BOOK REVIEWS:
POWER AMP PROJECTS
BUILD YOUR OWN TEST EQUIPMENT

UNIQUE HIGH SENSITIVITY LOUDSPEAKER DESIGN

KNOW YOUR PENTODE VALVES: WE EXPLAIN ALL

FREE D.I.Y. SUPPLEMENT No. 24
CHELMER VALVE COMPANY
for
High Quality Audio Valves

We offer below a selection of our CVC PREMIUM range of audio valves. These CVC BRAND valves are from selected world wide sources, processed in our special facility to provide low noise/hum/microphony PRE-AMP valves and POWER VALVES burnt-in for improved stability and reliability. Use this sheet as your order form. If you require matched pairs, quads or octets etc. Please allow £1.00 extra per valve for this service and mark alongside the valve type number ‘M2,M4, M8’ etc as required.

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MATCHING CHARGES £
POST & PACKING (UK) £3.00
TOTAL EXC VAT £
VAT @ 17.5% (UK/EEC ONLY) £
TOTAL TO PAY £

Please make cheques payable to:
‘CHELMER VALVE COMPANY’ or pay by ACCESS/MASTERCARD/VISA Please give details:

SIGNATURE: EXP. DATE: NAME: ADDRESS: Post Code:

VALVE AMPLIFIERS SOUND BETTER STILL WITH CVC PREMIUM VALVES!

130 New London Road, Chelmsford, Essex. CM2 ORG. Tel: 01245 355296/265865 Fax: 01245 490064
D.I.Y. Supplement
Contents

KIT NEWS
Cutting-edge components and hi-fi kits for the discerning DIY hi-fi enthusiast are all listed here.

KLS8 - HIGH SENSITIVITY LOUDSPEAKER
Our 94dB sensitive KLS2 loudspeaker was very popular, but the bass driver is alas no longer available. So after extensive in-house designing we've come up with an affordable replacement. Using a 10in. professional bass driver, it has a fast and powerful sound.

KNOW YOUR PENTODES
How to bluff your way in the world of valves. Andy Grove brings you up to speed on pentode valves and the most common types.

BOOK REVIEWS:

AUDIO AMATEUR POWER AMP PROJECTS
A collection of designs and articles re-printed from Audio Amateur, one of the US's best known DIY hi-fi magazines.

BUILD YOUR OWN ELECTRONIC TEST INSTRUMENTS
Good test equipment can be expensive, but it's essential if you want to develop your own designs properly. With this book you can learn how to spare your wallet by building your own.

DIY LETTERS
The only place to write in to if you want sound advice on kits, DIY designs and components - our panel of experts will provide all the answers.
F. Langford-Smith
Radio Designers Handbook

Langford-Smith Radio Designers Handbook is recognized as being the most important reference work ever published.

Vintage Audio are pleased to be able to reprint this important work and bring it to you in its original format. The Book contains 1500 pages, in 38 chapters, on every aspect of Valve Amplifier Circuits. Such is the extent of the subjects covered it would be impossible to list them all here. It is best summed up in the author's preface to the book: "It has been written as a comprehensive self explanatory reference handbook for the benefit of all who have an interest in the design and application of Audio Amplifiers".

To order your copy at £59 Please Call or Fax us on (01144) 1734 451737

Vintage Audio
850 Oxford Road, Reading, Berks.
CREDIT CARDS TAKEN
AMERICAN DREAM GOES RUSSIAN
After two years of hard work, New Sensor's investment in a project to develop a Sovtek version of the legendary 300B valve has finally borne fruit. Vladimir Shadeev, Russia's famous valve designer, led the work on the valve with assistance from Irusha Bitukova (Director of Sovtek) and Dr Nikolai Kuzmin (Chairman of Reflector, Russia's biggest power valve factory). Mass production is due to start as we go to press, with New Sensor as the valve's exclusive worldwide distributor.

New Sensor
20 Cooper Square,
New York City
NY 10003
Tel: (212) 529-0466

CABLES FROM CAMBRIDGE
Founded in 1988 to manufacture and supply high purity conductors for corrosion testing, Cambridge Scientific Supplies are now turning their attention to the world of hi-fi. They offer ready made interconnects, the CSS-025 (£99/stereo metre) and CSS-037 (£112/stereo metre), made from 99.99% pure silver and terminated with WBT plugs.

For those with DIY inclinations, CSS are also selling silver wire for use in modifying amplifiers, loudspeaker crossovers, etc. This comes in four diameters, 0.25, 0.37, 0.5 and 1 mm, the first two wrapped in PTFE insulation while the others are uninsulated. Prices range from £8/metre up to £20/metre. To ensure the best possible connections, CSS also have two gauges of silver solder (22 and 24swg).

CSS
12 Willow Walk,
Cambridge CB1 1LA
Tel: 01223 811716

BILLINGTON GLOWS ON
Billington Export, the valve suppliers, are continuing to expand their catalogue. New arrivals are a Russian 6550B3 with zirconium getter, Svetlana’s SV811-3 and 811-10, and an EL34 from Tesla who have recently re-started production. Billington are also reducing the prices of all their Chinese components.

Billington Export
Units E1 and E2,
Gillmans Ind. Est.,
Billinghurst,
West Sussex RH14 9EZ
Tel: 01403 784961

THE RETURN OF WILMSLOW
Lovers of DIY hi-fi will be relieved to learn that Wilmslow Audio is now up and running again under new owners Shaun Williams and Terry Sharpe. The company has been relocated to Leicester, where a new price list and catalogue covering over 1400 components is being compiled.

Wilmslow Audio
68 Carlton Avenue,
Narborough,
Leicester.
Tel: 01565 650605

FAIR’S FAIR
Good news for all audio collectors and boffins suffering from withdrawal symptoms - Audio Fair is back in 1996.

The fair, which plays host to electronic components and records as well as modern and vintage audio equipment, is scheduled for Sunday 20th October at Watersmeet on Rickmansworth High Street. £2 is all it costs to gain entry between the hours of 10.30am and 4pm. For more information contact Graham Tricker on 01895 833099.

OVERTURES FROM FARNELL
Fresh from Farnell is a pair of new power amplifier ICs for those who have an aversion to discrete components. Stirringly titled the LM1876TF and LM4700TF, these chips form part of National Semiconductor’s Overture range. Both are designed to operate free from pops and clicks when switched on or off, and can supply 20w stereo and 30w mono respectively. With prices set at £2.65 for the former and £2.02 for the latter, they could form the basic building blocks for either multi-amped or active systems.

Farnell
Edinburgh Way,
Harlow,
Essex CM20 2DF
Tel: 01279 626777

OCTOBER 1996

HI-FI WORLD SUPPLEMENT

World Radio History
Long known as specialists in rare tube brands, Billington Export provides a line of premium-grade valves to fill the increasing demand for hard-to-find tubes! BILLINGTON GOLD features specially tested valves selected for long life, low microphony and low noise. Versions with gold plated pins are available. BILLINGTON GOLD brand comes from a variety of countries around the world. We have carefully chosen the best manufacturer for each type, with an emphasis on the highest audio quality and product reliability. We stock one million valves including: BRIMAR, GE USA, GEC UK, MAZDA, MULLARD, RCA, RUSSIAN/SOVTEK/SVETLANA, SYLVANIA, TESLA, THERMIONIC, TUNGSRAM and other rare brands, as well as sockets and CRTs.

### BILLINGTON GOLD

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### RARE BRANDS

- **5R4G** RCA  POA       6550A GE USA  42.00
- **5Y3GT** RCA  2.90      CV4004 Brimar UK  POA
- **6B6H6** RCA  2.48      DG7-32 Tungsram Hungary  21.00
- **6CG7** Yugoslavian  6.75  ECC81 Mullard UK (CV4024)  7.50
- **6V6GT** STC UK  5.93  ECC82 Mullard UK (CV4003)  POA
- **6X4W** Raytheon USA  3.00  ECC83/ECC83S Tesla  13.13
- **6336A**  66.00  ECC83 Yugoslavian  2.93
- **12B6H7** Yugoslavian  6.90  ECC85 Tungsram  3.45
- **12E1** STC/ITT UK  15.00  ECC86 Tungsram  3.45
- **13E1** STC UK  120.00  GZ32 Mazda  9.00
- **85A2** Mullard  4.50  GZ37/CV378 Mullard UK  5.93
- **807** USA  8.20  KT90 Yugoslavian  24.00
- **5687** Sylvania  6.45  PL519 Tungsram  8.40

### RARE BRANDS

- **5U4G**  3.60  ECC83/12AX7WB  3.75
- **6L6WGC**  6.30  EF86  POA
- **6SL7GT**  2.50  EL34G  6.20
- **6E86** POA  8.20
- **EL34G**  6.30  EL84  1.99
- **EF86** POA  3.60
- **GZ34** Chinese  16.43
- **6550A** Russian  9.45
- **6550B** Russian Zirconium  23.63
- **7119/E182CC** Mullard USA  19.50
- **7668** (price cut for quantity)  23.63
- **Russian ECC83** near equivalent (BN2 centre tapped testers)  1.80
- **ECC86** Mullard  2.93
- **ECF80/6BL8** ECG PHILIPS  0.60
- **EF184** RFT  0.99
- **EF184** Sylvania  1.50
- **GZ34** Chinese  7.40
- **KT88** Chinese tested  12.50

### SPECIAL OFFERS

- **5Y3WGTA** Sylvania  2.93
- **6AS7G** Russian  2.99
- **6AU6WC** Sylvania  1.20
- **6AU8A** RCA/SYLVANIA  0.75
- **6BE6** Brimar/ECG PHILIPS  1.20
- **6CM7** RCA  2.70
- **6SN7GT** Russian  3.30
- **5614A** ECG PHILIPS  2.70
- **6350**  1.35
- **6550B3** Russian Zirconium  15.43
- **7119/E182CC** Mullard USA  9.45
- **7668** (price cut for quantity)  23.63

### SOVIETK

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### SPECIAL OFFERS

- **Jumbo 4-Pin** for 211, 845, etc  10.50
- **Jumbo 4-Pin, Gold Plated**, for 211  13.50
- **UX4 for 2A3, 300B, 811A**, etc.  1.95
- **UX4 Large Locking Type** for 300B  4.80
- **BS UK**  POA
- **UX5 McMurdo** UK for 807  3.60
- **B7A for 6C33CB**  2.85
- **B7G McMurdo** UK, chassis, skirted  7.50
- **811 ceramic**  1.50
- **Octal McMurdo** UK  1.20
- **Octal PCB, foreign**  1.20
- **B9A Ceramic, skirted, chassis, screening can; Russian**  0.90
- **B9A PCB, gold pins**  1.88
- **B9D Magnaloch, chassis, for PL519**  1.80
- **TOPCAP for 2C34, 807, etc**  1.20
- **TOPCAP for 12E1, 5B-254M, PL519**  2.93
- **MATCHED TESTING** £2.00 per valve (£4.00 per pair)

We manufacture sockets in the UK for use with DA 100, 4212E, F2A, EL156, ML4, PX25, etc. Please ask for our catalogue for full details.

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Dominic Baker designs and builds a high sensitivity loudspeaker using Audax professional drive units.

Back in our October 1993 DIY Supplement we published the design of our second kit loudspeaker, KLS2. Using a Richard Allan 8in. bass driver and an Audax 14mm polymer dome tweeter, it was impressively sensitive, producing 94dB for just 1 watt of input. To this day, we haven't produced a design as efficient, due to the lack of suitable drive units. And few commercial loudspeakers come close.

The Richard Allan bass driver used in KLS2 was discontinued a while back, so we lost our only design capable of producing more than 90dB sensitivity. That is until now, and the arrival of KLS8.

For quite a while I've had my eye on Audax's range of professional drive units, a number of which claim sensitivities well above 90dB, some even stretching above the magic 100dB. But until production started on the new PR12ST1 horn loaded tweeter, there hadn't really been a viable replacement for KLS2 suggesting itself.

The PR12ST1 is a horn loaded version of Audax's 25mm fabric dome tweeter, similar to the one we use in KLS3. The spec suggested a whopping 97dB sensitivity along with good power handling, so I ordered a pair straight away.

To accompany them, I chose a bass driver also from the professional range, the PR240M0. This is a powerful 10in. paper cone driver with an impressive specification. The voice coil uses edge wound flat wire on a fibreglass reinforced Kapton voice coil former and is connected to gold-plated terminals. It has a strong cast chassis, and best of all, a sensitivity of 95dB.

With all the right ingredients to hand, KLS8 was born. It is sensitive like the original KLS2, but has greater bass depth and impact, as well as improved power handling.
KLS8 HIGH SENSITIVITY LOUDSPEAKER

TWEETER MODIFICATION

The horn fitted to the front of the 25mm fabric dome tweeter increases its sensitivity dramatically, from around 92dB to 97dB. Unfortunately, because this horn has to be fixed to the four holes in the tweeter’s top plate, there are four deep recesses in the sides of the horn. These cause a deep and sharp suck-out as shown in the response plot below.

This suck-out is narrow enough not to be too noticeable subjectively, but I found a simple modification that would rid the problem completely. The suck-out is most likely caused by a standing wave effect in the cut-outs for the screws. This was confirmed, when, after a small piece of sticky-back foam had been stuck in each, the suck-out in the response reduced significantly.

The suck-out can be removed completely by smoothly filling over these holes with a black rubber compound, following the flare of the horn. This is simple enough for those of steady hand, but if you’re the slightest bit worried, just stick to foam pads. If you do decide the rubber compound route, be especially careful not to spill anything into the horn and down onto the tweeter’s fragile fabric dome.

THE CROSSOVER

TWEETER CROSSOVER

Audax’s PR125T1 horn loaded tweeter has a lot of energy concentrated between 1-5kHz. A simple 2nd order crossover, which gives a useful roll-off rate but doesn’t compromise efficiency badly, and which I wanted to use to ensure a good phase relationship with the bass driver, wasn’t enough to control this satisfactorily. To remove this lump of energy, I choose to use a parallel notch filter (capacitor, inductor and resistor in parallel), tuned across a wide band.

With this in place, the tweeter’s response already looked a lot smoother and better controlled. With the simple 2nd order filter added, the response flattened right out, and the correct roll-off rate and crossover point were set. The tweeter then needed a little attenuation (3dB) to match the midrange output of the bass driver, achieved by the L-pad resistor network.

CABINET DESIGN

KLS8 uses a large, sealed or infinite baffle enclosure. The cabinet completely encloses the rear of the drive unit, the springiness of the air in the box providing the correct loading. Although not as efficient as an equivalent reflex design, a sealed cabinet does tend to give a tighter, faster bass quality.

KLS8 is a largish standmounter, its cabinet some 50 litres in internal volume. This gives a system Q factor of around 1.1. A Q factor of 0.707 gives a nominally flat response, but I chose to build-in a little bass lift, just 2dB, but enough to provide good punch and drive in the bass. Its lower -6dB limit is 42Hz, low enough to play fundamentals well.

There is a little room for those who want to experiment with the PR240M0 driver. Raising Q to 1.2, reduces the box to around 40 litres, giving a bass lift of 3dB, but a lower -6dB limit of 45Hz. Reducing Q to 1.0 increases box size to around 70 litres, reducing bass lift to 1dB, but lowers the -6dB point to 40Hz.
KLS8 HIGH SENSITIVITY LOUDSPEAKER

Frequency Response

Once the response had been flattened, it was a fairly straightforward task to align the crossover. A 2nd order design was chosen, along with an L-pad resistor attenuator.

BASS/MID CROSSOVER

Again, as with the tweeter, the bare response of the PR240M0 bass driver was measured first. It looked promising.

The bare response of the PR240M0 was promising, in that up to around 1.2kHz or so it was smooth and flat. Unfortunately, above this there were some strong peaks as the cone moved into its 'break up' region.

What especially worried me was the strong peak (+5dB above the main driver's output) at 3kHz, right where the ear is sensitive to sharpness. Again I used a parallel notch filter, which reduce this peak from +5dB to -3dB below the driver's main response, ensuring a smooth sound.

IMPORTANT NOTE

It may be tempting to use different components to those specified for this design, i.e. different grade capacitors, thicker wire gauge inductors, but don't. The notch filters used rely on the characteristics of the components to work properly. For example, the resistance of the inductor in a notch filter affects its performance. You are likely to unbalance the sound for the worst if you use different components to those specified.
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The chassis (main chassis and transformer cover) is made from mid density fibreboard complete with a mesh valve cover and base riser unit in black. Price £30. For those who wish to use a high quality chassis for their own project, details of the chassis are given in the P2 manual. £50.

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BUILDING KLS8

The cabinets for KLS8 are made from 18mm MDF, which is strong and easy to machine. It is easier and far quicker to cut the holes for drive units and terminal dishes before you start to glue the cabinet together. It also reduces the amount of dust inside the cabinets which can find its way into the open voice coil of the bass unit and eventually cause rubbing.

The plans below show the general construction. Remember to do a dry run first to check that all the panels fit snugly together. In my case, even though the MDF was cut by a professional woodworker, it had to be sanded to size for a perfect fit.

Using Evostick Stick-W, apply the glue to the edges of the panels. They can then be slid into place, their 18mm thickness being enough to stand steady without panel pins. Any excess glue that oozes from the joins can be wiped away lightly with a damp cloth.

To ensure that the panels are firmly pressed together, either place suitable heavy implements on top of the cabinet, or use thick, stretchy carpet tape wrapped around the cabinet to pull the pieces together. After this last step, check that the cabinet is square and that all the sides are flush. The glue should still be wet enough to allow the panels to be gently pushed into line.

Once the glue is dry - overnight is normally enough for it to reach full strength - the cabinets are ready for their internal damping to be fixed into place. Carpet felt should be glued onto the sides, top, bottom and back of the enclosure.

The whole cabinet, is then lightly stuffed with long hair wool, to further absorb reflections and reduce the effects of standing waves. The long hair wool normally comes in knotted bundles, tear it out gently for best effect. Of course, you are free to experiment with other forms of panel treatment: BAF and Deflex pads for example. But we find that the combination of soft carpet felt glued to the panels together with long hair wool stuffing to be extremely good, as well as being cost effective.

Mount the crossover on a separate board, a piece of plywood is ideal. Because inductors, being magnetic components, have a field around them, they need to be spaced well apart and at right angles to each other to minimise inductive coupling. The components can be fixed to the crossover board with PVA glue, but I find a hot-melt glue gun holds them in place just as well, but the glue is more easily removable.

The drive units can now be soldered to the wires from the crossover and screwed into the front baffle. The tweeter should have wires attached using slide-on terminals to prevent heat damage from a soldering iron. A foam gasket made from draft excluder (you can get it in any hardware shop) should be stuck to the rear of the drive unit frames where they mate with the cabinet, to give a good air-tight seal.

TESTING

A simple test to reduce the risk of any damage to your amplifier when you first plug in, is to check the DC impedance of the loudspeaker using a simple multimeter. Using the resistance setting they should measure around 7 Ohms across the terminals. This simple test will indicate a short with a reading below 1 Ohm.
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World Radio History
KLS8 HIGH SENSITIVITY LOUDSPEAKER

PARTS LIST

DRIVE UNITS
BASS/MIDRANGE  PR240M0
TWEETER  PR125T1

CROSSOVER COMPONENTS
R1  3.3Ω/10W
R2  3.3Ω/10W
R3  15Ω/10W
C1  1.5µF Solen
C2  8.2µF Solen
C3  12µF Solen
C4  10µF Solen
L1  0.5mH
L2  0.1mH
L3  0.56mm wire/air core
L4  2.85mH
L5  1mm wire/ferrite core
L6  0.315mH
L7  0.71mm wire/air core

SOUND QUALITY

Eschewing my favourite session starter, the Sons of Champlin, I dipped my toe into the waters of the choral music contained in The Golden Age Volume I - Europe, which Peter Herring reviewed last month. Tonal colour and separation were both good - identifying individual voices in the polyphony was easy. A broad soundstage gave the different vocal parts room to intermingle without becoming confused, and captured the setting of St. Jude's on the Hill clearly.

Of a rather less subtle nature was the dance music of Total Eclipse Volume I. Throbbing, artificial bass lines and frostily clinical electronic percussion gelled to produce a stirring performance, literally, as my internal organs started getting involved in the music at high volume levels. The Audax 10in drivers remained stable and clean even running flat out tracking the drum machine beats of 'Nautilus'.

Still grinning from elevated adrenaline levels, I popped a copy of Orff's Carmina Burana into the Audiolab 8000CDM/Da Capo combination. I couldn't resist a splash of old faithful, so 'O Fortuna' found itself on repeat for a while. The more natural constituents of this CD didn't possess quite the same dynamic impact as the wholly artificial 'Nautilus', but packed an impressive punch nonetheless. The music's air of mystery and awe-full power, emphasised by the orchestral pyrotechnics, permeated KLS8's suitably edge-of-the-seat rendition.

Jon Marks

MEASURED PERFORMANCE

Our KLS8 design has a smooth and well mannered frequency response. There is a slight reduction in energy at the crossover point where the 10in, bass driver only just manages to get high enough to meet the horn loaded tweeter, but it does get there. It is possible to fill-in this gap by running the bass driver higher, but at the expense of some roughness from break-up.

There's good bass output from KLS8 too, something that can be a struggle with sensitive designs, where the trade off is normally stronger. KLS8 is an infinite baffle design, which helps here. Low bass rolls off slower at -12dB/octave rather than -24dB/octave, so there will be more low bass output adding weight to the sound.

Best thing of all about KLS8 though, is its whopping sensitivity. Supplied with just 1 watt (2.83V) of pink noise signal they'll deliver back 93dB sound pressure level. You'd need four times as much power to get the same sound level from a typical 87dB sensitivity loudspeaker.

Overall impedance measured 8.6Ω, suggesting they are an easy load too. The impedance curve confirms this, staying well above 6Ω across the whole audio band. There is an impedance rise through the midrange, reaching around 20Ω just above 1kHz. But this shouldn't be a problem even for zero feedback designs. KLS8 should match just about any amplifier. In a small room where high levels aren't required, just Swatts should give adequate sound level.

12Hz 20kHz

Frequency Response

0.5 10 20 50 100 1k 20k

Impedance

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OCTOBER 1996
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OCTOBER 1996
Andy Grove introduces you to the pentode valve and its variants.

Despite today's fascination with triodes, output pentodes are still the most widely used form of thermionic power device for audio. But before considering their anatomy it is necessary to take a look at the pentode's ancestors, the tetrode and of course the triode.

In the early days of radio a valve was needed which possessed good characteristics at radio frequencies. The triode suffers from the 'Miller Effect', which causes a multiplication of the effective anode to grid capacitance, by a factor of the stage's gain. Also the inherent electrostatic feedback mechanism in triodes between anode and space charge reduces the maximum attainable gain.

The answer to these limitations was to put another grid between the control grid and the anode and connect it to a fixed DC potential. The extra grid forms a screen (hence the tetrode's other name, the screen grid valve) between anode and control grid, blocking the electric field. Miller Effect is reduced and gain increased; yippee... well not quite.

Tetrodes were great for small signals, such as in RF amplifiers, being reasonably linear. But this was only over a limited range of anode voltage, making them unsuitable as power devices. The problem is 'secondary emission'. This effect happens suddenly at a particular anode voltage for a given screen voltage causing a sharp 'kink' in the characteristic.

Obviously, such a kink would be catastrophic for linearity in a power stage. Philips came up with the answer in 1927 with the B443, having patented the idea in 1926. They put another grid between the screen grid and the anode, this time connected to the cathode or a similar ground potential so it was negatively charged. Secondary electrons are reflected back to the anode and the kink is reduced or removed. The grid was named the 'Suppressor Grid'.

Without the kink in the way the Pentode (a valve with 5 elements) could give a large un-distorted voltage swing and pass a large current at low anode voltage, making it more efficient than a comparable tetrode. High sensitivity, making it easy to drive, along with high efficiency, giving more power for the pound, was a recipe for success and the pentode more or less eclipsed the tetrode.

There is another output valve commonly called the 'beam tetrode' or 'beam power tube', developed by RCA to get around the Philips patent. In these valves there is no suppressor grid, but a pair of plates form the electron stream into a tight beam onto the anode. The various elements in the valve are specially arranged to eliminate secondary emission induced kinks. Generally, a beam tetrode is more linear than a similarly rated pentode and possesses a sharper 'knee' which produces less odd-order distortion. These beam valves were more or less restricted to the U.K. and the U.S.A.

European manufacturers like Philips (who own Mullard and the Pentode patent), Telefunken, and so on, only really produced output pentodes. Pentodes and beam tetrodes are a good place to start experimenting as they are generally cheaper than decent sized triodes, which allows a realistically powered amplifier to be built on a budget. Their greater sensitivity reduces the number of valves needed, but as a downside pentodes produce more odd-order harmonics and because they have a high internal impedance require feedback for satisfactory speaker damping.

There are plenty of circuits available for the following selection of pentodes. A word of warning though; Mullard especially played the specification game to the full, quite often rating their valves at the limit. Modern day valves won't withstand the same punishment, and even original EL34s were prone to blow up if used at Mullard's maximum recommended conditions. Also, they seemed to be a bit creative when quoting power outputs on their valves, so don't be disappointed when you can't get the powers stated in the data books. Just be philosophical and make the best of it.

Many thanks to Billington Export, Tel: 01403 784961, for supplying the valves pictured.
KNOW YOUR PENTODES

PENTODES

The EL34

The EL34 is the classic output pentode, designed by Philips/Mullard. Its 25W dissipation and high power output made it very successful; I can’t imagine just how many have been used in Marshall guitar amps alone over the years! EL34s were rated for an output of 100W in push-pull Class B, with 800V on the anodes. The well known Mullard 5-20 circuit used EL34s to give 35W in Class AB, and the superb Marantz 8B which was based on the 5-20 used ‘34s as well. The Unison Research Simply Two uses one per channel in single-ended mode.

There have been a few variants over the years as versions were made by several manufacturers, including the Siemens EL34, the G.E. 6CA7 and the Gold Lion KT77. Some of these had reliability problems such as melting glass (Siemens) or internal short circuits (some Mullards), and the valve underwent considerable development during its life.

The EL34 is quite often used in “Ultra Linear” mode which has an influence on the overall sonic flavour of the output stage, creating a rounder quality, but possibly removing the edge from transients. Generally EL34 amps have a warm sound with strong bass and a sugary treble, and can be very musical if the circuit is well executed.

The 6CA7 and KT77 are beam tetrodes and seem to be more dynamic in their presentation. In cathode bias amps they can be fitted without modification in most cases, re-biasing may be necessary in fixed bias amps.

Modern Chinese and Russian valves sound good, but aren’t as rugged as the original valves. The early Tesla EL34s were excellent, but the new ones don’t have such a good reputation so don’t go for the 100W Class B job.

Class A operation at low voltages is best for reliability and sound quality. There are several versions of modern ‘34s; The current Russian ones include a copy of the Siemens type and the 6CA7 beam tetrode. Golden Dragon make the EL34 and the higher grade E34L so there is plenty of choice. Perhaps the best way to operate EL34s would be in a 5-20 with reduced H.T., say 350V. Use a 330ohm cathode resistor per valve. Expect around 20W with a 6.6k transformer.

The 6L6 and its cousins

The 6L6 was one of the first beam tetrode valves. It began life with a dissipation of 19W and a metal envelope. The grown up 6L6GC had a fat glass envelope and a dissipation rating of 30W. The 6L6 was, and still is, a very popular valve. In fact it’s probably the most popular audio power valve ever.

All manner of amplifiers have used 6L6s over the years, including the original McIntosh circuit and the new Rogers E20 and E40 amplifiers, and of course most American guitar amps.

As there are many variations on the 6L6 theme it is important to identify which type is used in your amplifier and replace with valves of an equal or higher rating. One of the best modern replacements is the Sovtek 5881 which is very rugged and can replace most 6L6 types without modification. The only downside is that compared to, say, the Golden Dragon 6L6GC, power output will be reduced by approximately 20%.
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and the sound isn't quite as sweet.

The Russian 6L6GT needs to be treated with respect as the anode has a low maximum dissipation rating (19W), and it would be unwise to run the Chinese 6L6GC at the full GC ratings if extended life is required. However sound quality is good in both cases.

The 6L6 spawned some very interesting offspring, for example the 5881, the 7581, the EL37 and the KT66. The KT66 is considered to be the highest form of the 6L6 genre. It possesses higher ratings and importantly is more linear. To replace KT66s use either the Russian 5881 or if you can, USA 7581s which are similar. The EL37 is in fact a Pentode made by Mullard. Like the KT66 it has higher emissive capabilities, but is limited to 25W dissipation against 30W of the '66. The 807 is a more rugged 6L6 with 25W anode rating and a 600V maximum voltage. The base is totally different, a UX5, and the anode connection is via a top cap. The British military used an equivalent to the 807, the SB254M.

The sound quality varies depending on the type used but generally is very sweet but also open and clear, more so than the EL34. The KT66 really is the best medium power pentode/tetrode, midrange is just so vibrant. It needs to be operated properly to get the most from it though, it is easy to swamp the sound with the driver stage's character. It is difficult to suggest an operating condition because of all the possible permutations, but the K5881 output stage would make a good starting point, Vb=450V, Rk=560 per valve, with the screen taken to B+, and Rl-a=10k for 20 very clean watts.

The EL84

The EL84 has to be one of the sweetest of all the output pentodes. It is a lovely little valve with a sweet, detailed and dynamic sound, especially if you have sensitive speakers and can go S.E. The EL84 was introduced at the same time as the EL34, as a successor to the EL42, but it seems it was better sorted by the Mullard team. It is very linear and efficient, it works at low voltages and is very easy to drive, plus it's cheap - the ideal valve for the audio experimenter. The '84 has found a place in the Mullard 5-10 and the G.E.C. 912, the basis for many modern amplifiers, and the Audio Note Oto and Oto S.E. amps.

Luckily there isn’t such a confusing array of EL84s as with, say, the 6L6. The best ones were made in Europe by Mullard, the standard EL84 and the upgraded EB4L, or G.E.C. with the N709. The American types are the 6BQ5 and 7189. The latter is a higher voltage version purportedly giving 20W from a pair. The modern Russian EL84 and EB4LM are great, the M version is very rugged and, in relation to its spec., is cheap. Golden Dragons are also good, if a trifle more expensive.

For replacing EL84s in existing amplifiers I would use the Russian EB4LM solely on reliability and longevity grounds; the Chinese valves have a more musical tone, but may not last as long in some amplifiers, especially ones which use a high H.T. voltage such as the Beard BB100.

For experimenters I would recommend an operating condition of Vb=265V, Rk=150, Rl=4.5K for one S.E. valve, power around 4W. Or 8k for a p-p pair, power then around 12W. Use the EB4LM or the Golden Dragon EB4L, it's worth the few pence extra for the higher grade valve.
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The KT88 and 6550

The KT88 is the heart and soul of all those big, expensive French and American super-amps, like Jadis and Audio Research. The 6550 is more or less a beefed up 6L6. Anode dissipation is 35W, and sounds like tempered steel version of it. For me it has excellent strength and authority, but it just isn’t as musically appealing as the 6L6. The obtainable power is high, McIntosh squeeze 75W from a pair, substantially into Class B I may add. However, 50 to 60W is quite normal in fixed bias Class AB though and in Class A 30 to 35W is possible; here sound quality improves substantially. The Classic McIntosh MC275 and the modern Jadis JA200 are two excellent examples of the potential capabilities of the 6550 if treated correctly.

There are a few types of 6550 around. The best type without a doubt is the Tung-Sol, but these are very rare now. The last of the G.E. 6550s are supposed to sound good, but their glass is eggshell thin and they don’t look that well made. The Sovtek 6550 has been withdrawn, and I found it gave very little power output, leaving the various Chinese types such as Golden Dragon or the Russian Svetlana 6550; the latter has an excellent reputation.

The KT88 was developed by M.O.V. (G.E.C.) and is similar to the 6550. However it is like a turbocharged version, having a higher rating in terms of voltage and power and as a result gives more output. Original KT88s are rare now and the only satisfactory replacement in hi-fi gear is the Golden Dragon. Go for the Super version. These aren’t anywhere near as indestructible as the originals, but at least they sound good and give the correct power output.

Beware of using too high an H.T. voltage on the screen grid! Run 6550s or KT88s at a lower voltage for a sweeter sound. Don’t bother with the 50W G.E.C. circuit because it never seems to work properly.

Yugoslavian, Czechoslovakian or Russian types are available at bargain basement prices, allowing for a few blow-ups during the development process.

Run the KT88 pentode sections at Vb=275V, Rk=-220, and with the screen grid taken to Vb. The load should be 9k for a push-pull pair, power output around the 10W mark. Use the two triode sections for amplification and phase-splitting and you have a complete amp for peanuts. The output transformer only needs to be small because of the low power and the PSU will be cheap using low priced 385V electrolytics.

The ECL86

The ECL86 would usually be found in the audio output stage of a valve TV set, but there are a few amps which use it and it’s good for the experimenter. The ECL86 sounds excellent, like a micro EL84, sweet and clean. The ECL86 has an ace up its sleeve in that it is a triode-output pentode, you get a free triode in the envelope which saves money on valves (the triode is an ECC83 section). The output pentode section has a dissipation rating of 9W, nearly as much as the EL84. It is feasible to make a 10W amplifier using only two ECL86s per channel, and the sound would be anything you could buy for the money (you could maybe get a ghetto blaster). Later Rogers Cadets used ECL86s and the Audio Innovations Series 300; both are good low priced amps.

ECL86s are commonly available at mega cheap prices, and if you want to be a real skinflint then use either the PCL86 or UCL86 which are even cheaper but have 14.5V and 44V heaters respectively. The Mullards are the best ones and because this valve is not all that fashionable they can be bought for a few quid each. Otherwise Yugoslavian, Czechoslovakian or Russian types are available at bargain basement prices, allowing for a few blow-ups during the development process.

Run the ECL86 pentode sections at Vb=275V, Rk=220, and with the screen grid taken to Vb. The load should be 9k for a push-pull pair, power output around the 10W mark. Use the two triode sections for amplification and phase-splitting and you have a complete amp for peanuts. The output transformer only needs to be small because of the low power and the PSU will be cheap using low priced 385V electrolytics.
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And Dominic Baker in Hi Fi Aug '96 agreed with us: "...the Hovland Musicaps took a clear step forward......the extra ambience combined with a very clean treble delivery that seemed far less prone to ringing or sibilance than the other types does make them really quite special."
Power Amp Projects

Reviewed by Andy Grove.

Power Amp Projects contains a cosmopolitan collection of articles which appeared in the American Audio Amateur magazine over a twenty-year period. Some of the authors of the articles carry legendary status in the international audio world; Arthur Bailey, William Johnson (founder of Audio Research), Nelson Pass (Threshold and now Pass Labs), Reg Williamson and Emo Borberley. Also present are Edward T. Dell, Roger Sanders and a host of other names from around the world. At least some of the authors will be familiar to prospective buyers of the book.

Their articles give an insight into the designer's thought processes, and after reading them you can go away and build their amplifiers too. Of course even these legendary names are not above criticism and any letters which were sent in to The Audio Amateur are printed after the article, together with the designer's reply and justification for their circuit. A few of the letters really do attack with a disconcertingly knowledgeable venom, which sometimes causes a reaction in the author rather akin to being stung by a hornet.

There are a wide array of projects to choose from. For those into valves there are two upgrades for the Dynaco ST70. One is a simple modification while the other, by Edward T. Dell, is a complete re-build to a fully balanced and cross-coupled circuit ala Audio Research. Apparently it still fits the Dynaco chassis. There is also the Super Brute; a high power amplifier using KT88s or 6550s for those who require large quantities of valve audio power. Hybrids are also present. There are designs with solid state input/valve output; three electrostatic speaker direct drive amps, two using 813 output valves and one using 8068 outputs. And valve input/solid state output in the DC300B, the last project in the book (unfortunately it does not contain 300Bs).

MOSFET amplifiers make up the majority of projects in the book though. Some are really elegant and ingenious and should serve as inspiration to the rather conservative solid state amplifier designers we have in Britain. The Borberly 60W MOSFET job with its fully balanced driver stage is a real beauty. It uses a configuration originated by Lender, but it is converted to fully symmetrical operation by Borberly using a dual long tailed pair input stage.

For those who have either super inefficient speakers or ears, or have neighbours they dislike intensely, there is a 500W MOSFET super beast, and considering the popularity of the large Maplin amplifier kits I'm sure it will be a hit with constructors. Nelson Pass has two contributions, a 40W Class A amp and a MOSFET upgrade to the Harman Kardon Citation 12. PCB and chassis layouts are given in most cases which is a real help because physical layout is so important to correct amplifier operation. It should be possible for most semi-experienced constructors to make chassis and PCBs from the diagrams supplied with the articles.

All in all there are some pretty serious projects in this book. Many of the amplifiers may be a bit daunting to the junior experimenter. But the Bailey 30W amplifier is a gem and can be built by a reasonably inexperienced constructor, and the Pass 40 watter should also be a snap - it just goes to show that a good designer can design both ultra complex super amps and very elegant simple designs aimed at the home constructor.

Some of the parts, especially the semiconductors, will not tie up with those available through Electromail or Maplin. This means it will quite often be necessary to either scour the equivalents books or to use your own judgement in selecting a replacement device. Otherwise, you may need to look overseas for the correct device. This isn't as bad as it seems; there are companies such as Newark Electronics which have branches in this country, but hold most of their stock in the US. Also look for adverts from Angela Instruments and Mouser Electronics. Steve Melkisethian at Angela isn't really into solid state, but I'm sure he'll help out if he can.

The presentation of the book is a bit home cooked, but this doesn't really detract from its value as a constructor's source book. For the experimenter who is interested in building something a bit different, there will be something for you in Power Amp Projects; overall it's a great book to have in the library.

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BOOK REVIEW

Build Your Own Electronic Test Instruments

Reviewed by Dominic Baker.

Once you buy an oscilloscope, an item not in this book, you should be able to save money by building test equipment yourself, with a little help from Build Your Own Electronic Test Equipment.

This includes the simple audio frequency digital voltmeter which forms the first project in Chapter 2. It is something that will also aid testing of future constructions. This, although one of the simplest projects, is actually extremely valuable to the audio experimenter. It is an RMS averaging meter specifically for audio work, even including an option of logarithmic display of measurement in dBs - very useful and a normally expensive piece of kit.

The detail this book goes into is impressive. Each project is clearly introduced, explaining how to use the equipment, what it is capable of measuring, some relevant basic measurement theory, a description of the circuit, how to test and calibrate the instrument you’ve built and even where to source any difficult components, like the plastic for the AF Voltmeter.

Another interesting little project is the AF power meter. This uses a toroidal air-core bobbin onto which you wind 40 turns of enamelled copper wire. It acts like a sensing coil, picking up the signal from the loudspeaker cable you pass through the centre of the bobbin. It converts the current flowing in the loudspeaker cable, which produces a magnetic field, into a proportional voltage. Once calibrated, you can view the power delivered to your loudspeakers, perhaps serving as a warning against overload, without affecting drive to the loudspeaker.

Next is a sound pressure meter, which along with a suitable test CD, could be used to plot the frequency response of a loudspeaker with reasonable accuracy. It is a little time consuming plotting the response by hand on graph paper, but very cost effective if you’re only going to design one ‘speaker for yourself.

Other general measurement instruments useful to the constructor include a digital capacitance meter (useful as the marking on some capacitors can be unreadable), an AC millivoltmeter with ranges from 0.2mV up to 60V, ideal for audio, a combined capacitance/inductance meter, two frequency meters, a wattmeter and more. For any home audio constructor, it’s worth having this book just for this second chapter alone.

The third chapter, concerned with generators and analysers, is where things start to get a little more complex; computer analysis works alongside hardware for the Logic Analyser. For those interested in vintage tuners, there’s an FM stereo signal generator (87-108 MHz) ideal for aligning those old valve stages.

Again there are some simpler and tasty projects for the audio constructor. I zeroed in on the sweepfunction generator, a piece of test equipment that goes hand in hand with a ‘scope to form the basis of any audio test bench. Although usefully capable of producing sine, square and triangular wave forms from 10Hz to 200kHz, is was a bit of a disappointment to see a distortion figure of 0.5% in the audio band. This isn’t important for most test work, but I thought I’d found a cheap sine-wave generator to use with a distortion analyser.

The final two chapters deal with small projects that are useful, though not fundamental to the test bench. These include a MOSFET tester, cable tester and measurement amplifier. For most of the projects a printed circuit board layout is provided, so you can make your own PCBs.

Looping back to the front of the book, there’s even an introductory chapter on measurement techniques. I’m running out of room to enthuse about this book, so I’ll have to keep it brief. If you’re interested in building your own hi-fi and assessing and improving its performance, buy it.

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Letters

PHONO EQUALISATION
It has taken some months but I've persevered and built your solid state phono head amp from the circuit board offered by yourselves. I have taken the plunge and purchased an Ortofon MC25FL cartridge which feeds a Naim Nait 2 amp via an LP I 2/Naim Aro combination. Now to the crux of the letter.

I switched the whole thing on, hoping for at least some sound through the Rega Elas, but also waiting apprehensively for a bang, and was rewarded by music. However, it was very 'trebly', 'spiny' and had almost no bass at all.

I've checked all of the component values and placements on the board. I used 1% resistors all over, polystyrenes for C2-C8, polysters for decoupling, large polyprops (Maplin audio grade) for C9, and mains supply is from a Maplin 20 VA transformer, DH 28. I've had to mount the DF08 on a separate board because it did not fit your board pin out, and C1 is Black Gate (470µF) as you recommend.

Please suggest checks or remedies I might undertake to improve matters (I cannot take the cartridge back). If nothing else, your mag has encouraged me to have a go, and I've learnt quite a bit by visiting the library. Keep up the good work.

M. Tracey
Chipping Campden, Glos.

The head amp should sound really good and clean, not spitty with weak bass. Something is obviously wrong here.

There is a few things which I can think of, but it is difficult to fault-find without your board in front of me. First, check that you have the correct circuit diagram because the original article appeared with a mistake on the schematic - all of the values were correct, but a connection was incorrectly placed. Building to this schematic would result in just the symptoms you describe. A corrected diagram was published in the following month's edition.

Make sure that the cartridge is operating into the correct impedance. Some cartridges do not like to see the wrong impedance and can end up sounding pretty horrible. Check the cartridge's data sheet for the right value.

I know how easy it is to go over and over something you have built and not pick up the simplest of wiring faults or a misplaced component. It is a good idea to get a friend to check the board for you; another set of eyes is always a real help. AG

VALVES ON THE LEVEL
I get great enjoyment from reading your magazine each month, in particular the DIY section containing design ideas, circuits, etc.

I wonder if you can help. I currently have a line level pre-amp which uses the ECC82 valve. Reading your article in the April 1995 edition about different pre-amp valves, you suggested that you would use the 6SN7 in place of the ECC82 valve for almost all applications.

From your comments on the valves, I would like to try a design with the 6SN7 valve. Could you supply a circuit diagram of the various biasing components required for this valve to slot into the existing design? This has a 350V supply with a 12V supply for the heaters, connected in

The corrected circuit diagram for our MM/MC phono stage originally printed in the April '94 Hi-Fi World DIY Supplement.
series in the ECC82, generated from a voltage regulator. The power supply employs a valve for the rectification.

If this is possible, what make of 6SN7 would you recommend?

In the future, I may consider a pair of Lowther horns. Will the pre-amp have enough gain to drive a speaker of 100dB+ sensitivity without the need for a power amp?

Phil Tolcher
Southampton,
Hampshire.

For really optimum performance the 6SN7 should be tuned in to the circuit, but considering the voltage levels you are operating at, a direct swap in your circuit should work fine, providing the ECC82 was operating correctly to start with. Alternatively, use a 33k 3W resistor for the anode load and 330 ohms for the cathode resistor for each section, and a 220µF bypass cap. Audio Note can supply parts at any budget level.

The only problem is that the 6SN7 uses a 6.3V heater. You can either swap the 12V regulator with a 5V one and put two 1N4148 diodes between the COM pin and 0V to raise the output voltage to 6.3V, or use a 12SN7 which has a 12.6V heater. This time you can use the supply you already have.

12SN7s are readily available from people like PM components, but the choice of brands may be a bit limited. On the plus side, as the 12SN7 isn’t as popular as the 6SN7 (why I just don’t know), you can get really superb ones at a good price. Go for well known American brands like RCA or GEC. Probably the best sonically are the earlier Sylvanias which have the flat anodes or the GEC.

R36. There are some nice specimens made by Brimar as well, but beware of re-badged Eastern European or Russian types - they may be cheaper, but it’s just not worth it for the few quid you will save.

Unfortunately, the pre-amp may be able to supply enough power to drive a sensitive horn, but it wants to operate into a much higher impedance than the 8-16 ohms usually present. You will need a power amp of some sort, although only a few watts is necessary. Your 12SN7 line stage will eat the ’82 for breakfast in terms of dynamics, clarity and tonal accuracy, as long as you use the right valve brand and fairly decent quality bits. Happy listening. AG

SPEAKING CLOSE TO THE WALL
Please could you advise me whether your KLS4 speakers can be used up against or close to a wall. I am interested in building them, but there seems to be no mention of room placement in the article.

If not, can you recommend a kit or commercial speaker of similar size that would be suitable. My system consists of: Linn LP12, Ittok LVII with Denon DL304, Manticore MB6 power supply and Naim 42/110 with Van den Hul D502 interconnect.

Incidentally, the whole system is hard wired - no din or phono plugs, just one high quality terminal block on the back of the power amp.

Speaker stands are my own design, cast in polyester resin and crushed marble, weighing in at 17kg each. I have Rogers LS7s bolted to the stands. The speakers are far too large for the room I now use and need to be away from walls, etc., hence the reason for writing to you. Speaker cable is Naim NAC A4. What cable would you recommend for the tweeter if I bi-wire? I look forward to hearing from you.

Brian Jeffcoat
Grayswood,
Surrey.

Our KLS4 loudspeakers were designed to be used against a rear wall, so should suit your requirements well. They use a stagger-tuned reflex system, where the two reflex ports are tuned to different frequencies to achieve a wider, flatter boost than a single port tuned to just one frequency. This means they have quite dry bass, but it is tight and tuneful - ideal for near wall placement.

Ortofon’s SPK cables have been my faves for a long time now, and I’ve still to come across any cable that beats its transparency per pound ratio. SPK100 will probably suit best for the treble section, or you could use the bi-wire version, which is basically SPK100 for the treble run, and a slightly thicker version for bass/midrange. DB

A QUIETER LOUDSPEAKER
I much enjoyed your article, ‘db on the level,’ in the February issue of Hi-Fi World because I have been wrestling with a problem with my speaker system for some time.

You specifically say at the outset that it is the crossover-driver interface that the article is about and hence, I presume, the arrangement within one

<table>
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<th>L-PAD ATTENUATION INTO AN 8Ω LOUDSPEAKER</th>
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Assuming an 8Ω load, the table above gives resistor values for an L-pad attenuator circuit.
output in order to get a better balance than I have? And if so, what value would give me some balance? I would greatly appreciate your help.

Incidentally, as a retired pensioner I enjoy your magazine and our mutual interest in hi-fi. The subject is not just the province of the young! Keep up the good work.

George F. Emerton
Holt, Norfolk.

It is possible to attenuate the signal to your satellites using an L-pad attenuator circuit as shown in the diagram below. This reduces the signal to the satellites without affecting the load impedance that your amplifier sees. I've included a table of values for R1 and R2 to give you a range of attenuation levels, assuming that your satellites are a nominal 8Ω load. 10W resistors should be OK. The values listed are easily available from Maplin (01702 552911) and other electronic component shops. DB

CROSSOVER QUERIES
Please could you explain why loudspeakers need air cored inductors as part of the crossover units? I have a pair of old Acoustic Research speakers which have provided pleasure over many years, but, have finally shown their age by perishing in places such as the bass driver surround. Choosing to replace the drive units rather than buy new speakers led me down the path of also replacing the crossover units (which on the ARs do not have air cores).

Having purchased the various parts from those nice people at Wilmslow Audio I proceeded to wire up the new drive units (Seas) and crossovers (inc. air cores). The resulting sound can only be described as 'muddy' can saturate if they are not large enough, causing a fall in impedance which may overload your amplifier. Some exhibit hysteresis and the core itself can vibrate causing signal distortion. For large values of inductor, like in the bass crossover section of a three way design where an air core is impractical due to its size and the amount of wire needed, a laminated core inductor is normally necessary. Everywhere else an air core type should be the preference.

But this is not really relevant to what you are experiencing. You are getting a little confused here. It is not the fault of the air core inductor that the sound is muffled. The value of the inductor applied to a bass driver affects its response as shown in the diagram below. Most bass units have a rising frequency response, which means they deliver more power in the midrange than in the bass. An inductor tilts the response downwards to balance the sound more evenly. It sounds as if, in your loudspeakers, the inductor value is too high and/or wound with wire that is too thin. Thin wire has a higher resistance, so less power will reach the drive unit and too large a value will reduce upper bass and midrange, removing important bass fundamentals, punch, speed and midrange detail. This would give the muggy sound you describe. It is not a fault of inductors, more design fault where the wrong inductor value has been used.

Thing is, you may well be getting a better, more open sounding bass with no inductor connected, but the crossover will rely on the phase shift this component introduces to keep the tweeter and bass in phase. I rang Wilmslow who are now under new management, but they were unable to tell me what the crossover design was. It is a simple enough 2nd order design, the culprit inductor being 2.2mH. You need to put an inductor back in, but to get more upper bass, I'd suggest reducing it to 1.5mH or so. This is going to effect the crossover in other ways, but you should be able to achieve a reasonable balance.

I also contacted Radio Components on Tel: 01923 250665 who are the distributors for SEAS drivers. They had a design...
a few years back similar to yours which used the same drivers. They suggested reducing the 2.2mH inductor to 1.5mH; it should have a DC resistance of less than 0.4Ω. Also, if there is not one already there, insert a 3.3Ω resistor across the bass driver's terminals. DB

KIT BUILDING MANIA

I am writing to you to congratulate the design team involved in the development of the KLS7, which I purchased from you at the end of December. Although I had a minor problem with a couple of resistors, the speakers were completed early January.

I have been on holiday since completing the kits, but have had a good chance to listen to them. In fact, I have rediscovered my music collection. I have found it very difficult to tear myself away from the music once actually sitting down.

The tweeter has the cleanest, smoothest treble I have heard in a speaker to date, with percussion instruments so clear and without the slightest trace of hardness. The midrange also being very detailed integrates marvellously with the high frequencies and really gets you involved with the music.

Although, as you say in your review of the KLS7, there is no deep bass as such, the bass that is there is very detailed. The imaging of the speaker is superb. I was positive I had an intruder playing triangle in the corner of my lounge last night. Your point out, as a result of one of the compromises we chose to make - trading bass weight for speed and sensitivity. If you do want to add a subwoofer, make sure that you get one that has a fast and clean sound. It would be a shame to weigh down the KLS7s with a sluggish sub.

Building one yourself may be the best bet. Production of the Audax PR24020 10in. HDA bass unit, which would be an ideal choice of driver, has just started as I write this. You could use a pair for stereo sub-bass, or feed a mono signal to a single driver - it is efficient enough to work well this way. A single driver in a 50litr reflec enclosure tuned with a 3in. diameter port 230mm long, would produce bass extending to 30Hz (~-6dB). For a richer, fuller bass, shorten the port to around 150mm, and for a dryer bass, lengthen it to 330mm.

Set the crossover point to around 80Hz, where KLS7 will start to roll-off in a free-field position; i.e., away from room boundaries where the sound will be clearest. If you want to keep the KLS7s closer to a rear wall where bass is reinforced, this crossover point should be lowered, but 80Hz is a useful starting point. Happy building. DB

W. Fotheringham
New Carron
Falkirk
Tel: 01324 638642

I'm glad you are enjoying our KLS7 design. It was a loudspeaker very much aimed at the audiophile on a budget. I didn't want to compromise on drive unit quality at all, so a 4inch carbon fibre drive unit (the same one as used in KLS4) was chosen to cover the majority of the audio band. Because this driver has a very smooth response that extends well up to 4kHz, the tweeter has very little work to do, just filling in a little top end detail. It doesn't have to handle the basic fundamentals of many instruments, really serving only to reproduce their upper harmonic structure.

The tweeter is a 14mm polymer dome type which we modify. These units have a one-piece voice coil former and dome, so the drive from the coil is transferred very efficiently, giving a fast and crisp sound. But in its basic form there are two strong peaks above 10kHz in the response which make it sound sharp. We modify the face plate of this tweeter to reduce these peaks and give a smoother response, as shown in the plot below.

The bass of KLS7 doesn't go that deep as you point out, as a result of one of the compromises we chose to make - trading bass weight for speed and sensitivity. If you do want to add a subwoofer, make sure that you get one that has a fast and clean sound. It would be a shame to weigh down the KLS7s with a sluggish sub.
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