BOOK REVIEWS:

AUDIO VALVE AMPLIFIERS by Rainer zur Linde

BUILD YOUR OWN HIGH END AUDIO EQUIPMENT, Elektor Electronics

WE BUILD AND TEST HART'S CHIARA SINGLE-ENDED HEADPHONE AMPLIFIER

ELECTRONICS WORKBENCH: SIMULATE YOUR DESIGNS ON A PC BEFORE YOU BUILD

FREE D.I.Y. SUPPLEMENT No. 22
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.

<table>
<thead>
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<th>PRE-AMP VALVES</th>
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<td>Anode Connector (For 807 etc.)</td>
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<td>Anode Connector (For PL519 etc.)</td>
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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: ..........................
 Supplement

Contents

KIT NEWS
All of the latest news on products for budding DIY enthusiasts.

HART HEADPHONE AMPLIFIER KIT
Many hi-fi components these days neglect to include a headphone output. Hart electronics offer a high quality solution in kit form and we have built one.

ELECTRONICS WORKBENCH
Electronics Workbench allows you to model and test your designs on a PC before you lift a soldering iron. We give it a whirl.

AUDIOCAD PRO
A CAD package to help you out with your speaker designs. This one includes a section on horn design though, which makes it well worth seeking out.

BOOK REVIEWS

BUILD YOUR OWN AUDIO VALVE AMPLIFIERS
A practical introduction to valves leads into numerous designs for pre and power amplifiers for audio and musical instruments.

BUILD YOUR OWN HIGH-END AUDIO EQUIPMENT
An anthology of Elektor Electronics' audio circuits brought together in one paperback.

DIY LETTERS
Tell us about your quibbles and DIY niggles. Give us the good news too of how you put together a kit or, um, two.
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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<td>3AMP1A Tungsram Hungary</td>
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<td>5C-405A STC UK</td>
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<td>665G6B Sylvania</td>
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<td>6V6GT STC UK</td>
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<td>12BH7A GE</td>
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**YUGOSLAVIAN/ETC**

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**SOCKETS**

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<td>Jumbo 4-pin for 211, 845, etc.</td>
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<td>UX4 for 2A3, 300B, 811A, etc.</td>
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<td>BFA for ECC83, EL34, EF86, suitable for pre-camps</td>
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**MATCHED TESTING**

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**CHINESE**

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**PAYMENT**

Access, American Express, Debit Card, JCB, Mastercard, Visa, Bankers Draft, Bank Telex, Eurocheque and Cheque (UK only).

Minimum order: UK £50.00 + VAT & carriage. Export £100.00 (US $150.00) + carriage.

Visitors strictly by appointment please.

1E Gillmans Trading Estate, Billingshurst, West Sussex RH14 9EZ UK. Tel: (0)1403 784961 Fax: (0)1403 783519
KIT NEWS

RUSS ANDREWS' 1996 CATALOGUE
High quality audio components supplier Russ Andrews Turntable Accessories has published its 1996 Audiophile Components catalogue. The catalogue comprises a mixture of in-depth articles, product descriptions and application notes.

All of the products described in the catalogue are available by mail order.

For more information and a free copy of the catalogue contact them on 0800 373467.

RATA
Edge Bank House,
Skelmergh,
Kendal,
Cumbria LA8 9AS

TRANSFORMERS FOR VALVE AMPLIFIERS
One Electron, designers and manufacturers of audio transformers for valve amplifiers, have appointed Antique Electronic Supply as their exclusive distributor. There are three transformers available at the moment, the PT-UBT-1 suitable for 2A3s, EL34s, 300Bs etc in parallel single-ended mode, the PT-UBT2 for single 300B, SV811-3s etc and a power transformer PT-BFT-1.

Antique Electronic Supply
6221 South Maple Avenue,
Tempe, AZ 85283
Tel 602 820 5411

QUAD'S BACK IN KIT FORM
Academy Sound's back panel upgrade for the Quad 33 is now available in kit form. This comprises a completely new back panel fitted with high quality gold plated phono sockets, instead of the original DIN sockets.

The upgrade kit comes with full fitting instructions and should be suitable for anyone with good soldering skills and presumably a Quad 33 handy.

The price will be £138 which includes complementary Ixos interconnect leads and carriage. This is a saving of £47 over the fitted version and of course there's the added pleasure of doing it yourself!

Academy Sound
Bank House,
St Agnes,
Cornwall TR5 0QW
Tel 01872 553317

PICO YOUR RESULTS
So you spent all your money on a PC and you've only a few hundred pounds left for test equipment, what do you do? Well one option would be to buy one of Pico Technology's Virtual Instruments. Via a choice of analogue to digital conversion units (depending on requirements) the PicoScope and PicoLog software provide a range of instruments controlled by your PC. These include a, digital storage oscilloscope, spectrum analyser, voltmeter, chart meter and frequency meter amongst others. The ADC's plug directly into a PC's parallel or serial ports.

Pico Technology
Broadway House,
149-151 St Neots Rd,
Hardwick,
Cambridge CB3 7QJ
Tel 01954 211716
definitive audio

* BORDER PATROL 300B Power Amplifiers.

10 Watt single-ended power amplifiers using 300B output valves and choke input filter power supplies.

The traditional single-ended qualities of sweetness, fluidity and integration are combined with wide bandwidth and strong bass performance. Unlike many single-ended designs, which have a tendency to lose resolution and shape when the music becomes complex, these amplifiers remain composed and controlled with firm extended bass and uniform dynamic consistency across the whole frequency range. They are highly recommended to anyone with an efficient (loudspeakers of 139 dB) extended bass and fine resolution. Two models: Brio and Accelarondo. Price £3550.00.

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Impulse H7 Walnut £400 (£750).

Tel/Fax: Brighton 01273 276716/208649

**KEF CONSTRUCTOR SERIES**

Wilmslow

* DEFINITIVE AUDIO.

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| BD1/2 Motor Suspension kit | 13.95 2.45                                                                |       |
| SALL2 headshell | 16.75 2.55                                                                 |       |
| SALL2 Connecting lead | 15.95 3.55                                                                |       |
| Standard Models | Wired arm tubes, Cartridge carriers, etc.                                    |       |
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| Original Phono stage assembly | 10.25 2.25                                                                |       |
| Original idler tension spring | 2.95 1.85                                                                |       |
| Original Speed control disc - 401 | 13.75 2.20                                                                |       |
| Xencor Owners Manual 301 incl. full size mounting template | 8.75 1.85                |       |
| Xencor Owners Manual 401 incl. full size mounting template | 11.95 2.55                |       |
| Repl. Intermediate drive wheel | 19.95 2.85                                                                |       |
| Repl. 301 control knobs | 4.25 0.55                                                                |       |
| On/Off switch select | pair 20.25 2.55                                                           |       |
| Repl. 301 suppressor unit | 5.50 1.55                                                                |       |
| Repl. 301 motor pulley | 2.00 0.55                                                                |       |
| Caster rubber | each 12.00 2.55                                                            |       |
| Replacement 301 Chrome plated mounting bolts | 4.00 0.85            |       |

Goldring/Lenco

| Part            | Description                                                                 | Price
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<tr>
<td>idler wheel (lock nut or clamping fitting)</td>
<td>19.95 2.55</td>
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<tr>
<td>Arm Pivot bearings with instructions</td>
<td>8.25 1.55</td>
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<tr>
<td>Spindle/Main bearing assembly complete</td>
<td>24.85 3.55</td>
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<tr>
<td>Headshell</td>
<td>21.95 2.55</td>
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<td>Instruction book</td>
<td>3.55 0.75</td>
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<td>Xencor Owners Manual 301 incl. full size mounting template</td>
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<tr>
<td>TD 124 series</td>
<td>Idler wheel - original</td>
<td>27.50 2.85</td>
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<tr>
<td></td>
<td>Idler wheel - our redesigned replacement</td>
<td>16.60 2.55</td>
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<tr>
<td>Drive belt</td>
<td>15.25 2.55</td>
<td></td>
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<tr>
<td>Chassis spring suspension (replaces 'mushrooms')</td>
<td>13.00 2.55</td>
<td></td>
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<tr>
<td>150/150 series</td>
<td>Drive belt</td>
<td>10.25 1.85</td>
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<tr>
<td></td>
<td>Suspension springs (1½&quot;, 1½&quot;, 1½&quot;)</td>
<td>11.65 2.55</td>
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<tr>
<td></td>
<td>Suspension bushes</td>
<td>12.50 2.55</td>
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Phono 1 MM or MC Phono Unit

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**EX REVIEW/Demonstration Stock Bargains, The Emotive Statement**

IFE Uni-Q Technology, the unique KEF driver design that delivers a sharply focused sound stage throughout a room, is now available to the home constructor.

KEF's Constructor Series of loudspeaker drive units and dividing networks, may be used in systems of your own design, or by following the KEF kit plans below:

KEF Kit 60 - A two-way bookshelf/stand-mounted loudspeaker using a single 8" Uni-Q drive unit in a compact 18 litre reflex loaded enclosure. The DN60 dividing network allows bi-wiring/bi-ampling.

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Kit 60 70 80

Price £250 350 450

Total £650 1000 1500

KEF Kit 60 - 2-way bookshelf/stand-mounted

KEF Kit 80 - 3-way floorstanding
TO RUSSIA WITH MONEY
The Defence Enterprise Fund, a U.S. government private venture capital fund to finance joint ventures that promote defence conversion in Russia, has decided to pour $3 million into Svetlana Electron Devices. Svetlana is an American corporation which owns a major share of the privatised Svetlana electron tube complex in St. Petersburg, Russia.

In its pre-privatisation days Svetlana was busy producing a line of military products that included components used in military radar and ocean deployed offensive and defensive equipment. Now, with funding from the old enemy, they produce power tubes and glass vacuum tubes for civilian uses worldwide.

Svetlana Electron Devices
3000 Alpine Road,
Portola Valley, CA 94028 USA
Tel 415 233 0429

POLYSWITCHES FROM FALCON
Polyswitches are conductive polymer PTC devices which have a very low resistance when cold, but when an overload occurs and their temperature increases they rise suddenly to a much higher resistance. A range of Polyswitches are now stocked by Falcon Acoustics of Mulbarton. These components can be useful for minimising the complexity of protection circuitry for loudspeaker crossover units or power amplifier output stages.

Falcon Acoustics
Tabor House,
Norwich Road,
Mulbarton, Norwich,
Norfolk NR14 8JT
Tel 01508 578272

NVA'S LOW POWER AMPLIFIER
A new low power amplifier suitable for driving headphones and high efficiency loudspeakers is available from NVA. The API0 is a 15 watt per channel machine built to the same dimensions as the P50, Phono 1/2, DACon and PSU units in their range. The API0 is available with black Perspex or chrome front panels. It is priced as a kit at £130, whilst a fully built and tested version can be bought for £160. A variation, the API0x, is also available which has four line inputs and a selector switch, intended to be used as an integrated amplifier. Kit price for the '10x is £150 and built price £200.

NVA
6 Watermill Ind. Est.,
Aspenden Road,
Buntingford,
Hertfordshire SG9 9JS
Tel 01763 272707

BELDEN AUDIO CABLES FROM ELECTROMAIL
Electromall are steadily increasing the number of items in their audio range, with Belden audio cables the latest to be added. The new range includes screened audio cables and 'speaker cables.

The analogue audio cables use a tinned copper conductor with polypropylene insulation and a paper tape separator to facilitate jacket stripping. The cable also has a bonded Beldfoil shield and a drain wire for grounding purposes.

Belden's loudspeaker cable is intended for amplifier to speaker connection and for the internal wiring of loudspeakers themselves.

The cable is a four conductor, 14-gauge high flex cable for bi-amp or tri-amp 'speaker connections and, we are informed, is compatible with Neutrik Speakon connectors.

Also included in the range are high flex multi-pair snake cables and microphone cables.

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Tel 01536 204555

OS-CON AUDIO OFFER
Audio-Links are running a promotional offer until the 30th June to introduce constructors to their range of Os-Con SG audio grade electrolytic capacitors. They believe, due to the unique technology implemented, they are the best electrolytic capacitors available. The offer entitles you to a discount of 20% off the catalogue price.

Audio Links
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Scunthorpe,
North Lincolnshire DN16 1EL
Tel 01724 870432
A High Quality Headphone Amplifier

Haider Bahrani builds and tests Hart's Chiara headphone amplifier and Andante power supply.

This one came courtesy of Hart Electronic Kits of Oswestry in Shropshire and it's a 'Chiara' class A headphone amplifier, as designed by John Linsley Hood. Well, actually I was sent two kits, the headphone amplifier itself along with the 3565 'Andante' power supply.

The original brief for this amplifier was published in Gramophone in October 1992 with Mr Linsley Hood clearly defining his intention as putting forward a design that can be easily built by the DIY enthusiast with little or no adjustment (or tweaking) necessary afterwards. Hence the reason for using an emitter follower in a 'single-ended' class A configuration at the output stage as opposed to a push-pull one. The latter requires quiescent current and bias adjustment and possible thermal coupling while the former has it fixed in the design.
BUILDING THE CIRCUIT BOARDS
Hart truly do make every effort to accommodate their kits to the absolute beginner. Provided is a hearty wad of paper introducing the wannabe constructor to the world of PCB construction and DIY electronics. The kit instructions too are a step-by-step guide - I followed them to the letter.

The order of assembly seems to have been well thought through. Mounting the PCB components is done in ascending size and height, making soldering a lot neater and easier. The only other tools necessary, other than the obligatory soldering iron, are a pair of wire cutters, screw drivers (crossed head and flat-blade) and a multimeter - one with basic voltage and resistance measurement will do. Everything else, including 'super audio grade silver solder', is provided.

FINAL ASSEMBLY
Once the PCBs were complete the front and rear plates of the headphone amplifier and the rear plate of the power supply were mounted. The end plates attach first to the PCB-mounted sockets, and are then screwed to the case. This too was a very neatly set out procedure, particularly the use of plastic bushes for the volume and balance control shafts which ensured they were wobble-free.

The power supply front plate wasn't mounted in the same way, and this was cause for my first criticism, though a minor one at that. Because there's only a power switch and LED on this panel, it isn't held to the PCB. This made it awkward to solder the LED in place and care was needed not to stress its mounting legs while the panel was attached to the bottom plate. My only other moan while I'm on a roll is that I struggled a bit getting the transformer to fit in the holes provided. This is probably just due to a combination of tolerance errors and nothing that a little bit of effort, a pair of pliers and some gentle persuasion couldn't sort out.

There's no wiring in the headphone amplifier - everything's neatly PCB-mounted, but construction of the power supply did require a little. These were primarily for the mains supply/switch connections plus the routing to the extra dc supply outputs (small PCB shown). The casing in both cases tidily slides together giving two elegant pieces of equipment.

SOUND QUALITY
Using Beyerdynamic DT 531 headphones with my Ziggy Stardust CD playing in our Audiolab 8000CDM transport and a Pink Triangle Da Capo CD convertor, I plugged myself into the 'Chiara'. 'Starman' was a stop on the way through I certainly couldn't miss, and I wasn't disappointed.

The sound was clear and pacey with plenty of life.
A mesh valve cover and baseplate, finished in paneled fit and dean finish. Each kit also induces giving connection diagrams, specifications, as cart be surdpiied to special order. Data sheets eliminates inter-channel ground loops in the between channels, new sharpens imaging and construction, as this gives superior isolation 1/1F stainless steel - NC machine tooled for a instructions provided. Price £ 70. The mains board £ 33. only £ 20.50: component pack, add £ 44: valve set acid £ 45. Paver suraddy board : board £49.50: component pack (including valve construction, 40W/channel, 12Hz to 25kHz the 4040 reference manual. £ 6.50. Kit £ 780, fully valve cover. 4xEL34, 4xEC,C83, 2xECC82. A full tairtmaker loads hie stainless steel chasse classic Whitish connection. which gives stele. cannot wart to listen to them.

The chassis (main chassis and taisskriner connection), which gives superior isolation between channels, which ensures imaging and eliminates inter-channel ground loops in the amplifier. Primary 0-20-240V, 2x25V/80,250 (4.4 HZ), 2x700/120MA, 2x25W/25A. Price £80. Your primary voltages can be supplied to special order. Your valves, giving connection diagram, specifications, as cart be surdpiied to special order. The chassis (main chassis and baseplate) is made from mild steel with a high accuracy precision RIM connector kit four gold plated phone connectors, 40W/channel, 12Hz to 25kHz the 4040 reference manual. £ 6.50. Kit £ 780, fully assembled £275.

Technical specification: 47Hz input impedance, 470 impedance output for driving headphones. Silene circuit board: board only £25, component pack, add £17.50, populated board £70, full set £250. The main transformer is wound for dual mono construction and is a solid toroidal for low leakage flux. Primary 0-20-240V, 2x25V/80,250 (4.4 Hz), 2x700/120MA, 2x25W/25A. Price £80. Other primary voltages can be supplied to special order. These transformers are also suitable for power supplies in preamplifiers and other line level valve circuits - see data sheet. £250.

Alignment, The only standards we recognise and work to are Manufacturers Original. Our Test & Measurement facilities are probably the best in this sector of the Industry... and we know how to use them! KIT-BUILDING. There are numerous kits around nowadays. They all require skill/experience to build satisfactorily and, in the case of valve equipment, safely. Some designs are good, others... well, let's just say their ‘designers' would benefit from a sojourn on that celebrated desert island with only Terman and Langford-Smith for company! Whatever kit you choose, though, it will benefit from a professional build. We will build it, de-bug it and give you a set of Final Test figures from your sample. KIT-RESCUE. In trouble? It won't work? Nil desperandum. Contact us about a rescue/re-furbish. For more details of our comprehensive services, 'phone or fax:

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Faster tracks like 'Sexy MF' of Mr Symbol's (now apparently called Prince again!) Symbol CD presented a harder sound than some might appreciate, but otherwise it was full and dynamic with fairly good separation. Reggae fans though may be a bit disappointed, but then these aren't 20 inch cones stacked to the ceiling.

The DT 531s, being closed headphones, do give, as is typical of their kind, a more confined sound than open counterparts. I tried several other 'phones and the results were always pleasing, with a detailed, spacious and open sound.

Tori Amos' 'Blood Roses' gave a wonderful sensation of her fingers tinkling the Harpsichord keys, between my ears. As with Jimi Hendrix's 'Highway Chile', my Stratocaster wasn't handy so an air guitar was necessary.

Comparing the Chiara with the headphone stage on the Audiolab 8000Q preamplifier did make it seem like a hill in the shadow of a mountain. The Audiolab had a clearer and fuller sound filling in the gaps in the lower registers, sweetening the treble and opening the image. Mind you, to get your hands on this headphone amp you would have to pay a great deal more, and it'd be without the added bonus of building it yourself. Well Ziggy played guitar and so did I at some points. Jolly pleasant stuff indeed.

**CONCLUSION**

Overall, particularly for the DIY newcomer, this is a very well presented and easy to build kit with a good sonic performance to match. Excellent for accelerating a beginner’s learning curve.

Hart Chiara £109.50
Hart Andante PSU £85.42
Hart Electronic Kits
Penylan Mill,
Oswestry,
Shrops. SY10 9AF
Tel 01691 652894

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**SINGLE-ENDED OR PUSH-PULL?**

In his design, Linsley Hood opted for a single-ended configuration. This is not to dismiss push-pull circuits out of hand. Considering the properties of each, one can be left to choose the appropriate topology for the given circumstances.

**Single-Ended**

With a typical bipolar transistor single-ended output stage, the output device swings the full audio signal, positive and negative half cycles. The output terminal (emitter) is held at half supply volts and passes half the peak output current when idling, meaning that in a powerful output stage it must dissipate a lot of heat. However, it does not have to “crossover” to another device, so device thermal matching and crossover distortion are eliminated. This configuration, by its very nature, is Class A only.

**Push-Pull**

Push-pull circuits use two output devices biased just into conduction (Class AB case). When complementary transistors (i.e. NPN/PNP) are used, one will turn on during the negative half cycle and the other during the positive half cycle. One pushes whilst the other pulls, as it were.

When there’s strict division of labour between the output devices, the method of operation is known as Class B. When there’s some overlap, to make a smooth change between them and minimise crossover distortion, Class AB, and when both share fully, Class A.

As the quiescent current required for each transistor is zero in Class B and low in Class AB, compared to the single-ended case, thermal dissipation is a lot less and efficiency much higher.
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ADDRESS _____________________________
POST CODE & COUNTRY ___________________________
An electronics simulator for the masses! Interactive Image Technology of Canada have had a go at producing one. Their latest version is reviewed by Haider Bahrani.

The first time I came across an Electronics Workbench package was a number of years back now whilst doing my degree. These were the days when Intel 386 based PCs were the state of the art and DOS was the predominant user interface. Having laboured away on programs like Spice and Analyser where inputting a circuit required a full blown programming session, the idea of a package that allowed you to build the circuit schematically and simulate it was very attractive.

It was this early version that invited me into a world where at the click of a mouse button I could have virtually any standard laboratory instrument. There was also the bonus of one or two which weren't typically found on a student's workstation, including a Bode plotter. OK, it was slow and the device models lacked the sophistication of its programmable counterparts, but it was user friendly and encouraged experiment.

With Version 4 in my grasp I took little time rushing to my PC to install it. The one sent to me runs under Windows, but it is also available for DOS and the Apple Macintosh. Having spent some time growing in educational establishments, the new version now seems intent on tackling the professional design field. As far as ease of use is concerned, Workbench is certainly first class. The much more expensive Microcap and workstation based Hspice are not as user friendly in my opinion, making Workbench look even better value at £199.

WORKBENCH INSTRUMENTS So what has Workbench got going for itself? Well instead of having a breadboard, components and test

An analogue amplifier circuit with the Bode plotter in action.
A selection of our stocks of **New Original Mullard - Brimar** audio types made in UK.

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<th>STANDARD TYPES</th>
<th>SPECIAL QUALITY TYPES</th>
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**AMERICAN TYPES**

| 5 R4GY RCA | 12AX7A GE | 7.00 |
| 5 Y3WGA / B SYL / GE | 128Y7A GE | 7.00 |
| 6 B4G WESTINGHOUSE | 61468 GE | 15.00 |
| 6 FO7/6CG7 SYL | 6550A GE | 25.00 |
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It comes in a small package (24cm x 5cm x 18cm chassis), but packs a big punch and a very musical sound. Designed for the rookie or first time kit builder, the only tools required are a pencil tip soldering iron, a screw driver, a wrench, a pair of electronics pliers, and a wire stripper or hobby knife. With only 21 solder joints and a handful of nuts and bolts, this kit goes together in one evening (typically about an hour). It's as easy as connecting the dots.

The parts quality is top notch. The board comes assembled and tested, implementing the Burr Brown 1702 DAC, a Crystal 8412 input receiver, an NPC 5813 digital filter, Analog Device's AD844 and 847 op amps and a custom potted toroidal power transformer.

At $499 US, the Assemblage DAC-1 offers an outstanding value in digital conversion and comes with a Satisfaction Guarantee (return it within 30 days of purchase for a full refund) and an Assembly Guarantee (if you can't get it running, we will!). We challenge you to find a DAC anywhere near this price with better measured performance, component quality, and most importantly, sound quality. Call us for more specific information on the performance or construction features.

To order the DAC-1 kit or to order The Parts Connection 1994 Catalog (for £3), full of a lot of other exciting stuff (including a $10 US discount coupon good on your first order over $100 US), send us your request and mailing address - or call with credit card information.

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Workbench's oscilloscope showing the amplifier's output.

The standard test instruments available include a multimeter, oscilloscope, function generator, logic analyser and logic word generator. These can be accessed via icons at the top of the screen in typical Windows fashion.

The not so typical items such as the Bode plotter and logic converter, which presents logic in gate, truth table and Boolean formats, can be pulled down onto the work area and plugged into the circuit. If we haven't been spoilt enough already, an endless number of voltmeters and ammeters can be pulled out of the indicator parts bin and plugged into desired points on our circuit.

The multimeter allows the measurement of both DC or AC voltage and current as well as resistance at DC and dB loss between two points. The decibel values are set at a default reference of 1 volt, but as with nearly everything else in this package, can be customised to suit your requirements.

The oscilloscope has similar characteristics to those of a standard dual-channel, real world device with basic triggering facilities and markers allowing point reference measurement along the horizontal axis.

The Bode plotter, having the least sophisticated of representations, in a not so standard fashion, can only display phase or magnitude responses at any one time. This does make it less straightforward to read off gain and phase margins (which is really one of the powers of the facility), but at least it is there.

An ADC-DAC circuit showing off the logic analyser.
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The core of the Electronics Workbench package is based on Berkeley Spice 2G6. The device models can be customised. A Spice I/O module can be added to the standard package which allows you to export the netlists for analysis using a Spice package. You can also import device models from Spice versions 2 and 3. Another addition allows the export of schematics to PCB design packages such as QuickRoute, a review of which we hope to bring you in the not too distant future.

Analogue Simulation

One of the frills of this most recent update of the Workbench package is the combination of both analogue and digital simulation onto one virtual breadboard. I had quite a bit of fun with the analogue simulation which is probably the most powerful aspect, managing to put together circuits and simulate them very easily. Double clicking on active devices allows you to easily modify their parameters. Clear, concise details are given in the technical reference manual. If the devices aren’t specified the program defaults to the ideal. As it is a Spice based simulator both transient and steady state analysis is possible, with an option to revert to linear operation if it can be assumed that all active devices will operate in their linear regions.

Digital Simulation

Much the same as with the analogue components, the digital and hybrid (including 555 timers, DACs and ADCs) component circuits can be put together using the ideal form. The components can then be replaced with TTL, CMOS or 74 series blocks etc. from the vast libraries, either provided or obtainable as extras from the 2100 or so Model Libraries available for the package.

The logic converter was probably the most interesting aspect for me as I used to hate doing Boolean algebra and Karnaugh mapping in my student days. Once I had supplied all of the input and output data, Workbench did the rest for me, building the circuit on screen. What more could you ask for?

CONCLUSION

Educationally Workbench is superb, with everything mouse handy on the screen. A budding designer can experiment by simulating device faults, forcing them to short or open circuit and even add current leakage into the circuit. As a designer’s package it is a perfect tool for pre-evaluation work; the speed you can put together a circuit and get a response out of it is phenomenal. It doesn’t, for now, provide the detail and low level programmability that a Spice package would have, but then we are playing a different game here. For this money we should be queuing for it. PC not included!

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AudioCad Pro is one of the most advanced loudspeaker simulation packages available for the PC. Dominic Baker outlines its basic features - more to follow in the next Supplement.

AudioCad Pro is quite different to the majority of loudspeaker modelling packages. Whereas most rely on Thiele-Small parameters alone to predict a result, AudioCad Pro is aimed more at the professional and enthusiast with access to PC based measurement equipment. It can interface with just about any PC measurement package like Liberty’s IMP, MLSSA, etc. If you have a package not already catered for, the author offers to write the necessary interface software for you. The ‘real’ measured data for the driver you are using can be imported into the package, making it more accurate in its calculations.

So, for example, if you input the measured impedance curve for a driver, AudioCad Pro will use this to perform calculations such as driver inductance (Le), resonance frequency (fs), and total electrical and mechanical quality factors (Qts, Qes, Qms).

AudioCad Pro requires an IBM PC compatible, 286 or higher with at least 640kB of memory, a VGA graphics card and DOS 3.0 or later. It takes up 2MB of hard disc space once installed, but during the installation process it needs 5MB of free hard disc space. It is copyright protected, and once installed, the copyright code is moved from the floppy to your hard disc; it can be installed up to three times though in case of error, like insufficient hard disc space.

Aimed primarily at professionals, AudioCad Pro allows you to set the configuration in a number of different forms. For example, you can choose between +/-24 or 48dB range, 0-16, 32, 64, or 256ohms for impedance, and the frequency over which the simulation will be performed. This is not such an important point, but it does allow you to make full use of the screen area if you have an idea of what you’re going to be looking for.

For the crossover optimisation section, the number of points AudioCad uses to calculate the data over can be set to 64, 128, 256, or 512. In most cases this can be set to the lowest value, where it will work fastest; it is only a simulation package, so don’t be fooled into thinking that just because you’ve selected the highest resolution it will be more accurate.

In its basic form, AudioCad Pro is very similar to the majority of loudspeaker modelling packages. If you don’t have access to PC based measurement equipment, the Thiele-Small parameters for the driver can be entered from manufacturers’ data and then the box volume and tuning frequency can be entered and optimised on screen. One useful feature of AudioCad Pro though, is its ‘Calculate Parameters’ section, which determines whether the data you have entered is feasible - a useful check, as it’s common to find typographic errors in manufacturers’ data sheets.

Below is a brief outline of the main sections of AudioCad Pro. It is such an involved package, with so many features and options, that it is impossible to cover everything in one article. In the next Supplement we’ll take a deeper look, using Liberty’s Audiosuite to calculate the Thiele-Small parameters, response, impedance and phase curves, and then import this data into AudioCad Pro for simulation.

Closed Boxes
As you’d expect, this section is similar to most other packages. There is provision for entering the serial resistance of the system, which includes your amplifier’s internal resistance, the cable’s resistance and that of the crossover, as there is for all simulations. The effects of the damping material can also be entered, which can effect cabinet volume by up to 30% for a heavily stuffed box.

Vented Boxes
Here again AudioCad Pro is similar to most modelling packages. Like BoxModel
it takes into account the loss factor caused by a leaky box, vent and damping materials. But usefully, the program adjusts this depending on the volume of the box; larger boxes having higher losses than small ones. And you can model both circular and rectangular ports, which is a useful feature.

**Band Pass**

The band pass enclosure, a driver mounted in a chamber driving a second chamber loaded by a reflex port, can also be modelled, as can a band pass two, where the driver sees a reflex loaded volume either side of the cone. These configurations are most useful for designing subwoofers, and a reasonable amount of practical advice is given. For example, for the band pass two case the author advises that you keep the volume of each chamber and their tuning frequencies identical, and that the ports terminate on opposite sides because their outputs are 180° out of phase.

In fact, there is useful practical advice littered everywhere throughout the manual, which will be a great help to many enthusiasts attempting a new type of design for the first time.

**Transmission Lines**

Where AudioCad Pro starts to become interesting is in its ability to model transmission line enclosures and horns. For TLs, the cabinet width, opening cross section, exit cross section, volume and length of the line can all be adjusted and optimised. It is a fairly basic simulation, but then there are so few packages that model TLs that it is still extremely valuable.

**Horns**

Even more valuable is the section on horn loudspeakers. AudioCad Pro is the first program I have come across that covers this topic. Again, a lot of practical advice is given to aid the designer in making the right decisions for driver choice and so on. The simulation itself concentrates on exponential and Tractrix horn profiles, giving the user the ability to vary chamber volume, fore chamber volume, throat area, horn length and mouth area. I hope to have a model of a small Tractrix horn driven by a 34mm dome tweeter up and running in time for the next Supplement, fingers crossed.

**Crossover Design**

AudioCad Pro also comes with a crossover designer. Using the driver data entered, it will predict values for crossover components for 1st-4th order designs. If you have the driver Re, fs, Qms, Qes and Le, it will also calculate a suitable network for impedance equalisation. This corrects for the rise in impedance towards high frequencies caused by a voice coil inductance, and is only really of use for midrange and bass drivers. It will also calculate values for an L-pad attenuator, given the attenuation you need in dBs to match the other drivers in your system.

When using the crossover optimisation section, the author recommends finding Le at the crossover point you are aiming for, if you don’t have the impedance curve data. This is good advice; it is important to know how the driver is behaving at the crossover point so that the data is relevant to where you are working.

**Acoustical Centres**

More often than not, the acoustical centres of the drivers you are using will not be aligned. The distance between the acoustical centres of the two drivers causes a phase shift that will effect your crossover design. AudioCad Pro can be informed of the distance between the acoustical centres of the drivers you are using, and then take this into account when optimising the crossover.

In the next Supplement we’ll bring you a more in-depth look at some of AudioCad Pro’s features.
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SJS Electroacoustics
Build your own
Audio Valve Amplifiers

by Rainer zur Linde, reviewed by Noel Keywood.

This book was written by a German, Rainer zur Linde, for Elektor, a Dutch magazine. But that doesn’t make it half-Dutch; for the most part “Build Your Own Audio Valve Amplifiers” is quite easy to understand if you have a grounding in electronics. All the same, its history in particular did remind me that culturally the English channel has always been a lot wider than the Atlantic.

Although Philips, a Dutch company, bought its way into Britain and its Empire when it purchased Mullard from Captain W.O. Mullard in 1925, valves like Philips’ AD1 power triode are rarely mentioned in the U.K., but it gets star billing in this book: “the legendary AD1 was both the pinnacle and final development of output triodes”. British and American readers who’ve never heard of the AD1 might be a bit baffled by this and its apparent superiority to the DA100 and the 212E, for example.

None of this impinges on the main strengths of the book though, which is to present a wide variety of circuits, many or all of which have been built and tested. There are more than ten power amplifiers, for example, with output powers up to 20watts. However, although at one level the book is very much a hands-on publication, it is not aimed at the beginner. There are enough graphs of transfer curves and formulae to keep a design engineer happy, but an absence of basics.

I was puzzled by some of the book’s curiosities. On p.128 the author talks of “the KT88 used as a pentode in the prototype”, when in fact it is a Beam Tetrode. The beam deflector plates I presume Linde treats as a suppressor grid. Since, it is said, RCA developed the beam tetrode to get around Philips’ 1926 patents for the pentode, it may well be that Europeans (other than Brits) treat the RCA 6L6, GEC KT (Kinkless Tetrode) series valves and all other beam tetrodes as pentodes-in-kind. This is confusing for Brits and Americans, who make a clear distinction between the two.

Also, although there are long discussions on why and how distortion harmonics affect sound quality, delivered with a confidence that I find disturbing in its simplicity, there is no mention at all of the role and importance of transformers. Of all things - especially in modern day valve amps - it is the output transformer that most affects performance.

Trouble is, transformers are so complex to model theoretically and build practically, their design is a black art about which little has been written. I can sympathise with Rainer zur Linde; I know of only one book that discusses audio transformer design in useful detail.

At times Rainer zur Linde had me baffled. I presumed that a 2xKT88 design, upon which Chapter 8 is based, would deliver good power. My presumption seemed to be confirmed by opening observations about push-pull being “a must”, “for higher audio powers”. A pair of KT88s can swing up to 40W or so, or 100W in fixed bias, GEC tell us.

Rainer zur Linde triode connected this high power Tetrode and used it in single-ended configuration to deliver just 6W. In my view, this is a bizarre way to use a KT88!

I have talked about the curiosities of the book, but it has strengths. In particular I liked its cookbook of solid-state power supplies and backup circuits - they’re scattered far and wide throughout the book. Purists may groan, but I believe there’s a lot to be said for “modern” valve amplifiers relying on the flexibility and cheapness of solid-state circuits in certain non-critical areas.

In true German manner, Rainer unashamedly includes arrays of relay switching circuits for an input busbar, with lines of ICs, albeit not in the signal path. He also includes a small but interesting final chapter on valve output stages, including filtering, for CD players using Philips’ TDA1541 convertor chip and there is, earlier on, a sizeable chapter on musical instrument amplifiers.

On balance I found Build Your Own Audio Valve Amplifiers a rather curious book, possessing a medley of strengths and weaknesses. For those who already know a bit about valve load curves, biasing and what have you, it contains useful information. It is fine if you use its circuit ideas for, perhaps, your own design. In this sense it can make a valuable contribution.
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BUILD YOUR OWN HIGH END AUDIO EQUIPMENT

Satisfy your high-end urges with this book from Elektor Electronics, reviewed by Haider Bahrani.

Build Your Own High-End Audio Equipment is, roughly, an anthology of articles and designs that have appeared in Elektor Electronics magazine. The book is presented in six parts laid out in a reasonably logical order with each one covering an aspect of the audio reproduction chain.

Part one is reserved for preamplifiers or as the heading describes them, voltage amplifiers. The first of these is a simple NE5534 (or similar) op-amp based line preamplifier circuit with input select, balance and volume controls only. A simple relay switch on delay circuit is added in for good measure.

The second circuit has a few more frills. For starters an RIAA circuit is included, usable/adaptable for both MM and MC cartridges. The phono stage circuitry is sophisticated, utilising a combination of operational amplifiers and matched pair transistors for the input differential stages. The final circuit shown in this section adds the not so typically high-end tone controls and a headphone amplifier for the budding builder who really wants them.

Descriptions and construction details for the all of the above circuits are kept to the point and reasonably clear. Ideas for enhancement and different component selections are also on offer, giving the average reader with even the most basic of electronics backgrounds plenty of room to experiment.

The following part, in much the same vein, concentrates on power amplification. Four circuits are shown in ascending order of power and complexity. The first two amplifiers shown use HEXFET and the not so commonly used IGBT (Insulated Gate Bipolar Transistor) devices respectively in their output stages whilst the final two rely on normal transistors.

Part three is dedicated to headphone amplifiers. Three circuits are given, presenting a variety of different ideas. The first of these is IC based (again NE5534) with a digitally switched volume control. The second is a fully discrete circuit with bipolar transistors in push-pull configuration throughout. The last of the bunch jumps back into IC mode with a miniaturised circuit taking advantage of the Philips TDA1308T surface mount headphone driver.

The fourth part of the book ponders the ethos of surround sound. It delves into some basic principles leading into the latter half of the section which presents a domestically usable design. Construction, calibration and circuit description are all well detailed, as are response characteristics and component lists.

Stepping somewhat back into line, section five connects us to the final link in the hi-fi/human interface, the loudspeaker. First is a three-way loudspeaker set up with IC amplifiers driving the upper and mid frequencies and discrete bipolar transistors driving the low frequency end. Full calculations of filter component values are provided, with various options including more complex filter arrangements.

The following two loudspeaker projects are an active, phase linear, crossover network and a mini active subwoofer. The former of these two utilizes time delay circuitry for phase correction. Again all the calculations are clearly presented, including the Linkwitz low frequency correction network formulae.

And so the final part. This section has logically been reserved for testing. The first part of the section describes the circuitry, build and use of a phase check unit for audio systems. Finally there's a general overview of PC based test systems available, placed in vastly varying price brackets, for measuring your electronic masterpieces. Most (not all) of the PCB layouts for the circuits shown are presented in the appendix.

Hobbyists and professionals alike should find some stimulation within this neat little collection, which is as much one of ideas as it is of fun to build circuits. I will certainly be making some space on my bookshelf for it.

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HIGH FIDELITY WORLD SUPPLEMENT

JUNE 1996

28

World Radio History
D.I.Y. Letters

HOME BUILD K5881
I have built the 5881 amplifier, with all my own parts and it was hard work. The overall performance is not satisfactory. The sound is very clear, with deep bass, full bodied and detailed, but also it has a strident sound in the treble and sibilance with human voice.

The output transformers are McIntosh 230 replicas (by audio Classics, N.Y.), with 5.4kohms primary. I think your transformer is 6kohms.

My question is - is it necessary to adjust any part values, such as grid resistors or feedback, for best sonic results?

The power transformer is custom built, but it is under powered, giving 360 volts, 250mA, and as a result, all the working voltages are 20% under your values.

As a solution I want to duplicate the power supply, with one transformer and choke per channel. Is this correct or is it necessary to have more parts or change any values?

Miguel Angel Alfonso Martinez
Elche, Spain.

Oh dear! We can’t usefully comment on an amplifier that uses unknown transformers and operates at too low an H.T. voltage. For low distortion the output transformers must match the output valves and too low an impedance reduces power and raises distortion.

The output transformers of our K5881 amplifier are carefully load matched for optimum power transfer with minimum distortion and broad load matching, using a high speed distortion analyser. They are of relatively high impedance. These transformers use multi-section windings to minimise distributed capacitance, in order to obtain flat high frequency response and relatively distortion free treble. Otherwise, the output valve ends up driving a capacitor whose impedance at high frequencies is so low, the output valve cannot supply enough current and serious slewing occurs at high output levels. The result is serious third harmonic distortion.

The gap between coil layers (see diagram) introduces distributed capacitance and is adjusted by the thickness of the insulant. This adjustment must be balanced against the leakage inductance, which increases as capacitance decreases. Transformers, as a science, are so complex theoretically, that their design and construction is a black art, one that demands both knowledge and experience for success.

Your transformers are of too low impedance, which will degrade treble quality. Furthermore, low H.T. will result in reduced power output. The best thing to try is parallel 5881s, which will utilise the low H.T. and match the transformers better. NK

I think that your main problem is that you have made a cheesecake using Gorgonzola cheese. Not that your transformers stink but the circuit and your transformers just
aren't compatible. Your output transformer's H.F. parameter's and load impedance are not correct for this circuit.

The K5881 achieves excellent linearity by running the 5881 valves at a high voltage and by using a transformer with a very high 11k anode to anode impedance. They are specially wound to reduce self capacitance which is very important at such a high impedance as the loading effect of shunt capacitance causes distortion and phase shifts which lead to a humped distortion and phase shifts.

Your mains transformer is not delivering the juice the circuit needs to kick into action, so it needs serious modification to get it working. You need to bite the bullet and either get a set of K5881 transformers or build another circuit which is more suited to your transformer set.

The 5881 valves can work at lower voltages and load impedances but you will need to redesign the output stage to account for this. You say you are getting a 360V H.T., try changing the cathode resistors to 270 ohms, this will increase the current through them putting the circuit back into Class A. Adjust the EF86 cathode resistor to give an anode voltage of 100V. Put a network of 220pF and 10k in series across the EF86 anode load resistor, use a 630V polystyrene capacitor, and try again.

If you can get hold of an oscilloscope and signal generator then monitor the output waveform and use a 10kHz square wave signal. If there is any strange blurring and ringing on the trace then try increasing the 220pF cap in 47pF steps until the oscillation stops. If you get stuck the best place to go for advice is probably a guitar shop with a repair technician, who will have experience of valve amp circuits and access to test gear. AG

SPLIT CROSSOVERS

I was interested to read Douglas Floyd-Douglass' report on the excellent QLN Signature speakers, a product I discovered at the Bristol show early last year and enjoyed tremendously. Being a bit of a DIY'er and having built a pair of Bailey Transmission Line speakers many years ago, and a very capable Crimson 100WIC amplifier which is still in constant use, I was pleased to speak at length to one of the QLN representatives on the philosophy of their external crossover units. My present system consists of: a Lingo'd LP12/Zeta and Audio Technica OC30 (more balls than a Klyde!), a Cyrus Dismaster-Dacmaster, Quad 34/606 and JBL SL120Ti 'speakers, a tremendous combination for my liking of loud rock music.

Looking towards future upgrades, my questions are two-fold: 1. Having delved inside the JBLs and found the crossovers to be manufactured in a relatively agricultural manner, can I re-manufacture them 'a-la' QLN, using high quality materials to re-assemble the current components, and using the option of a single input, or splitting the input/crossover stages completely? I predict this will give me the versatility of experimenting with different physical positioning of the crossovers and different cables and their configurations, but will it improve the performance of the, already satisfying, 120s?

2. I think I would like to build a high quality passive pre-amp, but am unaware of the pitfalls, complexities and problems created by this approach. Apart from requiring the obvious phono stage amplifier, I see a passive switching unit/volume control as being the answer to the 'single piece of wire' philosophy. I know that my other sources will drive the '606 without an intermediate pre-amp and also see this as being a way of saving money when the time comes to upgrade my amplification. I believe the Quad 34 to be my weakest link at the moment, but instead of spending funds on a new pre/power combination, I would like to take the passive pre-amp route and invest all available funds on a high quality power amp, possibly valve, such as the Tube Technology monoblocks.

I would appreciate your views and advice on this approach and look forward to playing with my soldering iron once again in the near future.

WOMEA (H) G. Dunsmuir
HMS Illustrious

There is certainly plenty of room for experimentation and tweaking with your JBLs, but a few things to be aware of first. Replacing the existing parts with better quality components, like polypropylene capacitors and higher grade inductors, may unbalance your loudspeakers. Even though we call a capacitor a capacitor it also has a resistance and some

![Diagram](image-url)

JBL's SL 120Ti loudspeaker crossover has switches for setting midrange and treble level and all capacitors are bypassed by 0.01µF.

In simplified form it is easier to see that it is a 2nd order design. Using high quality components and ‘fixing’ midrange and treble level the crossover could be re-built to this circuit.
inductance and an inductor will have some resistance and capacitance.

The components in the existing crossover will have been carefully tuned to each other to give a predicted response. Changing a capacitor for a higher grade equivalent will normally add some brightness, due to its different characteristics, mainly lower impedance. A higher grade inductor will normally use thicker wire, so will have a lower resistance too, allowing more signal to pass. The different characteristics can be enough to unbalance the crossover, causing a peak or a dip where before there was a smooth roll off. In most cases the effects are very mild though, so it is worth experimenting; better components will certainly improve the sound. You have a switch to set midrange and treble level on your IBLs too, so once you have found the balance you like with the new components, I'd recommend hard wiring the whole crossover without these. Use high quality speaker cable and silver loaded solder for best results.

I'd keep the original crossovers too; not only will they serve as a useful benchmark when you are building the upgraded version, but if you sell them, it will be easy to return them to their original form. Although it looks quite complicated, the crossover in the 120Tis is a quite straightforward 2nd order design. When you replace the capacitors, ignore the .01uF bypass capacitors. For example, in the treble arm there is a .31uF capacitor bypassed by 0.01uF; replace this with a single, high quality 3uF capacitor. I suspect that JBL have used cheap capacitors, then bypassed them with low value polypropylenes - a more economical approach than putting in a good polyprop in the first place. I'm only guessing though, as I can't see inside your 'speakers. I have drawn the simplified circuit you should end up with. There are no values on some resistors because this will depend on which switch position you prefer. DB

Letter of the Month

I've had some very pleasing results from Studio 12s decoder, which is available either in kit or ready built form. It is a very simple device to build, taking around 1 hour to finish. The main circuit board comes built and tested, so all that's needed is to wire up the mains transformer and a few other components. We reviewed this decoder in our June '95 DIY Supplement and its performance was very good.

A couple of months later Studio 12 made a few small modifications to improve performance further. One of the coupling capacitors was removed altogether so that the decoder is direct coupled to the MPX output of the tuner, the sensitivity potentiometer was increased to 1MΩ and the two output coupling capacitors increased to 10pF. I listened to this decoder again after these modifications, which all of Studio 12s decoders now come with as standard, and I must say that the level of performance is now really first class.

In kit form it is available for £28.50 and built up it's £48.50. You can contact Studio 12 on Tel: 01736 798393. If you're keen to experiment, try using a higher quality potentiometer and Solen or other high quality polypropylene signal capacitors. Oh, and another useful thing is that it boosts the output level a little, making it compatible with a wider range of amplifiers. DB

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Dear Hi-Fi World,

I read the article about the 15W single-ended MOSFET amplifier with great interest (DIY Supplement Isslo 2.0, February 1996). Whenever I buy Hi-Fi World, I do so mostly for the circuits published. Usually they are carefully drawn but this time I was disappointed to find several problems. From Hi-Fi World I did not expect such a way of publishing a circuit diagram.

I would like to draw your attention to the following points:

1. Andy Grove, in his description of how his circuit works, refers to parts R1, C1, etc. but these are not shown on the circuit diagram.
2. What exactly does "10 turns" mean on the circuit diagram next to the 47kΩ resistor?
3. Are the 100Ω and 10Ω resistors meant to be as in parallel in the source of the VN2406L MOSFET?
4. On Chris Found's alternative circuit diagram as many as four components are indicated without the values shown.
5. I can see no evidence that Chris Found's circuit uses considerably less feedback than Andy Grove's. The open-loop gains should be similar (the bias currents are similar and apart from a small amount of local feedback caused by the 10Ω resistor in the source of the P-channel FET in Chris Found's circuit, they are the same). The closed-loop gain is set to similar values (37 and 48). What accounts for the "considerably reduced feedback"?

Laszlo Gaspar
Nottingham.

C

clearly the single-ended MOSFET amplifier circuits published in our February supplement have been causing some confusion. We have to be very careful here. Building an electronic device can be dangerous and many of the questions we have received have come from inexperienced builders who are simply not safe to construct such a device. Some of your points are valid though, so I hope the following will help clear up any confusion.

Below are the two corrected circuit diagrams. The labels R1, C1 etc. should refer directly to Andy Grove's original article.

Now to answer some of your questions. One of the clearly visible differences between Andy and Chris' circuits are the ways they've treated the feedback. There is actually an approximate 28% decrease in feedback between Andy's and Chris' set ups although at best (or worst), admittedly, it only constitutes a 0.06volt reduction in the amount of voltage feedback. This, particularly as far as the first circuit is concerned, is only true in the midband frequencies as Andy has employed a fair bit of phase lag compensation. This in the form of C3 and C4 acts with the 330Ω resistors to form a phase lead network. These reduce gain at high frequencies (this one starts to operate at about 10kHz) taking it down to 0dB level before the 180 degree phase inversion which will occur, turning the -ve feedback in to +ve leading to oscillations at and above these frequencies.

Chris Found's circuit although shown unmarked in the original diagrams, didn't employ the same form of compensation. If anyone wishes to build this circuit they should omit Cf, Rf, Cc and Rc to start with and if any problems occur (i.e. oscillations) try placing a 3.3nF capacitor in place of Cc and Rc as in the first circuit and as ball park values 47pF for Cf and 100Ω for Rf. I have to stress that these values are untested on this circuit, but are a reasonable starting point.

To answer your questions, two and three; firstly the 10 turns refer to a multi-turn preset resistor. These types are a lot easier to set accurately offering far better precision and tolerance. And yes, the 100Ω and 10Ω resistors are in parallel at the source of the VN2406L (R4 as shown) giving approximately 9Ω. This value isn't so critical and just a 10Ω or an 8.2Ω resistor in place would do, although it will vary sensitivity a little. Happy building.
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