KLS 10 HIGH-TECH MINI MONITOR WITH GOLD DOME

24-BIT DAC WITH VALVE OUTPUT STAGE, PART 2

DIY BOOK REVIEWS

FREE D.I.Y. SUPPLEMENT No.37
for High Quality Audio Tubes

Everybody in the tube business knows that the justly famous Brand names of yesteryear like BRIMAR, GEC, MULLARD, RCA & TELEFUNKEN Etc. Etc. are scarce and often very expensive.

Although we supply all major brands when available (and have many in stock) our policy is to offer a range of tubes, mostly of current manufacture, the best we can find from factories around the world, which we process specially to suit audio applications. The result - CVC PREMIUM BRAND.

Our special processing includes selection for LOW NOISE, HUM & MICROPHONY and controlled BURN-IN on all power tubes to improve STABILITY and select out tubes with weaknesses Etc.

**A selection of CVC PREMIUM Audio Tubes**

<table>
<thead>
<tr>
<th>Pre-Amplifier Tubes</th>
<th>Power Tubes</th>
<th>Power Rails</th>
<th>Sockets Etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECC81</td>
<td>EL34G</td>
<td>7.50</td>
<td>B9A (Chassis or PCB) 1.60</td>
</tr>
<tr>
<td>ECC82</td>
<td>EL34 (TESLA)</td>
<td>8.00</td>
<td>B9A (Ch or PCB) G/Plated 3.00</td>
</tr>
<tr>
<td>ECC83</td>
<td>EL34 (Large Dia.)</td>
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<td>Octal (Ch. or PCB) 1.80</td>
</tr>
<tr>
<td>ECC85</td>
<td>EL84/68Q6S</td>
<td>4.70</td>
<td>Octal (Ch. or PCB) G/Plated 4.20</td>
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<tr>
<td>ECC88</td>
<td>EL509/519</td>
<td>13.00</td>
<td>4 Pin (For 2A3, 300B etc.) 3.30</td>
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<tr>
<td>ECF82</td>
<td>E84L/7189A</td>
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<td>4 Pin (For 2A3, 300B etc) G/ Plated 5.00</td>
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<tr>
<td>ECL82</td>
<td>KT66</td>
<td>9.50</td>
<td>4 Pin Jumbo (For 211 etc.) 11.00</td>
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<tr>
<td>ECL86</td>
<td>KT77</td>
<td>12.00</td>
<td>4 Pin Jumbo (For 211 etc) 15.00</td>
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<tr>
<td>EF86</td>
<td>KT88 (Standard)</td>
<td>12.50</td>
<td>Gold Plated 15.00</td>
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<tr>
<td>EB0F Gold Pin</td>
<td>KT88 (Gold Special)</td>
<td>21.00</td>
<td>5 Pin (For 807) 3.00</td>
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<tr>
<td>EB1CC Gold Pin</td>
<td>KT88 (Gold Lion Pair)</td>
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<td>7 Pin (For 6C33C-B) 4.50</td>
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<tr>
<td>EB2CC Gold Pin</td>
<td>PL509/519</td>
<td>9.00</td>
<td>9 Pin (For EL, PL509, Ch. or PCB) 5.00</td>
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<tr>
<td>E83CC Gold Pin</td>
<td>2A3 (4 or 8 Pin)</td>
<td>14.50</td>
<td>Screening Can (For ECC83 etc) 2.00</td>
</tr>
<tr>
<td>E88CC Gold Pin</td>
<td>211</td>
<td>22.00</td>
<td>Anode Connector (For 807 etc.) 1.50</td>
</tr>
<tr>
<td>6E17</td>
<td>300B</td>
<td>50.00</td>
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<tr>
<td>6SL7GT</td>
<td>6C33C-B</td>
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<td>Retainer (For 6L6WGC etc.) 2.00</td>
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<tr>
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<td>7025</td>
<td>6B4GT</td>
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<tr>
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<tr>
<td></td>
<td>6140B</td>
<td>10.50</td>
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and a few “Other Brands” (Inc. Scarce types).

<table>
<thead>
<tr>
<th>Tube Type</th>
<th>Power Tube</th>
<th>Power Rails</th>
<th>Sockets Etc.</th>
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</thead>
<tbody>
<tr>
<td>5AR4/5G3Z4 MULLARD</td>
<td>6B4G RAYTHEON</td>
<td>27.00</td>
<td>6SN7GT BRIMAR 5.50</td>
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<tr>
<td>5R4GY RCA, STC</td>
<td>6B6W BRIMAR</td>
<td>5.00</td>
<td>12AT7WA MULLARD 5.00</td>
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<tr>
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<td>6B87 GT SYLVANIA</td>
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<td>5U4GB RCA or GE</td>
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<td>12AZ7 GE 7.50</td>
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<tr>
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<td>12B97A GE or RCA 13.00</td>
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<tr>
<td>6AS7G RCA or SEIMENS</td>
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<td>12BY7A GE 9.00</td>
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<tr>
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<td>12E1 STC 12.50</td>
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<tr>
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<td>6B4G RAYTHEON</td>
<td>27.00</td>
<td>6SN7GT BRIMAR 5.50</td>
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<td>5R4GY RCA, STC</td>
<td>6B6W BRIMAR</td>
<td>5.00</td>
<td>12AT7WA MULLARD 5.00</td>
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<td>12AY7 GE-SYLVANIA 7.75</td>
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</table>

Please note carriage charge extra + VAT (EEC Only) - When ordering state if matching required (add £1.00 per tube).
Payment by CREDIT CARD (ACCESS, VISA, MASTERCARD) or BANKERS DRAFT, TRANSFER or CHEQUE (UK ONLY).

FAX or POST your ORDER - We shall send PROFORMA INVOICE if necessary.

Valve Amplifiers sound better still fitted with CVC PREMIUM Valves!
Chelmer Valve Company, 130 New London Road, Chelmsford, Essex CM2 ORG. England.

Fax: 44 (0)1245 490064
KIT NEWS

Budding DIY constructors turn to this page first for the latest audiophile components.

KLS10 GOLD DOME

Noel Keywood guides you through the construction of KLS10, a two-way kit that marries a carbon-fibre mid/bass to Audax's Piezo-electric Gold Dome tweeter.

24-BIT DAC WITH VALVE OUTPUT, PART 2

Chris Found takes the wraps off the final PCB layouts and build sequence for our 24-bit DAC.

BOOK REVIEWS:

VALVE AND TRANSISTOR AUDIO AMPLIFIERS

John Linsley Hood opens up his considerable thermionic and solid-state design knowledge to DIY fans in his new book.

DIGITAL AUDIO SIGNAL PROCESSING

Udo Zoitzer takes an in-depth mathematical look at modern digital signal processing.

DIY Q&A

Seek and ye shall find the answers to your DIY queries here.
**Standard Types**

<table>
<thead>
<tr>
<th>Code</th>
<th>Brand</th>
<th>Price</th>
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**Special Quality Types**

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**American Types**

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**Output Valves**

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**Other Types**

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<td>6SN7GT</td>
<td>USA</td>
<td>5.00</td>
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**Rare Original Valves**

- Siemens 6922 Gold pin - superb quality £15.00
- Philips E188cc Gold pin - special quality £15.00
- Telefunken ECC82 - diamond mark £25.00

**Attention:** Free delivery on all valves to anywhere in the UK until 30 April '98.
CROSSING OVER

In addition to the Two-Way Electronic Crossover (Maplin part number DR66W, designed for in-car use but suitable for home hi-fi) mentioned in some of our previous Supplements, Maplin stock more complex active crossovers.

If a three-way speaker is your idea of transducer heaven, then a three-channel crossover is called for. GK10L offers 12dB/octave roll-offs, each crossover point switchable from a choice of four different settings. Price is £46.99.

Another option is DR67X which is a five-way unit. This has more flexibility for adjusting crossover points, the ranges including 40Hz to 90Hz, 90Hz to 1kHz and 1kHz to 8kHz. Priced at £64.99, this crossover has a claimed 0.01% distortion and a signal-to-noise ratio of 100dB.

Maplin
PO Box 777
Rayleigh,
Essex
SS6 8IL
Tel: 01702 554002

BOXING CLEVER

South Coast Speakers are offering a design service for budding loudspeaker builders. They can help with cabinet design by calculating the ideal enclosure volume, port size and length on reflex designs for your chosen drivers. The service costs £25 + VAT.

Also offered is crossover design, where given drive units can be matched to a suitable crossover, again for £25 + VAT. If the chosen driver does not have a spec sheet, or if a finished loudspeaker needs to be assessed with a measured performance, this can also be undertaken, with phase, impedance and Thiele/Small parameters calculated for £5-£10 + VAT.

Speaking of drivers, SCS are going to be selling a new line-up of mid/bass units and woofers from Canadian company Loudspeaker Research and Development. These eight new arrivals with their polyimide cones all boast high power handling thanks to Kapton voice-coil formers and five vents behind the cone, which gives them their Max Pentivent name. Prices vary from £22 for the 4in. to £85 for the 250watt 12in.

South Coast Speakers
326 Portswood Road,
Southampton,
Hampshire
SO17 2DT
Tel: 01703 559312

WOUND UP

IT Electronics of Germany make a range of high-grade inductors wound with 99.99% High Conductivity Oxygen-Free Copper wire. Available exclusively from AudioCom, the air-core range are made in values from 0.10mH to 6.8mH, priced between £1.77 and £12.39 depending on value.

These air-core coils are claimed to outperform both ferrite and regular air-cores due to their low-resistance, high-purity copper.

Another option for enhanced performance is the Corobar range, which uses an iron-dust core to maximise inductance with fewer turns, thus allowing for further reduced resistance. The Corobar come in values from 0.10mH to 12.0mH, priced between £7.24 and £19.84. For close tolerance applications or where unconventional values are required, specific inductances can be created in-house by winding down from the next highest value.

AudioCom are also stocking an upgrade kit for use on most CD players - the Superclock module. This smart little device enhances the player’s in-built crystal-oscillator clock with precision high-grade components, all neatly encapsulated within a black box. Relatively simple to fit, the basic kit costs £145, or there’s a deluxe version with pure silver hook-up wire at £155. For the soldering iron-shy, the deluxe can be fitted for £165 inclusive.

We hope to be testing both Superclock and HC-OFC inductors in forthcoming supplements.

AudioCom
Unit 6,
Tindle Enterprise Centre,
Warren Street,
Tenby,
Pembrokeshire
SA70 7JY
Tel: 01834 842803
FERRITE: Standard. High Power, Super Power. Super Super Power + AIRCORED 0.56125mm win...

A comprehensive range of Focal kits from an even wider range of

CECIL WATTS Dustbugs/Parastats/Spares - incl. Preener wicks

THORENS
C600 521itre 2 way Column,
C500 301itre 2 way Column,
B400 181itre 2 way Compact,
B300 8.51itre 2 way Compact,
Recommended Lubrication set - early 301 or 301/401 ( specify)
Replacement 301 Chrome plated mounting bolts set
Replacement 301 motor pulley (- 2%), (- 1%), ( Std), (+ 1%) each
Original Brake pad
Original Idler tension spring
Replacement 301 control knobs On-Off/Speed select pair
Original Thrust pad assembly
GOLDRING/LENCO

Recommended Sylphon Mic. in capsule for 301 reeds:

GARRARD Stzlndemil4odela

I trge selection of Programs available from the very comprehensive Liberty AudinSuite test Kogan)

Send for our FREE price list PI.26: just send a large S.A.E. ( 38p stamp) or USS2 bill overseas,
via A1RR, LoudSpeaker Ver.6, BassBox 5.1. to the basic Bullock/White Boxresponse.

ALCAP Reversible Electrolytic Capacitors ( Non- Polar): 50v, f Cev & Low Lim.2mM to

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Back year sets of Speaker Builder, Audio  mouleur & Glass Audio. plus the Audio Anthology Set

Also the IMP ITT Test Kit, the Miley  Mie  Kit and MirJhuunp kit for Audiasuite or AIRR

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PO Box 21, Braithall, Cheshire SK7 1F

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http://www.sowter.co.uk

Polyester and Polycarbonate Film capacitors. 0.1 mFd. to 10mFd.

CECA WATTs Dualphase/Parasite/Spires - incl. Preener wicks

Cambridge and sty for 78s and Mono LPs in addition to curren Stato LPs

Falcon Acoustics Ltd Incorporating Phoenix Electronics, Basically Bound

New - Tapped Inductors. 0-10mHz in 1mHz steps & 6mHz to 0.1mHz steps

CALLS: by FOCAL and SOWTERS, and a pick of the best from other manufacturers.

COMPONENTS
Solen Polypropylene capacitors. 0.1mFd. to 100mFd.
Polyester and Polycarbonate Film capacitors. 0.1mFd. to 10mFd.
ALCAP Reversible Electrolytic Capacitor Non-Polar, 50%, 100% & Low Loss 2mFd. to 600mFd.

FERRITE: Standard, High Power, Super Power, Super Super Power + AIRCORED 0.56125mm wire

AUDIOMATICS PUBLICATIONS
NEW - Valves for Audio Frequency Amplifiers from Philips Technical Library plus inc in P.L.
Back year sets of Speaker Builder, Audio Amateur & Glass Audio, plus the Audio Anthology Set.
Altogether 54 books and 50+ Audio Amateur's magazine year sets. 1997 sets available.

Large selection of Programs available from the very comprehensive Liberty Audiosite test program
via AIRR, Loudspeaker Ver.6, BassBox 5.1. to the basic Bullock/White Boxresponse.
Also the IMP FFT Test Kit, the Miley Mk Kit and Mic/Preampl kit for Audiovue or AIRR

New Line Level Pre-Amplifiers

Two Models Available.
6 line inputs, 10dB of gain, zero feedback finest quality components, musical results
Model 1 £995, Model 2 £1995

"There's none of the wispy airiness and soft, slow bass that one associates with the breed - just consistently fine tone, edge-of-your-seat dynamics and effortlessness."
Jason Kennedy on the Model 1 in Hi-Fi Choice Sept '97

Arcadia Valve Amplifiers

Model 1 £995, Model 2 £1995

"There's none of the wispy airiness and soft, slow bass that one associates with the breed - just consistently fine tone, edge-of-your-seat dynamics and effortlessness."
KLS10 GOLD

A high-performance mini-monitor based on our popular KLS3 Gold MkII floorstander. It uses the unique Audax piezo-electric gold dome tweeter.

Noel Keywood on the FFT, assisted by designer Gary Holland.

Our KLS3 Gold MkII kit loudspeaker has been popular - people like the idea behind it. But not everyone can accommodate a big floor stander in their home. "What we want", many readers have said, "is a mini version". So here it is: KLS10.

KLS3 was originally conceived to give the classic advantages of a three-way, brought up to date with modern, high-technology drivers. I placed emphasis on midrange clarity and projection because there's no doubt that a loudspeaker able to project clean, cohesive and strongly embodied images of singers and instruments into the room, a few feet in front of the loudspeaker, is captivating to listen to. The superb carbon-fibre-cone Audax HM13000 midrange unit achieves this with some ease, sounding smooth and free from raggedness. That's because the small, light, stiff cone reaches up high before its response starts to roll off, covering the human vocal range using a well-controlled area of cone behaviour.

Small cabinet dimensions in themselves make for good imaging, so even before considering engineering details, I expected KLS10 to be good in this area. Just bear in mind though that counterbalancing this is the fact that compact monitors are space savers designed for use close to a rear wall, or perhaps on a shelf. Both positions degrade imaging a little so there is an inevitable compromise here.

To retain the sense of relaxed clarity the carbon-fibre cones of KLS3 provide, I chose to use Audax's carbon-fibre HM170CO. This is a 170mm (6.5in.) unit with enough cone area to generate good bass without excessive cone excursion and distortion. Otherwise it is similar to KLS3's smaller midrange driver, displaying the same excellent midrange clarity. There is, too, an absence of hardness or coarseness that comes from paper cones, or the slightly bland and occasionally quacky sound that arises if a better-damped plastic cone is used. Carbon fibre exhibits the strengths of both without falling prey to the weaknesses of either. So
the HM170CO is used as a mid/bass drive unit in KLS10 in order to provide similar properties to the dedicated midrange driver of KLS3.

A loudspeaker as compact as KLS10 cannot go as low in its bass reproduction as KLS3, but by using a 'speaker like this close to a wall (1ft or so away) it provides fast, punchy bass. A generation of Linn Kan owners got hooked on speedy bass, which you get by eliminating low bass whilst boosting the 'punch' region from 60Hz-100Hz. That's what KLS10 offers. It turned out to be a speed king, much as expected, by our choice of a slightly under-damped Chebychev alignment for its bass loading. This imparts a good sense of bass enthusiasm, or willingness to play a tune, without one-noting. As it's a reflex, constructors can tune port length to suit their room and their own tastes, or even put wool/foam in the ports to damp the bass down by moving toward infinite-baffle operation.

All the same, some prefer seismic bass and for this minis are best paired with a subwoofer, since it can be made reasonably compact. We're only at the head-scratching stage with this one, but it would likely comprise a single, large twin-coil bass driver in a reflex cabinet. Because the Audax carbon-fibre range use 8Ω voice coils it could run in parallel with KLS10s without becoming an excessive load for an amplifier.

To retain the essence of KLS3 Gold MkII we had to retain the unique Audax HD3P piezo-electric tweeter in KLS10. It's so expensive few manufacturers can afford to use it, but this tweeter is arguably the best in the world today. Apart from being technically impressive in all areas, it has the rare but invaluable property of sweetness. I have yet to meet anyone who didn't like it and loudspeaker engineers in particular - a hard group to please - all praise the HD3P. Its appeal seems to be universal, about the strongest endorsement you can get for...
any hi-fi product.

Take it for granted that the HD3P produces great treble: clear, highly detailed, incisive in a pleasant way - not cutting. Even the great Tonigen ribbon tweeter (no longer available) has to bow to the HD3P, since the latter is sweeter and has better dispersion. It reaches down further too, working from 4.5kHz up to 20kHz. The Tonigen worked from 6kHz up to 20kHz so it had to be used with a high-performance midrange unit in a three-way arrangement - few and far between these days for reasons of cost (a cheap three-way is not worth having - see my column this month).

Here again you can see how trade-offs and price (ie performance) enter the scheme of things. With cheap mid/basses you can opt for a well-damped synthetic cone that should be rolled off by the crossover at around 3kHz to avoid quack from break-up modes. Try and integrate this with the HD3P and you will get a midrange dip that will introduce softness to the sound and loss of detail. It's not a bad solution, but not ideal. A lightweight paper cone will go higher but they can get really nasty at high-ish volume levels. Both types of driver are relatively inexpensive and low-tech nowadays.

**KLS 10 CROSSOVER**

For a few dollars more you can get a good, modern synthetic cone which exhibits greater consistency and better damping. Manufacturers are slowly moving to Audax's High Definition Aerogel (HDA), used in our KLS9 for example. Others are now turning to carbon fibre. So a loudspeaker like KLS10 gets you into the high-performance picture easily and at little cost.

**CABINET**

From the above you can see how I chose drive units for KLS10. This process is crucial, because you can't hope to produce a high-quality loudspeaker by using cheap drivers. No amount of sophisticated engineering can compensate and I have to say that this penny-pinching approach hampers a lot of commercial loudspeakers, which use drivers costing just a few pounds.

We do not stray away from Audax's best for our kits and this has served us well by giving constructors a pleasant surprise for their efforts. But of course you can mess things up by putting good drivers into a poorly-engineered system. This is where experience comes in, plus our superb Fast Fourier Transform analyser, which can measure all aspects of loudspeaker behaviour in real-time - a killer development tool.

Sorting out box volume is, these days, just a matter of plugging Thiele-Small parameters into a computer programme. That's what I did for the HM170CO, built the box and found it didn't measure as predicted. Rats.

Box optimisation is time consuming and also where experience is needed to avoid insidious problems. Smelling a
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An alternative design by David Purton, from his little "Coupled Cavity Handbook", using the same drive unit but requiring a bit more woodworking skill as the speaker is set on a baffle in the middle of the box. The total box size is even smaller than the ASM 270 at all 418 mm high, 303 mm wide, and 344 mm long. Construction Drawing...£11.50

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a bit one-note. All the same, there's nowt like taste; some might prefer it like this. With the box as dimensioned you at least get this option, and I know from readers' letters that most like to have the opportunity to experiment. I would suggest a block of wood, up to 1000 cubic centimetres in volume, glued inside onto the cabinet's base, will reduce bass output and improve bass damping to the right level. Bear in mind that the HM170CO and the crossover intrude into the basic box volume, so a little less than 1000cc will be best.

Readers often ask if they can re-proportion our cabinets to suit their own requirements. The answer is yes, within certain limitations. The length/depth/height dimensions must not only all be different, they must also not be multiples or sub-multiples of each other. Get this wrong and standing waves will produce box honk.

Furthermore, the box should be kept deep so that energy reflected off the rear wall is attenuated by distance. Otherwise this energy will disturb frequency response and also be heard as a coloration, since reflected sound from the rear wall passes out through the cone.

We still use MDF for our boxes, and 15mm MDF (or thereabouts) is thick enough. Because there is concern about the dust being carcinogenic, and the glue exuding formaldehyde fumes, some constructors prefer block board or solid hardwood these days. I opt to use a face mask when cutting MDF.

Use Evode Resin W glue to hold the panels together. DIY shops are often able to cut panels, leaving you to glue them together and do the finishing work. Look for a cabinet maker to do all this if you want top-quality veneering. Routed-in hardwood edges are a nice touch, especially if they have a radius on them. Radiusing the edges also improves stereo imaging. The drive units can be inset into the front panel too, which also improves imaging. Again a router is handy. The idea is to avoid sharp edges and discontinuities, which improves high frequency dispersion, providing more assured images.

The way the panels fit together is not critical. We arrange it to a common pattern where panel seams are only visible on the sides. You can glue in the back panel, or screw it in against battens.

### MEASURED PERFORMANCE

The art of a good loudspeaker is to balance all parameters and make sure that they all reach a high standard. It's easy to get flat frequency response, for example, if you ignore a loudspeaker's impedance characteristics, since filters can lift or attenuate response anywhere needed, by drawing more or less energy from a constant voltage source (conventional solid-state amplifier). But then the amplifier has to deal with a difficult load. We aim to avoid this sort of thing.

The HM170CO cut-out is big enough to allow front access if the rear is glued. Reflex loudspeakers must not be over-filled with wool, since this influences port behaviour. It is best to line the cabinet walls with thick natural carpet felt or Deflex panels and leave it at that.

### CROSSOVER

The crossover is relatively simple, because the HD3P tweeter comes with its own high-pass crossover network attached to a small circuit board. The basic tweeter unit behaves like a capacitor, because signal is applied to front and rear gold conducting layers, which are plated onto a piezo electric film which forms the dome. It takes this form under pressure from a gas chamber behind it. There is no voice coil or magnet. As a result the diaphragm is twenty times lighter than the dome of a conventional tweeter, giving it the ability to accelerate rapidly and so reproduce high-frequency signals faithfully.

It flexes under piezo-electric forces generated by the applied voltage from a small step-up transformer that is supplied with the tweeter on the circuit board.

Note that the phase of this assembly is reversed in KLS10. You can connect the positive input wire to the negative side of...
the board, or alternatively just reverse-connect the tweeter unit, since it is electrically symmetrical.

The HM170CO mid/bass is fed from a simple second-order, low-pass filter. Having good sensitivity, KLS10 does not need a lot of power, so a ferrite-cored inductor is used to keep DCR low at just 0.18Ω, to improve electrical damping. The capacitor is a high-quality audio-grade Solen polypropylene type.

The crossover can be built on a tag board or a piece of hardboard. Because signal currents are high it is not a good idea to use a printed circuit board with thin tracks. Commercial loudspeakers use them only for speed and ease of assembly. Components should be glued down and connected together with copper wire.

The crossover can be screwed or glued anywhere inside the cabinet, the base board being most convenient. It is better practice to mount the crossover externally to lessen vibration on the components. It can be housed in a plastic case and screwed onto the rear panel, or even kept separate. If you want to go the whole hog, the crossover can be positioned close to the amplifier and the bass and treble cables run independently.

POWER HANDLING
The power handling of a loudspeaker is not a measure of how loud it will go. It is solely the maximum power it will take before suffering damage, thermal from the voice coil overheating or mechanical from the cone hitting its end stops hard. I mention this because many believe power rating is all-important; it is not. Sensitivity must be taken into account as well.

The maximum power KLS10 can handle is the rated power of the HM170CO, which Audax quote as 60watts. Since it has a Kapton voice-coil former I imagine this is fairly conservative, but all the same it is best to be safe. You can use a more powerful amplifier: how much power goes into the loudspeaker depends solely upon how loud you go. Because KLS10 is sensitive and high in impedance it does not draw much current and, therefore, power. Nor does it need much. It produces a loud 89dB SPL from 1watt, so will produce 108dB SPL at one metre from 60watts, which is pretty loud.

TUNING
KLS10 can be tuned in a variety of ways. Tweeter level can be varied by adjusting R2 to give a bright or soft sound. As set the 'speaker measures flat and is technically correct. However, those with hearing loss may well prefer a brighter sound (lower value of R2), whilst others with better hearing and a small, lightly-furnished room may prefer less treble energy (increase the value of R2).

The port can be tuned for frequency by adjusting its length. It is currently set at 60Hz. Increasing length will lower this. When port frequency exactly coincides with the bass unit's resonance, maximum acoustic and electrical damping on the cone will be applied, something I will discuss next month.

If you make a 9-litre 'oversized' cabinet, decreasing volume to 8 litres by putting wood inside will progressively lessen bass output and increase bass damping.

Finally, various absorbents can be used to line and fill the cabinet. We will discuss these tuning techniques next month.

AUGUST ISSUE
We will conclude this feature in the August issue DIY Supplement with details of port tuning, tweeter level adjustment, internal damping and related sound quality.

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KLS10 Gold PARTS LIST
(per loudspeaker)

Drivers
Bass/midrange Audax HM170CO 170mm carbon fibre cone/cast chassis
Treble Audax HD-3P piezo-electric gold dome tweeter

Crossover
L1 0.75mH, 0.18Ω, ferrite cored, 1mm wire
C1 4.7μF, Solen (400V)
C2 4.7μF, Solen (400V)
R1 4.7Ω resistor, 5W
R2 3.3Ω resistor, 5W

Hardware
Input bi-wire input terminal panel
Damping a little long haired wool (0.5 lb)
Port 55mm diameter, 110mm long
Wire PTFE silver plated copper

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KLS10 Gold is available as a Kit from HI-FI WORLD.

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<table>
<thead>
<tr>
<th>Liberty AudioSuite v 3</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>£696.00 plus VAT</td>
<td></td>
</tr>
</tbody>
</table>

**ETF4**

- **Room Measurement and Analysis System**
- **DESIGN ROUTINES for HELMHOLTZ RESONATORS and QRD DIFFUSERS**
- **USES YOUR EXISTING SOUNDCARD, AND AN OMNI MIC**

**LspCAD v3**

- **Combined Room / Loudspeaker Box / Crossover program**
- **imports data from LAUD, LEAP and MLLSA**

<table>
<thead>
<tr>
<th>LspCAD v3</th>
<th>Price</th>
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<tbody>
<tr>
<td>£68.00 plus VAT</td>
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</table>

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CRYSTAL CLEAR II

In April's DIY Supplement, Chris Found detailed the design of a 24-bit 44.1kHz DAC with a valve output stage. This month he explains how you can actually build the convertor.

The whole main unit is built on three printed circuit boards - the mother board, the valve output stage and the DAC module. Silk screening with component numbers is a good idea as any mistakes in component placement can be easily seen.

Everything except the mains transformers, power switch, IEC mains socket and input selection switch is placed on the motherboard. The digital inputs and audio outputs are PCB-mounted, as is the input selector switch. This allows for easy voltage testing outside of the case, if necessary, and providing that care is taken not to touch the high-voltage stages, there should be no real problems.

There's a specific sequence for building the main board which ensures that small components can be held properly in their position while soldering and reduces the number of cosmetic touch-ups that might be necessary later.

First to go on the board are the resistors, starting with the small 1/6watters in the digital section before moving on to the large resistor in the power supply. Next come the rectifier diodes in the PSU, whose correct orientation is vital - make sure you check this carefully.

All of these components except the large resistor have a 10mm pitch, so they can be folded in one go. When you mount these parts, bend the leads that protrude on the lower track side of the board slightly to hold the component in position while it is being soldered and so avoid burnt fingers. This technique allows more than one component to be soldered at a time and greatly reduces build time. Just double-check each component's location as you put it onto the board.

Once the resistors have been soldered in place, the integrated circuits can be mounted. Again, diligent checking is a must here - make sure the orientation of each device is correct and confirm that all of the pins have gone through the board before soldering each IC individually. You will find that the ICs' legs are pushed out at a slight angle; these can be easily straightened with care.

Then it's the turn of the rest of the small components - polyester capacitors, T03 and the tiny ZTX transistors. Try not to push the transistors down too far, otherwise the legs could bend apart further than intended.

Once that's finished, fit the larger components, observing the polarity of electrolytic capacitors where necessary. Finally, solder the valve bases onto their PCB before mounting it on the motherboard and connecting the wires for the heater supplies.

Once the boards are connected together and the...
The underside of the main PCB is reproduced here at 75% of full size. It can be blown up to 100% on a photocopier.

The two PCBs to the right include one (top) for the non-surface-mount version of the DAC chip and one (bottom) for the smaller SM type. These are printed here at full size.

transformers wired up, you can now run a series of basic tests on the PCBs. However, DO NOT fit the DAC module yet.

The initial testing of the DAC is done after one last check that all the components are in the right places. This is very important as a mistake could damage some of the parts and cost a substantial amount of money to put right. To test the unit you will need either an analogue or digital voltmeter.

When you are satisfied that the boards are correct, apply power to the unit. Give it some time to warm up while you look and smell for any strange happenings. After a few minutes you can begin taking measurements to confirm you have built the DAC correctly.

Start by setting the voltmeter to a range of 20VDC to 30V DC and testing the digital power supply and its regulation. There should be 5VDC +/- 0.3V on the left side of L1. For a ground point use one of the digital input sockets' outer rings. Simply clip a ground wire terminated with a crocodile clip onto this.

If these voltages are correct, test the supply rail to the DAC module on one of the cans of the 2N2219 transistors, where there should be 12VDC. On the top of R34 there should be 5.6VDC +/- 0.3V.

The following step are the valves' heaters. As these heaters are floating until all three valves are placed in their holders, you need to check at the heater pins near C25 and the large heatsink at the front of the motherboard. Place the black probe on the pin soldered to the same track as C25's negative terminal and the red probe on the other pin, which should give you a 12VDC reading.

Now you have checked the main supply voltages and nothing has blown up, you can safely assume that the board is built correctly. All that's left to do after the unit has fully cooled down is mount the DAC module and the valves and begin listening to all your favourite CDs through your new convertor.
Above is the layout for the upper side of the main PCB. Below is the component positioning diagram which can be silk-screened onto the PCB to aid construction. Both are at 75% of full size.
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### COMPONENTS LIST

#### Resistors
(all 1/6W, metal film unless otherwise specified)

<table>
<thead>
<tr>
<th>Value</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>R38</td>
<td>22R</td>
</tr>
<tr>
<td>R39</td>
<td>33R</td>
</tr>
<tr>
<td>R40</td>
<td>47R</td>
</tr>
<tr>
<td>R1, R2</td>
<td>75R</td>
</tr>
<tr>
<td>R37</td>
<td>220R</td>
</tr>
<tr>
<td>R23, R24</td>
<td>820R</td>
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<tr>
<td>R29</td>
<td>1k</td>
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<tr>
<td>R34</td>
<td>2k</td>
</tr>
<tr>
<td>R13, R14, R3, R4</td>
<td>2k2</td>
</tr>
<tr>
<td>R12, R15, R5, R8, R33</td>
<td>2k4</td>
</tr>
<tr>
<td>R16, R17, R18, R35, R42, R43, R9, R36, R19, R22, R25, R28</td>
<td>3k3</td>
</tr>
<tr>
<td>R6, R7</td>
<td>10k</td>
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<tr>
<td>R30</td>
<td>15k (1W Metal Oxide)</td>
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<tr>
<td>R20, R21, R26, R27</td>
<td>22k</td>
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<td>R31</td>
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<td>R32</td>
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<td>R10, R11</td>
<td>100k</td>
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<tr>
<td>R45</td>
<td>100k (1W Metal Oxide)</td>
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#### Capacitors

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<tr>
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<td>Axial Polystyrene 470pF 160V</td>
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<tr>
<td>C12, C13</td>
<td>2.5mm 22nF Polyester 63V WIMA</td>
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<tr>
<td>C14, C16, C17, C2, C20, C21, C27, C36, C1, C38, C39, C40, C42, C43, C44</td>
<td>5mm 22nF Polyester 63V 150pF</td>
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<tr>
<td>C15, C34, C35</td>
<td>2.5mm 47nF Polyester 63V WIMA</td>
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<tr>
<td>C41</td>
<td>10mm 0.1uF Polyester 400V</td>
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#### Inductors

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<td>R16, R17, R18, R35, R42, R43, R9, R36, R19, R22, R25, R28</td>
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#### Semiconductors

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<tr>
<td>D1, D2, D3, D4</td>
<td>1N4007 4off</td>
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<tr>
<td>U1</td>
<td>DIL 8 UA9637A</td>
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<td>U2</td>
<td>DIL 14 74HC00</td>
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<td>U5</td>
<td>DIL 16 74HC153</td>
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<td>U4</td>
<td>DIL 16 74HC173</td>
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<tr>
<td>U3</td>
<td>DIL 28 CSB412G</td>
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<td>Q1</td>
<td>TO220 TIP50</td>
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<tr>
<td>Q2</td>
<td>TO220 7812 1Amp</td>
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<tr>
<td>Q3, Q4</td>
<td>TO5 2N2219</td>
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<tr>
<td>Q5</td>
<td>TO220 78S12</td>
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<tr>
<td>Q6</td>
<td>TO220 TIP29</td>
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<tr>
<td>Q7</td>
<td>Zetec ZTX653</td>
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<td>LD1</td>
<td>5mm Green Led</td>
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#### Valves

<table>
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<th>Value</th>
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</thead>
<tbody>
<tr>
<td>V1, V3</td>
<td>B9A 6922 2off</td>
</tr>
<tr>
<td>V2</td>
<td>B9A ECC82 1off</td>
</tr>
</tbody>
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#### Miscellaneous

<table>
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<tr>
<td>CN1, CN2, CN3</td>
<td>Black PCB-mount RCA sockets 3off</td>
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<tr>
<td>CN4</td>
<td>Red PCB-mount RCA socket 1off</td>
</tr>
<tr>
<td>HS1</td>
<td>25mm Heatsink 1off</td>
</tr>
</tbody>
</table>
The DESKADEL range of Hi-Fi interconnect, speaker cables, hook-up wires and tone arm wires are precision manufactured featuring PURE SILVER conductors insulated with PTFE in a variety of designs to suit all applications. Using only the finest materials and the latest manufacturing techniques we aim to provide a selection of quality products for superb natural sound reproduction on a scale previously unheard.
Unlke many books I review, which are idiosyncratic in structure, Valve And Transistor Audio Amplifiers keeps to its aims in covering a lot of territory evenly, albeit with some uncon-vincing fly swatting when the author leaves his chosen subject to flail around at imaginary foes, especially the hi-fi press and other designers.

Valves (tubes) are a mysterious area to most solid-state engineers who weren't around in the valve's heyday. John Linsley Hood however was there: he tells us in a footnote that he had, "the great privilege of aquaintanceship with Mr Radford", and was "invited to his home in the early 1970s... as a consultant". Valve amps were moving toward apparent extinction in the late 1960s and a consultant at that time would have been very much aware of the debates around new fangled transistors, which possessed their own set of unique problems. It is this vantage point that gives the book the benefit of experience, and the credibility that comes from it. John Linsley Hood methodically and comprehensively works through the basic theory of operation of valve stages, identifying their particular problems. This alone gives makes it into Valve And Transistor Audio Amplifiers. Instead, the book concludes with chapters on 'Contemporary Power Amplifier Designs' and 'Power Supplies'.

In keeping with the usual approach of starting at the beginning, I ought to mention that the first two chapters cover active then passive components, with some interesting insights into capacitor construction and various effects that might explain their impact on sound quality. Which brings me to the many opinions expressed.

I valued the engineering information presented in this book but not Hood's opinions. If opinion is to be taken seriously then other views need to be gathered and presented, putting the case for and against different approaches. Hood's own views are shallow rhetoric from a distant place. Other designers, Martin Colloms, the dreaded hi-fi press and various other ogres on the author's personal landscape all argue. Because Hood has not, as a consultant, worked at length inside the industry or the press, unlike Stan Curtis or Andy Grove for example, both of whom design and write, he's not especially well informed about those he swipes at including "hi-fi publishers" like myself! Having heard it all before I tend to ignore this sort of thing, but it is at times misleading, as well as a lost opportunity to offer a broader view on various circuit techniques.

The topic of feedback is a good enough illustration. Working designers like Rob Watts (DPA) and Andy Grove (Quad/Leak/Wharfedale) keep a fairly open mind on the subject. The notion of producing an amplifier good enough not to need feedback is challenging to modern-day designers, leading to interesting techniques being aired by Douglas Self, and working products from Onkyo (Japan) and now Mission. None of this current interest and activity makes it into Valve And Transistor Audio Amplifiers. Instead, I see one particular MOSFET circuit used to suggest that low levels of feedback make things worse not better, based on distortion as a sole criterion, plus the view that lots of feedback is a good thing.

Hood tells us that "an amplifier block employing negative feedback, where this is applied correctly in a properly-designed system, will be substantially superior to that of a system without NFB. The fact that claims are sometimes made that the performance of an amplifier without negative feedback is superior to that of one using this technique seems to be due principally to the lack of design skills of those in respect of whose designs this claim is made".

This is a trite and unfortunate conclusion. If feedback is applied to improve performance then, ipso facto, performance without feedback must be unsatisfactory. So are we designing basically unsatisfactory amplifiers? Why not try and design an amplifier that is good enough not to need feedback? It is an interesting idea that could do with a more balanced airing than Hood is prepared to offer, which is a pity. All the same, Hood has a lifetime's practical experience and an enduring interest. Both contribute to making this an interesting and potentially valuable book for any designer interested in the thinking behind a wide variety of circuit arrangements.
Book Review

DIGITAL AUDIO SIGNAL PROCESSING

By Udo Zolzer

Reviewed by R. Casadei.

Digital signal processing is definitely here to stay whether you like it or not. As an audio designer I have gradually been accepting this fact and have since been burning the midnight oil trying to understand the concepts and make them work for hi-fi reproduction. Having been through several dozen books on the topic, ranging from those by Babani to John Watkinson's, Digital Audio Signal Processing (DASP) by Udo Zolzer is the latest addition to my reading list and it is probably one of the most technical reads I have yet to come across.

If you, as a hobbyist, bought this book after reading the back cover, you'd be excused for thinking it might be fairly technical but would still help you to understand most of the subjects mentioned herein. On reading the Preface things are immediately getting rather serious, however. It begins by stating that Digital Audio Signal Processing provides the basis of an advanced course in DASP for research students and professional audio engineers alike (ie the real ones!) So if you can actually understand the topics described in the contents page, then you are likely to be a technically well-informed individual.

Unfortunately, when you turn over to the book's main sections, you'll be left in no doubt that you'll have to be either a die-hard research student of Udo Zolzer or Udo Zolzer himself to take in any of it! This book is H-e-a-v-y! If it were a car then it would handle like an eighteen-wheeler doing a three-point-turn on Kilburn High Street with no power steering, if you know what I mean.

Digital Audio Signal Processing is divided into two main parts. The first four chapters present the basis for hardware DASP, beginning with a brief description of studio technology, digital transmission systems, storage media and audio components at home (but not as we know them, Jim!) Some good information is provided here on the different sampling rates used in the various types of storage media and broadcast systems, together with specifications for CD, R-DAT, DCC and DAB, leaving them all open for us mortals to pick holes in. (But who would argue about the pros and cons on DPSK modulation technique in DAB, eh?)

Then what you get is FFTs (Fast Fourier Transforms) and more FFTs, so much so that you are beginning to create your own versions for the meaning of the acronym "FFT"! Finally the book comes back to earth on digital amplifier concepts, with a clear and concise description via a few easily comprehensible diagrams and some plain English.

The following chapter concerns itself with Quantisation, Dither, Noise Shaping and Numerical Representation (Fixed Point and Floating Point). This section, like most of this book, is filled with hard-core mathematical formulae and frankly it's not for the faint-hearted. Yes, they are all real and they are the theory behind the world of DASP, but I do think they are far too theoretical for most people and there are lesser books around that can offer simpler ways to explain them. Analogue-to-Digital and Digital-to-Analogue conversion are the main topics covered in Chapter Three. Most of us interested in the topic would find half of each section to be informative on A/D and D/A conversion. That would be the right place to stop as well, unless you want to become either a researcher or totally confused; you have been warned!

From Chapter Four onwards you are on your own. Here you'll discover the dense mathematics and formulae for DASP techniques, digital filtering and digital equalisation, room simulation, dynamic range control, sample rate conversion and data compression. It is here that you can start calling yourself a Doctor or Professor, if you understand all this, and no one would ever argue with you. You would probably qualify for a seat in the Audio Engineering Society too, but then you probably wouldn't believe different interconnects or 'speaker cables can sound different and BluTack will remain just a good way to ruin your bedroom wallpaper.

Digital Audio Signal Processing is full of solid facts and theories that explain and prove how all the electronics should work, but not how good it will sound. As an audio enthusiast with electronics ability, I would recommend a lighter read for the hobbyist. For the die-hard, no-holds-barred audio researcher, then this book is the one to go for. But after digesting its contents, do try swapping your interconnects for better ones and get your 'speakers off the bookshelf and put them on some decent stands (and don't forget to the BluTack)!
The Audio Note Kit One

The Audio Note Kit One is illustrated and is based around the justly famous 300B directly heated triode. We see this kit as the introduction to real Audio Amplification; it covers all the important aspects of design necessary, Single Ended. No Feedback, Class A. Directly heated Triode, to become a member of this exclusive club of amplifiers.

Kit One has one 300B per channel running at 420 volts with 75mA current giving 8.9 watts of the cleanest power you will ever hear. The input stage consists of a 6550GT with a 5667 double triode driver stage running in SRPP. The power supply is capacitor-choke-capacitor configuration with a 6UAG KT rectifier, the 300Bs have a 12V filament supply for hum-free operation whilst the other valves are AC heated. Component quality is similar to our Level 2 finished products. Audio Note paper in oil signal capacitors, byychasing 1 watt 1% metal film resistors, good quality electrolytics (Tony NO Black Gates) and a simple, attractive stereo chassis in black paintwork. We have several component and cosmetic upgrades available for Kit One, please ask for details.

The Audio Note Kit Two

The Audio Note Kit Two features a single 6550 tetrode running in Single-Ended mode, yielding some 12 watts of pure Class A. With a valve rectified HT for the output stage, stereo chassis, and 6SN7GT input and 12AX7 ECC83 SRPP driver stage, componentry and chassis as Kit One.

Kit Two costs £699 incl. VAT, Includes valves, but not postage/packaging.

KIT TWO ORDER CODE: AN-KIT-002

The Audio Note Kit Three

The Kit Three features two x 300S per channel running in single-ended parallel yielding 16/17 watts in pure Class A. This kit is on two mono chassis with valve rectified HT supplies, no signal feedback, it uses a 6SN7GT double triode as input valve and a pair of 5667 double triodes running in SRPP as drivers. The Kit Three is essentially a mono version of the Kit One with double the power, the same component choices and on two chassis instead of one.

The Kit Three costs £1,550 incl. VAT but excluding delivery.

KIT THREE ORDER CODE: AN-KIT-003

The Audio Note Kit Four

The Kit Four is ready to industrialise the valve amplifier kit building, the circuit and power supply being mounted on a single printed circuit board. The high-quality push-pull output and mains transformers are all mounted in a small aluminium chassis covering everything so nobody will be able to see you have succumbed to the lure of the valve amplifier which is sweeping the world. The circuit consists of two 6550 tetrodes running in Push-Pull class A, yielding about 10 watts, driven by a 6SN7GT and a 12AX7 ECC83 input stage. Easy to build, even for the beginner. Visually Kit Four matches the Audio Note Pre-amplifier shown here but with a single chrome-plated volume control. As with all Audio Note kits everything (except sockets) is included.

The Kit Four costs: £299 incl. VAT but not delivery.

KIT FOUR ORDER CODE: AN-KIT-004

Audio Note Driver, Interstage & Pre-Amplifier Output Transformers

Here is a product group that you do not see advertised every day! As usual we start small with the intention to grow quickly.

Audio Note Paper In Oil Signal Capacitors

These handmade signal capacitors are sonically superior to any of the plastic or other paper types we have come across. If you have never experienced the difference that a really good paperfoil capacitor can make in a valve amplifier, then you really should try.

Audio Note Paper In Oil Tin Foil Signal Capacitors

The tin foil is better than alu-foil for most applications, we recommend you try them!

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The best solder available, used in all our amplifiers from ORIO to the mighty GAKU-ON.

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These handmade attenuators and switches are manufactured by a friend of Mr Kondo of Audio Note. They are the best you can buy.

Audio Note High Quality Valve Bases

All of our valve bases are of the highest possible quality materials. Ceramic, Tetlon and gold and silver plated. If you want the best look no further - they are the ultimate.

Audio Note Resistors

Audio Note endeavour to stock the entire E12 range of all the different makes of resistor, since most are used in our products stock & generally available within four weeks.

BVECSCHLAG - HOLCO - SHINICH Tantalum Film Resistors

AUDIO NOTE 1/2 Watt Tantalum Resistors

AUDIO NOTE 1 Watt Tantalum Resistors

AUDIO NOTE 2 Watt 1% Tantalum Resistors

AUDIO NOTE Precision Carbon Film Resistors

ALLEN BRADLEY 1 Watt 5% Carbon Film Resistors
Components & Valves

The Audio Note Pre-Amplifier Kit (Iustrated)

The best available from a sound quality / price viewpoint, made by Noble in Japan, capacitor clamp and are upright mounting.

The Audio Note Ceraline Powdered Ceramic Electrolytic Capacitors

Audio Note Potentiometers

The best available sound quality / price viewpoint, made by Noble in Japan, utilizing high quality conductive plastic film. However a better alternative is the KO-ON capacitor, a must in any single-ended project. The Ceramicines really cover many of the Black Gate values and where the prices for the BG's are prohibitive the Ceramicines are available.

Audio Note Moving Coil, CD Line & Input Matching Transformers

Audio Note now offer moving coil, CD and input matching transformers for general sale. Common to all of these small signal transformers is that they come in a non-magnetic aluminium chassis giving the very best sound quality.

Audio Note Black Gate Electron Transfer, High Performance, Graphite Foil Capacitors

Audio Note is currently the sole source in Europe that holds any significant range of Black Gates in stock, we use literally 1000's in production, as we were the first company to realise the tremendous benefits that Black Gate capacitors offer, and we are to date the only company in the world to incorporate Black Gate capacitors consistently in our finished products.

Audio Note Moving Coil, CD Line & Input Matching Transformers

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DIY Letters

STAYING REGULAR

I use a number of QED ‘Black Box’ components - a Digit DAC, Vector pre-amp, Discsaver phono stage, etc. I find that all of them sound better when powered by QED’s external Positron rather than the basic wall-plug type of supply.

My problem is that I have only one Positron, which QED have now discontinued. The input socket appears to be a standard 12V type, such as would be seen on a portable TV. My question is, do you, or any of your readers, know of a (preferably cost-effective) battery or mains 12V power supply which I could use instead? I remember once reading in Hi-Fi World that some people use a battery supply for the Digit, so I would be grateful for any advice or hints.

James Taylor
London.

You can choose either battery or mains supplies - both are easy to build with off-the-shelf bits and pieces and will give very good results. None of the components you list consume a great deal of current, which simplifies matters.

‘Old reliable’ in the regulator world is the LM317T variable-voltage positive reg. All you’ll need to make a fully-fledged PSU for each of your various QEDs is one variable and one fixed resistor, a couple of capacitors (preferably Sanyo Os-Cons from, say, Audio-Links, tel: 01724 870432), said LM317T and some lead/acid batteries. The circuit is therefore extremely quick and simple to construct according to the diagram shown. Here, R1 can be adjusted to give an accurate 12volts (it should initially be set for approximately 240ohms).

The LM317T requires an input at least 2volts higher than the output in order to work properly. So, by connecting three 6volt lead/acid rechargeable batteries together in series, you have a suitable 18volt supply. Paralleling up an additional three 6volt batteries alongside the originals will double the PSU’s overall current capacity - paralleling two 4Ah (Amphour) batteries gives you 8Ah to draw on.

With a proper PSU, QED’s Digit DAC can sound surprisingly good.

Series connection does the same for voltage.

Maplin (tel: 01702 554000) sell appropriate lead/acids (XG70M, 6V 4Ah, £12.99) and chargers (GL08J, £29.99). I’ve been using a set to power my DPA 50S pre-amp with fine results.

These parts might not look amazingly cost-effective at first glance, but bear in mind the charger will individually charge as many batteries as you have and the lead/acids should be good for a minimum of 500 recharges. You can either run all your QEDs off one PSU (although the batteries won’t last too long like this unless you parallel up two or three sets) or make separate PSUs for each component.

If that’s still too much expense to contemplate, perhaps a mains supply would be the answer. The cheapest battery option adds up to £13x3 plus £30, which is £69. Maplin have a 225VA toroidal transformer with 12volt secondaries at £25. A relatively chunky unit like this has superior regulation (ie, a more stable AC output voltage) than smaller alternatives and sounds better. You could follow this with four £1.10 11DQ06 Schottky rectifiers from Audio-Links and three or four 25volt 2200uF Elna RSH reservoir caps paralleled up to...
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HI-FI WORLD SUPPLEMENT

DIY Letters

Striking Gold(Ring)
I was interested in the query from Paul Fitzgerald in the April Supplement concerning modifying the Goldring-Lenco GL75. The hole for the tone-arm is, in fact, significantly larger than the diameter of the arm pillar and is an exact fit for a Decca London uni-pivot arm. Not only that, but the hole is within a whisker of the prescribed distance for that arm from the platter centre, so alignment is no problem. The Decca arm has no lifting device but the excellent built-in lift on the turntable works a treat, providing some tape is attached to the arm and/or the lift to prevent the arm from sliding sideways during lowering.

I have dispensed with the turntable mounting springs and bolted the top plate to a solid plinth constructed à la Bastin of layers of thick ply. The whole affair rests on Goldring Perfect-Sound spikes and damper discs. Whilst lacking the assurance of my 401/SME IV combination, the turntable delivers a secure sound using a variety of cartridges and forms the basis of a trouble-free second system.

P. Pascoe
Liverpool.

More Gold(Ring)
Much like Paul Fitzgerald of Birmingham, I too am a recent convert to the delights of a mint GL75 (cost £30) and a GL78 (cost £15), the slightly more up-market version of the former. Also like Mr Fitzgerald, I found that one of the turntables had suffered a lifetime of not having all the transportation screws released - no wonder some people claim these lovely bits of engineering suffer rumble.

I bought mine for playing a growing 78rpm record collection but found, with a few minor modifications and a reasonably decent cartridge, it would give my PT TOO (with RB300 arm and Elys cartridge) a run for its money. Indeed, having transferred the modifications to the GL78, and having acquired and used a stylus balance, test record and protractor to set up an Ortofon OM40 cartridge, I'd say in some respects, the GL leaves the PT in a trail of dust! For one thing, its motor rotation is more stable - I checked with a GL proprietary strobe disc. (By the way, I bought the OM40 because its style is easily swapped for one to play the 78s.)

Modifications? In fact, these are more 'tweaks' than modifications. For one, my entire hi-fi set up benefits from a purified and regulated power supply, courtesy of a 'late' Radar Electronics hi-fi grade filter and "virtual batteries", plus a hefty ex-Telecom purifier which sits in the power line closest to the wall socket. I have also mounted the beast on an isolated platform. The GL78 sits on a marble slab which is supported by Sorbothane sandwiched between three Michell cones and its underside.

The next trick is more Sorbothane (I love the stuff! I use it to great effect in other parts of the hi-fi system, too). The underside of the cast metal platter has a covering, which helps eliminate its bell-like ring. There is more Sorbothane on the top of the head shell, some underneath it, and a couple of tiny bits of it stuck to each side of the cartridge.

But what about that awful arm? This too seems to benefit from a strip of Sorbothane curled around the length of it. Also, forget the counterbalance - get a nice, heavy brass one made in its place. Then, use a stylus balance to get close to the stylus pressure weight but don't assume that is spot-on - it may need a bit of fine adjustment to ensure the stylus tracks properly once the bias weights are set. To find this out you will need a test record, such as that from The Cartridge Man. I have found my GL78 with Ortofon OM40 passed the most exciting bias test-track with flying colours (which is more than can be said of the PT TOO/RB300/Elys) once I slightly increased the pressure on the stylus.

Having done all that and used a blob of good ol' BlueTak to secure the record to the spindle (it's cheaper than a turntable clamp), play the black stuff... And be amazed!

CDs? Pah! PT TOO! To be honest, there are still records I may prefer to play on the PT TOO - for example, Mary Black's voice is softer and less nasal than it sounds on the GL78. But on the other hand, the midrange tonal quality and transients are better defined on the GL cymbals zing, ting and tong rather than simply tash, while violins sound like they are made of different woods. But then, with two different cartridges, the comparison is hardly fair.

My only gripe is that I cannot get the GL78 auto-return mechanism to work properly (if at all.) Now, if anyone can tell me what's wrong with it...

Graham Nelson
GiroGANelson@compuserve.com

Crossing Over
Being an avid reader of your magazine for the last 12 months or so, I decided to upgrade my 20-year-old Wharfedale Glendale XP2 'speakers. I replaced the crossover components, terminals and internal wiring with modern equivalents and a large improvement was the result. Having read the DIY Supplements I became interested in making my own.

So I purchased The Loudspeaker Cookbook and Bullock On Boxes and bought a 'scope, an AF signal generator, frequency counter and soon a suitable multimeter. I duly digested the contents of both books. My question relates to the designing of the crossover. Following the procedures in both books is no problem, but the authors seem to make the assumption that the crossover is already designed and finished. I refer particularly to: “taking into account the series resistances” when calculating Kg, the source resistance. After reading and re-

Carry on classic - Goldring's GL75 is an excellent second-hand buy.
reading the texts my only conclusion is that initially a 'basic' crossover is used, then the enclosure volume found and then the testing and re-testing begins. Am I correct in this assumption of, as Dickason puts it, "the art of 'speaker design" or am I still missing something? I've also tried to 'reverse engineer' your KLS9s from the crossover point of view but without a great deal of success, so any help would be gratefully appreciated.

Also is there any advice you can give regarding the pros and cons of software for analysis of 'speakers, ie L.E.A.P, Liberty, etc, other than your recent articles in the Supplements? My maths ability starts to get ragged about the level of Laplace, Fourier and Partial Differentiation.

Michael Abbott
mabbott@compuserve.com

You are not alone in being confused by the crossover. I'm told the first person to write a comprehensible book on crossover design is likely to make a fortune. I've even given it some thought, having done a few in my time, but I just do not know how you explain such a subject in any easy manner. Also, I should point out that most practising loudspeaker designers admit to using theory to start a design, to get into the right ball park as it were, then experiment thereafter - and that includes me.

Here's my own entirely conventional and relatively simple approach to loudspeaker design, echoed by many others in the business. You might be surprised that matters such as Rg (amplifier source resistance) don't figure. You will realise why small external variables like this subside virtually into insignificance relative to other matters - especially 'driver acoustic centre' or ZDP - once you get stuck in.

1) Sort out your basic concept - what drivers you want to use to achieve what end.
2) In a two-way, obtain the Thiele-Small parameters of the bass/midrange drive unit, plug them into a loudspeaker design programme like L.E.A.P, and find the ideal box volume for the response you hope to achieve.
3) Validate this information by building a quick prototype box and then measuring the frequency response of the bass/midrange driver in it. At this point you need no crossover. You are determining the bass performance, which really means the behaviour of the box acting as a high-pass filter. See the theoretical response of an HM1700 on p8 of my KLS10 article in the Supplement this month.

You can, if you wish, add a source resistance of 10hm or so to simulate the DCR of the low-pass crossover inductor. This will make the electrical damping more like that in real life, but it has no great effect. Loudspeakers are damped acoustically and magnetically, as well as electrically. Fiddling around with minuitae at this stage is pointless. And if you use a port, its acoustic damping effects will swamp Rg. Yet in spite of all the theoretical flim-flam around ports there's little agreement on their optimum dimensioning or frequency of tune. It's all a matter of perspectives.

4) Having matched bass/mid to box you must now match in the treble unit - and this really means design the crossover network (I assume your bass/midrange unit in its box measure well). It is usual to roll off the high frequency output of a midrange driver where it starts to get ragged (the break-up region), so that this raggedness and associated problems like coarseness and coloration are not audibly intrusive. I find 99% of bass/midrange units are rolled off at 3kHz. My advice is
to start off with a second-order Butterworth or Linkwitz-Riley; both are popular. You must use measurement to decide whether you have a smooth roll down or not.

5) Now try and match the treble unit to the bass unit. This is where the fun starts. Your bass/midrange response could look pretty smart and you could be thinking “this is a doddle”. Start praying. If you are lucky, using a second or third-order high-pass filter to drive the tweeter may give a net flat response and good phase matching, with a reasonably even impedance curve. But there’s a 90% chance it won’t because of all the variables involved. This is why, in the end, you must experiment. Also, it can be faster than ploughing through theory that only gives a partial result. But of course you must use calculation and then validate your results with measurement. Loudspeakers are too complex to be designed on an ad hoc basis. NK

**Kitted Out**

Having become sick to death of the endless search for something approaching ‘jouissance’ from ‘hi-fi’ amps in the sub-£1000 bracket I am now researching the DIY option. The most adequate musical reproduction I have enjoyed to date was via a Gamma Acoustics Rhythm, utilising 211 triodes. Is there an integrated kit based around these valves or alternative valves with a similarly neutral sound (preferably at least 17 wpc SE and real bass) well under £1000? Alternatively would I be best off starting from scratch and, if so, what design source literature could you recommend? I am also interested in your ‘speakers. Would the three-way design be suitable for this sort of power and do you supply ready-cut cabinet board or must this be purchased and cut separately? I am very much a beginner (with more than adequate carpentry skills) who is fortunate enough to have some electronically-gifted friends.

Tim

tim.hicks3@virgin.net

**Sorry to disappoint you, but 211 amplifiers are not so easy to build. We considered using the big brother of the 211, the 845, which has a graphite anode capable of 100W dissipation, in a single-ended amplifier. Here is an early circuit for you to peruse. Because of the low conversion efficiency of a single-ended design this amplifier would deliver around 30watts - but look at the HT voltages! The output valve needs a stunning 825V. At these levels you have to start to consider arcing and tracking along insulators, breakdown in the mains transformer due to surge voltages and, most horrifying of all, primary-to-secondary breakdown across the output transformer. This would do interesting things to your loudspeakers - and the cat would definitely leave home.

We’ve built an amplifier with 211s and transmitter rectifier valves in the power supply delivering a 1200V HT line for one customer, but decided this was not suitable for DIYers or those without experience. We used a transformer subcontractor who specialised in EHT.
What are the pitfalls to be avoided in specifying the motor for an LP12?

I’ve just had a similar experience to the one which spurred Nigel Purdy into building what sounds like a top-quality LP12 but only because I didn’t know enough about the necessary knowledge and skills, including your friends I suspect.

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MOTORING ON

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It’s not just Goldie fans who need 45rpm these days; there are many new vinyl releases which favour the 7in. single speed. Recent examples we’ve come across include Roni Size & Reprazent’s Newforms on quadruple 12in. 45 and Primal Scream’s Vanishing Point on double 12in. 45s. The motor pulley adaptor will do the trick but if, like me, you prefer not to have to fiddle this on and off during a listening session, then a quartz oscillator power supply is the answer. This is because the motor’s speed is frequency dependent. To spin the platter at 45rpm requires a higher frequency than the mains’ 50Hz.

The Airpax motor fitted to the LP12 is a synchronous 24-pole affair specified for 110V operation on two separate phases, and is designed to work optimally with 50Hz in most applications a lower voltage, typically 80V, is used to reduce vibration. Any lower brings the motor closer to silent operation, but the lower torque gives trouble overcoming the inertia of the platter on start-up).

To electronically shift to 45rpm requires 67.5Hz ac power. This is not easily done without regenerating a signal from scratch. The traditional technique is to use a quartz-crystal signal generator which pulses precisely at MegaHertz frequencies, step this down with frequency divider networks to 50Hz or 67.5Hz and low-pass filter this square wave to a clean sinusoidal waveform. This can then be phase shifted 90° with a capacitor, with alternate motor coils connected via the red and blue motor lead-out wires. Grey wires can be commoned for motor earth.

Building such a dual-frequency supply requires no small amount of expertise in solid-state electronics; a short-cut to building this kind of project from first principles would be to rebuild an existing single-frequency unit for solely 45rpm use - the Linn Valhalla board may be a useful starting point as they can be acquired second-hand for less than £50, but do beware of the high voltages present on the board. We don’t know of anyone who has tried this yet, but it may be possible to substitute a different crystal, or to recalculate and modifying the frequency-divider circuitry. Either way you’ll need to adjust the value of the phase shift capacitor at the output stage to give a true 90° shift at the higher operating frequency.

Once a supply is running, pay attention to the suppression of RF noise, a by-product of very high frequency oscillators. You could start by investigating copper shielding on the quartz crystals, or using ferrite-ring RF suppressors around connecting cables and the power supply mains lead. AH

Supplement Advertiser’s Index

| Audio Links | 4 | Falcon | 6 | Marton Music | 14 |
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