Components

This has been a highly debated subject for many years. The argument on whether one resistor sounds better than the next or this tube versus that tube or connector type A or connector type B, and so on. I have some theories concerning this subject and they follow:

1) When comparing an electronic component (resistor, capacitor, integrated circuit or tube) how is this comparison done? It is a well known fact that to compare two pieces of electronics, the double blind A-B or A-B-X tests are the only way to compare. To conduct an A-B test a simple switchover between A and B is done. In an A-B-X test you listen to A, then to B and then to X which is either A or B. The listeners than note which they think X is, A or B. Much has been written on this subject and I shall not go into the where's and why's but suffice to say that the human brain whilst being very "smart" does not have a good "memory" when it comes to these tests. The accepted MAXIMUM time for switchover is **5 seconds** and even this is considered too long by some experts. Let me qualify this. When we compare two pieces of equipment, we assume that they are comparable and that one is not grossly inadequate. The double blind test is elegantly simple. The equipment is set up with gains set to better than 0.1dB, the listeners have no idea which piece is playing at any given time and the switchover is done by a person who is not involved in the listening test. The switchover is instantaneous so no time delay exists between the listeners hearing one or the other piece of equipment. The listening panel's results are tabulated and the results are an average.
2) So an interesting question arises. How do we compare say two resistors or capacitors or integrated circuits in a piece of equipment? To do this is almost impossible. One would have to wire a switch into the gear and then the main problem arises of the time for the break before make switch that there is NO component in circuit. Assume we could overcome this, how does one compare integrated circuits which have at least FIVE connections? In this case the op-amps (Integrated Circuit) can be both fed the same signal and then a switching system (either relay or mechanical switch) can select which op-amp is being listened to. I am very skeptical of those who proclaim that they heard the difference between one resistor and another. The time interval to change these parts is way longer than the brain can remember. I have done A-B and A-B-X tests with integrated circuits but I have used either 2 amplifiers, one with one IC and the other with another OR I have done as I describe a few lines above.
3) The same argument is valid for capacitors and other components which some say sound different. Please read the short excerpt in the CAPACITOR link about a blind listening test comparing a piece of wire to a cheap electrolytic capacitor.
4) Tubes fall under the same 'argument". Changing a hot tube, waiting for the replacement to heat up – the human brain simply cannot remember over this "long" period of time.

Cost of components

Why do some amplifiers or preamplifiers cost so much more. My answer is simple, "Because they can". It is all marketing hype, no more and no less. Of course we accept that a manufacturer can spend a lot of dough on the cosmetics, gold plate this, chrome that and so on. Twenty millimeter (3/4") thick aluminium panels, beveled edges, machined heat sinks do add massive cost to an item and these costs are most certainly reflected in the final price of the article. But they do not contribute one single thing to how it sounds. I do admit is it cool to

look at an amplifier that we know weighs more than a grown man, looks better than a beauty queen and has rows of glowing power tubes like soldiers waiting to do battle.

If one compares two products of similar pedigree and one costs several times the other, the question begs, why? I refer to the car stereo market and to amplifiers in particular. Many amplifiers have come across our workbenches at Zed. I have repaired some and tested others. I have been asked why something is what it is and why there is a substantial difference in price. I have been asked about 105 deg C capacitors, 1% metal film resistors, film type capacitors, integrated circuits and cables. Unfortunately the media and others have hyped many of these issues with garbage and misinformation. Most media writers have little or no technical knowledge and DO NOT write from a position of knowledge! Also people out there tend to believe the media and normally do not have access to good information which has not been geared towards marketing.

One of the big buzz words now is 105 degree C electrolytic capacitors. I am asked continually if our amplifiers have these. My reply is always the same. We use them where appropriate. The issue of film capacitors arises all the time. What kind of film capacitors does Zed use? Are they from manufacturer A or B? Are they in the signal path? These questions which people ask me have been asked simply because the misinformation has been put out and people tend to believe what they read or hear – without question. I write from a purely technical and not from a sales point of view. The purpose of these technical pages is to educate, nothing more and nothing less.

Many so called purists out there harp on about the fact that the signal must never pass through a dreaded electrolytic capacitor.
My answer about these capacitor issues is as follows: Even if an amplifier (or preamplifier) is DC coupled from input to output, (that is no actual capacitors in the traditional signal path) the signal MUST pass through the power supply, loop wise. Guess what 99.9999% of all power supplies have in them, great **big ugly electrolytic capacitors.** So the signal passes through these ugly large value electrolytics. Furthermore think what the signal passed through in the original recording process. It had to go through a torturous maze of transformers, cheap electrolytic capacitors, lots and lots of operational amplifiers (ICs), tape heads, equalizing circuits, fader controls, really low tech connecting cables…..should I go on?

And now all the techno-boffins are worried about the last 1% of the signal chain. This makes me laugh.

One of the other questions which arise is that of film capacitors (all types) versus ceramic capacitors. Please read the link CAPACITORS on the techtalk pages.

Oh I forgot to mention that another buzz is the use of oversized, both in dimension and value, of the capacitors in the secondary supplies in the amplifiers. Some people seem to think that the use of high value electrolytic capacitors in this part of the circuit helps the amplifier to perform better at low frequencies. This is just not true. I do not advocate the use of wimpy low value capacitors but there is a point of no return. Those large and heavy home amplifiers with the great big computer grade electrolytics (or lots of smaller ones in parallel) have to work from a 50 or 60Hz power line. With full wave rectification as standard, the capacitors are recharged 100 or 120 times a second. In large home amplifiers we need large value capacitors in the power supply. However in a mobile amplifier with the power supply frequency at say 50KHz, these capacitors are recharged 100,000 times per second. That is 2,000 odd times more often than the home amplifier!

The power which an amplifier can deliver is 100% dependent on the power transformer alone (assuming the power source can deliver – in a vehicle the battery + alternator, in the home the wall socket). Power supply capacitors contribute ZERO to the continuous power rating of an amplifier. It is synonymous to saying that wide tires on a car add horsepower!

Whilst we are on the subject of "buzz" items, the infamous **TO-3 power transistor** comes to mind. These look like they do simply because they were designed to fit into the same space as the octal tube socket for power tubes. Before the advent of plastic encased power transistors, the TO-3 was the only game in town. All one has to do is look at it and see that its physical construction is awkward at best. It requires no less than four mounting holes and to dissipate the heat correctly equal torque must be applied to both mounting screws. They require either insulating shoulder washers for each screw or an expensive socket which resides on the opposite side of the heatsink and has threaded inserts to accept the mounting screws. Wow, this was a mouthful just describing the TO-3's mounting criteria! TO-3 devices are typically rated from 50 watts to 250 watts of dissipation. Of course in the real world there is no TO-3 capable of dissipating 250 watts. All one has to do is refer to the SOA curves for a particular device and take any point on the curve and read off the volts and the amps. Multiply them together and look at the results. On the secondary breakdown part of the curve the V-I product never comes close to the rated dissipation number. Let's look at the popular TO-3 pair MJ15003/MJ15004. These are epi-base devices with an Ft of 2MHz and a gain of 25 with 5 amps of current. They are rated at 250 watts. At 100 volts they can pull 1 amp of current (100 watts), at 70 volts they can pull 2.2 amps (154 watts). On the thermal limitation part of their curve (single pulse signals only) the numbers are: At 50 volt they can pull 5 amps (250 watts) at 20v they can pull 12.5 amps (250 watts). So what can we learn from these numbers. First they are theoretical only and of no use in practice. The device certainly cannot dissipate 250 watts and if the temperature rises above 25 Deg C these current numbers MUST be derated (As all semiconductors are).

Plastic devices are no better than TO-3 and TO-3 are no better than plastic in terms of power dissipation if used within their limitations.

Plastic power devices are so much better, easier to mount, less expensive, better specifications, large selection of device types and more readily available. Why the big urge to use and see TO-3 devices? At the dawn of the car stereo age certain manufacturers used them, as higher power plastic devices were not available. The TO-3 devices were available in high voltage and high current types. The only plastic power transistors of consequence, was the TIP35/TIP36 pair. Whilst these have massive current capability they could not dissipate the heat due to their smaller base plate. About 20 years ago along came Toshiba with the TO-3P packaged 2SC3281/2SA1302 complementary pair which is similar in base plate dimensions to the TO-3 but it in a plastic housing. Either single hole mount or as most prefer bar or clip mount. Why was this device so good? That is easy. It had a high breakdown voltage (200v), it is rated at 150 watts and has a collector current of 15A. Where it absolutely outperforms the TO-3 devices is in its linearity, Ft (transition frequency) and gain versus current. These old TO-3 devices are slow hogs with Fts ranging from 800KHz to 4MHz where the Toshibas have Ft of 20MHz. Sanken makes plastics with FTs of 50MHz. Both Toshiba and Sanken now make many complementary power transistor pairs to satisfy all power requirements.

One supplier of amplifiers in the USA who brings in cheap Korean product made by Abyss Audio, uses TO-3 devices and then quadruples the price and more and claims that they are

high end, boasts that they use TO-3 devices with a breakdown voltage of 250 volts. (These are the MJ15023/MJ15024 pair). Big deal! What does the 250 volt specification do for them in circuits that are typically limited to less than 120 volts? NOTHING AT ALL. This is just advertising hype by people who really know little about what they write. If the breakdown voltage of a semiconductor device is 10 or 20 volts above the voltage used in the amplifier that is safety margin enough. You can use a 10,000 volt transistor and you gain ZERO!

Sorry for moving sideways. But all the techno boffins who claim the superiority of TO-3 devices need an electronics lesson. They are more expensive than plastics and have ZERO advantage. My philosophy is “use enough power devices” and you will have a reliable amplifier, all other things being equal.

One BIG advantage of using lower power devices but more of them is the following. The current gain of a bipolar transistor goes down as the current through the device increases. So those using single TO-3 devices, where we at Zed may use two or three plastic types in parallel, are at a distinct disadvantage. The current gain of our output stage is significantly higher than the single TO-3 because the current through EACH of our multiple paralleled devices is lower and thus the current gain is higher. This means less current demand on the driver stages and lower distortion. The MJ15003/4 devices I mentioned earlier in this document have a current gain of 25 with 2 amps of current. In the same amplifier we would use TWO of our lower powered plastic devices from Sanken and their current gain at 1 amp is 180. So the gain of our output stage is 7.2 times greater, we have 20MHz devices instead of 2MHz and the total dissipation of our output stage is similar to the TO-3.

At Zed we choose the type of component which will do the job sonically and reliably. We use surface mount components wherever possible and the reason is reliability. Consider the following. Any component which has wires must be placed on the PCB and the wires must go through holes on the PCB. The holes on double sided material are through plated. This means that there is plating on the inside surface of the hole. The process of making the board is not perfect and so there is the chance of bad plating (We have seen this many times). With surface mount there are NO holes. The component is “shot” onto the board by high speed auto insertion machines. This method of assembly is many times more reliable than through hole insertion. When a leaded component is inserted onto the board, it’s leads are “clinched” (bent) on the backside of the board to prevent it from falling off during handling prior to flow solder. These bent leads can, and do touch other leads if care is not taken. With surface mount there is no lead to bend.

Of course the larger components must be leaded types (Large capacitors, power devices, transformers, etc.) but these are all hand inserted and so little stress is placed on them.

Connectors, switches, potentiometers and other mechanical parts:

A lot of common sense prevails here. Power and speaker connectors can cost less than $1 or up to $3-4. Depending on the power requirements the sheer size will determine this. Most high quality amplifiers use either custom or production connectors which have set screws to clamp the cables and are usually made of brass which is normally gold plated.

At Zed we use high quality RCA sockets which do not break. They use Teflon inserts which are much better than the plastic used in most cheap RCA sockets we see on most car amplifiers. The supplier I mentioned above blabs on about their TO-3 devices and then puts penny RCA sockets on their amplifier (well Abyss in Korea do this).

The design of the chassis and all the other bits and pieces influence the cost of a car amplifier tremendously since the chassis is the single most expensive component of the amplifier.

A potentiometer is a typical “high” distortion component. Ideally if we were able to control the level or volume of an amplifier without the use of a traditional carbon film or plastic film potentiometer it would be better. At Zed Audio we use the potentiometer in our level stage in a shunt configuration. This means that all the actual potentiometer is doing is shunting signal to ground. The signal never passes through the control.

Below are some quotes from a well renowned engineer where he talks about cables. The same applies to some of the components used in amplifiers.

If one were to attempt to summarize the objectivist argument in the proverbial 100 words or less, it might read as follows: "High-priced cables are based on voodoo science, designed for gullible consumers who are so swayed by their cost, looks, and status symbol appeal that they delude themselves into believing they hear differences when such differences do not exist. The proof that the differences do not exist is that they are neither measurable nor provable in blind testing."

‘It is human nature to have an opinion based on such perceptions. When someone says, ‘I hear a difference between this and that,’ it is an opinion.

“Now, why is it that our senses fail us so? A big part of this, especially when we’re talking about audio, has to do with the fact that what seems straightforward and reasonable is not. It seems straightforward and reasonable to listen to a piece of audio equipment and then develop an opinion on how it sounds. Unfortunately, due to the complex way that we humans take in sensory information and then combine it with prior knowledge and experience, the resulting perception may be incorrect. If we really want to know how something sounds, we must separate out prior knowledge and visual cues and force ourselves to only use our ears. This is why we do the test blind. Our eyes play a HUGE role in our perceptions of audio quality. Counter intuitive? Yes, but true.
“Now there are perfectly good reasons to buy expensive power cords. For one they look cool. ‘The better it looks, the better it sounds.’ (This has been shown to be the case in studies that compare sighted to blind tests using identical equipment.) Another reason to buy them is that they cost a lot. They are status symbols. Status is good in our culture. Fear is another reason. Fear of not doing everything you can to get ‘the best sound.' Of course there is plain old faith. If you believe that they make your stereo system sound better, then they do! If having them makes you feel better, makes you more relaxed when you listen to music, gives you comfort in knowing that you have left no stone unturned in your pursuit of musical enjoyment, by all means, go for it!”