AUDIO BASICS

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Zero Returns, Zero Field Failures!

Not to be bragging or anything, but the overall results of our winter special for *Audio Basics* subscribers were even better than you might have realized. Not only did we accomplish our goal of paying for the start-up costs of tooling a new amplifier chassis from scratch, but we had a perfect yield from our suppliers, our internal assembly and Q.C. process, and our customers.

We have not had a single field failure of any of our new power amplifiers or preamplifiers - not a single warranty claim or repair. And we have not had a single satisfaction guarantee return for refund of any of our new amplifiers or preamplifiers either.

We build very durable, rugged, and musical audio components that are excellent values. We dedicate our resources to designing and producing equipment that is faithful to the spirit of the music and that will perform reliably and rationally for you. This is what we call high quality - not fancy packaging, blinking lights, or outrageous overpriced audiophlake voodoo.

Our satisfied clients know that our definition and execution of high quality gives them the best reproduction of music they have ever heard in their homes. The new Audio by Van Alstine amplifiers and preamplifiers do not work great because we were just lucky in making initial design assumptions. They work great because we have the background and experience to have made many good engineering judgements during the design process. I think you might like to learn about the details of the design process this month. So the following will give you an inside look at the design and engineering creativity necessary to produce these new high value audio components.

We Didn't Have To Start from Scratch

For many years we have been designing complete new audio amplifiers and preamplifiers without designing and tooling our own new chassis. As long as there were other companies supplying the necessary hardware that was capable and reasonably priced, why make the capital investment to re-invent the wheel?

We started as Dyna dealers in the 1960s. Our speciality was custom building the kits for our customers. This allowed us to reach clients that wanted the high value of the original Dyna designs, but did not want to invest in wiring their own kits.

Because we built so many of the original kits during the heyday of the original Dyna company, we observed things more mundane audio dealers never were aware of. Namely, that although the outer package of the Dyna components stayed much the same for long periods of time, the internal circuits and components changed often due to market availability of parts and to fix previous engineering mistakes. The circuit design of the St-120 was modified several times to try to keep it alive. Transistor types in St-400s changed as noisy device types surfaced in extended use. Circuit boards were changed, thermal protection changed, and we started to ask ourselves why. As we observed the same failures in the original Dyna solid state amplifiers time after time (even when they were correctly built and used) we began to wonder if it couldn't be done better.

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We got tired of fixing Dyna St-120 and St-150 power amplifiers. We began to investigate why they blew up so easily. The answer was pretty simple. They were built with parts with voltage and current ratings that could be exceeded in normal use. For example, the St-150 uses TIP31-32 driver transistors with 80V ratings. The supply voltage is ± 53 volts. During normal operation, there are only 53 volts maximum across those 80 volt rated devices. But, at clipping, half the amplifier is turned on hard, while the other half is turned off. Then, the full supply rail to rail voltage (106 volts) is across these 80 volt devices. Guess what happens when you overvoltage and overstress the parts? Far too often, the answer is boom! The repair shops are full of them – of many brands and types. Mundane repair shops seem to be slaves to simply putting things back together the way they were (if that good - substitution type transistors are called "floor sweepings" by the technical experts of the OEM semiconductor companies). We decided to fix things so they did not blow up again.

Except, by the time you upgrade the devices to ones with much better safe operating limits and deal with their differing biasing and compensation requirements you open another can of worms. The original circuits were not really working all that well even under the best of conditions and there was no point trying to simply make them more rugged. As long as we were going to design more durable circuits, we might as well design more linear circuits too - ones that were faster and more stable, with better current drive, immunity from feedback loop overload, and free of transient distortion effects.

We learned that the best way to fix the Dyna units was to discard the original mistakes completely and install our own brand new circuit sets.

Thus, as you all know, Audio by Van Alstine audio components have successfully utilized Dyna and then Hafler sheet metal for many years. Unfortunately, although our circuits have been more than competitive in the marketplace and have kept up with the best of modern technology, the original Dyna kits and Hafler kits did not.

David Hafler sold the Dyna company he had founded and their engineering designs grew stale (their greatest successes were the Pat-5 Bi-fet and the St-416 - both pathetic rip-off copies of our early circuit improvements in the Pat-5 and St-400 chassis). How pathetic you ask? The Pat-5 Bi-fet had a compensation capacitor on its PC card that simply had no circuit connection at all to the LF356 Fet Op-Amp we had selected in our original circuit upgrade. The device we selected and that they copied is internally compensated. The parts left over on their circuit board from the bipolar LM301 were absolutely useless - except to show any decent engineer that their copy was without understanding.

Hafler came back with the Hafler brand of amplifiers and preamplifiers, and with more good chassis values for us. We needed good boxes – reasonably priced chassis, heat-sink, transformer, and controls, and for several years the Hafler company was another rational source. But now this source has dried up too. Hafler sold out again. The kit designs vanished and the open and versatile USA built chassis designs have been replaced with made in Mexico "everything on one circuit board" designs done to lower production costs. We wonder when all USA manufacturers make their products in Mexico or thereabouts who is going to be left in the USA earning a productive income that will allow them to afford to buy these products. Or do the USA manufacturers plan on selling all the equipment to their Mexican workers too?

We continued to get by with new old stock Dyna metal. When Tyco Labs pulled the plug on its money losing Dynaco division, they cut it off so quickly that the place was chock full of new chassis metal that had never been used. That finished chassis metal (thousands of pounds of it) was sold for pennies on the dollar to a mail order discount house and we had access to it at reasonable prices for several years. With our new faceplates, controls, and circuits, we could still produce new components economically and competitively.

But we were getting tired of the limitations of those sheet metal layouts and even more tired of dealing with that mail-order discounter. The surprises of "we are now out of that part" when we re-ordered were getting hard to cope with.

Last spring we started on our own amplifier chassis design project. It was a scary decision – we did not have the resources available to do it wrong. We couldn't afford to make mistakes. It had to be done right the first time. It was. Fortunately, we had both the original Dyna and Hafler chassis designs to learn from.

We learned from and avoided their mistakes.

We had never been thoroughly satisfied with any of the Dyna or Hafler mechanical designs.

Hafler's extruded heat sink design as used in the DH-120 thru XL-280 was efficient and allowed building of completed audio channel modules. But the heat sink placement on the sides of the chassis forced all the circuits into close proximity with the power transformer. This created a higher hum level than if there is more space between the transformer's electromagnetic fields and the circuits. The layouts were so tight that service access was poor, wiring routing could never completely escape the effects of the transformer, and build efficiency was compromised.

The larger DH-500 and XL-600 chassis had another problem - a fan. Fans are expensive, noisy, and not as reliable as well engineered passive cooling designs. If the fan fails (or the dust it inhales coats the insides too thoroughly) the circuits will overheat and fail too. The AC fan on the DH-500 had another nasty effect - its motor inducted hum into the loudspeaker ground wires (and into the speakers) unless the wiring was dressed and located exactly right – watching the results on an oscilloscope while making the adjustments. Will randomly changing the internal wiring in your amplifier change its sound? You bet it will – it will make it much worse unless you know exactly what you are doing. We can overcome these limitations with careful wiring layout and by cleaning the fan, adjusting its bearings, and lubing it with low friction synthetic motor oil. But the expense, noise, and hassles of fan cooling was not something we chose to repeat in our own original amplifier chassis design.

The Dyna chassis designs had their own sets of problems.

The original Dyna St-120 was not a bad little box at all - except that it overheated and blew up at the slightest provocation. The chrome plated steel chassis with many bends and pieces would not be cost effective to reproduce today, and its open screen cover is a dirt catcher, but it is useful for a modern circuit of up to about 75 watts per channel. Dyna thought that a major problem was that its heat sinks were too small because it blew up so easily. Dyna was wrong. It overheated and blew up because the original circuits were relatively unstable and fragile. The overheating came from internal oscillations, the blow-ups because it was a crummy design (although better than the plastic offshore refugees from table radios masquerading as high fidelity then and even now). Once we got the grounding right (Dyna seduced us into doing it less then perfectly in this box for years by doing so badly themselves) we can use existing St-120 chassis for a great little amplifier - but the concept would never work for a larger new design. It has neither the mechanical nor thermal capacity, and the layout is antique.

Because Dyna thought their big mistake with the St-120 was heat-sinks that were too small, they went for overkill in their next solid state design - the St-400. There are three pounds of aluminum per output device in this beast - unfortunately mostly all in the wrong place. The output devices stayed cool, but the driver cards ran so hot that parts literally burned themselves crisp and charred and fell off. The heat-sink is inefficient without its optional fan cooling so it is lucky it is so big. But the mechanical layout makes for destabilizing long wiring runs between the drive circuits on the PC card and the output transistors themselves (and for lots of expensive and tedious hand wiring). We can overcome the layout limitations with very thorough critical damping of all the lead terminations inside the heat-sink assembly. We can overcome the high cost of repair service of this inaccessible layout by carefully building new circuits so rugged they never blow up (unless the "they will never learn" types go rummaging inside the heat-sinks themselves putting in "better sounding wire and jacks"). We can build a very good and very reliable amplifier in the Dyna St-400 or 416 chassis – but it is not much fun to do. There was no way that we wanted to replicate this inefficient and heavy chassis layout today.

The St-400 chassis design was expensive and inefficient. The next Dyna design took care of that - it was cheap and inefficient – the St-410. It used the same audio circuits and power supply as the St-400 but in a different chassis layout. The big upright heat-sink extrusion was replaced with four smaller folded sheet metal cooling fin sets. Internally a cooling fan was added to keep the hot running drive cards alive. The design did not work too badly except that the wiring layout was unhappy, the output transistors were scattered all over the landscape, more metal bits and pieces were needed, no two pieces of metal fit together without being forced, and fastener holes stripped out with the blink of a power screwdriver. The chassis paint on later production units literally fell off (we had to send all the metal out for complete stripping and refinishing). But with new paint, new faceplates, new circuit layouts, and lots of skilled workmanship we could turn out a great amplifier using the St-410 chassis, and when we got done with it, you would never know its origins. Still, it was too heavy, too difficult to assemble, and not a suitable starting point for a modern design. The St-150 chassis is essentially a small version of the St-410, with a bit better layout and less excess weight. It is useful but not cost effective or efficient to redo. But in both the St-410 and the St-150 the layout does keep the audio circuits further from the transformer and the audio wiring away from the AC wiring. It is much easier to get a very quiet amplifier using a rear heat-sink design than with a side heat-sink design. Bigger is better in this respect.

So what we wanted to design was:

1. An amplifier design that is cost effective to build mechanically. You don't need to pay for somebody else's design inefficiencies. We must make a profit and yet offer great value and competitive prices. The design must be buildable without waste or error. The metal parts must be designed, tooled, and fabricated to fit together cleanly, precisely, and repeatably.
2. An amplifier that is cost effective to build electrically and easy and open to service or upgrade later. We wanted an open modular layout so that each assembly was accessible to build and service and so that final assembly would be easy to build and to Q.C. inspect.
3. An amplifier with excellent passive thermal capability. It must be quiet and reliable long term.
4. An amplifier with excellent structural strength without excess weight. It needs to last, to be roadable, but not to be a hernia maker.
5. An amplifier that is happy to look at. If form follows function, and if we made our design the ultimate in function – to allow audio reproduction with the least possible intrusion, but with not a single penny spent to impress fools, then the design should come out darned comfortable to live with.

We got great help from our metal suppliers.

They are all right here in Minnesota where we can and have visited their facilities and can work directly with their engineering and production people.

Alexandria Extrusions built a great heat sink for us and helped give us a big bonus in thermal efficiency.

We wanted an efficient extruded aluminum heat-sink with the output devices on the inside of the amplifier. This eliminates the need for protective covers on the devices and allows for a much more compact and electrically stable layout. Lots of fins work better than taller fins, but there is a limit as to how close they can be before they become impossible to extrude.

An aluminum extruder uses horizontal hydraulic presses about the size of a railroad locomotive to squeeze a semi-molten slug of aluminum the size of an artillery shell thru a 7" diameter and 2" thick steel die. In moments (with the input of lots of energy) that 2 foot long slug is transformed into a 40 foot long red hot extruded aluminum rail. Then all that is necessary is to cool it, temper it, slice it up like baloney, and finish it. It is not quite that easy.

Designing the die is a black art. When the aluminum is squeezed through, it does not want to come out straight - it wants to curl like toothpaste from a tube. The tapers and shapes of the die must be pre-formed to make up for this. You have to know what it is going to do and make up for it in advance in the die designing and making process. We designed the finished profile – Alexandria Extrusion made our design work.

They also told us of a new process (striations) they could add to our design (at no extra charge!) that made the design nearly 100% more efficient. Other amplifier heat-sink designs have nice smooth fins. Ours do not. Our heat fins are completely covered with small vertical grooves (striations). This effectively doubles the surface area of the heat fins. Our heat fins are actually nearly twice as big as they look, at no increase in cost to us or to you.

Because Alexandria Extrusion (of Alexandria, Minnesota) has complete self contained facilities for all the machining processes we needed to produce a finished heat sink, they could quote a complete finished piece and have control of the whole process. They even delivered in their own truck. We got perfect heat-sinks, edges deburred and smoothed, holes machined and tapped exactly right, and on time and at a rational price.

We did have design ideas that helped. We planned on a modular sink extrusion using either two or four per chassis depending on the power rating. Each finished extrusion can carry one to three power output transistors, depending on the application. We were able to get a better value for the money by designing a very universal heat-sink and taking advantage of higher quantity pricing. We designed our chassis so that the inside of the heat-sink would work efficiently too. This effectively makes the power dissipation capability better yet without adding weight or cost.

For the chassis design and fabrication we got great cooperation from Dana Engineering of Burnsville, Minnesota. We wanted a stiff and rugged main chassis, so that was done in steel with the inner front panel an integral part of the main chassis bottom because this comes out much stronger and lighter, and is less expensive too. The cover was designed in a lighter gauge steel, formed to fit perfectly. Both the bottom and top have matching ventilation patterns to allow flow thru cooling of the drive circuits and to remove heat from the insides of the main heat-sink extrusions. It is good to keep both the outside and the inside of the amplifier as cool as possible. The back panel, where the audio circuits are located, was made of aluminum to eliminate magnetic reflections from the transformer and possible uncontrollable hum and grounding problems. It is not a good idea to completely enclose audio circuits in a steel chassis. The back panel accepts the heat-sink extrusions and all the input and output hardware and can be completely prewired outside the chassis as a finished audio circuit for easy inspection and testing. The external front panel was a simple aluminum slab, done as thick as possible within the mounting specifications of our high inrush current power switch. Too thick doesn't allow proper mounting of parts without further machining cost. We decided not to make the amplifier more expensive to impress fat faceplate lovers; we were designing to impress music lovers.

We had observed that simple tapped holes in the sheet metal as Dyna and Hafler had done did not work very well. There was not enough thread and screws stripped out too often. We specified all staked-in nuts in our design for long lasting fastener and chassis reliability.

Although we had the computer CAD capability to allow us to turn out precise design plans we did have to purchase a HP DraftPro plotter to get these plans out on full sized paper. Even then it took about three months to get our ideas refined down to precise plans. The final step on paper was to glue the full sized plans to tagboard and actually bend up and fabricate the completed design, adding heat-sinks, jacks, and all fittings and hardware. This allowed us to be sure we had not put a part or fastener into an inaccessible location or made an impossible fabrication step. It all fit – at this point we had the world's best air amplifier.

Dana Engineering helped us out immensely by agreeing to produce one complete metal prototype from our finished plans at a reasonable cost. This allowed us to catch any minor mistakes before they were replicated many times and to make final design improvements. This also allowed Dana to make suggestions that made the final design better and easier to assemble perfectly. We were able to adjust hole tolerances for a more uniform fit, adjust the cover bend for a more precise interface with the bottom and get the bend tolerances perfect for the paint and finishing materials we planned to use. We even adjusted the ventilation pattern so that small parts could not drop in. The outstanding workmanship on the prototype also assured us that we would get metal that fit - no more old Dynakit "warp it together with a crowbar" problems. Every hole set lined up perfectly, every bend was precise and crisp, and a complete production run was commissioned. The extra cost of a one-off prototype up front paid off in easier to build and perfectly fitting finished metal.

For the metal finishing we already had suppliers we could trust. Excel Metal Finishing of Minneapolis had been doing magic for us stripping and refinishing all the new Dyna covers and chassis we had been previously buying. They were turning rusty, peeling, "new" Dynakit metal from out east into acceptable parts. Their same quality metal preparation and paint work starting with clean and shiny Dana Engineering parts gave us outstanding finished parts, carefully wrapped and protected. We have not found a paint flaw on our new metal yet.

The aluminum faceplate and back panel are finished with a double anodize process. Normally the artwork is silkscreened onto the finished panel in baked-on paint. Normally this wears off with time and use (just try too find a perfect Dyna faceplate now). The double anodize process makes the artwork part of the metal - impossible to wear off. It is a precise two step process in which the artwork is clear anodized and the background black anodized. We had two aluminum finishers quote this project for us. One seemed to offer a better value but they simply could not make their time deadlines and managed to spoil half a run of back panels in the process - causing us to tear our hair and delay introducing the amplifiers for a month. Fortunately, Dana Engineering did an instant job of replacing the damaged panels and the other supplier, Nor-Ell Metal Finishing of St. Paul, Minnesota, smiled and gave us a rush and reasonably priced job on precisely finishing the work the "low bid" supplier could not handle properly. They helped us out of a real bind and confirmed that a low bid is not always necessarily low priced.

The final result is a complete chassis with fit, finish, cooling, and function exactly as we wanted. Next month we will talk about all the parts that make up the insides – another interesting set of design and procurement challenges.

USED EQUIPMENT

Ωmega II 150 Integrated Control Amplifier. This is a $1000 unit in nearly new condition for $650 + $15 USA shipping . It combines our Ωmega II 150 power amp circuits with Ωmega II preamplifier circuits in one compact full function chassis with dual tape monitors, switchable speaker outputs, switchable tone controls, and a headphone jack driven by the power amplifier. It has our custom black faceplate, a toroid power transformer, and factory fresh updated circuits with a six month parts and labor warranty. There are no more new chassis so this is your only chance for Ωmega II performance at this price.

Ωmega II 150 Power Amplifier in a good Dyna St-120 chassis. This was a very clean Ωmega 150 traded in on a Ωmega II 400. We upgraded the circuits to Ωmega II to give it brand new performance and a one year parts and labor warranty. The price is $495 + $15 USA shipping.

Transcendence 150 Power Amplifier in a near perfect Dyna St-150 chassis. This is a generation back in our design, but still quiet, clean, rugged, and musical. The price is $295 + $15 USA shipping and a 90 day parts and labor warranty.

Super Pas Three Ωmega Preamp. It is not here yet, but we should get it soon. It is a full bore unit with our faceplate, jacks, tubes, ceramic switch, and Ωmega line and phono buffers. If it is as clean as we think it will go for $495 plus $10 USA shipping. Call soon!

Frank and Darlene Van Alstine