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HIFICRITIC

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MUSIC & MUCH MORE

The Rhythm King *Part 2*

THE SECOND, CONCLUDING FEATURE ABOUT THE BMR-BASED *HIFICRITIC* DIY LOUDSPEAKER

MARTIN COLLOMS

Carrying out the transfer from the initial active-drive prototype with its DSP-synthesised active crossover to the passive crossover version of the TRK loudspeaker proved successful. This passive crossover was built with Wilmslow Audio supplied components, and the final voicing was done with all the cables in place, including 4m runs of DNM *Precision* cables to the amplifier. And after seeing the loudspeaker in the flesh, I am not minded to alter anything, save perhaps to specify a black finished alloy for the bass driver cone and black socket head screws for the driver fixings.

Component Quality

The specified crossover components are appropriate for the purpose, and where small losses are present, these have been taken into account in the tonal balance – in the precise alignment of the relative outputs of bass, midrange and treble drivers. A larger, lower resistance bass inductor might therefore not represent an improvement, as it could subtly alter low frequency damping. Likewise, capacitors with lower losses might change the response shape of the filters or increase the relative level of higher frequencies more than was intended.

Crossover component upgrades must always be made with caution and backed by careful listening. However, the open architecture of the design makes such a procedure relatively easy. Furthermore, because the standard crossovers are relatively inexpensive, those intending to go active should in any case prototype with the passive version and retain it as a reference platform for further work. Incidentally, I originally underestimated the peak current that supplied the 2.6mH high-pass midrange inductor: it was undersize and I heard early onset core saturation distortion, so this component needs to be the same HD type as for the bass.

Construction: Enclosure

Skilled woodworkers may want to build the enclosure from scratch, as the drawings will be available for downloading. However, note the particular fine detailing on the shaped recesses for mounting the drivers, in particular for the BMR unit, so as to leave the rear apertures as open as possible and minimizing any unwanted cavity effects which could colour the sound. The pre-cut enclosure kit fits together like a jigsaw puzzle, and needs to be assembled with plenty of good quality PVA wood glue, plus the usual clamping and tensioning to hold it tight during bonding. The joints need to be well filled to avoid any rattles or unwanted vibration. If one or two short sections of joints seem dry, short lengths of 20 to 50mm square section fillets may be glued into position as reinforcement.

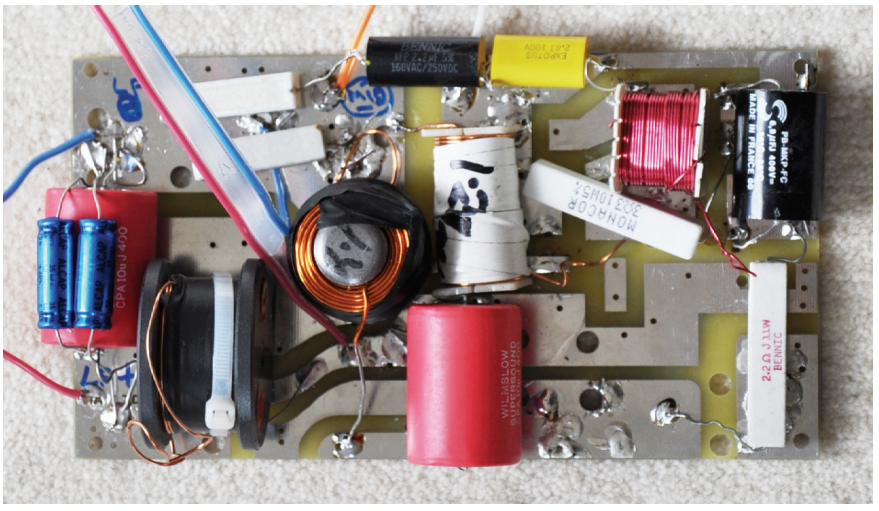
What is important is that the bass enclosure is properly air sealed once all fittings are in place. (The specified sockets are air tight if well fitted.) One way to confirm the air seal is to depress the bass cone carefully and slowly inwards about 10mm and watch it come out. It should do so slowly, taking a few seconds or more. If not there must be an air leak somewhere, which may whistle or hiss, and some very low bass energy may not be fully reproduced. Also there must be no leak between the bass and mid enclosure or the bass will modulate the mean centration of the BMR driver and introduce some distortion, heard as a loss of transparency at the very least.

The mid enclosure has a small and essentially un-tuned damped vent, which suppresses the effect of the low frequency pressure field acting on the driver thus increasing clarity and subjective dynamics. Otherwise this can cause some residual diaphragm motion. The dimensions of the duct and the amount of stuffing in the mid vent may be adjusted to taste, though this BMR section is not intended to produce any meaningful low frequency contribution. A 5cm long duct with a little acoustic wadding push-fitted into the duct will do.

Construction: Crossover

The crossover can be supplied ready assembled or as a kit, but it should be housed in a neat box, such as the ABS detachable lid model from Maplin [22x17x7cm, ABS *MB6* (*YN39N*)], or a small home made wooden box. Remember that the push-through M-C 4mm entry sockets must be fitted before soldering to the board, and they may be secured with the ring and with hot melt glue on the inside. For prototyping I soldered the components to the track side of the standard Wilmslow three-way board for easy access and experiment, but take care to keep the inductors spaced away from the board with adhesive foam or felt pads so there is no chance of the wire turns shorting to the track. Also take care too not to get the circuit wrong, noting the slightly odd 'universal' track layout. The crossover board may be dispensed with altogether and the parts hot-melt-glued to a piece of plywood, MDF or similar, with point-to-point wiring. (See listing for wiring colour codes.) Use star grounding practice; follow the circuit drawing to avoid unwanted circulating currents which will mildly dilute the performance. Nearby inductors should be at mutual right angles to avoid magnetic coupling.

The bi-wire DNM cable comes in orange and white (mid/treble plus/positive and minus/negative), plus red and blue (bass unit plus/positive and minus/negative), and the plugs and sockets are coded accordingly. The speaker design is calibrated with this cable, and for typically 4m lengths to the crossovers. There won't be huge differences with other cables but I wished to remove as many variables as possible between the prototype and home constructed version.



The Target Functions

The crossover frequency responses at the driver terminals are reproduced. These work in combination with the drivers, the enclosure, and the known local acoustic to generate the overall acoustic target function for the design, which inevitably dominates the overall perceived sound. Consequently, the voltage drive responses are not flat. With 'by the book' simulation methods (or should I say by the ubiquitous and commonly used computer based techniques), arbitrary axis flat frequency responses may be readily achieved, but the perceived frequency response may sound anything but flat, and it is therefore not likely to sound natural. The energy responses of the drivers *in situ* have been taken into account in the overall voicing.

General Points

Loudspeakers do run in, not a lot, but enough to affect the more subtle design decisions, so give the speaker 50 to 100 hours of good use before considering any fine tuning. Crossover capacitors seem to settle down, cabinet and driver fixings attain a stable level of tension, while the driver build adhesives mature to a point of stability, and suspensions reach a median level of compliance, mechanical centration and damping.

The reproduced frequency responses show some imperfections; for example the BMR principle is approximately realised in practical driver form and has some irregularities. It is certainly not as smooth at high frequencies as a conventional dome tweeter. However, the BMR was not chosen because is particularly smooth, or has low distortion, or any other specific parameter. It is used because it coherently operates all the way from the lower midrange to the high treble in one pass, with moderate coloration, stable directivity, a particularly even power response, and probably its greatest asset, exceptional time coherence. Add in the fast, clean, and consistent low frequency performance from the 220mm SEAS pistonic bass driver, and the overall performance with the BMR is respectable, while the standard of musical communication is exceptional. It's relatively uncritical of listener height or lateral angle, and because the room loaded frequency response is more stable than most, due to the designed wall boundary location, it should give consistently better sound in more situations than usual. I feel that this is a more important element in the listening experience than a perfect looking frequency response.

Most kit speakers adopt theoretical low frequency alignments, matching the drivers' notionally uniform responses with a time aligned crossover network. However, the actual sound presented will be a subtle summation of alignments, directivity, phase and frequency integration, and can easily be way off the desired 'voice'. Either the design gets stuck at this point, or the constructor tries various modifications to leaven the mix, often with uncertain results.

The design of *TRK* starts by respecting the individual voices of the drivers and enclosure. When these have been properly aligned, the system may be fine-tuned for the most musically natural result. Constructors may wish to leave out the two mild response shaping networks, since these only amount to +/-2dB or so in the pass band; a single 2.7ohm 10W series resistor could be tried instead. But we consider that they make quite a difference. Natural piano timbre, the depth layering in the stereo image, and optimum articulation in singing voices, it is here that this subtle extra voicing makes its mark in combination with level matching and crossover integration. As these shunt networks only act over a narrow frequency range, and are effectively 'off' elsewhere, their component quality is less critical.

To fine tune for room and partnering system variations, R1 adjusts the mid-treble level and may lie in the range from 1.8 to 2.7ohms (1R8 to 2R7). R2 sets the upper mid 'projection'; to pull it back reduce it to 3.6 or 3.3ohms; to push it forward increase it to 4.3ohms. Finally, for voicing the upper treble, The 6.8ohm value may be safely varied from 5.6ohm for a sweeter sound to 7.5ohm for a crisper effect. (Note that changing the overall or individual levels may alter your opinion of each setting.)

Lab Results

Noting the driver terminal responses, and that some interaction with the speaker cable impedance will occur, the 300Hz crossover point is well defined, with close to 12dB/oct slopes, and no allowance is needed for relative driver diaphragm depth displacement. The mild lift at 70Hz is a function of the crossover network interacting with the bass driver motional impedance; this is quite normal and has been taken into account in the tuning. Since the BMR is the more sensitive driver, it is attenuated by about 3.5dB, and those two small response corrections are also applied, centered on 1.8kHz and 8kHz, which help to balance the timbre.

This design is intended for close-to-wall location, so I measured the low frequency response in the nearfield on a ground plane, balancing the relative bass and mid outputs, and found it respectably uniform. The bass extends to 33Hz -6dB, which is also the practical in-room response limit, while the low frequencies proved to be quite consistent across different room and listener locations. It could take 40Hz 35W sine wave and sounded clean, which is a good result.

While the BMR is smooth to about 850Hz, it shows fine textured variations of some +/-4dB thereafter. However, when 1/3-octave smoothed (according hearing perception thresholds) it is satisfactorily smooth, as the 'yellow' trace indicates. Individual response traces do vary quite significantly with measurement axis but the room-averaged response shows that the sound power is distributed with impressive uniformity into the room space. This curve tells us much about the overall voicing, the balance and the timbre. We have also shown the impulse response because it shows the fine time alignment and 'speed' of this system, albeit not without some evidence of some midband decay artifacts (which are subtly different for each particular measurement axis).

The smooth impedance curve, only mildly reactive at low frequencies, indicates a 6ohm system with a minimum of 4.5ohms. The 380Hz blip may be due to a controlled mode in the BMR driver. System resonance is at a low 33Hz, rather lower than the 40Hz calculated partly due to the interaction with the low pass crossover section. System sensitivity is on target at 86.5dB/W, which is fine for a sealed box system.

We did not expect a pretty result for the frequency/decay response, shown here as a waterfall representation for one mike position. There are moderate buried resonance modes for this measurement axis at about 3kHz and around 10kHz, while the feature at about 23kHz is a single frequency measurement artefact. However, note also the good result for the 'time/frequency matched' overall decay, beginning from the start of the time response at the back of the graph.

As with 'single driver' speakers, the measured results do not fully convey the sound quality advantage of covering most of the audio range with a single diaphragm and voice coil. For example, the German Manger 'full range' driver is a long established but very different example of a wide range planar diaphragm, controlling resonances through high levels of damping rather than the BMR's dynamic mode balancing. Again, fine sound quality, particularly for timing, belie some of the Manger's less than impressive measurement results.

Comment

There is always a risk when beginning such a project, as the results are invariably binding unless the whole thing is abandoned. In the event I feel that it has turned out pretty well, and the overall performance is more than good enough for the design to be published. If well constructed it will bear comparison with a numerous commercial examples, and has some particular qualities that are all its own.

All those who have heard a finished pair (see *Listener Comments* Box) have approved of their speed, good timing and fine exposition of rhythm, though of course TRK will only deliver timing as well as the program feed will allow. Dynamics are good and the bass is very presentable, particularly in its power and consistency with different types of material. It is notably free from any boomy character, and the overall room drive is also very consistent. Coloration is moderate, with an essentially neutral timbre. Image depth is good despite the wall location; and if I may say so myself, I feel that the design team have scored well above average. Many thanks to all who have contributed so much thought and effort to realise *TRK*, especially Christien Ellis of CE Electro-Acoustics, Miles O'Carroll, Terry Sharp of Wilmslow Audio, and Denis Morecroft of DNM.

ESTIMATED PRICES

(NOTE: these prices are only tentative estimates at this stage and may well change)

Parts only (no enclosure) £500/pair
Parts plus flat pack enclosures £950/pair
Parts plus pre-built enclosures £1,250/pair

NOTE:
A section on the *HIFICRITIC* website has the complete documentation and contacts. See also the DIY *TRK* section on the *Forum*.

LISTENER COMMENTS

These independent comments were based on listening sessions using a Naim Supernait, CD drive, and DNM Cables

Stefan Wagner (studio audio correspondent)

I've had the pleasure of listening to *The Rhythm Kings*, and I want them – NOW! Being used to my own wall-mounted speakers I enjoyed the 'wall of sound' delivered by *TRK*s and the corresponding image structure behind them. The sound has a clear texture and nice multi-dimensional image that clearly shows where things are happening.

The most outstanding feature must be how it handles the beat and tempo of any song it plays. No wobble or choking whatsoever. As a result some music might sound faster and slightly more out of breath than it does using more typical commercial speakers. Nevertheless I like the dry and clean pulse of the *TRK*, and the clean response to challenging dynamic sounds should also make it an interesting speaker for a movie/cinema sound system. I am considering making a full-blown, in-wall multi-channel set.

Our Computer Audio Correspondent

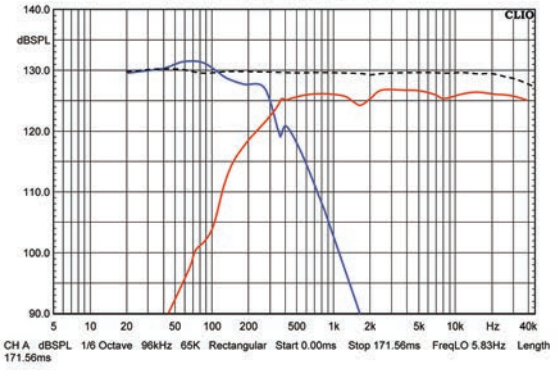
The *TRK* is an interesting speaker that delivers a lot for the money. It has a directness that normally only a full range driver delivers, but doesn't have the very obvious 'character' that full range drivers usually have. Of course it has some character, and for me it is a little reticent in the 'lips and teeth' area. But it's clean and free from 'splash'; the low end delivers weight; and the system times rather well. Which is not to mention the sweet but explicit upper mid, the treble quality, and the fine imaging.

Chris Bryant (who had no design involvement)

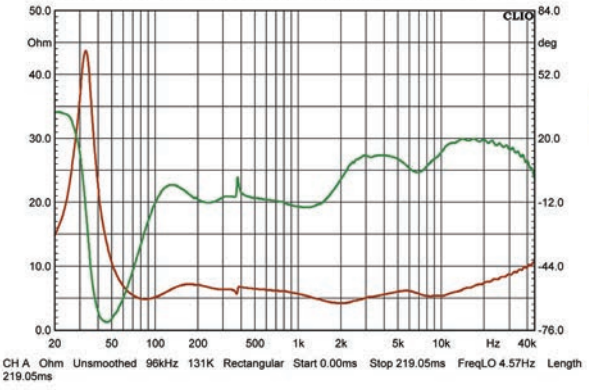
I am aware of that characteristic and attractive BMR 'directness', which fortunately is not hidden in this design. *TRK* is communicative and well timed; coloration exists but is satisfactorily controlled; and the bass is deep and fast. Image focus and depth are good, and the wall boundary is smoothly handled.

First port of call for all parts and packages:
Wilmslow Audio
Tel: 01455 286603
www.wilmslowaudio.co.uk

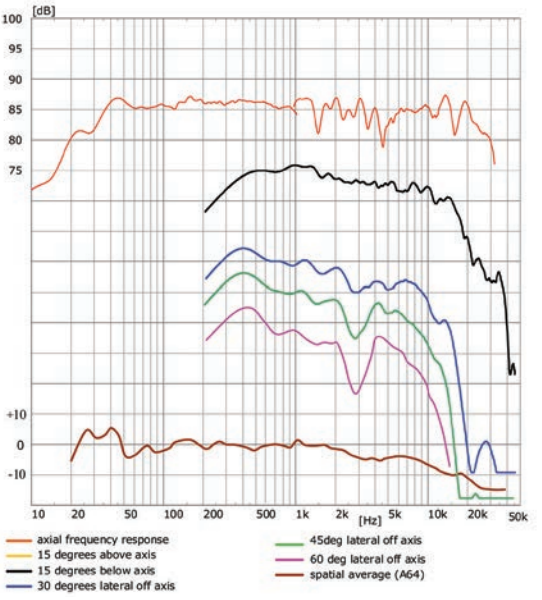
TRK Driver Frequency Responses



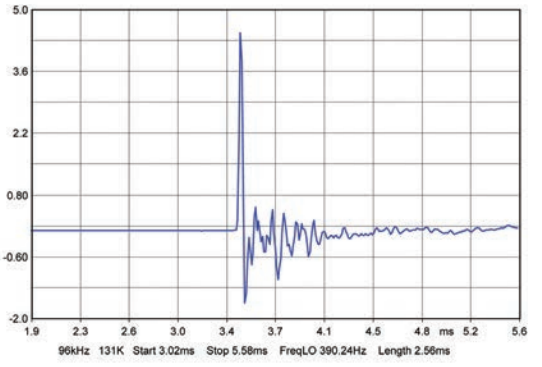
TRK Impedance, Frequency/Phase Response

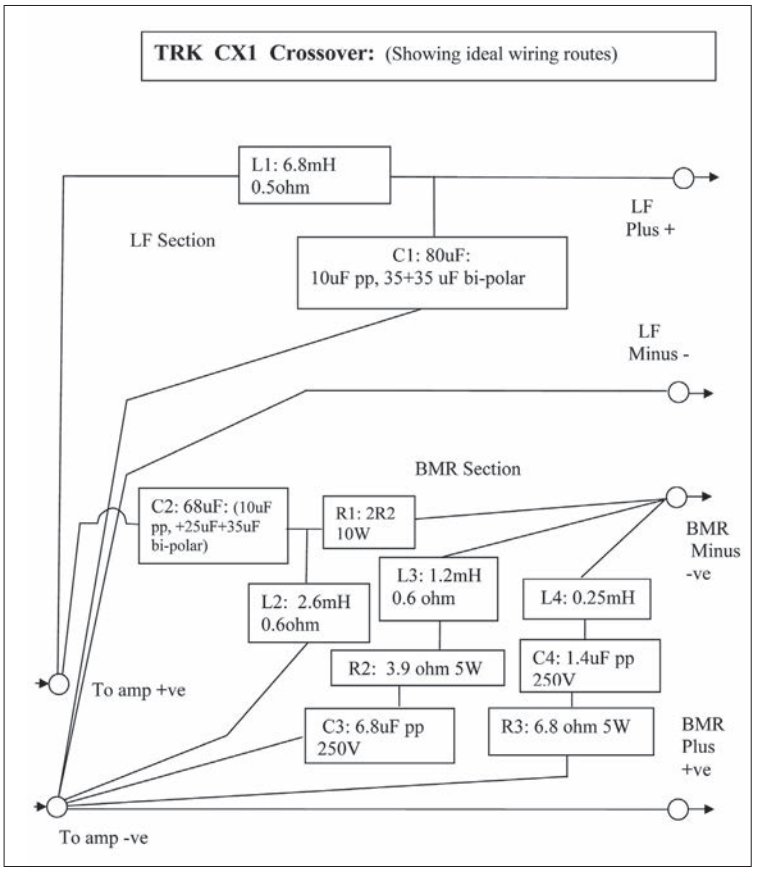


TRK Frequency Responses



TRK Impulse Response





TRK Waterfall, essentially linear phase, plus some ringing