9K	Mouser
8.2kΩ 2W metal oxide 262-8.2K (2)	Mouser
18kΩ 2W metal oxide 262-18K	Mouser
220kΩ ½W carbon 3BJ500-220K	Mouser
33kΩ 2W metal oxide 262-39K	Mouser
47kΩ 2W metal oxide 262-47K	Mouser
100kΩ 2W metal oxide 262-100K (3)	Mouser
100K audio taper, single, R-V38-100KA	AE
100pF 500V silver mica C-SM100 (3)	AE
1µF 250V polypropylene 5869-250V1.0-F	Mouser
0.22µF 600V polypropylene C-RD22-600 (orange) (2)	AE
40µF 500V electrolytic C-SA40-500	AE
100µF 450V electrolytic 140-XRL450V100-RC	Mouser
200µF 63V electrolytic 647-TVX1J221MCD (2)	Mouser
5687, double triode	AE
2AT7, double triode	AE
6550C-WC, power Pentode, Winged C (matched) (2) Note: Order extra 12AT7 and 5687s in case of defective tube. T1- Output Transformer, P-T1640N Push-Pull, 60W, Primary Impedance 4,300Ω center tapped, Secondary 4,8,16Ω, 20Hz to 20kHz (±1dB maximum at 60W), weight 6.8 lbs.	AE
9-pin ceramic tube socket, PST9-162 (2)	AE
Octal tube socket, PST8-209MIP (2)	AE
J1, RCA Jack, Gold Plated, 274-852	RS
J2, Binding Post, Insulated, Back, 15A, 530-111-0103-1	Mouser
J3, Binding Post, Insulated, Yellow, 15A, 530-111-0107-1	Mouser
J4, Binding Post, Insulated, Red, 15A, 530-111-0102-1	Mouser
P1, 4- Plug Jones, Male with Hood, 538-13041	Mouser
4-Wire Cable, # 16, 6'	—

The power supply (Fig. 2) has a 6.3V AC center-tapped 10A heater transformer and a 200V AC 870mA plate transformer. The plate supply has a full-wave bridge with two 560µF capacitors functioning as a voltage doubler circuit. In a voltage doubler application, the current rating of the transformer is reduced to 435mA. The final filtering of the +475V DC is provided by two 560µF capacitors connected in series with a 51K resistor connected across each capacitor. The series-connected 51kΩ resistors function as a bleeder.

The AC ripple of the +475V DC output of the power supply is 3.9V AC. The ripple at the 40µF capacitor of the inverter is 1.6V AC and 0.2V AC at the 100µF capacitor of the driver. The plate and heater transformer furnishes power to R and L channel power amps. The 12AT7 and 5687 heaters are paralleled for 6.3V AC operation.

Important: To prevent electrolytic capacitor burnout, separate switches are provided for the filament and high voltage circuits. The high voltage switch is connected to the output side of the heater switch so it can never be turned on unless the heater switch is set to the on position.

The triode amplifier frequency response at 28W is flat from 30Hz to 20kHz (Table 3). The 1kHz and 10kHz square waves at 28W are reproduced perfectly and the 100Hz square wave shows a moderate amount of tilt. Sensitivity is 0.4V RMS for 28W output and 0.24V RMS for 10W output.

The UL amp frequency response at 50W is flat from 30Hz to 18kHz. The 1kHz and 10kHz square waves at 50W are reproduced perfectly, and the 100Hz square wave shows a moderate amount of tilt. Sensitivity is 0.48V RMS for 50W output and 0.22V RMS for 10W output.

Caution: If the amp squeals when it is first turned on, reverse the plate leads or the 5687 output coupling capacitors. Use an inexpensive speaker during the initial turn-on.

FORCED-AIR COOLING

Photo 2 shows an 81cfm (noise 33dB) fan located directly behind the filament and power transformer. The fan also cools the four 6550s. Use mounting feet on the bottom of the chassis to give good under-chassis airflow.

CONSTRUCTION TIPS

Use an aluminum chassis and not a painted steel chassis to ensure good grounds and ease of hole punching. Do not use a common ground bus. Use single ground lugs and the ground lug of the five-position terminal strips for all grounds. All audio signal leads over 3" must use a shielded lead grounded at the input end. A short ground path is provided for the plate, grid, and cathode circuits.

Use a shielded cable (although not required) for the inverse feedback lead. Use 16 AWG hook-up wire for the R and

L channel heaters of the amp. Mount the 6550 tube sockets so the centers of the socket are about 3" apart. The four-conductor cable has wires from one end connected to the B+, chassis ground, and heaters of the amp and the wires from the other end connected to 4-pin, male Jones plug, P1. *aX*

WARNING: Lethal voltages are present! Exercise extreme caution when constructing and testing the amp. Never leave the amp upside down when children are present.

**TABLE 4: UL POWER AMP
DISTORTION WITH 12DB FEEDBACK**

UL Operation					
	10W	20W	30W	40W	50W
35Hz	0.20%	0.28	0.50	0.90	1.5
100Hz	0.15	0.26	0.30	0.56	1.0
1kHz	0.16	0.22	0.30	0.48	0.8
10kHz	0.18	0.26	0.32	0.60	0.96
15kHz	0.19	0.28	0.38	0.76	1.1



PHOTO 2: The amp with fan shown in back.

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A Line-Cleaning Filter, Pt. 2

This approach to cleaning power lines employs a filter circuit.

In part 1 (Aug. '08), I reviewed why you may need to clean up your power lines and looked at a simple voltage booster. In this article I begin to explore more ways to clean the noise.

I prefer to use a separate circuit for a line-cleaning filter. The equipment that does best with a filter does not always need the extra voltage. Two boxes allow me to use them both to best advantage.

The simplest filter can be a resonant circuit, which is formed by placing a capacitor across an inductor. The current travels from the capacitor into the inductor and back again. This is called a circulating current.

If the capacitor and resistor were perfect, this flow would never stop. That means that if you just fed this from an AC current source, the voltage would continue to rise until something blew up. Of course, I am connecting it to a fairly stiff voltage source, so I am trying to approximate the immovable object meets the immutable force, and hope I win.

You know that when inductive and capacitive impedances are equal, they are resonant. I chose to use a 72mH inductor, which gives me an impedance at 60Hz of $(2\pi f * L)$, or 27.14Ω. This will limit the current drawn from a 120V 60Hz AC line to 4.42A. A capacitor with an impedance of 27.14Ω at 60Hz would be $(1/2\pi f * C)$, or 97.7μF.

Even though both the inductor and capacitor draw current, they only dissipate a small amount of power. Perfect components would dissipate none! The energy stored in the inductor would be $\frac{1}{2} * L * i^2$, or .7 joules per peak, which should be enough to make up an 84W shortage!

PARTS SELECTION

The problem with this approach is the

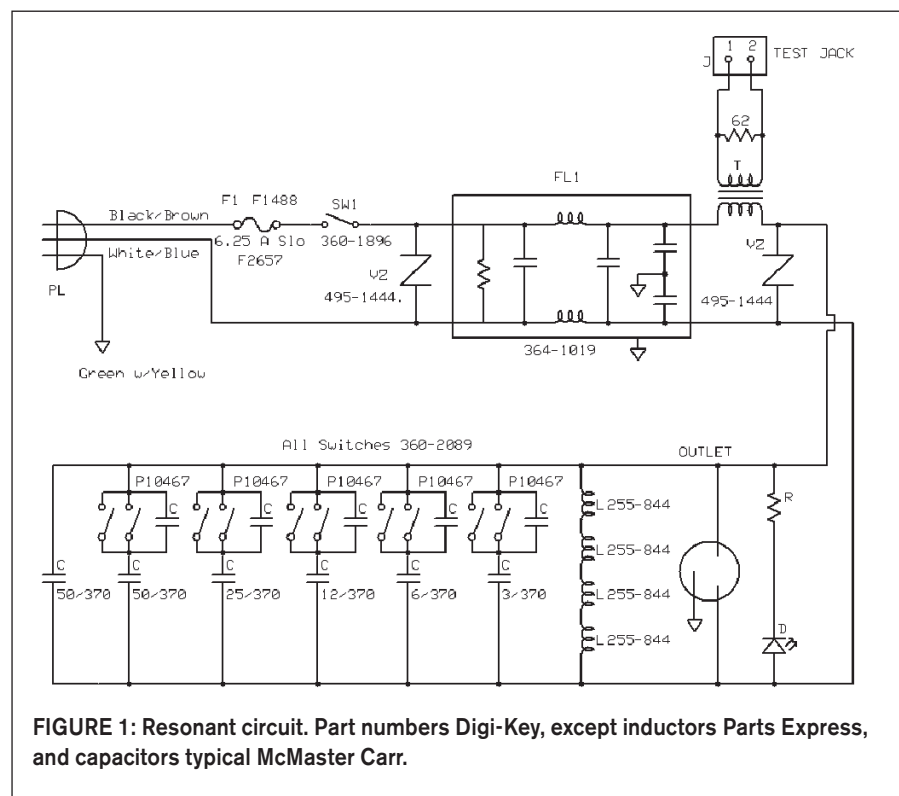
hidden components. To a small extent, the capacitance of the wiring in the AC supply will add to the designed storage capacitor. Much more important, the inductance of the power transformers in the audio equipment will have their inherent inductance placed in parallel with the storage inductor, effectively reducing its value. I will need to add capacitance to correct for this.

To accommodate these unpredictable variables, I made the resonant capacitor adjustable (Fig. 1). In addition, I included a current monitor. The resonant capacitor is made up of many smaller units. These capacitors are basically binary weighted to minimize the number required.

I picked commonly available motor-run-type capacitors in a sealed metal can.

These are available from most industrial suppliers. The capacitors in Fig. 1 are from my semi-local supplier; Grainger or your local motor shop will also have these. Check to see whether the mounting strap is included or is extra. Because the current in these capacitors will be many amps, do not try to use ordinary metalized film capacitors. The voltage here is at least 370V peak-to-peak under good conditions; skimping on these parts is not only a bad idea but is a safety issue.

The inductors presented a bigger problem. I could not find an inductor rated for this kind of service. Not only is the voltage breakdown an issue, but so is the resistance of the windings. As the current keeps going round and round, whatever resistance just dissipates



energy, making the coils become warm. In addition, because these are iron-core coils, there is a current limit at which the inductance drops.

If you ever built a telegraph out of a coil wound on a nail and a piece of tin can as a child, you probably wondered if adding more turns to the coil made it work better. If you added lots and lots of turns, you were probably surprised to find out that after about 20 turns of wire on the nail, your electromagnet did not become stronger. That is because once you have magnetized the iron all the way, there is no more to magnetize. This limit occurs in all transformers and inductors. The higher the current, the less time it takes for the magnetic core to saturate. All the extra energy is available to become heat.

I am using Jantzen inductors from Parts Express rated at 700W, but no frequency for this power level is given. That is why I used four coils in series. It gives more power handling and a higher inductance, which lowers the circulating current and voltage across each coil. Note that these inductors are not de-

signed for this service. The insulation is not rated for this use. You must be sure they are insulated from each other and from ground so that each coil effectively sees only 30V. The coils will hum because they are not fused or varnish impregnated coils.

To reduce the noise and make mounting them easier, I encapsulated my inductors by filling medium-size disposable plastic food containers from the grocery store with half of a cartridge of silicone window and door seal caulk. Wearing latex gloves, I then pressed the coils into the goo and smoothed out the tops. A bit of round scrap plastic pressed into the center made my mounting hole. The silicone rubber compound took a few weeks to set enough for use.

There is also an important issue with iron-core inductors: The magnetization versus current curve is not linear. That means that depending on the current, the inductance will change. Four inductors in series means more iron, less current and so less swing. You could, of course, use a larger inductor if you can find one for this use; be sure to reduce

the capacitor appropriately.

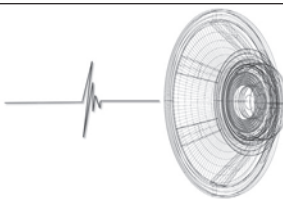
CIRCUIT OPERATION

This circuit really needs to resonate smoothly at 60Hz. It will pull current from the line to do this. When the voltage sags at the top of the cycle, this circuit will then push current back into the line raising the voltage. The capacitor also acts as a low-pass filter for noise on the AC line.

One downside of the resonator is that the energy it puts back goes both to the outlet where your equipment is connected and back into the wall outlet to try and fix the rest of power service. This problem is reduced by the inductance of the filter, the resistance, and the inductance of the building wiring. These hidden components here work to your advantage.

Taking in energy and putting it back out each and every cycle is work. The internal resistance of the inductor and the dissipation of the capacitor cause some of the work energy to become heat. The capacitors I chose have a very low dissipation factor (.005) at 60Hz, and the in-

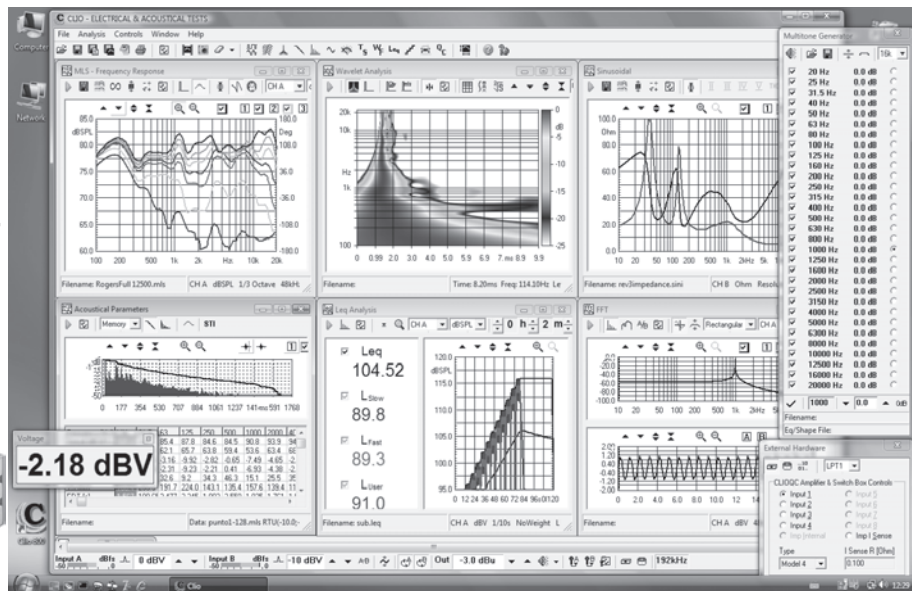
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ductors have low DC resistance (.174Ω). These parts barely become warm in my version. If you get the wrong parts or try for too much energy storage, this circuit can become quite hot!

If you try this filter circuit, you will note that there is some buzz from the inductors, which gives a nice sense that there is lots of energy here. The capacitors should come with a note that the oil inside is flammable. That strongly suggests using a quality metal case and mounting the inductors with nonflammable materials. Also, do not use a piece of bare wire as a tie wrap to hold the coils in place. That would make the coil a shorted transformer!

There is a great place to put a cleanup resonator such as this: after the loosely coupled power transformer inside of your preamplifier or source. Keep in mind you must size the power transformer for the extra circulating current this will add. Very few transformers specify their inductances. You could measure it with a bridge, but the more accurate method is to use a capacitor box to determine the best value based upon the current draw of the input to the transformer. The voltage rating of the winding used and the final capacitance determine the power storage. As far as I know, no one does this commercially.

You will probably choose to try this kind of filter on the power line that feeds your preamp, CD player, and tuner. Its back into the wall action will also help your other gear. I find that this circuit noticeably mellows my CD player's sound.

CONSTRUCTION

To build either power line cleaner, you will need a metal box. A great source is your local electrical supply house. Boxes are typically stocked from 6" x 6" x 4" to several square feet and come painted or galvanized; you should purchase a painted one. In addition to the box, the store will also have a suitable strain relief (called a straight liquid tight cord relief for a 1/2" knockout for the size of power cord you are using), the nut to hold the grip (sold separately), and even the outlets for this project. Be sure to pick up a box of yellow or even red wire nuts (the real ones—not the home center cheapies)—they might

just come in handy. I would also buy a round 14 gauge 8' extension cord for the inlet cord and use some of the extra for the internal wire. They also will carry THHN wire if you need more.

The boxes from electric supply houses come without any holes in them, so you must drill or punch your own holes. Be sure to also pick up outlets that mount in round holes! These are sometimes called clock outlets. The long name is a NEMA 5-15 straight blade single female receptacle.

The box will have at least a front that comes off and can be drilled and punched while completely flat. If you design your power supply correctly, you can drill all the holes you need with either regular twist drill bits or a stepped Unibit (also available at your supply house). The hole for your cord grip should be 5/8" and made by drilling a 3/8" hole and a 5/8" chassis punch (the supply house carries this as a 1/2" knock-out punch), or you can use a Unibit.

Place all your components on the plate, leaving room around the capacitors and inductors for ventilation. Once you know where you want the holes, mark the locations with a pencil or marker. Then use a center punch to make a dent for the drill bit before you try to drill any holes. Gloves are a great way to keep blood off your project while drilling. Safety glasses will let you admire your work later.

Pushing down hard with a big drill leaves the scars that show how macho you are. Go slowly and smoothly if you prefer clean work. Of course, a hand drill is fine for this, but a drill press is better if you can set it to the right speeds. 1500 surface inches per minute (not RPMs) is a good speed for steel. RPM = 475/drill diameter. Whenever drilling metal, a drop of oil before you drill should be a suitable offering to Vulcan to ensure a clean hole.

The AC outlet(s) require three holes with a 5/32" diameter. These should be in a line and spaced 1.640" apart (or 1 41/64" for those with 6" steel rules and adjustable dividers!). Enlarge the center hole to 3/8", then use a 1 3/8" (or 35mm) chassis punch. This (Mouser 380-0350) will give you a hole big

continued on pg. 41

continued from pg. 16

enough for the outlet. If you make a mess, just get a wall plate for your outlet and use it to enhance your skillful design.

Before you use a chassis punch (even brand new), you should always hone it. The chassis punch usually has three parts: the punch, the die, and the draw bolt. To sharpen the punch, first take everything apart. Put a piece of 400-grit silicone carbide waterproof sandpaper on a flat surface. I do not use water or oil. Then push the flat surface of the punch away from your body as you wipe it flat on the paper. After three strokes, turn it halfway and do the other side. Some folks prefer a figure-eight grinding pattern. Wipe off any grit and then put single weight oil (5 wt.) on both the punch and the draw bolt. You probably cannot find single weight oil, so use Mobil One. Do not use universal oil such as 3 in 1 or multi-weight automotive oil. The thickeners they contain tick off Vulcan.

If you do not want to use chas-

sis punches, you can use a nibbler—or even use a hole saw—to make the larger holes. There are two kinds of hole saws. The good ones have a drill bit in an arbor that holds the blade. The other kind has an adjustable blade and is referred to as a suicide cutter for good reason. Most hole saws are good for wood or metal if you use a lubricant. Be sure to screw your flat sharp metal plate to a large piece of wood before you attempt to cut the larger holes. Use four screws in the plate mounting holes.

Once you have finished your metal work, you should paint the case over the gray primer paint. One area of concern is where the preassembled filter mounts to the plate. The screw holes and area under the filter should be reasonably bare metal. Sand or scrape this area and then apply masking tape before you paint. You can leave the tape on until you are ready to begin wiring.

Hardware-store or home-center paints are fine. Auto-parts stores carry better paints. I use a fully ventilated spray booth that has an “explosion proof” exhaust fan and a cold LED light

source. You should paint outdoors on a calm day and leave the chassis outside for an hour or two. Second choice is a garage with the door open.

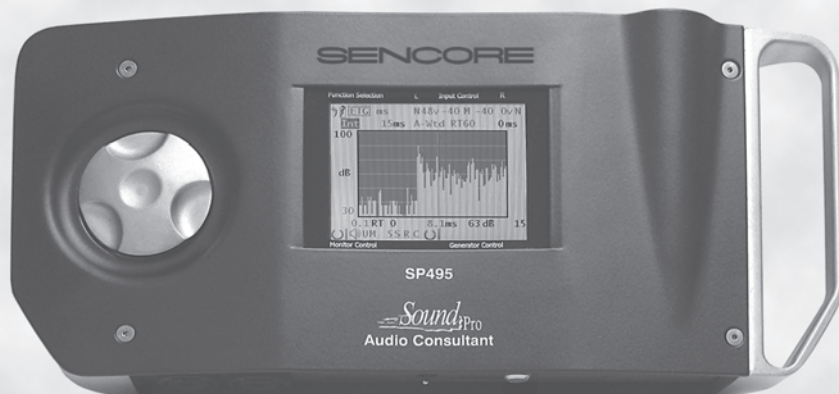
ASSEMBLY

Allow at least a day or two for drying. Then you can mount all the parts. I find 6-32 pan head Phillips machine screws are great for this. I use nuts with built-in lock-washers. Many of the parts will take fast-on connectors. I prefer to solder to all of the parts except the outlets, which will take a wire directly.

This project is great for a soldering gun! If you don't have one, use a large electric soldering iron; 25W is not going to be enough. The best place to begin to wire is with the power cord and then along to the output. You should wire the fuse holder so that the incoming line goes to the terminal at the back. The side terminal goes to the switch. Remember the notch in the switch's barrel is the “off” side. To mount the switches, use a wrench on the inside of the case for a flush-looking front panel without scratches.

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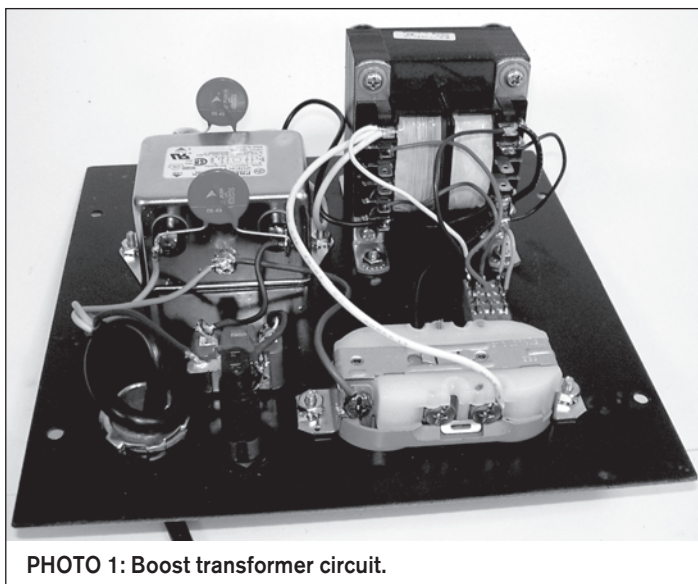


PHOTO 1: Boost transformer circuit.

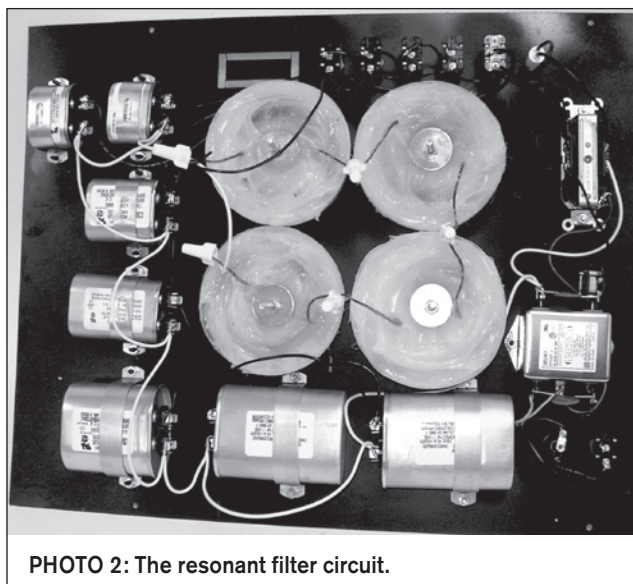


PHOTO 2: The resonant filter circuit.

Do not solder to the fuse holder when the fuse is in it! You can mount the MOVs on the filter's terminals so that you do not need terminal strips. The black AC hot wire goes to the brass terminal on the outlet(s). The white goes to the silver, and the green is ground. If you did not get mounting straps with your capacitors, you can fake them with

a strip of old tin can. When you are finished, remember to install the fuse.

These gizmos mounted in steel boxes with high magnetic fields will want to hum. If the case is not tight, the hum will become a buzz. You can use a bit of silicone rubber to form gaskets where this happens. Rubber feet will prevent this song from spreading to other gear. See the boost transformer circuit in Photo 1.

TESTING

Before you plug your project in, be sure to check for shorts across the line with an ohmmeter. If you correctly assembled the resonant filter, you may think you have a dead short across the AC line because the DC resistance of the inductors is so low. I measured 1.1Ω! It is

even more important to check for shorts to ground. I then plug everything in through my light-bulb box. I may see current drawn even without a load! That is because the output filter is trying to fix the incoming line!

To adjust the resonant filter circuit, turn on only the 60W lamp (Fig. 2). Plug in the filter without anything connected to it. I found that setting the switches to a value of 93μF caused the lamp to be at its dimmest. Adjust the capacitor bank switches when the power is off. Otherwise the extremely high circulating current will weld the switches closed. There are three reasons for the difference between the value I would have expected (97.7) and what worked: One, the value of the capacitors is slightly off; two, the inductors are not

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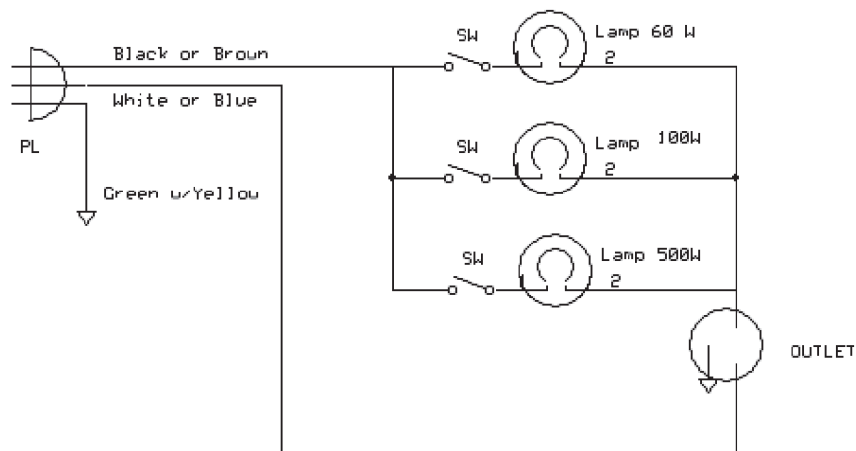


FIGURE 2: Light bulb test box.

quite on value either due to manufacturing or mounting; three, there is extra capacitance elsewhere that is coupling into the circuit. I, of course, used my bridge to check the capacitors and my un-mounted inductors. They both were well within tolerance.

After you first trim the capacitors, connect the equipment that you wish to serve. You may need to readjust the capacitor value (Power off while adjusting!). If you own a clamp-around ammeter, use it for adjusting the resonant capacitor bank. For those who do not own one, I have included a current transformer to make this easy. Just connect an AC voltmeter to the output and trim for the lowest reading. I got my minimum reading down to about 220mV. Hooked up to my audio gear, the required capacitance was about 120µF (Photo 2).

Now check that the output is the right voltage, which is harder than it seems. Your equipment may have been designed when the wall outlet was expected to be 110V, 117V, or even 120V. I design for a low line voltage of 108 and a high line voltage of 132V. The AC voltage from either circuit is now "stiffer" than an ordinary outlet; this will increase the turn-on surge. If your equipment was borderline, it may burn out the silicon rectifiers.

If your gear is classic, I would aim for 117 to 120 PRRI volts. If the voltage is higher, you may wish to put a thermistor inrush current limiter (Digi-Key 490-3942 to 490-3948) in series with the AC line going into your particular piece of equipment. With modern gear, I would be comfortable with line voltages of 126V or so. If you have saved and read the manuals, they may tell you that 130V is fine. Keeping a PRRI voltmeter here for the first few uses is a good idea.

These devices do not correct for changes in the incoming line voltage. If you built the filter version, this will act as a very stiff load and help flicker type of line bounces, but not brownouts. There are devices that use tapped transformers and switches to automatically adjust the output voltage even if the input voltage changes (brownouts!). I have not added this feature; you might want to try it.

To get the best out of either line cleaner, I would start off with only the preamplifier and music sources fed from a cleaned AC source. Then try just the power amplifier(s), and finally everything. Leave it set up whichever way you prefer.

There are several interesting variations in these basic designs. One is a transformer that actually lets the magnetic core go into saturation. A capacitor can then resonate with the inductance

of the transformer to re-circulate this excess energy. As the core saturates, the output waveform will not be a sine wave but will have constant peak-to-peak amplitude even as the input voltage drops. This design yields what is called a constant voltage transformer.

There is another method to clean up the AC line that does not use circulating currents or dissipate as much heat. I will examine that and other methods in Part 3. **ax**

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THE LOUDSPEAKER JOURNAL

Testing Loudspeakers: Which Measurements Matter, Part 1

Measurement factors to consider when designing a loudspeaker.

By Joseph D'Appolito

The controversy over subjective versus objective loudspeaker evaluation has raged on for decades. However, to my mind, there is no controversy. These criteria are simply two faces of the same coin. When describing how a loudspeaker sounds, using terms such as neutral frequency balance, musicality, midrange transparency, graininess, harshness, imaging, ambience, and others in the reviewer's lexicon is totally appropriate. As a loudspeaker designer, however, these subjective terms do not tell me how to design a loudspeaker.

Evaluating and comparing drivers, designing crossovers, and assessing cabinet geometry all require quantitative engineering data as part of an efficient and repeatable design process. So the question arises—of all the measurements available to the designer, which ones are the best predictors of listener preference?

In over 30 years of designing loudspeakers, I have found the following measurements taken as a group provide the strongest predictor of loudspeaker preference available to us today. These measurements are:

- On-axis frequency response
- Impulse response
- Cumulative spectral decay
- Polar response
- Step response
- Impedance
- Efficiency/Sensitivity
- Distortion
- Dynamics

Clearly, none of these measurements quantifies “musicality” or “transparency.” However, based on my experience, it is possible to relate these measurements either singly or in various combinations to some aspect of loudspeaker quality. Let's examine each of the above measurements in some detail. Where appropriate I will provide examples using the DAAS PC-controlled acoustic measurement systems.

FREQUENCY RESPONSE

No other single measurement correlates more strongly with listener preference than frequency response. There has been extensive experimental research in this area. Dr. Floyd Toole and his colleagues at the Canadian Research Council and later at Harman International Industries have conducted exhaustive controlled listening tests over a period of years using both trained and lay participants. This work is summarized in an excellent

white paper¹. I will not repeat the details here. However, one conclusion of this work is “that flatness and smoothness of high-resolution on-axis curves need to be given substantial weighting” in predicting loudspeaker preference.

Although in a much less rigorous study, John Atkinson, Editor of *Stereophile Magazine*, examined the measured frequency response of 320 loudspeakers reviewed for the magazine². He defined the standard deviation (SD) from flat response over the frequency range of 170Hz to 17kHz as a criterion for judging flatness of frequency response. He then asked the question, is there any correlation between this statistic and the chance that a speaker would be added or not to *Stereophile's* “Recommended Components” list? Of the 15 speakers with an SD of 1dB or less, 14 were added to the list by *Stereophile* reviewers. As Atkinson grouped the speakers into higher and higher SD brackets, the

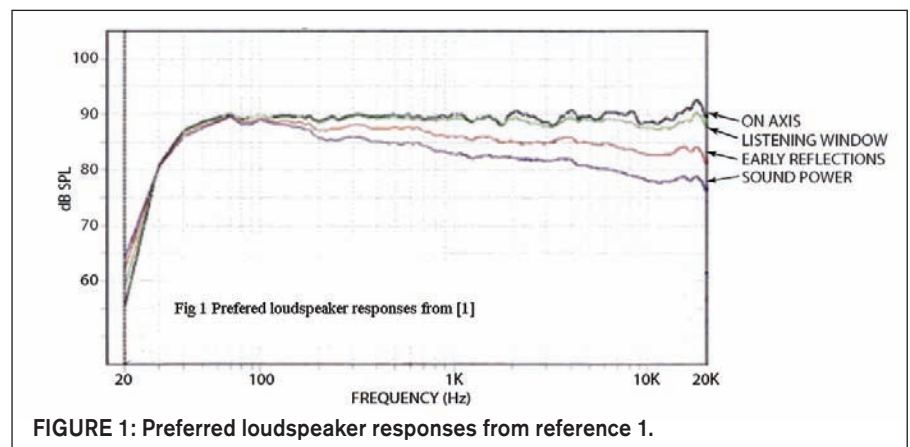


FIGURE 1: Preferred loudspeaker responses from reference 1.

Frequency ranges from 300Hz to 20kHz. The crossover frequency from the woofer to the tweeter occurs at 2.1kHz. Notice that frequencies above 5kHz decay very rapidly, being down by 20dB in less than a millisecond.

At first glance there appears to be a very slow decay of low-frequency energy. The plot shows substantial signal level below 500Hz at 4ms. Again, this is an artifact of the FFT processing. Remember that you are analyzing only the first 5ms of the impulse response. By the time you get out to 4msec, you are analyzing the last 1msec in the tail of the impulse response and the resolution is now 1000Hz. Data below this frequency is not valid. I'll discuss ways to improve low-frequency accuracy shortly.

Figure 3 represents a rather good loudspeaker. The CSD shows no significant resonances. Look at some more revealing CSD plots from lower quality loudspeakers. **Figure 6** depicts the frequency response of a small two-way loudspeaker used in a voice announcing (PA) system. You can see major response peaks at 1.4kHz and 14kHz and the

start of a third peak just below 20kHz. There are also many small ripples in the 6 to 10kHz range.

The CSD for this speaker is shown in **Fig. 7**. This plot covers a dynamic range of 20dB. Most prominent is that the broad ridge is associ-

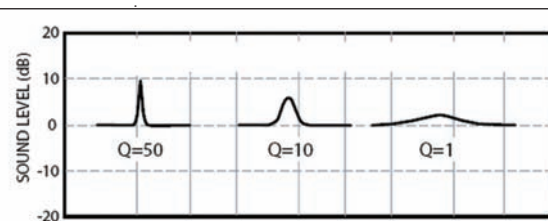
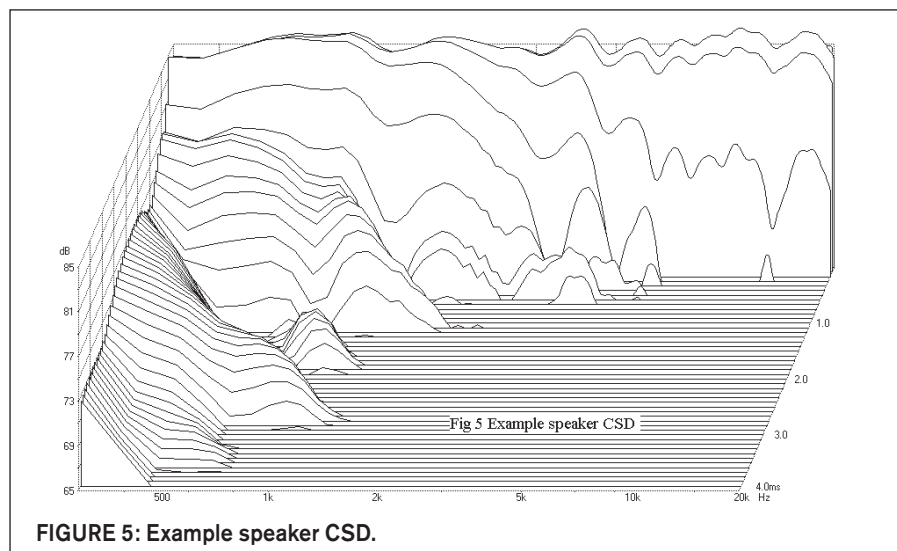


FIGURE 4: Detection thresholds for high, medium, and low Q resonances from reference 1.



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resonance shown in **Fig. 10** lasts for about 15 periods, which is a time span of 30msec. This extended time scale can lead to errors in the PCSD if the test is made in a reverberant enclosure. The 3kHz ridges run out to 37 periods, or about 12msec.

The CSD is made using a broadband pink noise input signal. With this signal all resonances will be excited, but with little energy in any particular resonance. The pulsed sine waves are relatively narrowband. If a sufficient number are used in the input sequence, one is likely to fall within the bandwidth of a resonance providing a high level of excitation. The PCSD provides better low-frequency resolution and finds higher frequency resonances possibly missed in the CSD. On the downside, the PCSD can be corrupted by echoes in a reverberant environment. Summarizing, the CSD and PCSD are useful tools in analyzing loudspeaker resonant responses. They often reveal subtle resonances not immediately obvious when viewing frequency response plots alone.

DIFFRACTION RESPONSES

I mentioned that diffraction effects can also produce response peaks and dips. These peaks and dips may persist in the CSD and be confused with resonances. Fortunately, diffraction responses are angle dependent and can often be isolated by looking at off-axis responses.

So far all the frequency response plots of my example loudspeaker have been taken with the grille off. **Figure 11** compares the on-axis responses both with the grille on and with the grille off. Relative to the grille off response, you can see severe response dips at 3, 5, and 14kHz and a broader peak at 12kHz.

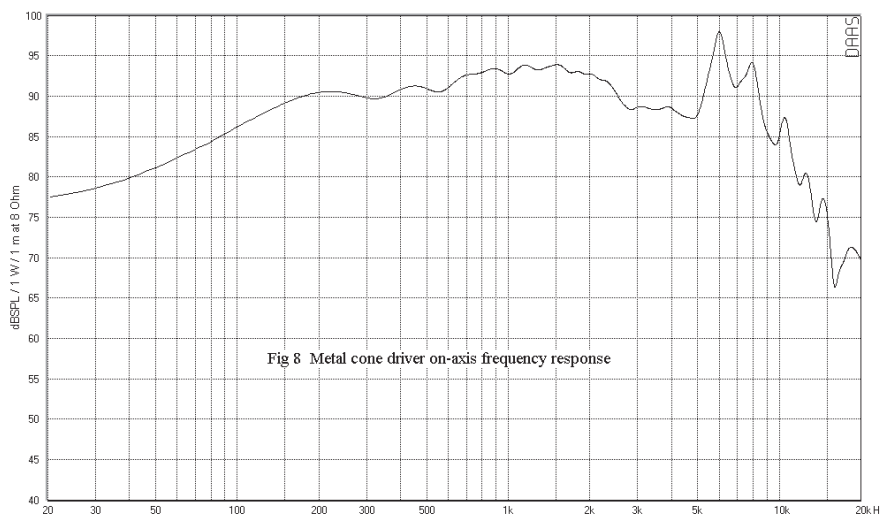


FIGURE 8: Metal cone driver on-axis frequency response.

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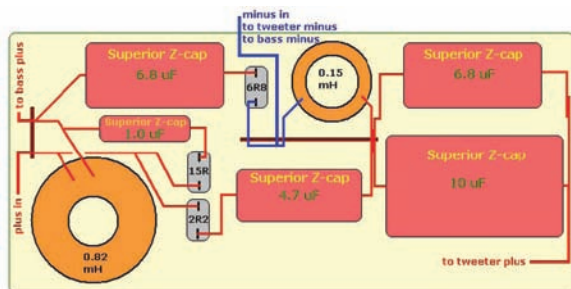
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Figure 13 is a plot of the power cepstrum for my example loudspeaker taken with the grille on. There are several spikes in the cepstrum plot. In my diffraction example the inside edge of the grille frame edge is 5.5cm from the tweeter axis, so the diffracted wave is approximately 160µsec behind the main response. You can see a point on the cepstrum plot at 160µsec. Interestingly, the cepstrum also tells us that there is a second reflection off the outside edge of the grille at 210µsec.

You must be careful in interpreting the cepstrum. To see the delayed response clearly, the initial impulse response must have decayed sufficiently so as not to hide the delayed response. The earlier spikes in the plot of Fig. 13 are from the initial impulse and do not represent reflected or diffracted responses.

Next month we'll continue our look at those measurements that best determine listener preference.

REFERENCES

1. Toole, Floyd E., "Audio-Science in the Service of Art," available at www.harman.com/about_harman/technology_leadership.aspx.
2. Atkinson, John A., "Measuring Loudspeakers, Part Three," *Stereophile*, January 1999, available at www.stereophile.com.
3. D'Appolito, Joseph A., *Testing Loudspeakers*, Audio Amateur Press, 1998, www.audioXpress.com.
4. Toole, F.E., and S. E. Olive, "The Modification of Timbre by Resonances: Perception and Measurement," *J. Audio Eng. Soc.*, vol. 36, pp. 122-142 (1988 March).

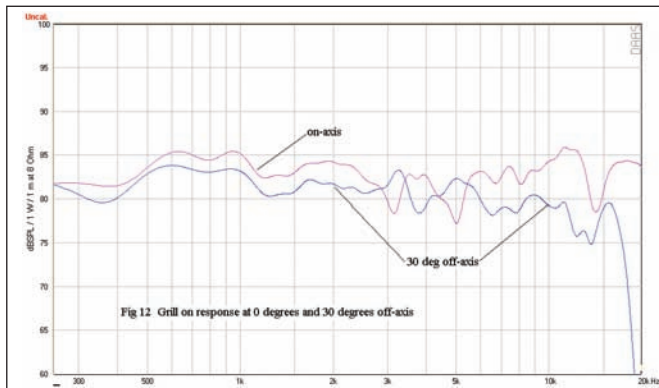


FIGURE 12: Grille on response at 0° and 30° off-axis.

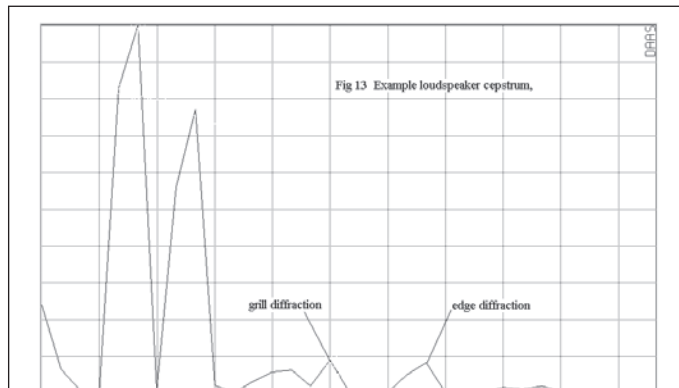


FIGURE 13: Example loudspeaker cepstrum.

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change as you go off-axis, giving a lumpy off-axis response. So the dilemma is that with no tweeter setback, there is too much delay dispersion, and with complete setback, a poor frequency response.

An answer is to use a tweeter setback of 100μs less than complete, or, in this case, 110μs (1.5") of tweeter setback. This gives the tweeter step response time to settle (mostly) before the woofer step response gets going (mostly), yielding a step response and frequency response that are mostly unmarred⁴. Specifically, for the drivers chosen I measured less than 1dB in frequency response changes because the delay dispersion was reduced to 100μs by moving the tweeter back 1.5". Granted, results will vary with different drivers, and lower crossover frequencies will need a larger tweeter setback.

Tweeter setback works for any crossover, improving delay dispersion. A popular choice is 0.75", but it is usually not optimum.

The 24dB per octave L-R crossover is not the best choice for low delay dispersion. Lower order filters would have less mid-bass delay. A Bessel filter would re-

sult in a more uniform delay. But I prefer the results with the 24dB per octave L-R crossovers, because their faster rolloff gives less acoustic interaction between the mid-bass and tweeter. By using tweeter setback, I can get steep slope crossovers and a desirable delay dispersion.

To measure delay dispersion I feed a step waveform, or a 2Hz square wave, to a loudspeaker. I use a step generator (of my own design) to generate the step, but a Sound Strobe, or even a function generator generating a square wave at 2Hz, will do as well. Any measurement mike (including those in the Radio Shack sound level meter) will do. The oscilloscope you use to measure delay dispersion should have a delayed sweep and good brightness.

For frequency response tests I use a pink noise generator and Real Time Analyzer (RTA) and the same measurement mike. I usually put the mike just in back of the chair I sit in, which is 72" from the loudspeaker under test. I don't put much faith in the measurements below about 500Hz, because the room response will cause peaks and valleys in the RTA.

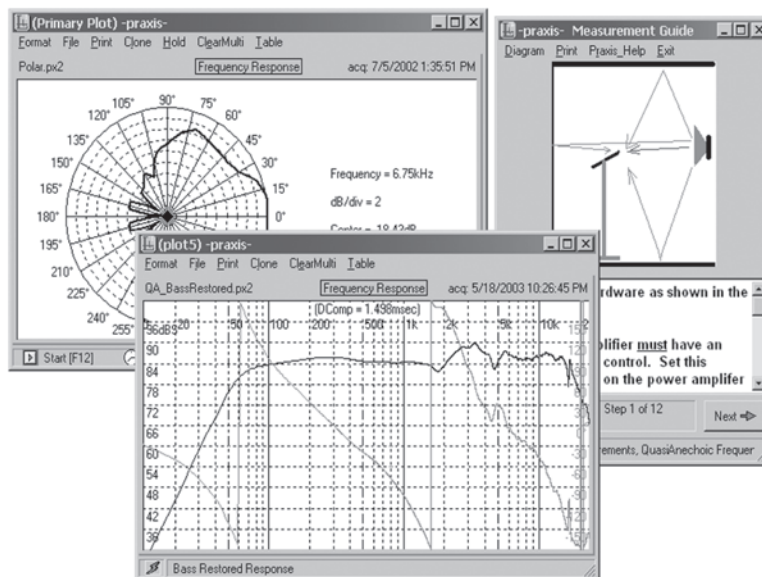
You can use passive crossovers with

tweeter setback, but I prefer active cross-overs because of their ease of experimentation. I like the Behringer DCX2496, which is digital, very flexible, low noise (both mechanical and electrical), and small. I try to use digital processors sparingly, because I have had problems with digital processors when I ask them to do too much. For example, I could generate the tweeter setback with the DCX2496, but I prefer to mechanically move the tweeters back the 1.5". I appreciate the digital world, and I am glad I helped it to come along in my lifetime, but as they say, it takes a digital device to really screw up your signal.

Why not use setback for subwoofer/mid-bass? The answer is that the subwoofer/mid-bass crossover is about 100Hz, and the driver imperfections have much smaller consequences at 100Hz than at 3.5kHz. An imperfection (such as the center of sound radiation) might cause 1" setback at 3.5kHz, which is a significant 92° of phase shift at 3.5kHz. The same 1" setback will cause an insignificant 2.6° of phase shift at 100Hz.

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A Step Forward

By Dennis Colin

There's something about live percussive sounds that grabs your attention even if the source has been reflected or diffracted around obstacles. For example, a spoon dropped in another room, a fire engine bell heard from inside your car, or a neighbor playing drums—despite the long path colorations, you *know* it's a real, physical object.

That's because the ear is extremely well acclimated to (therefore, can "tune out") the effects of reflections and diffractions. We still hear the initial attack transient, which if reasonably coherent in time, says, "I'm a *real* spoon, bell, or drum!"

Dick Crawford's combination of time coherence (via tweeter setback) and spatial coherence (via the symmetrical MTTM configuration) should, with well-recorded music, convey a superior sense of realistic immediacy.

Regarding transient response, I would say that Mr. Crawford's "setback" is a "step forward." ■

CABINET FOR TWEETER SETBACK

I designed a cabinet to accommodate tweeter setback. It is 24" high $\times$ 11.25" wide $\times$ 12.25" deep. The front panel has two mid-bass and two tweeters in an MTTM sequence⁵. The dual tweeters have the same advantages as dual mid-bass, namely, increased power handling, increased efficiency, lower distortion at the same sound level, and increased vertical directivity. However, MTTM cross-overs can become complicated.

The two tweeters are in a cavity (or recess) of 6" H $\times$ 6" W $\times$ 8" D (internal dimensions). I have built front panels with larger cavities to accommodate larger tweeters, such as planar tweeters.

Of course, you can use this cavity for a single tweeter in an MTM arrangement, and still achieve tweeter setback. This cavity is in the center of the front panel. The mid-bass drivers are mounted at each end of the front panel. There is usually enough room for up to 7" mid-bass drivers, but you must measure carefully.

I attach the tweeters to a separate bracket (made of wood 1×4 s), and then

I slide this bracket (with the tweeters) in and out of the cavity to achieve the desired tweeter setback. Then you can fasten the bracket in place in the cavity. I then put sound-absorbing foam around the tweeters, which thus have low reflections from the cabinet. You can attach a grille cloth to the front panel.

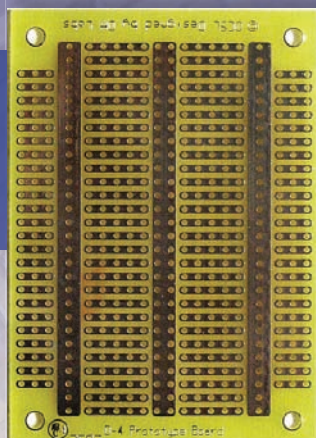
I use the same size cabinet for a 10" subwoofer. For the subwoofer, the driver is mounted near one end of a flat front panel (24" H x 11.25" W). I then place the subwoofer vertically with the 10" driver near the floor, and stack the MTTM cabinet on top, giving a 48" high tower. I put foam rubber between cabinets to reduce vibration. The cabinets should be tied together at the back to reduce the chance of the top cabinet sliding off, crinkling your toes.

Figures 1 and **2** show a sketch of the MTTM cabinet, along with the wood dimensions. All of the wood widths and thicknesses are standard and available at lumberyards or DIY stores. The front panels are available cut to length at Lowes. The sides are 1" thick stair treads, cut in half. Stair treads can be in oak,

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I have a stereo pair of these loudspeakers, with the following features:

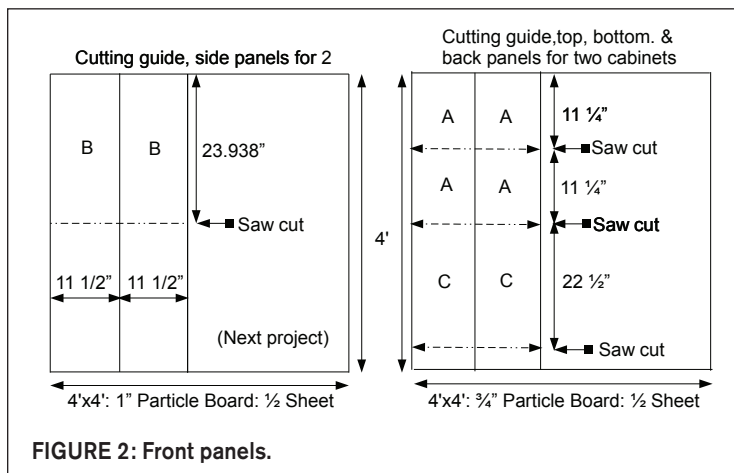
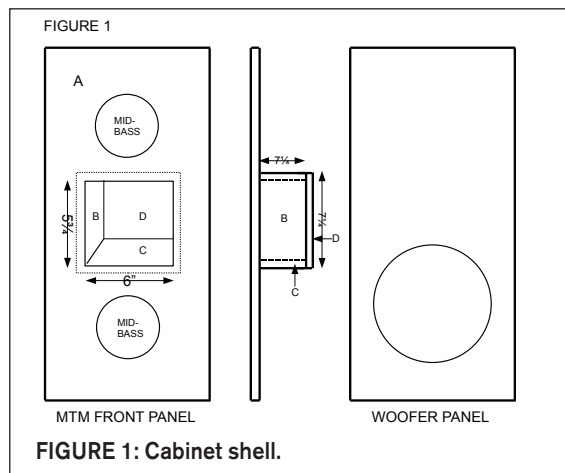
1. They are tower loudspeakers with a small footprint.
2. They are three-way designs with each loudspeaker having a subwoofer, mid-bass, and tweeters.
3. The mid-bass and tweeters are in pairs (MTTM), aligned vertically, which gives me improved power handling, improved efficiency, and some vertical directivity⁵.

4. The tweeters can be moved to achieve 100 μ s delay dispersion.
5. The tweeters are near ear height when seated.
6. The cabinet designs are easy to build and modify.
7. They can play loud.
8. They measure well and sound better.

I like the results so far, but I suspect the MTTM configuration contributes as much as the tweeter setback. *ax*

REFERENCES

1. Dennis Colin, "Waveform Phase Distortion," *SB* 1/97.
2. Williams and Taylor, *Electronic Filter Design Handbook*, ISBN 0-07-070434—1, Chapter 2.
3. John Atkinson, "Vandersteen Quattro Wood: Measurements," *Stereophile* 12/07.
4. John Atkinson, "Dynaudio Confidence C1: Measurements," *Stereophile* 11/07.
5. John Atkinson, "Dynaudio Confidence C4: Measurements," *Stereophile* 3/07.



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How to build the biggest box from any rectangle of MDF.

By Mark Rumreich



When it comes to subwoofers, it's usually true that bigger boxes mean deeper bass. When a friend asked me to build a powered sub for his garage, I wondered what was the biggest box I could make from a half-sheet of MDF (medium-density fiberboard). I was able to come up with a design that used every square inch of the half-sheet, except for the sawdust.

Even more surprising, I found that it's possible to design a box from any size rectangle of wood that uses every square inch of material and gives the largest possible box (**Fig. 1**).

THE DESIGN PROCEDURE

Figure 2 shows the three types of cutting patterns I will consider. Which cutting pattern is best depends on the length-to-width ratio of the rectangle of wood you're starting with. In general, the type-A cutting pattern is best for near-square panels, the type-C cutting pattern is best for long and thin panels, and the type-B pattern is best for in-between panels. You can choose to use a sub-optimum cutting pattern if you prefer the finished box dimensions that it provides, but at the price of reduced box volume. This will become clearer with some examples.

For each of the three cutting patterns, x represents the short dimension and y represents the long dimension of the original panel. The values x_1 , y_1 , and y_2 represent finished dimensions of the six cut pieces used to construct the box.

Determining these values is complicated by needing to consider the thickness of the wood, and also the

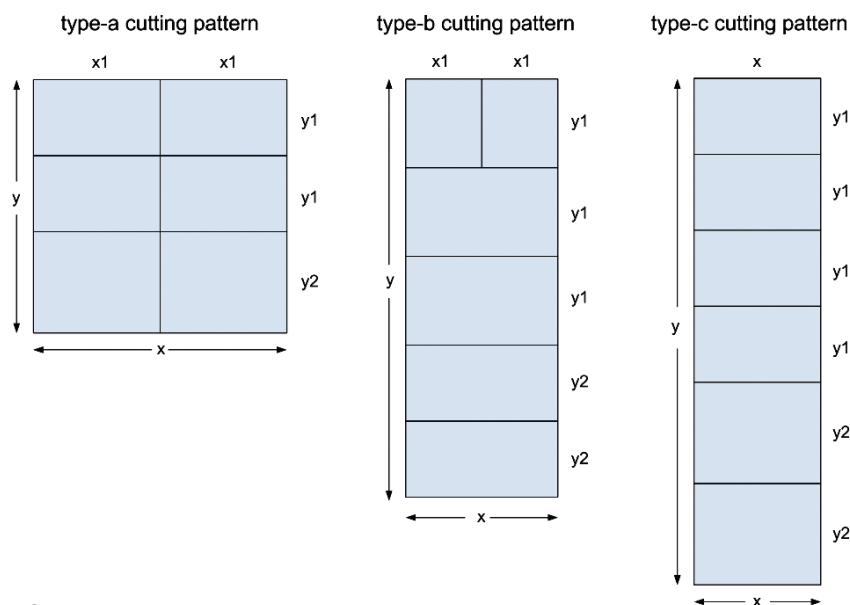


FIGURE 2: Three cutting patterns.

kerf of the saw blade (the material lost to the cut width, i.e., the sawdust). The formulas would have been much simpler with zero thickness panels and zero kerf!

I've produced an Excel spreadsheet to perform the calculations. You can

download it at www.mfr-eng.com/box_panels.xls.

Figure 3 shows the spreadsheet. For this example, I entered the half-sheet dimensions of 48" × 48", with a thickness of 3/4" and a 1/8" kerf. To use the spreadsheet, enter your own values in

the first four columns, and the spreadsheet will calculate the rest. If you're interested in the actual formulas, you can see them by clicking on the appropriate boxes in the spreadsheet.

The spreadsheet calculates the length-to-width ratio (in this case

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC			
1	panel					type-a cutting pattern								type-b cutting pattern							type-c cutting pattern											
2	x	y	thick	kerf	ratio	box1	box2	box3	x1	y1	y2	vol a	eff a	box1	box2	box3	x1	y1	y2	vol b	eff b	box1	box2	box3	x	y1	y2	vol c	eff c			
3	48.00	48.00	0.75	0.125	1.00	25.44	23.94	12.66	23.94	12.66	22.44	3.47	79.6	49.50	23.94	0.88	23.94	0.88	22.44	-0.39	-8.9	49.50	48.00	-11.41	48.00	-11.41	46.50	-16.67	-382.8			
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Notes:

Dimension y should always be greater or equal to dimension x.

Box dimensions are listed in optimum order for the Subwoofer Design Toolbox enclosure design tool.

Volume is in cubic feet for dimensions in inches.

100 percent efficiency value is referenced to a perfect cube with zero thickness panels and zero kerf.

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type-a cutting pattern

type-b cutting pattern

type-c cutting pattern

FIGURE 3: Spreadsheet view for 48" x 48" panel.



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The Loki uses an 18cm Seas coaxial speaker. The tweeter is mounted at the base of the woofer cone, coincidental with the woofer voice coil. This type of mounting allows you to hear the woofer and the tweeter at the same "time" and from any direction, nearly eliminating the confines of a "sweet spot". This configuration also allows you to use the speaker on its side without any change in sound.

Cabinets are available in Maple, Natural Cherry, and Black Painted Ash. The cabinet dimensions are 8" wide by 15" tall by 11" deep. The cabinets are constructed from 3/4" MDF with a 1" MDF front baffle. The cabinets are veneered with real wood on all sides. Cabinets are fully assembled.

Crossover are constructed from air coil inductors, polypropylene film capacitors and film resistors.

Frequency response is from 46Hz to 25kHz, with an average efficiency of 88db. The speaker impedance is 8 ohm.

Consider the Loki all the way around in your home theater system; as book shelf speakers; or as computer monitors.

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1.00). This number provides guidance for the best cutting pattern type. The spreadsheet also calculates the following values for each of the three cutting patterns.

Referring to the spreadsheet in **Fig. 3**, the type-A cutting pattern provides a box volume of 3.47ft³ and a volume efficiency of 79.6%. The type-B and type-C cutting patterns show negative values for volume, which means that they aren't useful for this square panel. Negative volume values result for a cutting pattern when the calculated dimensions of any of the sides drops near or below zero. This happens with the type-C cutting pattern when the length-to-width ratio is too low, and there isn't enough residual length to support the y1 dimensions, given that the y2 dimension is approximately equal to x.

Looking at the values for x1, y1, and y2 for the type-A cutting pattern, you can see that the value of x1 is 1/16" less than half the width x of the original panel. That makes perfect sense because I specified that the kerf is 1/8". If you add up the two y1 values plus y2, you see that you are 1/4" less than the original panel length y. This also makes sense because you have two 1/8" kerfs to accommodate.

Figure 4 shows how the pieces fit together to form the box. This view is from the Subwoofer Design Toolbox software. You don't need the Toolbox software to make use of the spreadsheet, but it makes it easier to envision how the box is constructed. To learn more about the Subwoofer Design Toolbox, visit www.mfr-eng.com.

WHICH CUTTING PATTERN TO USE

Which cutting pattern to use for the half-sheet example was clear—only type-A provided a useful result. For larger length-to-width ratios of wood, the other cutting patterns may be better. **Figure 5** shows the spreadsheet results for a range of length-to-width ratios from one to eight. The x and y values in the spreadsheet were chosen to provide a uniform panel area of 8.0ft², to provide a level playing field for this comparison.

The highest efficiency values are highlighted in the chart. As the length-to-width ratio of the panel increases, the best cutting pattern (from the standpoint of highest box volume) shifts from type-A to type-B to type-C. To help decide what's the best cutting pattern to use, here are a few rules of thumb to consider:

- For length-to-width ratios below 2.5, the type-A cutting pattern produces the highest box volumes.
- For length-to-width ratios of 2.5 to 4.0, the type-B cutting pattern produces the highest box volumes.
- For length-to-width ratios above 4.0, the type-C cutting pattern produces the highest box volumes.

For subwoofers (in which the sound wavelengths are much longer than any panel dimension), the shape of the box has little importance from a performance standpoint—all that matters is box volume. But you may prefer the dimensions of one of the

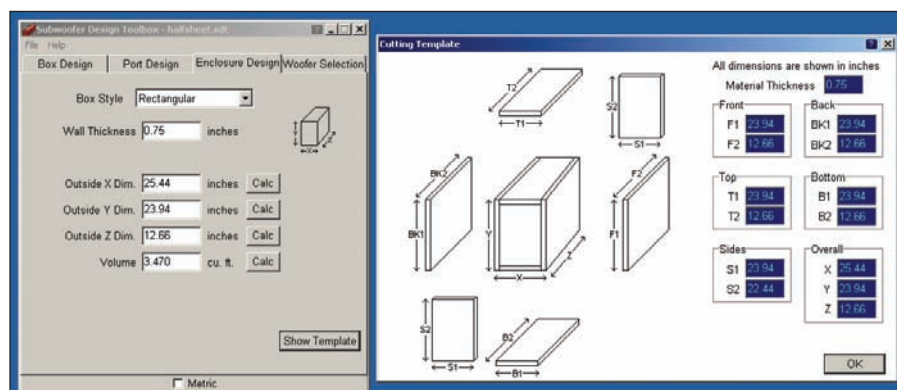
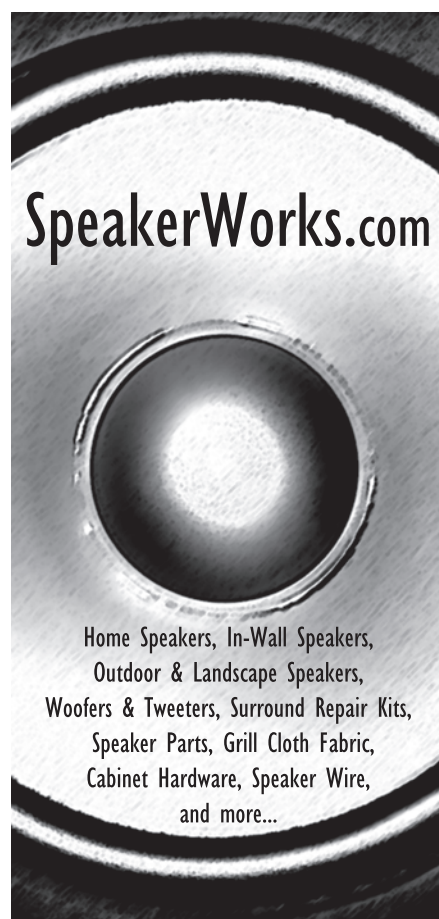


FIGURE 4: How the pieces fit together to form the box.

It's not the recording engineer; it's the stations and the marketing people that drive it, and sometimes the artists. One panelist related that in a particular case the band he was producing wanted "clean, dynamic sound," only to come back after a few days asking "why is my CD not as loud as xyz's?" Especially young people growing up with the current loudness wars may not even have any notion of dynamic range and how that may play a role in appreciating and even understanding music. One example mentioned a classical concert given for



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school classes, in which many students seemed quite puzzled and asked “why are some of the passages so quiet?”

There are other subtle effects. If you record up to 0dB digitally, that means the digital samples remain at or below 0dB. But when the signal becomes re-constituted in the DAC, it may well be that the analog output signal is higher in level. An unclipped digital signal may generate analog clipping. If you record a piece of music once at 0dB and once at -6dB, there is a big difference in distortion products at the analog side.

It was also found that data reduction schemes such as MP3 can lead to an increase in program peak levels and thus to added distortion. One demo played the S signal from an M-S AAC-128kbps compressed signal. In theory, all things being ideal, this would be total silence, but in reality distortion, artifacts, and noise were audible to the point where you could actually recognize the music.

Generally, the opinion was that music recorded and mastered in the early 90s was probably the best in terms of dynamic range, and that it has been going downhill ever since. For example, a 1992 album from Bonnie Raitt with great dynamics contrasted with a recent album that was more loud than anything else. But the tide seems to be turning.

Several initiatives are underway, notably by Italian and Canadian broadcasters, to measure and control program loudness rather than peak levels. It involves new ways of assessing program "loudness," and several companies were showing special-purpose metering equipment for this. One interesting metering system from TC Electronics gave two numbers related to the dynamic range of the signal. "Center of Gravity" (CoG) showed the level of the signal most of the time, while "Consistency" (Cs) indicated the variations of the signal from the Center of Gravity.

Some very loud and compressed tracks were played that gave CoG and Cs numbers indistinguishable from those of white noise. And, to be honest, they also sounded a lot like white noise! At any rate, the attention on loudness issues can only lead to better sound for all of us.

BACK TO AUDIO DESIGN

Douglas Self, who shouldn't need any introduction, gave a master class on analog amplifier design. Basically, he covered the wealth of material from his two books (*Self on Audio*; *Audio Power Amplifier Design Handbook*). There were a few insightful nuggets for me. For instance, that the dominant pole compensation capacitor C_{dom} transfers the global feedback at low frequencies to local V_{as} feedback at high frequencies. As a result, V_{as} gain changes from $G_m * \beta * R_c$ (where G_m is input stage transconductance, R_c is V_{as} collector load) at low frequencies to $G_m/\omega * C_{dom}$ at high frequencies.

Self investigates these effects with a test amp consisting only of the input- and Vas stages followed by a small class-A output stage to drive the test equipment. In this way he can isolate Vas nonlinearities from output stage ones. He also found that common-mode distortion of the input differential pair at a closed loop gain of 23 is too low to matter, so from this perspective he didn't see any reason to use cascodes in the input stage.

Still on the input “long-tailed pair”: it is well known that unbalancing the currents in a LTP increases distortion because the operating point shifts away to a less linear part of the transfer curve. What I hadn’t realized, but Self pointed out, is that such an unbalance also results in a lower G_m , in turn leading to less available loop gain for the negative feedback to work its magic. So, there are actually two effects that both lead to increased distortion.

Then, finally, you can minimize the output stage crossover distortion with measures such as the smallest Re value that still gives sufficient thermal stability, multiple parallel output devices, and accurate setting of the bias current. But in the end, Self conceded that it is something you just have to live with, whether in class-A, AB, or B.

My current interest is in Darlington's with integrated on-die thermal compensation diodes such as the Sanken STD03N and P devices. They have very high gain and very high F_t , and the on-die diodes give almost perfect thermal stability. One disadvantage is that the bases of the Darlington drivers

You must realize that a filter induc-
tor at one frequency can be a series ca-
pacitor at another and vice versa. Sup-

1. “Bringing back dynamics into the mix,” panel chair Ronald Prent, Galaxy Studios, and “Wow, this sounds great,” panel chair Christian Hugonnet, Consultant.

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ing of the midrange boxes was a welcome option because they are hidden from view and because it preserved their internal volume.

Midrange systems lead a very demanding life and are difficult to get transparent sound out of, as is well known in the audio industry. There is no such thing as a simple, high-resolution midrange system. More elaborate designs are seen in references 4 and 5 for this reason.

I extended the woofer cabinets downward to make up for the increased midrange box volume, and installed new stiffeners as well.

Finally, I protected the tweeters from woofer cabinet pressure by mounting small wooden boxes on the rear face of the front panel. I ultimately mounted the tweeters on neoprene, just like the midrange drivers, with positive results.

FRAMES

Photo 3 shows a simple internal frame as you might find inside a woofer cabinet. Several are required in a large design. It is useful to have cross ties there as well, and I have even indicated a blob of damping material where the cross ties pass each other, an ideal place for such a feature.

Frames like this are easy to install piecemeal into a five-sided cabinet that is already assembled—this means no exact fits are required—you can clamp each new piece to a previous piece where they intersect.

I don't use frames cut from plywood with circular openings in them because of the precise fit required, and because most material is located where it does the least good—in the corners rather than mid-way across the panel.

HIGH-PERFORMANCE FRAMES

Photo 4 is a model of a very efficient, lightweight frame element. By using a thin web separating the upper (hardwood) cap from the cabinet wall, I increased the stiffness of the assembly enormously with very little added



PHOTO 3: Simple internal frame.

weight. You could cut the webs (with lightening holes) from 3/8" marine or Baltic birch plywood—this thickness provides a generous glue line. And then you could assemble manageable woofer cabinets from 3/4" particleboard

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PHOTO 1: This lunchbox contains the remedy for your ailing discs.

A small silver lunchbox appeared in my office one day, probably unpacked by Mike, our diligent and efficient shipper. I finally opened it out of curiosity and discovered packs of

white, soft cloths, another pack of firmer squares of white fiber, and a plastic container of white liquid that looked like Elmer's glue. Folded over the contents was a sheet with the message "ATTEN-

TION!!" Safety warning. Caution, sharp object with lots of exclamation points.

Under that was an instruction sheet which revealed that a kit for improving the sound of CDs and DVDs was spread over my desk. No details about cost seemed to be included and at the time I could not think of any of my discs which were misbehaving. So I put the kit back in its neat box and set it aside.

Months later (my apologies to the manufacturer) I was attempting to install a Microsoft application from two DVDs. Frustratingly, the installation went well until about a third of the way into the program. Then that nasty halt, and hopeful waiting. So I brought the kit home and read the instructions. Jena Technologies is the maker of this Esoteric 3D-X, which they describe as a CD-SACD-DVD Optical Enhancer. The contents of the box they describe as Esoteric 3DX cream, non-latex (hypoallergenic) applicator sponges and lint-free, optical quality polishing pads.

It turns out that what I had was their mid-size kit. It includes plenty of materials to treat quite a few discs. The instructions advise advance washing of discs that are obviously dirty or have fingerprints on them. The treatment is a very thin application of 3D-X with the sponge, which is a firm block of material which does a good job of applying the cream. Leave this coating on for five to ten minutes. Then use one of the lint-free pads to "remove" the cream by buffing. The manufacturer implies that a coating which enhances the performance of the disc remains. They suggest that the response of the disc will be improved by this treatment.

Given the number of "improvement" offerings there are in the hi-fi world, I was frankly doubtful about such a procedure. Why wouldn't a thin layer of cream on a disc degrade performance? However, with a practical problem of a disc that was not functioning, I thought "why not give it a try?"

Jena Labs do not claim that their product can "fix" discs. They imply that a treated disc will sound better after treatment. "Enhance" is their word for the results of treatment.

I treated my malfunctioning disc once, carefully following the instructions. I didn't wash it first because it did not

AROUND the DCX-2496...



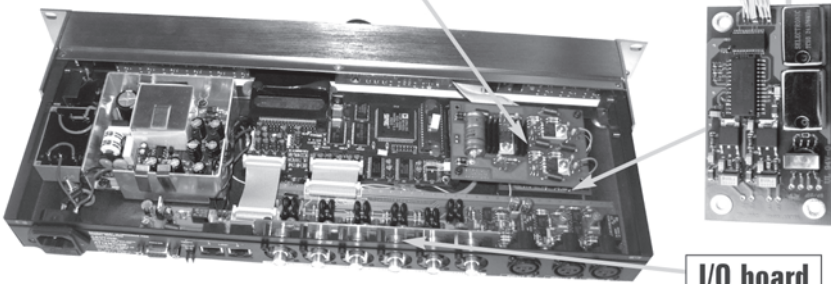
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seem dirty, nor were there fingerprints on it that I could see. However, when I inserted the disc, the program loaded without any hesitations. I was pleased as well as surprised.

In the meantime I remembered that a few years back I bought a Nimbus recording of Schubert's which hangs up about a third of the way through the first side of a 2-disc set. Nimbus is an excellent company. I am a delighted owner of a number of their products. They record routinely in Ambisonic format, which gives excellent results with The Quadpod (Audio Amateur 1971 series). On replaying the Schubert set, however, it refused to skip, stop, or misbehave at all.

I have two copies of a Decca disc with Ernest Ansermet and the Suisse Romande Orchestra accompanying four vocal works of French composers sung by Reginé Crespin. I treated one of these and played the first track of both, the delicious Berlioz Nuits d'Ete. I must report I heard no difference. But then despite my excellent equipment (Adcom preamp, Pass amps, and D'Appolito SEAS Thor speakers), my ears have become ancient somehow and therefore this is likely an unreliable result.

The less expensive Jena kit is available for \$40 plus postage from Old Colony (PO Box 876, Peterborough, NH 03458, 603-924-9464, custserv@audioXpress.com). If others of you are adventurous enough to do tests, and report on them, I'll be happy to publish your opinions.—
E.T.D. *ax*



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Elektor's Component Database CD

When I was first contacted to review the Elektor Component ECD 4 database CD, I jumped at the chance (*Elektor* magazine is by itself quite a wonder, but is outside the scope of this review). I had just come through two weeks without my Internet connection. The usual drill for looking up component data these days is to Google it.

Among the problems with this approach is that the first sites to appear are usually subscription offers; the

manufacturer sites often require two or three more searches to get to the actual datasheet, and, worst of all, sometimes my Internet service provider runs slowly. Another annoyance is that older or odd-ball parts are often not available, or the only data is in another language.

In the old days I had a bunch of data books to find much of what I wanted quickly, and then I could actually leave the book(s) open to the printed page for further reference. Bits of paper could hold several places, making it possible

to select a device or find comparable devices.

Those are the two major reasons for looking up data—designing new projects with the optimum device or finding a replacement to fix a piece of gear. During the first age of vacuum tubes, a popular service guide was the *Tube Substitution Handbook*. No techie was without one. The typical book was the size of your pocket protector. Need a 12AX7 but don't have one? The book would list a dozen possible choices to replace it.

I still have a few germanium transistors—mostly CK722s, the first transistor for the price of a tube! The 2N107 and 2N170 were the first transistors I actually used for projects. The 2N404 was the most popular germanium transistor. I consider these collector items and would not use them for service work. The NTE102 is the transistor I would use for replacement purposes for the CK722, 2N107, or 2N404. The 2N170 was an RF transistor; today's replacement might be an NTE100.

I could find the 2N404 replacement just by using a vendor's website. The rest were not there. As you probably know, looking up the data is hit and miss. If someone has posted it to a website then that's great, but otherwise the manufacturer may be long gone. Even worse is when there are just a few code numbers and no actual part number.

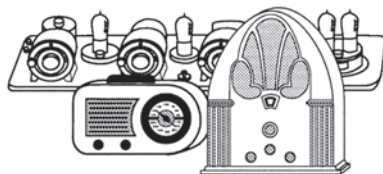
If you are lucky enough to have a good semiconductor replacement guide, then you can find a replacement. Even though these guides have grown to the size of a small phonebook, they never seem to have a device or two that you need. Worse, many only show you which

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replacement device to use. Unlike the vacuum tube guide, they do not let you know which transistors you already own will work in the circuit.

A DISC OF DATA

Enter the Elektor CD database, a collection of the basic parameters of more than 68,000 devices. Not just germanium transistors and silicon transistors, but also germanium, silicon and even selenium diodes, FETs, triacs, SCRs, optocouplers, and integrated circuits.

It contains programs to let you decode inductor and resistor color codes. There are also some basic programs to calculate voltage dividers using either two or three resistors, calculate dropping resistors for either LEDs or zener diodes, along with a few other very simple programs. The standout program among the rest allows you to size power supply capacitors, sort of. It assumes a 230V 50Hz AC line, so be sure to double the fuse ratings. You may also wish to reduce the ripple a tad by increasing the filter capacitor value for audio use.

The data on the 68,000 devices is a bit limited to basic parameters such as NPN/PNP, CE voltage, current, beta, case, and pinout for transistors. For integrated circuits it shows the device type, equivalent, and pinout. This is perfect for service or quick experimentation, but not quite enough for tweeky designs. If you are into state-of-the-art designs, then you probably will need a full datasheet or to evaluate the devices under consideration yourself.

The program also allows you to inventory what you have in stock. My experience is that an hour spent entering the information will pay off in the long term, both in reduced search time and money saved by not buying what you already own.

This is made even better because, unlike the replacement guides, which give you only one proprietary substitution, this CD shows you many possible replacements. You can enter new device data, assuming you can find something that is not already in there. The amount of work that went into compiling the data is impressive.

The database is naturally heavy with European part numbers, as well as Japanese and JEDEC devices. It has the

2N107, 2N170, and 2N404, but not the CK722, so it is not yet complete.

One other feature it does not seem to have yet is the phone for updates. Some of my better programs not only download updates, but with my permission let home know what I have found lacking.

I installed the disk on my Dell Dimension 3000 running XP professional seamlessly.

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32MB of on-board RAM
Internet Explorer 4 or higher
CD-ROM drive
25MB free space on hard disk

If you are doing any repair or restoration, then you already know that you never can have enough references. The cost is much less than one replacement transistor sent overnight mail. The next time you can't complete a project or fix a gizmo, you won't want to be without this disc. *ax*



In The 21st Century

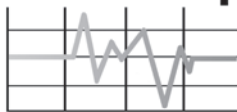
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CORRECTION

In the Aug. '08 issue of *aX*, in a letter response from Dennis Colin (p. 45), *aX* incorrectly transcribed a word on his submission. The phrase "temporary stability" should read "temperature stability." We regret the error and extend our apologies to Mr. Colin. —Eds.

FIRST-TIME BOX BUILDER

I was originally an *Audio Amateur* reader with no interest in woodworking, which looked too messy to me. You published an article on one of my A75 projects and another on a Dynaco upgrade. When *audioXpress* came along, I was a bit disgruntled about sharing pages with speaker builders and vacuum tube aficionados. But I read on and I didn't let my subscription lapse. My interest in audio grew. Then, a month ago, I felt compelled to assemble a pair of those Bill Fitzmaurice Tubas (April '04, p. 34). They are a great addition to my PA system, and the glue is setting on a second pair as I write to you.

In response to your recent editorial ("Longevity," June, p. 6), I now have seven Plitron transformers in my house and I tick off *aX* every time they ask me how I found them. It's the same thing with Parts Express, DIY Cable (Hypex), and other suppliers who ask. I do \$3000 worth of business with companies which advertise in *aX*.

Julian Evetts
jevetts@telusplanet.net

WITCHES BREW

Having just received my July '08 issue, I was both impressed and depressed with the comments regarding PowerKords having any influence on the sound of equipment and the United Kingdom's response to the bogus claims (Xpress Mail, p. 46). Three cheers for someone or some institution finally saying that these kinds of claims are bogus and without any merit whatsoever. It's

about time. The same mysticism associated with speaker wire and interconnect cables should also be discounted. Being from the "if you can't measure it, you can't hear it" school, I think that most of the claims for esoteric wire and other gadgets used in high-end sound systems are fundamentally bogus or highly exaggerated.

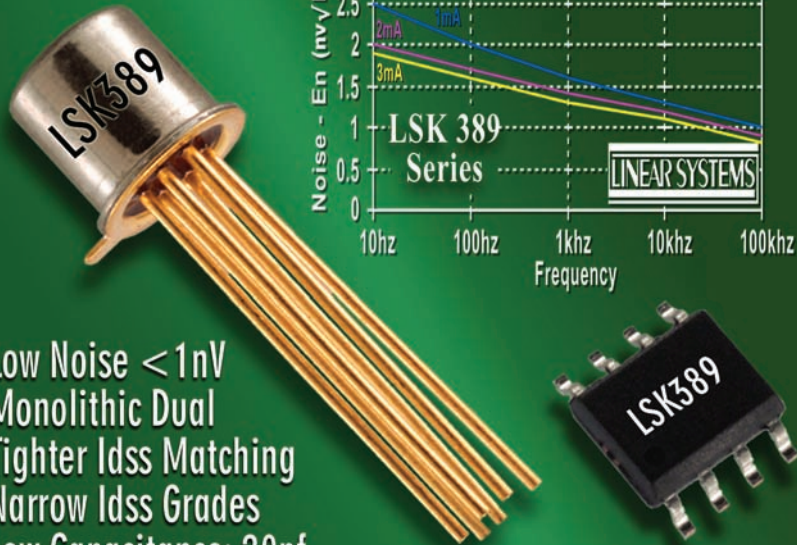
Oxygen-free copper, long grain copper, silver wire, cryogenic treatment, wire break-in periods, designer power cords, and little wooden rings to slide on vacuum tubes seem to be part of the mysticism we once ascribed to fairy tales where witches brewed up magic potions with bat wings, eye of newt, tail of rat, and so on. This was the good news.

The bad news is how the publisher

of this august journal tried to minimize the importance of this announcement saying that it is not important to tell the truth, but that we who putter in this last domain of the audio amateur need not question the technical merit of a specific product, but to base purchases on how the product makes you feel. And he says in closing that not all cable ads are guilty. Indeed! While there is nothing wrong with advertising a cable citing its quality of manufacture and durability, to heap on the ad a long list of euphemisms citing that it somehow will add sonic improvements to one's system is purely fallacious short of quantifiable measurements.

Bob Miller, KE6F
MillerKE6F@aol.com

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The image shows a cylindrical LSK389 Dual JFET component with four gold wire bonds. To its right is a graph of Noise - En (nV/√Hz) versus Frequency (Hz) on a log scale from 10Hz to 100kHz. Three curves are shown for bias currents of 1mA (blue), 2mA (red), and 3mA (yellow). All curves show a decrease in noise as frequency increases. The 1mA curve starts at approximately 2.5 nV/√Hz at 10Hz and drops to about 1.0 nV/√Hz at 100kHz. The 2mA and 3mA curves start lower and also decrease with frequency. The text 'LSK 389 Series' and 'LINEAR SYSTEMS' are visible on the graph.

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LOW-POWER AMP

Here is a question for Aren van Waarde regarding the G40EP headphone amp (March '08, p. 36).

I built the amp on a Velleman VM114 K4001 audio amp circuit card, which is based on using the TDA2003 as a 4W amplifier. Of course, I changed the com-

ponent values to what you listed in the article. As per your schematic, I routed the leg containing C5 and R3 from Pin 4 to the juncture of R1 and R2 and *not* back to Pin 2. The TDA2003 datasheet has that leg going from Pin 4 to Pin 2. I just wanted to verify the correct schematic.

The amp works, but does not sound good.

Carl Pendola
Houston, Tex.

Aren van Waarde responds:

Mr. Pendola asks how I have connected the C5 and R3 leg: From Pin 4 to the juncture

CONTRIBUTORS

Joseph Norwood Still ("A \$450 Triode/Ultralinear Integrated Stereo Amp," p. 8), retired from the electronics industry, is designing affordable high-quality amplifiers for the dedicated audiophile. He lives in Towson, Md.

Ed Simon ("A Line-Cleaning Filter, Pt. 2," p. 14, and Elektor's Component Database CD review, p. 46) received his B.S.E.E. at Carnegie-Mellon University. He has installed over 500 sound systems at venues including Jacob's Field, Cleveland, Ohio; MCI Center, Washington D.C.; Museum of Modern Art Restaurants, New York; The Coliseum, Nashville, Tenn.; The Forum, Los Angeles; Fisher Cats Stadium, Manchester, N.H.

Joseph D'Appolito ("Testing Loudspeakers: Which Measurements Matter, Part 1," p. 17), regular contributor and author of many papers on loudspeaker system design, holds four degrees in electrical and systems engineering, including a Ph.D. Previously, he developed acoustic propagation models and advanced sonar signal processing techniques at an analytical services company. He now runs his own consulting firm specializing in audio, acoustics, and loudspeaker system design. A long-time audio enthusiast, he now designs loudspeaker systems for several small companies in the US and Europe.

Dick Crawford ("Tweeter Setback," p. 26) has been building hi-fi amplifiers since the Williamson, which was a Class A design of the '50s. In the interim, he has earned a BSEE from Cal Poly (SLO), and an

MSEE from Stanford. He works as an analog design engineer in the San Francisco area.

Mark Rumreich ("More Box, Less Sawdust," p. 30) has been designing audio gear and building speakers since the days of 8-track tape players. He's the author of the *Car Stereo Cookbook*, published by McGraw-Hill, now in its second edition. By day, he's an electronics design engineer with over 40 US patents.

Jan Didden ("AES Nuggets from Amsterdam," p. 34) lives in The Netherlands and is a long-time contributor to Audio Amateur publications.

Darcy Staggs ("Portable Loudspeakers," p. 38) has been interested in electronics and its magic since building a crystal set in grammar school. This elementary model was later equipped with the first commonly available transistor amplifier, a GE 2N107. A college education (MS, engineering) was followed by work on the Apollo Lunar project (simulation of the electrical power system), war gaming, management software for Swedish IBM, weapons system simulation, and successfully raising two sons, who also love good music.

Edward T. Dell, Jr. (Review: Jena Mystery Cream, p. 44) is editor/publisher of *audioXpress*, *Voice Coil*, and *Multi Media Manufacturer* magazines.

John Sunier ("Super Fidelity," p. 54) is a CD reviewer for *Australian HiFi and Home Theatre Technology*. His website is www.audaud.com.

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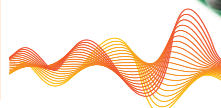
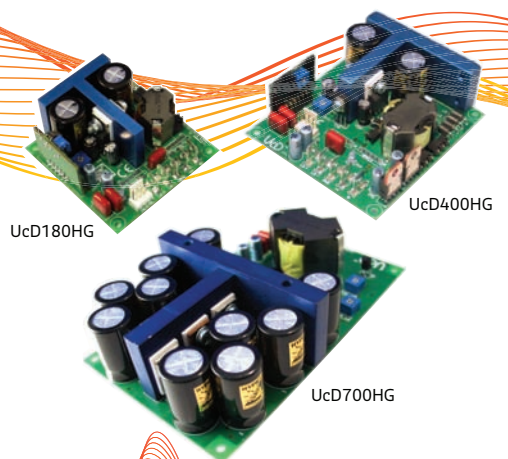
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of R1 and R2, or to Pin 2? I re-checked the G40EP website, the original article in *SPRAT*, and my own PC boards. In all cases, the C5 and R3 leg is connected to the juncture of R1 and R2, as shown in the *audioXpress* article. Both the original G40EP and my own copy sound very good. THD measured by G40EP is 0.006% at 1V peak (1kHz) in a Sennheiser HD25SP. G40EP indicates that the 2nd harmonic is at -90dB and the 3rd at < -88dB under these conditions. Square wave reproduction (measured both by G40EP and by yours truly) is excellent.

If Mr. Pendola's amp has a poor sound, I suspect something else is wrong. I can think of three possible explanations (assuming the headphones are themselves OK):

1. One (or more) of the electrolytic coupling capacitors may be leaky or have been connected with the wrong polarity. I made this mistake once in the audio section of a shortwave receiver, and it ruined the sound completely, until I discovered my error. After I had turned the cap the other way around, everything was OK. When Mr. Pendola's amp distorts, this could be the reason.
2. The TDA2003 IC may have been damaged by static electricity or by overheating.
3. The TDA2003 may oscillate because of a poor layout of the PCB.

I hope Mr. Pendola can get the circuit working. I have myself used the amp for more than one year now and it still operates without any flaw.

OTL FOLLOW-UP

As I mentioned in my article ("Build a Hybrid SE OTL Amp," p. 34, May '08), this amplifier has been made of parts that I had on hand, but if you start from scratch you can make it differently, enhancing its performance. In most cases, people who make an OTL have high-efficiency speakers, and a maximum output of 32W will be fine, so you can reduce the voltage of the power supply for the TDA 7294 op amp to $\pm 25V$ DC as well as the input to the TDA by changing R6 to 22 Ω . Now the power for the filaments of the PL509, which need 40V AC/DC at 300mA DC, can be taken from this supply as well. I increased the plate

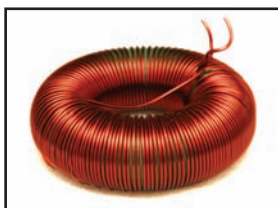
current through the PL509 to 250mA and the 3rd harmonics almost disappeared. For this higher current simply increase the plate voltage on the tube to about 120V DC.

In principle, the power delivered by the tube is not very large, but because the TDA is slaved to the tube it sounds like one big tube. If you mount the TDA somewhere out of sight, nobody will know about its existence and will just admire the good sound of your OTL amp. Personally, I don't care what is in an amplifier and how it is built, as

long as it performs my way. The tube works all the time in class A, hence the amp gives a big triode sound.

Other high current tubes exist, but they need a lot more electronics to drive them. If you want to know all about this, just look at Mr. Broskie's website, glass-ware.stores.yahoo.net. He explains in detail how the circuit is working, but doesn't seem to see that in accordance with the law of Kirchhoff, both tube and TDA see a different load depending on how they share the current to the load.

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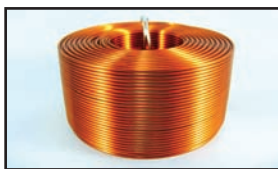


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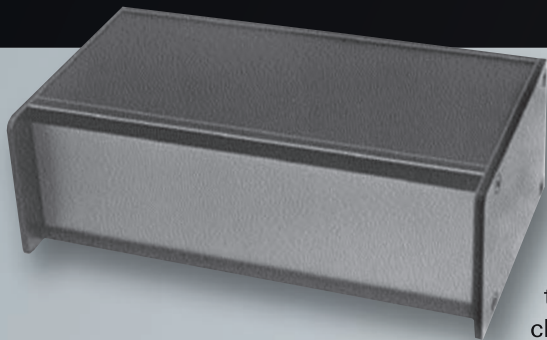
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Say the speaker gets a current of 1A; that means the output is 8V and 8W as well. If the tube delivers 100mA, it sees a load with an impedance of 80Ω and thus the TDA, delivering 900mA, sees a load of about 9Ω . Don't think, as Mr. Broskie suggests, that a small tube will do the same or even better. I've made quite a few hybrids that way; it isn't the same at all. Period. I made tube tracking systems, all of which have in common that the triodes work in class A and the pentodes in class B. In this configuration the power delivered by the pentodes is two to three times the power from the triodes. It would be polite if people informed the author of an article when comments about that article have been published.

AJ van Doorn
epine31@casema.nl

RESISTOR CODE

I'm writing on behalf of my friend, Max Carter, who doesn't have e-mail capability. Terry Bicknell's article in the May 2008 *aX* looks very interesting and Max is going to build the Figure 5 circuit ("Valve Regulated Power Supplies," p. 26).

In the schematic, R2, R8, and R10 are identified as "HS." Does the "HS" stand for "Heat Sunked," or something else? If it's to be heat-sunked, we're curious as to the reason for that. Can you be more specific about these resistors? For example, would 1 or 2W 1% non-heat-sunked resistors be adequate?

Greg Burnett (for Max Carter)
gbusg@comcast.net

Terry Bicknell responds:

Thank you for raising the comments about "HS." On my side of the world, HS has meant high stability, not heat-sunked. This latter is often, although not always, denoted by a pattern of dotted or radial lines around the device concerned.

As to specifics, 1% and a power rating of 1W would be fine. The only other significant resistor to watch is the feed to the zener diode. It will become warm, and plenty of airspace will help generally.

Regards, and good luck with your project.
aX



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Flanders Recorder Quartet|Banchetto Musicale|Various Composers|Aeolus Multichannel SACD AE-10156

The Flanders Recorder Quartet is one of the world's top recorder ensembles. One of the Flanders' many attributes is its huge collection of differently-voiced recorders—ranging from descant high soprano models to long contrabass instruments. The quartet's musical attributes include technical perfection and the ability to achieve a homogeneous sound without ever being the least bit off-pitch. The disc's programming is wide-ranging and creative, with music from Johann Schein (one of his suites opens the program), Bach (the included Prelude and Fugue was probably transcribed from the keyboard original), Vaughan Williams, Tarquino Merula, Frans Geysen, Piet Swerts, and Jan van der Roost. The low noise floor surround recording presents the four players very specifically arced in front of the listener and makes it easy to appreciate the subtle sound of these polite instruments.

Mikis Theodorakis|Rhapsody for Cello and Orchestra|Suite from Les amants de Têruel|Johannes Moser, cello|Coviello Classics Multichannel SACD COV 30612

Theodorakis is Greece's leading living composer, known for his film scores, songs, symphonies, cantatas, ballets, five operas, and music for some of the great Greek tragedies. His Cello Rhapsody dates from 1997 and uses themes from some of his previous song cycles. Theodorakis feels the cello is the instrument most closely related to the human voice, and has created nine "songs without words" for the concerto, which are named for the nine muses.

All are very short movements, under three minutes. Moser has a lovely tone and interprets the often-traditional melodies with much emotional fire. The Lovers of Têruel is based on a 13th century legend about a pair of young lovers who are barred from marrying. The boy goes to seek his fortune but while he's gone the girl marries another. The boy returns and dies of grief, as does the girl. Both performances and the sonics are exemplary.



Respighi|Ballad of the Gnomes; Three Botticelli Pictures; Suite in G Major; Adagio|Geoffrey Simon|Cala Multichannel SACD CACDS4028

Another imaginative collection from conductor Simon, who finds obscure but worthwhile works by well-known composers to spice up his concert programs around the world as well as provide material for his Cala record label releases. The series of which this SACD is a part normally has a concert warhorse as the centerpiece. In this case it's not a warhorse at all, but one of Respighi's loveliest works, the three musical impressions of famous paintings by 16th century master Botticelli. The Ballad of the Gnomes is a symphonic tone poem, and a smashing piece of music that would be a wonderful replacement for the usual boring overture on many concert programs—and an audiophile's dream. The Adagio could be the middle movement of a gorgeous cello concerto, but the rest of it unfortunately doesn't exist.



This Is K2 HD Sound!|Sampler|Various artists|First Impression Music K2HD xrcd 078

JVC's xrcd K2 HD technology seeks to squeeze the ultimate resolution into the standard 44.1kHz/16-bit compact disc format. FIM's Winston Ma was so captivated by the K2 HD enhancements that he has scheduled a new series of reissues of his previous xrcd recordings.

The 16 selections on this sampler are clearly exceptional audio demo tracks, and even more interesting and exciting than some of the selections he has made for previous FIM samplers. The excerpt from Rachmaninoff's Symphony Dances and the War Dance from Respighi's Queen of Sheba Suite are smashing audiophile demos. The Tchaikovsky track from the original Decca LP of the Swan Lake score has the rich analog soundstage obtained back in 1959 in London's Kingsway Hall. Bruce Stark's sax is right in your lap in the track from his Tale of Foreign Lands CD, and the double bass in the Hot Club of San Francisco comes through with gusto in the Stardust track. The clarity and transparency are truly impressive.



Nat King Cole|The King of Sound|TopMusic International|Stereo-only hybrid SACD TM-SACD9006.2

This SACD appears to have been produced as a promotional/giveaway disc for the Asian importer of Tivoli Audio table radios. The 17 Nat Cole hits are from the 40s and 50s so it's a surprise they are really in stereo. Perhaps they were re-recordings made in the late 50s when stereo had

become a reality. Some notes about this would have been welcome. The sound was very good, and it was enjoyable to hear these classics again, but they are really not SACD material. So my main question about the disc would be: "Why?" Perhaps these tracks are old enough that no licensing payments were required. A 180-gram vinyl remaster is available from China's ABC Records. Track List: Unforgettable, Mona Lisa, Nature Boy, Smile, Sweet Lorraine, For Sentimental Reasons, Tenderly, Blue Gardenia, A Blossom Fell, Walkin' My Baby Back Home, Route 66, It's Only a Paper Moon, Straighten Up and Fly Right, Too Young, For All We Know, Answer Me My Love, Darling Je Vous Aime Beaucoup.

BCQ(Blue Chamber Quartet)|First Impressions|Stockfish Multichannel SACD SFR 357.4046.2

On this, their first disc, BCQ's four classical players—Julia Bartha (piano), Angelika Siman (harp), Thomas Schindle (vibes), Holger Michalski (double bass)—combine their classical roots with elements of jazz. The familiar Toccata from one of Prokofiev's piano sonatas starts things off at a good clip, followed by five of Chick Corea's Children's Songs. Two Piazzolla selections employ more equal use of all the instruments. There is a three-movement jazz suite by Richard Michael which is something in the line of Claude Bolling's suites, and the program ends with the up-tempo Corea tune *La Fiesta*. The mixing and spatialization of the four players is very creative. Sometimes portions of the piano are heard from one of the surrounds, similar to the "Moving Real Surround" on Tacet's SACDs. It is clearly a performance creatively intended to be listened to in surround.

