The Black Gate Story

by Martin Colloms

Ticking away in the background, you might even say on the outer fringes of audio design, is the question of how the actual audio building blocks sound - the components themselves, not the made up equipment nor the circuits. We are talking about resistors, amplifying and rectifying devices, capacitors and wound components, transformers and inductors not to mention connectors and wiring.

An electronics designer uses these parts to craft the circuitry and layout of an audio product. Even now, in certain academic circles, the existence of sound quality differences between technically well behaved amplifiers is disputed. However, many others contend that not only do the design and form of theoretical and practically expedited circuits matter, but also the specific components or parts have their own sonic characteristics.

Many such parts are customized through experience and unique build and specification aspects known for many proprietary audio ranges. Companies such as NAIM and Audio Note exemplify such attention to detail. Taking one of many possible examples, substituting a given, selected power transformer for one of nominally equivalent size, voltage and power, will probably not generate an equal sound quality for the unit built using it. In elevated audio circles, there is rather more to a transformer spec than the standard figures for regulation and volt- amperes.

It's some years since some reviews of component sound quality were published in HFN- RR and there is understandably a limited following for this material. Since then, in audiophile design circles, one branded range of parts has been gaining a cult following for sheer sound quality. If true, this is an important finding because the industry is finding that the supply of traditional higher quality discrete audio compatible parts is declining. This is due to the inexorable advance of surface mount technology and larger, more complex integrated circuits. The opportunity is diminishing for design creativity through the considered selection of electronic parts in audio products. One aim of this review is to alert designers of the possibilities and generate broader international recognition of parts of real quality. We should also help sustain the valuable endeavors of a dedicated band of audio enthusiasts.

Black Gate is the name of the range of otherwise humble capacitors, which has attracted our attention.
A Japanese inventor Kazuo Ishi patented a new way of making electrolytic capacitors back in 1978. Rubycon, a noted Japanese company, makes a large number of types under license.

I last looked at such a passive component when reporting on the Moorcroft patent for the 'T' network capacitor for power supply reservoirs, their successful use licensed in the UK to Aerovox. With test power amplifier chassis in place it was possible to compare that new three terminal design with a variety of conventional two terminal devices [HFN-RR Aug '97].

For these 'T' network components the emphasis was on the internal structure and current paths of the capacitor and a way was sought to maximize the performance of the device by separation of charge and load paths combined with a significant reduction in high frequency impedance.

Capacitor designers are painfully aware of the limitations of various types, for example the odd and varied properties of the film dielectric in the case of the plastic capacitors. Other aspects include the conductive layer, is it an 'ethereal' vacuum deposition or perhaps one with solid metal foil? For electrolytics, a wayward construction of aluminum foil is used with a deeply etched oxide insulation, paper or fibre separators, the whole bathed an electrically slow [slow ionic charge movement] and complex conductive goo. Generally the goo or electrolyte has a closely guarded composition and is an ionic electrolyte, the standard way of achieving an electrical barrier connection to the oxide layer on the foil. It's been known for a long time that this electrolyte is imperfect and amongst other details of construction it may well dominate the electrical performance [distortion, bandwidth, loss factor] and in association, the sound quality. For those not in the know, I here point out that the humble electrolytic power supply reservoir can significantly contribute to amplifier sound quality. Causing much vexation, such differences can't generally be found even with the most searching measurements of the complete amplifier itself.

It was again time to put some components to the test, and what better choice than the ongoing developments in Black Gate technology.

Cherry-Picking

I can't hope to do justice to the Black Gate range as a totality so I've cherry picked from the line, mainly dipping into the stores at UK agent Audio Note for my selection. My task was complicated by early reports that a significant running in period was required [several days] which unfortunately turned out to be true. Certainly there were first impressions available right away which gave helpful clues but at least a day or two was needed to begin to properly gauge the result. For the first series of tests I set up an open structure, a 'breadboard' [actually a maple chopping board] mounted solid state amplifier of known quality, to allow relatively easy substitution of the test capacitors in a range of circuit positions. Later I also experimented with a trusted audiophile CD player which it would not be fair to name.

I experimented with small, medium and large decoupling capacitors [standard type 470u 50V, 470u 16V, 22u 50V, and 47uf 25V] as well as standard power reservoirs [10,000uF 80V, 4,700u 35V and 220 + 220u 350V 'Heart of Muse'. Then came the NH type non polarized at 100uF 160V, 4,700 35V, singly and back to back, complemented by the NX type of completely symmetrical non polars [470uF 16v, 22uF 50V, 20uF, 50V, 22u 6.3V, 0.47uF, 50V, and the delightful 0.1 uf 50V]. I also tried some of the N and NX types in the ultimate back-to-back configuration. Finally I checked out the bi-polar higher current crossover capacitors, [6.8u, 50V].

Certainly the Black Gate capacitors are very, very expensive and I was consequently hoping for some significant advance over normal types. However I couldn't possibly have predicted the magnitude of the sound quality changes I heard. The changes were so dramatic that of necessity I made multiple repeat comparisons over many days, and ultimately weeks for this project.

Do please note that the use of these devices is not a 'fix all' solution, you cannot just throw them at a design. Painstaking comparisons showed that each type and value needs to match the requirements of the specific circuit and circuit position as well as be technically and sonically compatible with existing types of capacitor or indeed other BGs when used.

While parallel combinations of Black Gates were generally foolproof, on some occasions adding BGs in parallel to conventional capacitors could actually make things worse. For example, even one of the best 100uF BG 'N' types when added to a fine sounding 10,00uF Great Supply Nichicon reservoir didn't help matters, while by contrast a much smaller 0.47uF NX really did lift this combination significantly when used as this reservoir bypass.

With no significant measurable differences to speak of, judgments must be made by ear. You need to know you equipment thoroughly, be used to assessing small differences in sound quality and be open minded, expect poorer as well as better results. If BG devices are going to help you, will likely hear something right away, while the full benefit may not develop until week of use has passed. In the case of the Nichicon and 100uF bypass tetst I can only speculate that the high frequency current in the system must have been in some sort of disordered exchange, power sharing above 10kHz or so, because while the sound became clearer, it also became sharper and more aggressively forward in the treble.

With the 0.47u NX bypass such tonal changes were placed out of band while the improvement was heard as improved yet subtle clarity, and a purer sweeter upper treble; less noise and grain was now evident.

So strong was the BG effect, that existing selected quality 0.1uF polypropylene de-couplers on the power amp supply lines had to be removed from the circuit as they were found to audibly degrade the performance advantage even of a 47uF 25V standard polarized BG used with no other supplemental high frequency decoupling.

If the standard BG electrolytics were exceptional, and in my view surprisingly so, and rated I my comparisons as typically 50% better for sound quality than conventional good quality electrolytics, then the 'non polar' types were simply extraordinary.

Chosen by trial and error for the right value and circuit location, by the end of the process the overall sound quality of my audio test amplifier was transformed by the addition and/or substitution of BG polars and non-polars. Moreover these capacitors as a whole proved just as effective in many of the digital areas of an experimental D/A converter as in its analogue sections, as they were for the test amplifier. Here we are talking of clocks buffers and signal related microprocessors

Cobwebs over the sound stage that you hadn't realized were there, were now magically swept away. Substantial gains were also present in every aspect of sound quality. The difference was so great that we were forced backwards time and again to cross -check the non BG types and also to refer back to other known reference grade audio types to make sure that we were not fooling ourselves.

Running-In

When you are very familiar with how a product sounds, it is often surprisingly easy to detect subtle changes between electronic components used in it. This is even more obvious when the product is both very short and simple, and very good.

I have previously reported on running-in phenomena with other components, the most obvious being the moving coil loudspeaker. Nevertheless amplifiers, CD players etc may be observed to run in over a period of time, usually no less than several tens of hours. Sometimes the rate of improvement will be slow, almost imperceptible, and several weeks may pass before you actually realize the sound has got better. Assessing these changes is made easier by a valued stock of long term, well run-in, reference products.
A top quality amplifier, first auditioned from brand new may be surprisingly flat and mushy sounding, almost average, but if of real quality then rapid improvement may be heard over the first few hours of use.

While in general Black Gates sound pretty good out of the box, the potential performance ceiling is so high that the process of improvement during running in can appear to go on for many tens of hours!

Take the 10,00uF 80V high current polar reservoir, performing very well in the power supply of the test solid state amplifier First trials showed it was certainly the best of this type in this test station, compared with top grade alternatives including 'T network, Elna and Great Supply. Nevertheless on a raw value basis these BGs did not at first appear to be worth a quoted up to 6 times that of the other types.

And then they ran-in.....

As the days went by the BG reservoirs gradually and inexorably built up their lead to a point where their contribution to sound quality was so great that a temporary return to those other well regarded reference capacitors resulted in amazement, confusion and real disappointment.

Certainly this big BG reservoir is very expensive [about £100 each in singles] but in a circuit which can fully exploit their potential I consider there's no other device of this type and value which can make such a contribution to sound quality.

The Technology:
Aspects of BG technology are protected under trademarks and also seven patents, for Germany, Japan and the USA. First released in 1978 the technology began with an advanced modification for the electrolyte of the capacitor, namely the inclusion of finely divided graphite. Do this incorrectly and the capacitor may become a short circuit!
Chemically neutral, the particle size is appropriate for the exploitation of tunneling, an ultra fast and virtually lossless quantum conduction mechanism far superior to the lazy ionic transport of a standard electrolyte, this resembling a chemical battery. With this dramatic conduction improvement, self noise and distortion is claimed to be reduced by between 10 and 300 times depending on type [and cost!] and the ESR, or unwanted internal impedance may be improved right across the board, by between to 2 and 10 times, over the frequency range, and especially over a wider range of temperature. Normal ionic conduction is known to be rather temperature dependant and many audio electrolytic capacitors sound and measure at their best at a respectably high temperature such as 40 degrees centigrade, a known factor in the sometimes encountered extended warm up of some hotter running power amplifiers.

The top BG models are specified to have extraordinarily low distortion, for example at 10kHz , 200mV drive, reading -148 dB for harmonics for the NX non-polar series [eg 15V 1,500 uf] compared with an average of -88dB of distortion for three commercial standard, types of equivalent rating. I am not saying that -88dB of capacitor distortion in this test is directly audible in any case but the figures do give a clue to the special properties of the non-polar BG.
Special measuring equipment, itself upgraded with BG capacitors to reduce inherent distortions, was required to define that noted distortion improvement of some 50 dB, or 300 times.

Sound Quality

The test amplifier;
So comprehensive are the BG advantages at this point of exploration that it's hard to know where to begin, Referenced to the benchmark of the known best non BG capacitors [including Nichicons, Elna Cerafines etc], the sound stage of the test amplifier after its treatment was remarkably expanded in width and depth, yet its focus is still more solid. Images now hung in space, set in floodlit pools of detailed acoustic ambience. Subtleties which were previously just hinted at were now firmly and expressively delineated. Every point in the audible frequency range was clarified, sharpened, resolved. Rhythm and timing are redefined. Musical notes appear to linger in time and space, of near perfect entity and with breathtakingly natural instrumental and reverberant decay compared with previous experience of that design.

Colorations which were previously blamed on circuit behavior and specific active devices, if you like its technology makeup, were in this unit now seen to be largely the fault of the previous capacitors and these familiar errors were almost banished by the progressive and graded installation of the Black Gates.

If these comments seem extreme I offer in my support the experiences of several other listeners, some hard-bitten and difficult to impress. In general they were shocked by the magnitude of the changes I could make in the test system with these capacitors, and when the combination of BG parts was felt to be in balance with this particular test unit, agreed that the overall audio system improvement was not the usual 10 or 20 % resulting from the insertion of a new and better review amplifier, but rather a complete order of magnitude.

I also tried 4,700 35 V polars for the main reservoir of a high performance CD player, and with substantial benefit, if not quite as great in context as for the amplifier. Here I suspect that the complexity and chosen technology of this player design had set a natural limit to performance and that the BG additions had moved it closer to that limit. For this player a gain of about 15 % in sound quality was noted once it had all run-in, with a scattering of non-polars also used for local decoupling. Despite the cost I valued even this project to be well worth while.

In one simple test an inexpensive old standby CDP, a Marantz CD 60SE was tried with the BG non-polar crossover capacitors as output couplers. It had already been modified where the bi-polar Elna Cerafine output capacitors had been replaced to advantage by 4u7, 400V ICW polypropylenes. Known to be good capacitors it was a surprise to hear how the player changed with just this substitution by BG. Overall the sound lifted about 8% with the most notable feature being a more relaxed quality, a more spacious sound stage with better flow and rhythm. I have also heard them sound well in an audiophile loudspeaker application but have not personally made direct comparisons in this higher current application for which they are really intended. I did however try them for power decoupling and they are clearly not as good as the appropriate N or even polar types of comparable capacitance.

Tests have continued to the non-polar supply reservoirs, in this case 4,700u 35 V. For a single ended FET preamp with multiple pass regulators, the gain in quality over the polar BG was substantial. Compared with standard non BG types one again hears reductions in coloration and grain, deeper silences, greater image depth and ambience.
Following the apocryphal BG story to the very end I added further non-polars in the reverse orientation, the costly back-to-back arrangement, and heard an additional gain about equivalent to that already described. A month later and I can hear continuing incremental improvements in clarity and focus.

Amongst these many winners there is one true star in the series. It is also one of the cheapest and the smallest. It is the 0.1u 50V NX, [non- polar]. This almost grain of rice sized electrolytic it seems can be put almost anywhere, on IC supply pins, as audio speed ups, digital and analogue. Chuck out the films and ceramics which would otherwise be needed because they will audibly detract from the NX benefit. They seem to be able to clean up the sound while maintaining a musical balance and yet do not significantly interfere with the designers intention. They are small enough to fit almost anywhere.

Comment

A word of caution is needed to temper my evident enthusiasm for these capacitors.
I have found that the magnitude of audible improvement is dependant on the equipment to which they are applied. Some circuits seem capable of exploiting and revealing the gains which are possible. Others seem to have a closed nature, and reach a natural limit beyond which it is more difficult to make gains in sound quality. We listen through a long chain of components and equipment and some of these set inherent barriers to improvement.

Taken overall, and in circuits which are capable of exploiting the BG advance, the gain in sheer sound quality is in many cases roughly and simply proportional to the one-off amateur cost of the BG part. Even the lowest cost capacitors in this technology are significantly rewarding and should not be overlooked, while the top grade, non-polar components, do, in my view change the rules for the design of high quality audio equipment.

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