



The Roksan theory

JUST AS THERE'S MORE THAN ONE WAY TO SKIN A CAT, THERE'S MORE THAN ONE WAY TO DESIGN AN AMPLIFIER. TOURAJ MOGHADDAM LIKES THE VEHICULAR APPROACH.

Circuit design, topology, layout, components and power supplies are all merely parameters in amplifier design. The relationship between these parameters and the sonic performance of the final design has been the quest and the challenge for designers since the dawn of audio electronics. To put another perspective on amplifier design, let us consider the car and how we would like it to perform. Why a car? Because it's an analogy which highlights some of the challenges facing the designer.

- ◆ The car should be able to ride on any terrain.
- ◆ Should have the most comfortable ride yet be the most responsive when driven hard.
- ◆ Should be the quietest and yet the fastest.
- ◆ Should be the most powerful and yet the most economical to run.
- ◆ Should be luxurious and yet inexpensive.
- ◆ The overall shape should be sleek and the interior spacious.

Some of the objectives set above are contradictory in nature. It is only possible to design this car with its contradictory objectives optimised to certain criteria. An amplifier is not different in this respect, and it is equally impossible to design the perfect amplifier. Just as a Formula One car is different in its

concept to a family estate car, a budget integrated amplifier would have its design parameters optimised differently to a state of the art pre/power combination. The objective is to optimise the balance of all the relevant parameters.

Over the years many designers and critics have developed techniques to measure certain parameters which theoretically define the performance of an amplifier. These conventional measurements do indeed separate the competent designs from average run of the mill products. However, many amplifiers that have been through these tests and measured very similarly, couldn't sound more different. Is this inconsistency because we are not measuring the right parameters, or not measuring all the parameters that matter, or not measuring these parameters correctly?

For example, why do so many powerful and high current delivery amplifiers sound relatively 'sluggish' or 'slow' in tempo? On the other hand why do some 'medium' power amplifiers, in the same system, sound faster, more dynamic and rhythmic than others? An amplifier which is performing well in a particular system must be responding correctly to the rest of the system components. It is therefore important to consider the whole system in order to analyse an amplifier correctly. After all, we can't avoid using loudspeakers in order to listen to and judge the overall sonic performance of the amplifier.

Hi-fi systems rarely capture the involve-



EGREGIOUS AMPLIFIED RAPPERS

ment of the live performance, and this is often because of limitations in amplifiers that are unable to preserve the dynamics, tunefulness, tempo, space and the interaction between the musicians that can exist in the source material. To address the design parameters responsible for these qualities, it is important to understand fully how the amplifier works.

One often misunderstood concept is that the input signal to an amplifier travels through it, is amplified, and then fed to the output. In fact the amplifier only 'looks' at the input signal and copies it at a greater amplitude. The power supply of the amplifier, on the other hand, should act as an endless reservoir which feeds the output, its ability to do this effectively dependent on its efficiency and responsiveness to the load placed on it. The 'flow' from the reservoir to the output is controlled by the circuitry that copies the input signal, and the accuracy of that copy is paramount in order to reproduce the source material faithfully.

Once the amplifier output is controlling the load presented by the loudspeaker, measurement of relevant parameters will accurately highlight their effects on the sonic performance. Only after these parameters have been measured correctly and their effects understood, can the designer(s) begin to address some of the problems discussed above. It would then become apparent that the design, layout of the PCB, choice of components and even the casework all contribute to the overall performance.

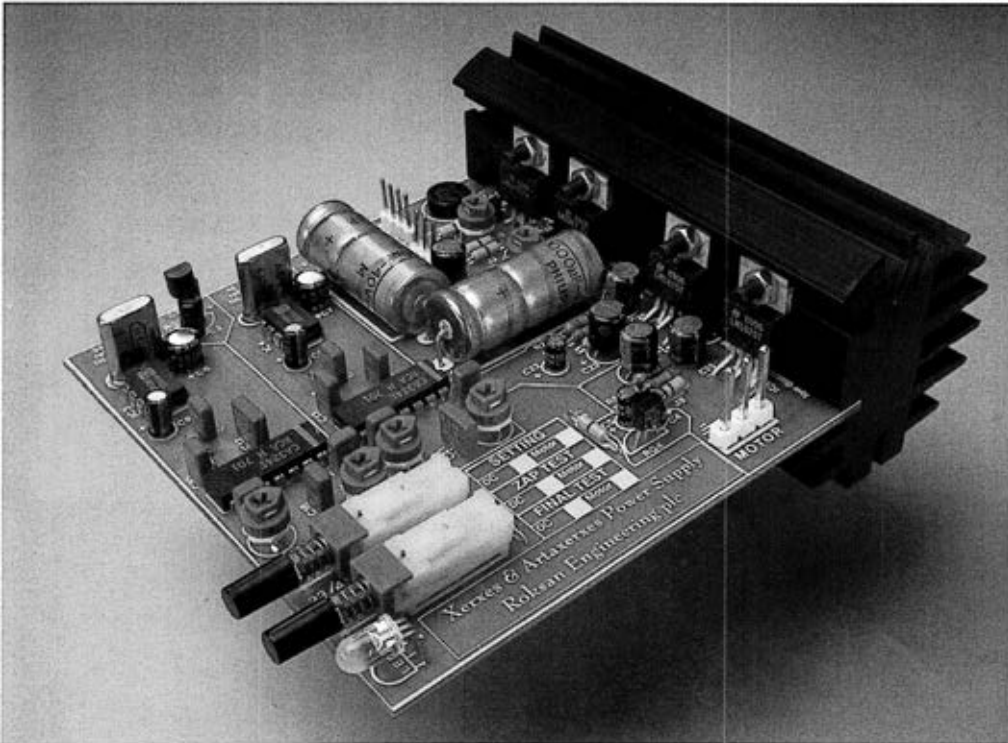
Over five years ago Roksan embarked on its first amplifier project with the following objectives. We wanted to design a coherent sounding amplifier with excellent dynamics and realism. It had to be musically involving and able to preserve the tempo across the audio band, from the lowest notes to the highest harmonics. It had to portray the structure of the music and the space between different musicians, and had to make it easy for the listener to choose the musical instrument or the musician he/she wanted to listen

to. The power amplifiers had to be capable of handling a wide range of loudspeakers.

We felt that most high quality amplifiers excelled in some areas and fell short in others, and wanted an amplifier with which we could listen to the music and not 'hear' the amplifier. As Bernard Shaw once said; "Progress is impossible without change", so we made a few changes. After extensive listening to and measuring of many parameters, the circuitry, its layout, the type of components and the topology of the amplifiers were finalised.

The design of our first amplification system is as revolutionary as our Xerxes record player was nearly a decade ago (he would say that though, wouldn't he? Ed.). The ROK-L1 preamplifier utilises two PCBs, one for 'earth' and the other for the signal. The two PCBs span the back panel of the preamplifier and connect directly to the input and output terminals, and every input is switched through an ultra low noise relay, further shielded to preserve the delicate input signal. The amplification circuitry is fully complementary and symmetrical to ensure faithful reproduction of the input signal. The ROK-L1 preamplifier requires an external power supply to feed its circuitry. Despite this, internally there is a power reservoir and local high speed, ultra low noise power supplies to further regulate the input power. Even the switching relays and the tape outputs have their own separate regulated supplies.

The ROK-DS1 dedicated power supply acts as the main DC reservoir for the preamplifier. It's based on the same principles by having the entire circuit on the PCB directly mounted to the output sockets. The 350VA power transformer is shielded internally and externally to minimise any noise interference. As a supply to the main reservoir, the transformer is capable of a continuous 7 amps AC per side. The rectification of the AC supply from the transformer is via discrete high speed diodes to optimise the response, and the wide band reservoir for the regulators ensures a stable, ultra low noise $\pm 26V$ DC to feed the preamplifier. Typically the ROK-DS1 has less



This neat little power supply was designed for the late lamented Xerox turntable and Artaxerox phono stage.

than 10 microvolts of noise from 1Hz to 3MHz.

The ROK-M1 monoblok power amplifiers have a 1000VA, 7.5 kg power transformer which can continuously deliver over 11 amps AC per side. The shield for this transformer and the main heatsink, which acts as a secondary shield, effectively eliminate any transformer induced interference. The entire amplification circuitry from input to output terminals is on one PCB directly mounted to the heatsink. The symmetrical and complementary circuit design, coupled with tight component tolerance, contribute towards accurate input signal reproduction. There are three inputs to choose from, DC (Direct coupled), AC1 and AC2, which differ only in bandwidth. The DC input, for example, has

its -3dB points at 0.5Hz — 120kHz, a very low output impedance (typically less than 0.05ohms) with a high current delivery of ± 13 amps to the output stages, enables the power amplifier to control almost any loudspeaker. This control is achieved without compromising the speed/response of the amplifier to the load. Techniques such as active or passive multi-amping can be used to control very difficult loudspeaker loads. With this method the amplifier design and drivability is optimised.

The most important part of amplifier design is understanding the whole circuit, and with this mind we will endeavour to continue our research to ensure that Roksan equipment continues to provide a high standard of sound quality.



EGREGIOUS AMPLIFIED RAPPERS

The Audio Innov

AUDIO INNOVATIONS' MAIN DESIGN DUDE GUY SERGEANT WHIPS OUT HIS TUBE AMPLIFIER

At present there is probably more interest in valves and valve amplification than at any time since they ceased to be the building blocks of electronic equipment in the 1960s. It is interesting to consider why this remarkable resurgence of enthusiasm has come about; why this apparently outmoded technology inspires a fervour that its modern equivalent seems incapable of matching; and why valve amplifiers almost became extinct at all.

Beginning with the last of these, valve amplifiers were simply too large, too hot and too expensive. By the measurement criteria used to evaluate performance they were soon matched and surpassed by smaller, cooler running and cheaper solid state alternatives. Reading through the literature of the time one does get the impression that the development of the new transistor circuits was viewed with a certain mild scepticism. It was almost as if even the engineers working with the new technology knew that what they could hear did not quite tally with the measurements they were taking. But those days were long before subjective evaluation reared its (problematic) head, and the technical 'progress' was greeted with much the same unquestioning acceptance that for the most part accompanied the more recent launch of digital audio.

Today's highly regarded transistor amplifiers are often large, expensive, and take days or weeks to reach optimum operating temperatures. This is partly due to the misguided

belief that there are some qualitative advantages to be gained by using grossly inefficient loudspeakers. There aren't. Other than making the living room look like a set from Star Wars and impressing the hell out of neighbours who know no better (an important consideration for some purchasers of expensive hi-fi) such a combination serves little useful purpose.

By the mid 1980s the popularity of this ridiculous approach had reached its peak world wide. But there has been little or no new development along these lines for over 10 years, and once consumers realised that there was no progress being made, some began to reconsider the technology that had been left behind.

The small quantities of valve power amplifiers that were available in the early 1980s generally mimicked the

specifications of their transistorised competitors, while valve preamplifiers also enjoyed some commercial success, as their beguiling characteristics became apparent.

Anachrophilia

Serious Japanese enthusiasts have been investigating low powered valve amplification and high efficiency loudspeakers since the 1970s. The approach had all but been abandoned in the west but was effectively reintroduced on a small scale by Jean Hiraga in the French magazine L'Audiophile. There has since been a proliferation of valve amplifier manufacturers worldwide. Some old valve types have been resurrected, and there are rumours of



Have you seen this man? The Two and a half Watt Kid, aka Guy Sergeant, is part of the power supply crazed, single ended triode liberation front.



EGREGIOUS AMPLIFIED RAPPERS

ations approach

DESIGNER'S AXE AND GIVES IT A GOOD GRINDING ON THE GREAT POWER SUPPLY STONE.

new audio valves under development.

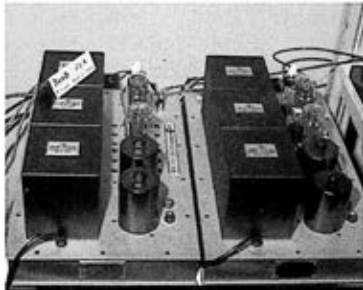
So what is the appeal of this anachronistic technology? It has to be more than just being able to say 'I'm different and discerning', more than the warm friendly glow of a few filaments, or even the potential for 'hands on' involvement when replacing valves or resetting bias.

With almost any valve amplifier there is an organic quality to the reproduced sound that is beyond the scope of almost all solid state designs. There may well be excessive distortion, limited bandwidth and some lack of clarity, but it is this natural quality that first catches the attention. Once a taste for it has been acquired, life becomes a quest to find a valve amplifier that gets the other aspects right as well.

I find the flaws in the performance of a bad valve amplifier as objectionable and distracting as anyone. I can think of many instances where a simple and conventional transistor amplifier would be preferable because it just wouldn't be so obvious. If I could find a transistor amplifier that gave better results than the best valve amplifier (and if I could afford it), I would have no hesitation in buying one, especially if it would fit inside a matchbox. I don't have any nostalgic yearning to fill my living room with glowing tubes (why not? Ed.).

Every man and his dog are now building valve amplifiers, and the choice has become bewildering. Since the early 1980s, when all

that was available were high powered and priced behemoths from the USA, the audio industry's obsession with fads and buzzwords has left a tangled trail of assorted and occasionally abandoned design philosophies for the unfortunate customer to unravel. Those giant amplifiers were both complex and exceptionally powerful. Speaker sensitivity had been sacrificed at the altar of low coloration, and anything less than 100 watts a channel, particularly in the larger American living rooms, was unthinkable.



This is the sort of thing that gets Guy hot; a home made single ended triode design with Western Electric 300B output tubes from L'Audiophile in Paris.

Nostalgia

Audio Innovations began manufacturing and marketing simple low powered and relatively affordable valve amplifiers in 1984. These used class A circuits and had more in common with the old Leak

and Lowther amplifiers than anything else, so were only suitable for use with higher sensitivity loudspeakers. In 1987 we launched the first volume manufactured all triode amplifier for over 40 years. At around the same time Croft was also manufacturing a sensibly priced range which included an output transformerless design reminiscent of the American Futterman amplifiers of the late 1970s.

Since then there have been triode coupled pentode and tetrode amplifiers, all triode amplifiers, single ended designs and all manner of strange valve/transistor hybrid circuits; then there are variations on each of these themes where the valve type is more



important than the configuration in which it is used.

To offer a full assessment of the respective merits of each approach requires both technical appraisal and subjective evaluation beyond the scope of this piece. Unfortunately the measurement criteria still used to judge audio amplifiers are the same ones that led to the original rejection of valve circuitry in favour of solid state designs in the 1960s. Remarkably, even in 1994 it remains impossible to explain why there is so little correlation between measured and subjective performance — other than to suggest that the measurements are irrelevant or that the likeable qualities are imaginary.

Apart from information concerning noise, power levels and input sensitivity I believe that the other measurements taken are about as relevant as the amplifier's overall dimensions or its weight. Note that this only applies to amplifiers. Digital equipment or loudspeakers can, to some extent, be described by their measured performance.

To offer a rational explanation for the character and behaviour of the Audio Innovations L2, P2 and Second Audio amplifiers tested in this journal, I have to include observations on the alternative design approaches that could have been adopted. These views are totally prejudiced by a preference for loudspeakers that convert a relatively large percentage of the electrical energy supplied to them into sound rather than heat. I have never encountered an inefficient loudspeaker that was able to reproduce an adequate degree of dynamic contrast, although I've heard plenty that can play loud. Whether this lack of resolution is a function of the speaker design or of the necessarily large and complex amplifier required to drive it is open to question. I would always make the judgement using sensible loudspeakers and a handful of watts at most. Anyone who claims that their amplifier sounds better when it is working hard needs their head looking at.

Unfortunately the valve amplifier revival has not yet fostered a new generation of

affordable, efficient loudspeakers, even though there are signs that the market may be starting to move in that direction.

The Power Paradox

The high powered valve amplifiers that are currently available tend to be generally rather vague in character, with bass performance that can at best be described as lacking punctuality. If you really feel the urge to buy a very powerful amplifier, stick with transistors, as it will be cheaper in the long term.

True class A operation (all other things being equal) is still preferable whatever the type of amplifier. There are now many different class A pentode and tetrode designs available, most of which have a sparkle and life that they share with the better designs of the 50s and early 60s. Component quality has improved considerably since that time, and contrary to popular belief, the output transformers that can be purchased today are technically far better than their predecessors, due to improvements in materials.

Triode amplifiers are back in a big way. Chinese factories are now reproducing the most famous triode tubes such as the 2A3, 300B, 211 and 845. These allow the development of the most simple circuits which may be operated without negative feedback and which, if properly implemented, can give tremendous speed, clarity and dynamic range. Some of the newer designs are chasing after the higher power outputs achievable with pentodes, and compromising quality by operating triodes out of class A. This strikes me as the audio equivalent of putting orange juice in a glass of Dom Perignon.

The output transformerless amplifier still has many devotees. There are several companies now manufacturing them in the US and elsewhere. While they may share the grace and clarity of other triode amplifiers, in my view they lack any sense of grip or control even with horn speakers. It isn't necessary to regard the output transformer as such a problem. There are other design considerations that have a far greater influence.



Taking the simplicity and nostalgia a stage further has led to the reintroduction of the single ended power amplifier. This particular bandwagon has left tracks all the way from Japan where any number of companies are making 'reproductions' of the Western Electric WE91A amplifier. In Europe and the US there seem to be so many 'new' designs that the small market that exists for this type of product is already saturated. The circuit topologies and the valve types have become precious talismans: 'if it isn't done this way or it hasn't got those then it can't be any good'. I would be the first to admit that I shared some of these dogmatic beliefs for a while, but experiences over the past few years have dissolved them.

Supplies matter most

Incorporating any one or two of these design features is no guarantee of a satisfactory performance. The key area in the design of any single ended amplifier is not the valve used, not the quality of the output transformer or the components, but the design of the power supply. A single-ended triode amplifier is far more dependent on the quality of its power supply than any other kind — and yet no one, anywhere, at any price, appears to be paying any attention to it. It is as if the obsession with the circuit topology is blinding the designers to what they are actually asking the valve to do.

These same designs often include a low impedance cathode-follower driver circuit, and the power supply is again ignored, whereas if that type of driver is to work at all (and I have my doubts on that score) its power supply cannot just be an afterthought.

If the power supplies are properly attended to, the single ended circuit is arguably the best (as well as the most expensive) solution, but current examples, including some most extravagant Japanese exotica, can all be comfortably outperformed by a humble push-pull pentode amplifier with a good supply.

Push-pull triode amplifiers, such as the Second Audio, are less dependent on supply

quality than single ended designs, and can therefore sound more purposeful and dynamic, although the added complexity of the configuration can result in a loss of clarity and finesse.

The valve types used have also become part of similar dogma. Any of them can be better than any other if they are used correctly. This applies as readily to the comparison of valves such as the EL34 and KT88 as to comparisons between various triodes. The current favourite and subject of many a new amplifier design is the Chinese version of the WE 300B, but for anyone to proclaim its magical properties over any other audio triode is ridiculous. Its advantages are better described in terms of ease of use, cost/watt and availability.

Having experienced the benefits of careful power supply design and weighed them in importance against circuit configuration and component choice, I anticipate that future developments within our product range **will** focus more on this area of design. The P2 phono stage features valve rectification, a two section LC filter and a valve shunt regulator circuit referenced to valve voltage stabilisers. The power amplifiers may in future have to undergo some of the same treatment.

It occurred to me some time ago that there was probably some perverse (and inverse) relationship between quality and efficiency in amplification. Nothing good is ever easy. The more watts that it is necessary to put into an amplifier to get one out, the better it's likely to sound. An efficiency of under three per cent would be fairly serious.

Our approach to product design has always been, and will continue to be based on the subjective performance of the product regardless of its price. The means used to achieve the end may include valves, transistors, magnets or even steam, provided that the results are satisfactory. This approach may not be as easy to sell as whatever the flavour of the month might be, lacking as it does the political correctness of the latest fads and fixations. But we have never been too concerned about following fashion. Fashions change.