NEW

Our new 32W amplifier with tube and choke power supply

THE NORTHSTAR AUDIO DAC MODEL 3 KIT REVIEW

Plus: news, letters and more...
WATFORD VALVES 3 Ryall Close,
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E88CC/6922 Harma
ECC85 R.F.I.
ECC83 Tungsram

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ECC83S Tesla.
ECC803S Tesla.

EL84 Sovtek
EL34G Sovtek
EL34E Sovtek
EL34N Sovtek
EL44A Russian
EL44A Russian
EL44A Russian

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300B JJ/tesla rave review
In Stereophile’s November 1999 issue Peter Van Willenswaard evaluated over fifteen 300Bs using the Audionote Kit 1 and the cost no option de Jong System Amplifiers. He said of the JJ Tesla 300B - Worked well in both amps, very good bass - real pressure there and very involving, even euphonic - almost as if trying to make things nicer than real. It has good dynamics, reasonably fine detail, and threw a remarkably wide stage with the ‘Audionote’. He summed up by saying in short ‘The JJ electronics looks a real bargain’!

We offer this great 300B at only £68 each upgrade.

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ECC81 Philips 5.00 GZ32 Harma 9.00
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ECC803S Tesla 20.00 A3 Sovtek 18.00
E833C Siemens 25.00 5687WB Philips 5.00
ECC85 R.F.T 5.00 5881WTI Sovtek 5.00
E88CC/6922Harima 12.00 6550C Svetlana 18.00
ECL86 Harima 6.50 6550WE Sovtek 16.00
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EL34L JS/El/15 Sovtek 8.50 6G8S GE 7.00
EL34 Sovtek 4.50 6G8C Svetlana 12.00
EL34 Telefunken 35.00 6SL7GT Svetlana 8.00
EL4M Russian 6.00 6SN7GT Philips 15.00
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ELS1 Mullard 12.00 7199 G.E. 15.00
ELS1 EL 12.00 12AX7LPS Sovtek 8.00

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DIY NEWS

KIT 34 - A HIGH END 32W SPECIALIST DESIGN
Our latest kit valve amp, designed by expert Andy Grove

CAUGHT IN THE WEB
Another visit to some fascinating DIY web sites by Jon Marks

NORTHSTAR DAC MODEL 3 KIT REVIEW
Jon Marks builds a kit D/A convertor

BOOK REVIEWS
Dinsdale on Horns, Valve amp. circuit diagrams and the history of H.J.Leak & Co are reviewed this month.

LETTERS

ADVERTISERS’ INDEX

4 6 11 14 12 22
NEW ELECTRO-HARMONIX 12AX7EH TUBE

American company electro-harmonix have taken the 12AX7 (aka ECC83 double-triode) and added "a tad of tasteful second-harmonic" they tell us, to give "soulful warmth" for guitar amplifiers. Musicians are all convinced second-harmonic distortion gives tubes their "warmth", largely because a few vociferous companies have claimed this. It isn't really true though, so the new EH tube may well be a good preamp for quality audio work, because it has other strengths. They state "special plate (anode) design results in super low microphonic balanced with high gain". Sounds interesting. "The unique spiral filament (heater) eliminates filament-to-cathode induced hum common to amps that use AC on the filaments". We even have a picture: better than the front cover of Loaded any day!

SITE NEWS

Welcome to the Audio DAC page

The following subjects can be found:
- Project description
- Technical overview
- Measurement (will be added soon)
- Parts list DAC yourself
- Credits
- Feedback (will be added soon)
- PHASE1.pdf
- PHASE2.pdf

D/A CONVERTORS

We are happy to announce our D/A web page, the result of some work carried on digital electronics: http://members.chello.nl/~m.heijligers/DAChtml/dactop.htm It may save your weekend, at least. Most of it looks "straightforward" though I would like to point you to:

Phase Locked Loop and Voltage Controlled Crystal Oscillator at http://members.chello.nl/~m.heijligers/DAChtml/dig_r2c.pdf

and the Reclocking Circuit http://members.chello.nl/~m.heijligers/DAChtml/dig_r2a.pdf

Note 1: We do not supply kits, but PCBs if there's sufficient interest. Note 2: The design, implementation along with conceptual ideas are our properties. It may be copied for private use. Commercially interested parties must contact with me.

We wish you happy reading! Guido Tent and DAC team
AUDIOMEM SPECIAL AMPLIFIER REGULATOR BOARD

Audiocom are pleased to release "Q-power", a discrete voltage regulator board. All of the design requirements necessary to achieve the optimum in power supply regulation are borne out in Q-power. This design starts with an ultrasound. Low noise precision voltage reference, the output from this is RC filtered before feeding into one of the industry's lowest noise op-amps available. The output from this op-amp controls a high current series-pass transistor. Incorporated within the feedback loop there is also additional filtering. The supply to the op-amp has an extra pole of low pass filtering. The main de-coupling capacitors chosen are the Black Gate BG-N & BG-NX type, unsurpassed in performance for low the-art CD-ROM that enables users to design a customised speaker box for in-car and home use. The software can be installed on a PC in minutes and allows the user to model closed, vented and bandpass boxes to deliver the best bass response.

The software will calculate and display the expected response of a new speaker box in a matter of minutes. You can then print out cutting and layout plans for use either at home or by a commercial timber yard. You can also print out the different response graphs to provide useful reference material and impress your friends. The software includes an online help guide, illustrated manual and tutorials on how to get the most from your speaker set up.

The Eminence CD-ROM, £49.99, order code NZ67X, can be obtained from 57 Maplin stores nationwide where specialist staff are available to help with component selection and technical enquiries. Maplin’s mail order hotline (0870 264 6000) is open 24 hours a day, 365 days a year and orders placed before 7.30pm will be despatched same day. A technical helpline for advice on installation is also available to customers.

And finally Maplin have produced a CD ROM of their catalogue which contains 15,000 products ranging from individual electrical components to state-of-the-art electronic equipment. To receive a copy of the CD-ROM catalogue, which costs £1.99, contact the Order Line on 0870 264 6000 and quote order code CQ07 or click on the icon at - www.maplin.co.uk.

MAPLIN UPDATES

Maplin have introduced a range of Celestion speakers nationwide through their 57 retail stores. Amateur and professional musicians alike can choose from the wide range of guitar, bass guitar and PA drivers. With 17 Celestion products there's plenty of choice, including the best selling guitar speaker of all time, the G12-T75. They are also available mail order through the company's catalogue and CD Rom, and online via www.maplin.co.uk.

Maplin have also introduced Speaker Enclosure Designer software from Eminence, a state-of-the-art CD-ROM that enables users to design a customised speaker box for in-car and home use. The software can be installed on a PC in minutes and allows the user to model closed, vented and bandpass boxes to deliver the best bass response.

The software will calculate and display the expected response of a new speaker box in a matter of minutes. You can then print out cutting and layout plans for use either at home or by a commercial timber yard. You can also print out the different response graphs to provide useful reference material and impress your friends. The software includes an online help guide, illustrated manual and tutorials on how to get the most from your speaker set up.

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ON A PLATE

Paul Barker has put up a page titled Plate Load Chokes. Here's an esoteric subject.

The anode load of a valve is usually a resistor, except in the output stage where impedance transformation is needed. An alternative is a choke. Chokes are big, heavy, and expensive so they don't look like much of a substitute for a resistor, which is just the opposite.

However, they allow a lower HT to be used, which may have advantages, although the output stage usually sets rail volts.

Paul's page discusses winding techniques and makes reference to some U.S. books on transformer winding. Good stuff for all those interested in this balck art.

http://www.westbourne-park.freeserve.co.uk/Page4.htm

SITE NEWS

Plate load Chokes

Various types of plate load choke are described in detail. Plate load chokes are considered to be an essential part of any good power supply designer's equipment. They are used to reduce the ripples in the voltage supplied to the valves. They are also used to reduce the amount of radio frequency interference (RFI) that the power supply puts out. The choke is a type of inductor, which is a device that can be used to store energy in an electric field or a magnetic field. Plate load chokes are also used to provide a high impedance path for the anode current, which helps to stabilize the amplifier.

The choke is a type of inductor, which is a device that can be used to store energy in an electric field or a magnetic field. Plate load chokes are also used to provide a high impedance path for the anode current, which helps to stabilize the amplifier.

http://www.westbourne-park.freeserve.co.uk/Page4.htm

World Radio History

HI-FI WORLD DIY SUPPLEMENT APRIL 2001 PAGE 5
Valve enthusiasts insist an all-valve power supply gives better sound quality than a solid-state design where diodes are used in a bridge rectifier. This sort of view can be easy to dismiss as the romance of valves taken to extremes, until you look a little more closely. Then the all-valve power supply starts to make some strong technical arguments in favour of itself, I have found.

With this knowledge and demand behind us, we decided to produce a simple, classic valve amplifier with a valve power supply. People like usable power so it gives 32W from EL34s in push-pull.

There are many questionable features in conventional power supplies, from fundamental behaviour through to the components used. It isn’t just the existence of solid-state components that is the problem! Capacitor input supplies used in today’s solid-state amplifiers draw current only on mains peaks, something power supply authorities object to quite strongly. A “choke input” power supply is ideal, drawing current smoothly, but it has practical problems, I found. The choke thrums like mad, it gets hot and it produces a strong hum field. Add a capacitor in front and everything calms down. What have you got? The classic pi filter arrangement valve amplifiers have always used.

Although a pi filter might appear to be a “capacitor input” arrangement, in fact it is a compromise where some of the output energy is drawn from the choke, which stores energy, as well as the output capacitor, of course. Solid-state amplifier designers were glad to get rid of the choke, but they threw out more than the pi filter and its smoother mains current draw by doing so. They also threw out a wonderful low pass filter that gave pure DC on the supply lines, free of noise.

Solid-state regulators took over. They are small, cheap and have low output impedance - a great replacement for a big, expensive choke it would appear. But they produce noise that cannot be filtered out, which feeds into the amplifier.

Finally we come to the diodes themselves. They switch harder than valves, producing high frequency spikes. Slower Schottky diodes are a favourite alternative to the usual power diodes, to soften things up a bit, but there’s nothing to beat a valve for smooth switching. Until now good valve
Kit34 INTEGRATED VALVE AMPLIFIER

one channel, signal circuits only

Valve pin layout

Rectifiers have been difficult to obtain. The SU4 in this design is a big diode now back in regular production, making an all-valve supply a realistic proposition once again. All the same we needed two of them to handle the current demanded by a 32W per channel amplifier, plus their own heater transformer winding for isolation purposes.

You can see how impractical valve rectifiers are compared to diodes, yet they give slow switch on and great performance once aglow. Once again we find that the best solution is neither the cheapest nor the most convenient, so it is rare in commercial designs. Only in a specialised DIY amplifier can such techniques be used without cost becoming excessive.

In a nutshell then, this power supply draws mains current smoothly and it feeds noise free DC out to the amplifier. You will notice we use DC heaters on the first valve to virtually eliminate hum, which otherwise upsets people used to solid-state silence!

The amplifier itself is a classic push-pull able to deliver a useful 32W per channel, enough to give good volume levels from ordinary loudspeakers. Bear in mind that big floorstanding speakers are more sensitive than small bookshelf types, contrary to what you might expect, so think big if you want volume. I am currently using a 28W valve amp into KLS-9s and have plenty of volume, with room shaking bass, so lower powers don’t have to mean lower volumes (but I did design KLS-9 for valve amps). NK

We will be finishing this article next month with a thorough appraisal of sound quality, kit construction and kit contents.
KiT34 INTEGRATED POWER AMPLIFIER - POWER SUPPLY

KiT34 circuit description by Andy Grove

KiT34 is a simple, vintage style design using an ECF80 input valve and a pair of EL34 output valves in push-pull. The ECF80 (V3/4), a triode/pentode combination, is connected as a "Floating Paraphase" phase inverter. With this type the pentode section is connected as a conventional voltage amplifier with a gain of approximately 150, with R15/18 as the anode load and R11/12 as the screen grid dropper resistor. C8 is the screen decoupling capacitor to maintain a constant screen to cathode voltage at audio frequencies.

The triode section performs the actual phase inversion thus: a bridge is formed by R25/26 R29/30, R27/28, and R21/22. The junction of R29/30 and R27/28 is taken to ground, these are the EL34 grid resistors. R25/26 and R21/22 form the other half of the bridge while R23/24 increases the resistance in one arm to provide the necessary signal to the grid of the triode, derived from the combined antiphase outputs of the two input valve sections. There is an amount of local feedback around the triode section which stabilises operation against valve ageing. R19/20 and R17/18 are the anode load and cathode resistor for the triode respectively. C13/14 and C11/12 are the AC coupling capacitors to the bridge and output valves via their grid stoppers.

The output stage utilising EL34 output pentodes (V5/6 and V7/8), is again conventional. Here pure cathode bias is used for simplicity, rather than the compound technique used in our other kit. The EL34 screen grids are connected via screen stopper resistors R41/42 and R39/40 to ultra linear taps on the output transformer. These U.L. taps are at 1% of the total primary winding. The H.T. voltage in KiT34 is lower than that used in the Mullard S-20 and so a lesser amount of U.L. is permissible to maintain a good power output. The experienced builder can experiment with Pure Pentode operation by connecting the screens to the H.T. Ultra Linear by using the circuit as shown or in Triode Mode by connecting the screens to the respective valve anodes. Triode operation will result in a loss of power output. Before attempting this please make sure you understand what you are doing!

There is a Zobel network connected across the output transformer secondary to ensure stability into inductive loads and the overall feedback network includes the usual L.F. and H.F. compensation schemes seen in our other kits. The power supply uses two Russian 5U4 rectifiers. The current requirement of the four EL34s requires that each 5U4 is connected as a single diode with its two sections in parallel. These are then configured as a full wave rectifier of high power capability. In the filter, stacked electrolytic capacitors are used, together with balancing resistors, to ensure a wide voltage safety margin. The stacked capacitors form a pi filter with the choke L1 for superior supply smoothing. The preamp section is fed from a potential divider to ensure that C5, never experiences an overvoltage thereby ensuring reliability.

MEASURED PERFORMANCE

- Power: 32 watts
- Frequency response: 15Hz - 85KHz
- Separation: 60dB
- Noise & noise: -90dB
- Distortion: 0.05%
- Sensitivity: 300mV
KiT34 PARTS LIST

RESISTORS

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<tr>
<td>R1/R2/R3/R4</td>
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<tr>
<td>R5</td>
<td>1.5K, 0.5W</td>
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<tr>
<td>R6</td>
<td>56K, 6W</td>
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<tr>
<td>R7/R8</td>
<td>1M, 0.5W</td>
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<tr>
<td>R9/R10</td>
<td>3.3K, 0.5W</td>
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<tr>
<td>R11/R12</td>
<td>430K, 0.5W</td>
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<tr>
<td>R13/R14</td>
<td>10R, 0.5W</td>
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<tr>
<td>R15/R16</td>
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<td>R17/R18</td>
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<td>R19/R20</td>
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<td>R21/R22</td>
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<td>R35/R36</td>
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<td>R43/R44</td>
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<tr>
<td>R45/R46</td>
<td>560R, 0.5W</td>
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<tr>
<td>VR1</td>
<td>100K dual log potentiometer</td>
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CAPACITORS & LT RECTIFIER

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<th>Capacitor</th>
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<tr>
<td>C5</td>
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<td>C6</td>
<td>4700uF, 10V</td>
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<tr>
<td>C19/C20</td>
<td>0.1uF, 50V</td>
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<tr>
<td>C21/C22</td>
<td>2.7nF, 63V</td>
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<tr>
<td>BR1</td>
<td>KBU4D</td>
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CHASSIS

2mm thick mild steel, black powder coat
with white screen print x 1
2mm base plate, black powder coat x 1
6mm thick anodised front plate x 1
34mm diameter chrome knobs x 2
chrome finished transformer caps for mains & outputs x 3

HARDWARE

2 pole/6 position selector switch x 1
tape/source switch x 1
IEC socket & power switch combined x 1
1.6A slow blow fuse x 1
gold plated red phono sockets x 7
gold plated black phono sockets x 7
M6 fibre washers x 28
earth post x 1
gold plated banana speaker posts x 2 pairs
M4 x 12 hex. bolts x 4
M4 x 12 screws x 2
M4 nut x 6
M3 x 12 screws x 30
M3 nut x 22
self adhesive feet x 4
IEC mains lead x 1
assorted wire
instruction manual

KiT34 VALVE AMPLIFIER IS AVAILABLE AS A KIT!

KiT34-K240/120
(with valves)

KiT34- K240/120
(without valves)

or purchase the components individually:

KiT34 transformer set
KiT34 mains transformer
KiT34 output transformer(pair)
KiT34 choke

UK
(inc. vat & p&p)

Overseas
(exc. vat & p&p)

<table>
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<th>Component</th>
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<td></td>
<td>£420.00</td>
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<tr>
<td>KiT34-K240/120 (without valves)</td>
<td>£430.00</td>
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<td>£365.00</td>
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<tr>
<td>KiT34 transformer set</td>
<td>£250.00</td>
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<td>KiT34 mains transformer</td>
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<td>KiT34 output transformer(pair)</td>
<td>£130.00</td>
<td></td>
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<tr>
<td>KiT34 choke</td>
<td>£45.00</td>
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</table>

Call or fax Nick Lucas on: +44 (0)1908 218836 (9am-5pm, Monday-Friday)
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For overseas freight charges, please call, fax or e-mail.
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Tel (UK ONLY): FREEPHONE 0808 - 100 - 6868
FAX: (++4) (0) 1276 686353
(CT HFW 0401)

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Best Interconnect & Speaker Cable

Best Speaker Cable & Highly Recommended Interconnect

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(CT HFW 0401)
CAUGHT IN THE WEB

Bemused and befuddled by which component to buy, or how to modify your latest kit? Jon Marks went surfing for advice.

The best places to find out about hi-fi - commercial as well as DIY - are those which are, though I hate to use such an abused term, 'interactive'. There really is no substitute for being able to communicate with like-minded people who have been there, done that and learned how in the process...

WWW.AUDIOASYLUM.COM
Audio Asylum is a superb site for a range of topics, including in-depth forums dealing specifically with loudspeakers, high-resolution digital formats, vinyl, etc. If you're a fan of panel loudspeakers, and especially Magneplanars, this is the place to visit to discover how to squeeze every last ounce of performance out of them.

The tweaking side of the audio arts is catered for with a never-ending stream of questions and answers, amongst which hot-rod-ding DVD players is a very popular subject. Concepts for cables and stands there are aplenty too, and the emphasis is most often on major upgrades for minor money.

If you're stuck trying to find suppliers for some of the more esoteric parts for your latest lash-up, Audio Asylum scores again, even if its bias is American.

REC.AUDIO.TUBES
Followers of the glowing bottle need look no further than this US newsgroup for answers to just about any DIY valve question, no matter how technical.

Whether you keep an eye on the day-to-day postings, or prefer using the huge archives as a handy database, just about any query you have, no matter how technically demanding, is almost guaranteed to generate a useful response here. The whole spectrum, from jerry-built piles to no-expense spared esoterica, gets abundant coverage.

Recurring topics are the varying sonic characteristics of different brands of tubes from different eras, comparisons between output transformers (including Tango and Tamura from Japan), and optimum bias points for the ultimate sound (to mention a very few).

WWW.AUDIOVIEW.COM
The comprehensive American site Audioreview is another useful location for researching both ready-made and home-brew hi-fi.

While the slant in this instance is more towards the commercial than the DIY, if you happen to be a fan of picking up Seventies and Eighties battlehips and tweaking them, its reviews section is highly informative (although you won't find every piece of equipment ever made).

Other topics in the Tech Talk forum include cables, tubes and vintage gear. There's a market place too, if British classifieds have failed to yield that rarity you've been hunting all these years.

Should you wish to expand your range of test equipment from a lowly multimeter to something more highly evolved (such as a first oscilloscope or signal generator), these can often be had at very reasonable prices, although it's American mains volts of course, and shipping is required. (JM)

WWW.WORLDAUDIODESIGN.CO.UK
Closer to home is this site. Although allied to Hi-Fi World and its kits, all the same there's plenty of general discussion about valve amplifier techniques, problems and what have you, plus loudspeakers.

Ordering special parts in and from the U.K. makes it valuable for U.K. based DIYers. Some esoteric discussions take place and there's always a surprise or two. (NK)
BOOK REVIEWS

Horns, valve circuits and the history of Leak are in this month’s esoteric review bag.

**Manuale Hi-Fi a valvole**
* Schemario. Volume 2
* by Macri and Gardini
* reviewed by Andy Grove

Don’t let the Italian title put you off, this book contains virtually no text so there is no need for a translator. It is a collection of literally hundreds of audio circuit diagrams. Looking at the index, we start at Acrosound and end up at Uesegi. Let me whet your appetite by giving a few tasters of what’s in this remarkable book.

For triode fans there are circuits for the classic Audio Innovations First and second Audio amplifiers, push-pull and parallel push-pull 2A3 amps. There are the circuits for the Audio Note Neiro, single ended 2A3s, and the legendary Ongaku, single ended 211s. Audio Note will supply most of the components to build these two amps.

Equally esoteric are some of the Luxman designs using things like the 6336 double triode. How about some of the projects which have appeared in MJ, the Japanese audio magazine? There’s a Loftin-White lookalike using an ECC83 and a 2A3. There are some other very esoteric Japanese circuits from Ken with push pull 2A3s, S.E. 2A3, and S.E. VT52.

For power hounds there are the complex and elegant designs from Audio Research with their unique cross coupled phase splitter. Also take a look at the Luxman A3000 and the Michaelson and Austin M200, TVA1 and TVA10 amps.

For Mega Power there is a design from Altec using a pair of giant 813 pentodes with Xenon rectifiers for the H.T it will will seriously kick butt if you’re brave enough to build it!

Fancy big classic style American amps? Take a look at Conrad Johnson, Carver and Macintosh.

What about O.T.Ls I hear you cry? Why don’t you build the MJ 40KD6 design, or the 6H13C design? On top of all this esoterica are many of the classics like the QUAD I1, the LEAK TL25 and TL50. The Bogen D30A, the Avantic Beam Echo DL7-35, the Radford STA15 and so on. Interestingly there are circuits from Loyez, using that phase splitter which had me scratching my head when a reader asked about it.

There’s more! Preamps, tell them about the preamps. I can’t see anyone building a LEAK Varislope or a QUAD 22, but how about a Conrad Johnson Premier 7A, or an Audio Research SP10? Or maybe a Luxman A2002? They’re all in there.

The final pages contain some data for the 6336, 100 TH and 211 valves, including curves. This book is a must buy. Keep it next to your bed!

**FIRSTS IN HIGH FIDELITY - THE PRODUCTS AND HISTORY OF H.J.LEAK & CO.**
* by Stephen Spicer
* reviewed by Noel Keywood

H.J. Leak & Co was a particularly interesting British hi-fi company. Amplifiers like the TL/I2 are held in high regard even today and the Leak Troughline is one of my favourite tuners. I researched the company’s history some years ago (Hi-Fi World, October 1996 issue) and realised in the process that Harold Leak was something of a pioneer. Stephen Spicer has put a massive amount of effort into research to come up with this definitive history of Leak. And what a great book. It was a job that needed to be done in my view.

Companies like Quad, Wharfedale and Tannoy were established at a similar time, are alive today and better recognised, but Leak encapsulates the early spirit of high fidelity. The company produced some great products, so much so that they have better survived the passage of time than most rivals.

I kicked off my research by contacting an ex-Wharfedale employee, who put me into contact with Ted Ashley, Chief Engineer at Leak, who joined in 1944. Although retired and living in Devon Ted was very helpful. The material he sent me, notably a picture of a pre-war Leak amplifier “introduced at Olympia in 1936” also signalled that Leak were emphasising performance criteria early on. Here was a true hi-fi company, one that went on to export some wonderful products around the world.

Stephen Spicer picked up on this history and has gone to remarkable lengths to catalogue every detail, it seems, of Leak’s employees, products and history. Running to 270 pages it’s a sizeable work comprehensively illustrated by pictures, maps, cir-
This Italian book and "Schemario," also reviewed here, makes me wonder if I'm living in the wrong country! Obviously, these Italian guys have a true passion for Hi-Fi, and by Hi-Fi I don't mean dull, grey sounding black boxes and six-inch-woofer-plus dome-tweeter speakers. I think it must be the climate and food. As I sit here and look out of my window into the English winter gloom I dream of sunny Italy...

Onto the review. "Horn Loudspeaker Design" is a bilingual book written in both Italian and English, with the pages divided into two columns, Italian on the left, English on the right. Presented first is a reprint of the articles written by Jack Dinsdale for Wireless World in 1974, these articles cover the essential theory used in horn design culminating in two, practical domestic horn designs.

For those not familiar with the Dinsdale articles, they begin with a short history of acoustic horn design and usage, from primeval man and his conch-shell through acoustic gramophones to modern day horn speakers using electrodynamic drivers.

From here we meet the problem of which flare contour to use, conical, exponential, tractrix and so on, and then go onto the topic of mouth area. There is a special discussion regarding the shape of the wavefront as it passes along the horn, leading Dinsdale to the special case of the tractrix horn which assumes a spherical wavefront. Also covered in the first of the articles are the loading volumes at the front and rear of the driver and their effect on frequency response. At the end of the first article is a reference section.

The second article has a more practical slant. For example, using the horn as an acoustical filter and the integration of multi-way horn systems, also the importance of horn positioning in relation to bass loading performance. There are tables giving mouth and throat dimensions for various loadings and drive unit types.

Practical advice is given as to the construction of horns, selection of materials and construction techniques.

Finally, two example designs are worked through using the formulae and methods derived earlier in the article. One is a small folded horn and uses an inexpensive full-range drive unit, and the other is a large multi-way horn using drive units from the KEF Constructor series. There are drawings of both designs.

After Dinsdale's articles comes a discussion of the articles by Paolo Viappiani. This is a "question and answer" discussion of whether the articles are still relevant, given the work by modern acoustic engineers. Viappiani also gives some more reference material which came after Dinsdale's work and which may be of interest.

Towards the end of the book are plans, drawings and internal photographs of a great number of horn speakers. These designs are from University Audio, Lowther (such as the Bicor, Classic, Accolade, Academy, Medallion and Acousta) and Mauhorn. Using these plans you can build your own horn speaker. I'm not sure of the availability of University Audio drive units but Lowther drive units are definitely available. Some of the designs are horrendously complex and should only be attempted by the expert woodworker, but some would be fairly easy to construct at home. I suppose one could even get a local carpenter to make the enclosures for you, or at least cut and shape the panels.

Supplied with the book is a software floppy disc for those who would like to design their own horn speakers. There are two version of the software, one English and one Italian. This software utilises the equations presented by Dinsdale and others to calculate the optimum horn for a given driver. It speeds up the process enormously. It also has a handy feature whereby it will calculate the tapered conical sections of a constant width horn to assume the required flare. The package is easy to use and there are instructions in the book in case you get stuck. If you read Dinsdale's articles you will already have a pretty good idea of what's going on anyway; the software takes the pain out of it.

Overall, this book is excellent. You may already have the Dinsdale articles but I bet they are dog eared photocopies like mine. And with this book you get speaker plans and design software. There are plenty drive units around which could be used in horn systems. The craze for in-car audio has produced some great full range drivers, both twin-cone and multi-way. Or you could go the whole hog and use a mega unit from Lowther, Pioneer or Fostex, the latter two are available over the internet from Japanese suppliers.

If you are daring enough to take the plunge you could build yourself a speaker which will make the stuff in your local Hi-Fi shop look and sound futile.
Digital kits probably come alarmingly close to the top of the complex-o-meter in most constructors’ minds. Static-sensitivity and surface-mount parts the size of a stamp with more legs than a millipede convention loom in nightmares of unbuildability. The reality can be somewhat different though, as North Star Design’s Model 3 DAC illustrates.

This converter can handle inputs from 33kHz up to 96kHz thanks to Crystal’s C584 14 receiver chip and a pair of Burr-Brown PCM-1716 D-to-A chips. Yes, all three are SMD (surface mount) components with some very closely spaced leads, but all three come ready-mounted on the single PCB.

That’s the hard part finished. All the other components are leaded, and anyone with a little soldering experience behind them should have no fears about attempting this kit.

MR DIGITAL AT AUDIO ANALOGUE

The name North Star Design may not ring too many bells with UK kit purchasers – it is, after all, an Italian company. On the other hand, Giuseppe Rampino might cause some slight pealing; this is the man who created Audio Analogue’s respected Maestro CD player.

Hoping I might find in the Model 3 the same sort of neutral, open and musical sound manifested by Audio Analogue’s offerings as a whole, I opened the sturdy packaging eagerly and checked through the contents.

The manual itself is a humble photo-copied item running to 14 pages of A4. Each of these is divided into a pair of columns, the one on the left explaining everything in what is doubtless perfect Italian, the one on the right doing the same thing in a form of ‘anglish’ which will occasionally have you grinning. Mind you, poking fun at home-spun translations is hardly fair, or politically-correct in Greater Europe.

As ever, once you’ve read the manual cover to cover (and discovered a couple of omissions), the next stage in readying yourself prior to soldering is to check that all the bits in the individual parts lists are actually to be found in their respective bags.

Another point to consider before populating the PCB is that it’s through-hole plated – there are pads on both sides of the board. North Star recommend soldering both sets of pads to ensure the best joint quality. The disadvantage of this modus operandi is that it makes removing incorrectly-located parts more difficult than with a single-sided board, and increases the risk of component damage due to overheating.

If you’re mulling over future upgrades, you might want to plan ahead and not solder all the way through the board, or put in pins to solder to, or be prepared to cut parts off the board before fitting their replacements.

BOARDING PARTY

Having bolted the four stand-offs to the PCB, I began laying out the resistors. Forming the leads is easily done with a pair of needle-nosed pliers. The full-length leads can then be slipped through their holes, bent back parallel to the underside of the board, and trimmed with a small pair of side-cutters.

The manual suggests cutting the leads to length before fitting, but using cutters is considerably faster and allows the resistor to be held in place for easy soldering (bending back a pre-trimmed lead on a small solder pad is not fun!)

While R1-R46 were taking up residence, I spotted a cut track on the top-side of IC14’s spot. Giuseppe confirmed this is a little post-production revision of the layout and not a duff board.

Unless you read the instructions first, you might also be puzzled by silk-screening for both R44 and RV1 (neither of which appear on the resistor list). A foot note explains they are one and the same (and that this variable resistor is used to trim the crystal oscillator circuit during set-up).

Mounting and soldering the resistors was uncomplicated. The sockets for ICs 12, 13 and 14 came next, along with the three rectifier bridges.

If you know you’re not going to be tweaking the Model 3 and you have no fears regarding soldering chips, I’d suggest that you leave out these sockets. Their main purpose is to allow the power supply voltages of the finished DAC to be checked without the chips inserted. These sockets
introduce extra contact resistance and, due to their height, increase the area of any current loops which might resonate and radiate at RF frequencies (see Guido Tent's article on RF layout techniques in a past Supplement, or Audio Crafter's Guild at www.galstar.com/~mtracry/AUCGI). To tweak or not to tweak will also dictate how you approach the rectifier bridges. No substitutions planned! Mount these parts flush with the PCB. On the other hand, if you feel the call to modify, give them 4mm-5mm clearance so they can be snipped off later.

Up next were more diodes in discrete form, a slew of 100nF Wima polyester caps doing duty as bypass caps on the numerous electrolytics, some tiny ceramics, and finally a sprinkling of tantalums.

MANUAL LABOUR...

While the bulk of the caps went onto the board without a fight, the markings for a couple of the tantal's hadn't been printed on the board, and it took some brief track-tracing to confirm the correct polarity. The 220uF electrolytics were also spec'd in the manual as 50volters. In fact, they turned out to be rated at 25volts, and had a smaller lead pitch than their solder pads. None of the above proved a problem, but it did detract from the otherwise slick, professional feel of the kit.

Once the ten regulator ICs had been placed, along with remaining sundries like the FETs in the discrete output stages, it was time to mate board to chassis. Or at least that was the theory. There were a pair of very unfilled markings on the PCB with C101 and C102 inscribed therein. In the parts list, these were described as 2n2 1kV polypropylene. Mine were 1n3s. To top it off, nowhere in the assembly instructions did these caps even get a look in. Another e-mail left swiftly for Italy, and the reply confirmed these blue box caps should be soldered in with everything else.

After sorting that puzzle, I scraped away the paint around each of the four board-mounting holes on the chassis, and slipped the eye of the earth lead's tab to the chassis. I found this made life easier. The XLR socket comes with two countersunk holes to allow it to be fixed to the chassis, but in this instance, it is secured with its lower lip trapped between the rear of the chassis and the PCB. This sort of no-bolt fixing doesn't generally bode well for long-term reliability, as the solder connections take a pounding every time an interconnect is plugged or unplugged. I would prefer to have seen the XLR properly fastened to the chassis. The next minor but annoying hiccup involved the fascia's LEDs. They were all there, but the bi-colour one which indicates signal lock was supposed to have a kinked lead, which would tell me the correct pads to solder to. However, the three wires sticking out of mine were all straight as arrows. Seeing as the worst that could go wrong would be green instead of red showing no-lock, I just flipped a coin and soldered...

...AND MORE MANUAL LABOUR

So far, it was definitely a case of Kie: I, Manual 0. I girded my loins for a final assault where my trusty iron would finish off the connections to the mains transformers. This boiled down to series-wiring the two dinky donuts to the rocker switch on the back panel, and then linking this (and the earth lead) to the RF filter built into the IEC socket. Piece of cake (even if the diagram shows the blades of the switch at a confusing angle).

At this point, I heaved a sigh of relief and vowed to burn the manual once the Model 3 was working properly. However, during one last run over the board before firing it up and checking some voltages, I noticed the empty spaces where the four Tranzorbs (transient absorbers) were supposed to be. Hmmm, I was gearing up to offer the author of these instructions a hearty breakfast, a last cigarette and a blindfold. I soldered the Tranzorbs in and managed to stop myself mercilessly shredding the manual as soon as I'd finished. Instead, I carried out the requisite PSU checks, confirmed all was OK (apart from two transformers which seemed to be duetting in Hertz's most famous work, the 50th), and plugged the remaining ICs into their sockets. Another flick of the mains switch and although I was half expecting a big BANG, surprisingly there were no fireworks, just music. Success was mine.

The sole fine tuning was to persuade the Lock LED to glow green, and the appropriate frequency indicator to light up, by adjusting the potentiometer in the crystal circuit as a CD is spinning in the matching transport. This is as simple as it sounds, and I soon had the output of a modified Pioneer DV-505 flowing through the Model 3.

Now it was time to screw the lid in place, enjoy a well-deserved cup of tea, and admire the end-product of all that placing and soldering.

SQUARE ONE

Without any burn-in time under its binary belt, the Model 3 sounded as you might expect — clearer, more detailed and more realistic than the DV-505's on-board conv-

The main PCB unpopulated except for three SMD packages, input receiver and D/A converters

The XLR socket comes with two dinky donuts to the rocker switch on the back panel, and then linking this (and the earth lead) to the RF filter built into the IEC socket. Piece of cake (even if the diagram shows the blades of the switch at a confusing angle).

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Vertor, but not by much, and rather timid and constrained with it. Giuseppe had talked in terms of a 40-60 hour run-in period, so the Pioneer and partner were left to repeat for a day or two.

Over that time, the presentation acquired more body, more liquidity, and left behind less appealing traits like a mild sibilance and a plodding way with rhythms.

As the sound filled out, the North Star's pedigree became increasingly evident on CDs such as the compilation, Bob
Marley And The Wailers – The Early Years.

One of the most noticeable improvements was the clarity with which some of Mr. Marley's more mumbled lyrics came through the bucket-bottom recording quality of many of the tracks. Then there was the swelling power to his voice which lent it real substance, and the lucidity of the soundstaging which meant backing vocals and instruments were far more easily picked out than on the '90s.

THE GOLDEN MEAN

As the days went past, the North Star proved it was perfectly capable of striking that fine balance which exists between out-and-out transparency, detail retrieval and crisp dynamics on the one hand, and natural tonal colour, musicality and cohesion on the other. A lot of hi-fi struggles to find a workable solution to this problem, and tends to fall into one of two camps – 'fast' (used pejoratively to describe light bass and plenty of treble), hard and overtly detailed - or soft, rolled off in the treble and not very revealing.

One disc which will swiftly show if any given piece of equipment is a 'camper' is Alanis Morissette's Jagged Little Pill. Played through brighter equipment, this album can take the top of your head off, all of its plentiful rough edges exaggerated. Too much of the softly-softly approach fails just as miserably, the songs lacking the required impact and venom as their vital raw energy has been sapped. Get it just right though, and you'll have a smile on your face from track one through to the acapella tacked on after track 13. Here, Ms Morissette's vocals were incisive and suffered from no shortage of bite, but since the Model 3 wasn't adding any extra sibilance of its own, they never overstepped the line. The same went for 'You Oughta Know', where cymbals and vocals were powerful but controlled above the taut, propulsive bassline.

Koto Music Of Japan is probably not a disc monopolising transport drawers across the land, but it has a sense of atmosphere that only the better-engineered digital gear can capture. Play this disc through mediocre machinery, and the lack of musical expression and involvement will leave the other-worldly vocals and extremely sparse arrangements sounding like random clips from the cutting room of Name That Tune. There was no such shortfall in the North Star's rendition, the plucked koto strings, shakuhachi flute and bizarre singing dovetailing neatly into a spell-binding performance.

Such a stalwart it's graduated at the school of Lift Music, Vivaldi's Four Seasons nonetheless enjoyed a freshness and vivacity which made for a truly engrossing listening session. The Model 3 accurately and securely placed the various sections of The English Concert within a soundstage where fine width and depth were joined by a decent sense of height, not a forte for most converters. The tonal balance was equally satisfying, with none of the smearing which blends instruments together into an amorphous lump of noise.

UP THE REVOLUTION

With a 24/96 disc (Red Rodney's 1957 jazz album on Classic Records) whirring inside the DV-505 at high speed, the Model 3 reacted in a very predictable manner. Basically, there were all the fundamental qualities it had shown with 44kHz recordings, but now much more obvious thanks to the higher resolution format. Transparency, detail, dynamic range and impact all benefitted massively, which only served to heighten the musical enjoyment the North Star conveyed in the conversion process.

ELECTRONIC ESCALATOR

Of course, gifted DAC that the Model 3 is, no self-respecting Difter is likely to be able to resist the urge to tweak for long. As a starter in the right direction, North Star publish a number of suggestions for component upgrades (caps, resistors and a third PSU transformer). They have also noted the effect different mains cables can have on the sound (which is why none is supplied with the kit).

In addition to the substitutions published on the website, there's a couple of others well worth sampling. The I 100 is a very major upgrade over any normal discrete rectifier diode, and a rating of 1.1A at 100V means it can be used in a wide range of equipment. Then there are the regulators. The next step up from the standard types would be Linear Technology's versions with their higher spec. If you wanted to go all the way, there are bespoke devices from Audiocom, Acoustic Precision, etc. These two also provide a range of clocks, as do Dutch firm LC Audio and Trichord Research (the Model 3's crystal runs at 6.144MHz). Finally, there's Noise Blocker visco-elastic spray from Rockford-Fosgate, available through car audio shops for about £23 for a 600ml can. Simply spray on one or two fine coats and listen as it cures over a fortnight. The improvements are not subtle!

QUE BELLA!

Viewed as a kit, the Model 3 gets marked down for poor instructions, which really should be considerably better. Viewed as a completed DAC, the Model 3 is very good value for money. Instead of the uninspiring and frequently uninvolving sounds emitted by too much digital equipment, the Model 3 does a real 'heart and soul' job of music-making. It scores convincingly in all the 'technical' areas – imaging, sound staging, detail, etc - and then tops off this attractive package with a genuine ability to coax the full emotional content from a recording.

North Star Design Model 3

300 Euros + VAT

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The circuit is similar to that of the ever popular KEL84 with a few changes to incorporate the Tesla, Un balanced KEL84 power triode. This is a pure Class A push pull design providing 36 watts into an 8ohm load. Gary Devon has come up with a gem of an output transformer (E/I). Combined with the KEL84 it offers a virtually unattainable result for a valve amplifier. Frequency response measured 11Hz to 75kHz, separation 71dB, 60Watt, sensitivity 40mV and distortion 0.03%*. As valve amplifiers go, the KEL80 is one of the best measured performances I have ever come across, says Noel Kennedy. Jon Marks says, “The KEL80 is putting all of the superlatives of surprisingly fast, meaty basslines out of its trick bag when dealing with Suzanne Vega's Nine Objects Of Desire album. As if this wasn't enough, the mid and treble were nice too - cymbals had a deliciously natural, golden shimmer without sounding soft, and vocals were extremely transparent and crispily defined. The KEL80 is a perfect partner when it comes to exploiting the virtues of its four output valves on numbers such as 'Leaves' and 'Suspect Sustain' from Cirrus' Land's End Jazz CD. The KEL80 will highlight all the intracacies and depth of detail in your favourite recordings whilst retaining a warm and fullness. This combination of both detail and warmth is almost the exclusivity of pure valve amplifiers and rare at this price point.”

The Keli weighs in at 10kg. External dimensions with valves are 300mm(w) x 270mm(d) x 150mm(h).

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KIT88 VALVE INTEGRATED AMPLIFIER KIT & KAT88 VALVE POWER AMPLIFIER KIT

Here is the amazing KIT88. The circuit is similar to that of the ever popular KEL84 with a few changes to incorporate the Tesla, Un balanced KEL84 power triode. This is a pure Class A push pull design providing 36 watts into an 8ohm load. Gary Devon has come up with a gem of an output transformer (E/I). Combined with the KEL84 it offers a virtually unattainable result for a valve amplifier. Frequency response measured 11Hz to 75kHz, separation 71dB, 60Watt, sensitivity 40mV and distortion 0.03%*. As valve amplifiers go, the KEL80 is one of the best measured performances I have ever come across, says Noel Kennedy. Jon Marks says, “The KEL80 is putting all of the superlatives of surprisingly fast, meaty basslines out of its trick bag when dealing with Suzanne Vega's Nine Objects Of Desire album. As if this wasn't enough, the mid and treble were nice too - cymbals had a deliciously natural, golden shimmer without sounding soft, and vocals were extremely transparent and crispily defined. The KEL80 is a perfect partner when it comes to exploiting the virtues of its four output valves on numbers such as 'Leaves' and 'Suspect Sustain' from Cirrus' Land's End Jazz CD. The KEL80 will highlight all the intracacies and depth of detail in your favourite recordings whilst retaining a warm and fullness. This combination of both detail and warmth is almost the exclusivity of pure valve amplifiers and rare at this price point.”

The Keli weighs in at 10kg. External dimensions with valves are 300mm(w) x 270mm(d) x 150mm(h).

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$£75.00

KEL80 MONOBLOC AMPLIFIER KIT

Following the success of our budget KEL34 40watt kit amplifier, we have come up with a ‘bigger brother’ design. The output stage utilises two pairs of TESLA EL34 in parallel-push-pull mode, allowing KEL80 to turn in 80 watts into an 8 ohm load. Heading up the input stage we have the wonderful circular Tesla 6AU6 working into an American 5687 phase-splitter. KEL80's output stage employs the Tesla type. Feedback is adjusted to suit the end bargain." Weight 16kg. external dimensions with valves: 14cm(w) x 8cm(h) x 43.5cm(d). Musicality as well as power, at 590.00 GBP a pair, a definite valve winner. Each monobloc weighs 12kgs., external dimensions with valves: 18cm(w) x 8cm(h) x 43.5cm(d).

$£175

HD83 VALVE HEADPHONE AMPLIFIER KIT

The HD83 is our new headphone amplifier, a beautifully simple design using Mullard ECL83 valves, and can be used at home or power outlets housed in the same envelope. It works directly from any source, be it CD, tape, tuner etc. or from an amplifier's tape or pre-out sockets. The circuit utilises high specification output E1 input transformers that will drive any headphone load from 16 ohms to over 300 ohms depending on how the secondaries are wired up. The HD83 is a single-ended design with the power pentode wired up in triode configuration for that added purity and is a quiet as a mouse. For sound quality, Jon Marks says: "The bass is punchy and controlled without becoming analytical while treble has the crispness of the best solid state, with the total purity, delicacy and speed associated with valves. External dimensions 180(w) x 300(h) x 80mm weight 4kg.

$£20.00

mains transformers & chokes

KEL84 mains transformer 120mm dia x 60mm high

KEL80 mains transformer 120mm dia x 40mm high

KIT88/KAT88 mains transformer 120mm dia x 60mm high

parts directory
KIT34 VALVE INTEGRATED AMPLIFIER

The Kit34 is a 32 watt stereo valve integrated amplifier. Featuring a pair of EL34s, in push-pull mode, per channel, with an ECF80 pentode stage as a class A input stage. The power supply is valve rectified (2 x 5U4) incorporating a heavy duty choke to achieve exceptional smoothing. The output transformers are 14 x Ultra Linear tapped to keep distortion down to its lowest level and the kit is totally hard wired utilizing 3 tag boards. It offers 5 line level inputs, plus, a tape in and tape out, all controllable from the front. As you can see the Kit34 looks amazing, a true classic in the making. Simon Pope says, IThe Kit34 carries on a true valve signature, it has everything you could ever want and more from a tube amp, a absolute winner.

Weight: 22lb. External dimensions with valves fitted - 390mm(w) x 360mm(d) x 210mm(h)

£495

KLS10 HIGH TECHNOLOGY COMPACT MONITOR

Our new-model uses an Audax carbon fibre bass/midrange unit, married to the world's most advanced tweeter, the piezo-electric gold dome tweeter. Giving it the sweetest and most extended treble. Innovative oval gold dome piezo electric tweeter. KLS3 Gold uses the latest version of Audax's THREE WAY LOUDSPEAKER

For all KLS10 Gold customers. Sensitivity 89dB.

£949.50

KLS9 TVTWO WAY FLOORSTANDER

Here's a storm for you - KLS9, with its BB4 alignment bass cabinet and Audax High Definition Aerogel ten bass/midrange unit. Designed by Noel Keywood to possess optimal bass damping and a clean step response. Aided by a teensy bit of bass mix, KLS9 really thunders; it will re-arrange your furniture. But it does not waffle, falling silent when there's no bass in the music. Aided by a teensy bit of high power 1 in fabric dome tweeter. KLS9 is balanced, neutral and clear reproduction, and a powerful 8in. bass driver for superb depth. This is married to a 4in. carbon fibre cone midrange and the kit is totally hard wired utilizing 3 tag boards.

Weight: 22lb. External dimensions - 800mm(w) x 600mm(d) x 600mm(h)

£149.50

KLS10 GOLD SUBWOOFER

Designed to complement KLS10 Gold stand mounters by providing a deep and open bass. The subwoofer is inexpensive, easy to build, comprising a simple crossover network to a high quality 8 inch Aerogel dual voice coil unit. A must for all KLS10 Gold customers. Sensitivity 89dB.

£160.00

KLS3 Gold Mk II

ADVANCED TECHNOLOGY THREE WAY LOUDSPEAKER

KLS3 Gold uses the latest version of Audax's innovative oval gold dome piezo electric tweeter, giving it the sweetest and most extended treble. Married to a 4in. carbon fibre cone midrange driver for neutral and clear reproduction, and a powerful 8in. bass driver for superb depth, this is our top-of-the-line reference speaker. Sensitivity detailed, evenly balanced and images superbly. It is an easy 120ohm load and is 88dB sensitive. For amps up to 60W. Easy to build and great for beginners. Internal volume 70ltrs, 18m MDF external dimensions 25cm(w) x 93cm(h) x 40cm(d).

Drive units & crossover kit £230.00

Drive unit pack £160.00

KLS9 TWO WAY FLOORSTANDER

DRIVE UNIT & CROSSOVER KIT £149.95

Drive unit only £71.00

KLS10 HIGH TECHNOLOGY COMPACT MONITOR

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Drive units & crossover kit £230.00

Drive unit pack £160.00

KLS9 TWO WAY FLOORSTANDER

DRIVE UNIT & CROSSOVER KIT £149.95

Drive unit only £71.00
These are expert kits, not for the inexperienced. You must be able to solder and make a circuit diagram. The wife kits contain lethal yob.

**Amplifier Kits Description**

- **Kit34 Valve Integrated Amplifier Kit (with valves)**
- **Kit34 Valve Integrated Amplifier Kit (without valves)**
- **Ke184 Valve Integrated Amplifier Kit (without valves)**
- **Ke184 Valve Integrated Amplifier Kit (with valves)**
- **PSU - II mains transformer**
- **Pre - II - phono stage module (with valves)**
- **Moving Coil upper transformers**
- **Kit88 Valve Integrated Amplifier Kit (with valves)**
- **Kit88 Valve Integrated Amplifier Kit (without valves)**
- **PSU - choke**
- **HD83 Valve Headphone amplifier kit (with valves)**
- **Jen - 0.47uF**
- **Tag Board 2 x 16 connections (hard wiring)**
- **300B - 0/p T (pair)**
- **PSU - choke**
- **HD83 - PCB**
- **Ke184 PCB**
- **Ke184 Printed Circuit Board**
- **HD83 Printed Circuit Board**
- **PSU - II Printed Circuit Board**
- **Pre - II Printed Circuit Board**
- **PHONO - II Printed Circuit Board**
- **Tap board 2 x 16 connections (hard wiring)**
- **Alps blue audio grade 50k dual log potentiometer**
- **Alps blue audio grade 100k dual log potentiometer**
- **L482 22.5uF 440Vdc polypropylene capacitors**
- **Ansr42.25uF 630Vdc polypropylene capacitors**
- **Jensen 0.47uF 630Vdc paper in oil capacitor**
- **Black Gate 220uF 50Vdc electrolytic**
- **Black Gate 4700uF 16Vdc electrolytic**
- **K8510Chassis**
- **K5881 Chassis**
- **650V safety gloves (a pair)**

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**NAME:**

**ADDRESS:**

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**COUNTRY:**

**TEL. (DAY):**

**METHODS OF PAYMENT:**

- International money order in Sterling
- Mastercard or Visa

**ORDER NO.**

**QTY**

**UK**

**OVERSEAS**

**AMPS & PCB**

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Neville Roberts shows us how to build a quality attenuator and even offers formulas on a special website. Mick Tracey has an overheating 5881 and wonders why - Dr John to the rescue!

ATTENUATED
Following the recent successful upgrades to various resistors and capacitors in my WAD K5881 Mk II power amp and WAD Series II Modular Pre-Amp, I decided to turn my attention to the volume control. Although there is a quality Alps Blue supplied with the Series II kit, a friend of mine achieved significant improvement by replacing the Alps Blue in his KLPPI pre-amp with a stepped attenuator.

The first step along the track was to locate a supplier of a suitable switch. I found one UK based supplier who could provide a 23-way, 2 pole, make-before-break (or 'shorting') rotary wafer switch with end stop for just over £55. This constitutes the bulk of the cost, as decent quality metal film resistors cost 7p + VAT from Maplin, so the cost of the finished unit will still be less than half the cost of a commercial product.

The next stage was to calculate the value of the resistors for each step. In Mr. White’s original article, he stated that the attenuation for a given pair of resistors comprising the potential divider (above) could be calculated from:

\[ A = -20 \log \left( \frac{R_y}{R_x + R_y} \right) \]

where \( R_x + R_y \) is the total value of the equivalent potentiometer, \( R_y \) is the sum of all the resistors in the chain to give the attenuation at a given point and \( R_x \) is the remainder of the resistor chain. What we actually want to calculate is the value of each individual resistor in the chain to give us the range of attenuations required. Rearranging the above equation, we get:

\[ R_y = A.R_t \quad (R_t = R_x + R_y) \]

where \( R_t \) is the total value of the attenuator (\( R_x + R_y \)) and \( A \) is the attenuation, shown simply as a ratio for clarity. Where \( A \) is in dB it must be divided by 20 and the anti-log found.

For the Series II pre-amp, a total value \( R_t \) of 100kohms is required. You, of course, may require a different value to suit your amplifier.

I decided that it would be worth writing a simple program in Javascript to allow the calculation of each resistor for a given value of \( R_t \) and required attenuation at each step. It can be found on my Web site at http://homepages.tcp.co.uk/~nroberts/atten.html.

To use the program, change the ‘total value of attenuator’, ‘number of steps’ and ‘attenuation required for each step’ to the required values, then click the ‘Calculate Resistor Values’ button. The program suggests some default values for a 24-step, 100kW attenuator. Obviously, you will have to select the nearest ‘preferred value’ for each step. The exact value is not critical, but if you wish to see the exact attenuation you will get for a given \( R_y \), there is another calculation area at the bottom of the screen that does this.

Here is a table showing the values I calculated for my 23-way switch:

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<th>Resistor</th>
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<td>2</td>
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For my 23-way switch, I calculated the approximate attenuation and resistor values shown in the following table:

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<td>1K6</td>
</tr>
<tr>
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<td>23</td>
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</tr>
<tr>
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</tr>
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<td>16K</td>
</tr>
<tr>
<td>23</td>
<td>0</td>
<td>20K</td>
</tr>
</tbody>
</table>

Total value: 99.2kohms

How the rotary attenuator is wired. Position 23 offers full volume (no attenuation), whilst Position 1 goes to ground to give no signal transfer. Position 2 gives a low -75dB signal. We do not show all 23 positions here.
I had to drill a hole in the front panel to accommodate the locating pin to the side of the spindle as this was in a different position from that in the Alps Blue. It is easier to make such mechanical changes before wiring up the resistors.

Wiring up the switch (Figure 2), make sure you have the following available before starting:

- Two sets of all the resistors (one for each channel) appropriately labelled and laid out in order (those coloured bands start to look all the same after a while);
- Soldering iron, cutters and pliers;

Remember that the switch is, in all probability, somewhat larger that the potentiometer it is replacing so it is worth getting the resistors to lie as flat as possible.

I wired up a temporary unit with the attenuator feeding into the existing volume control via one of the inputs. I was then able to switch between the attenuator and the volume control by turning the attenuator to maximum and using the volume control, and vice versa. This was worthwhile as I discovered the first step was too loud for a minimum setting. I originally used 60dB attenuation, but it wasn’t enough. My loudspeakers (Chris Rogers’ PRO-TL transmission lines) are not very sensitive so the effect would have been worse with more sensitive speakers.

I decided on 75dB and returned to my program to recalculate all the other resistor values for a new range of attenuations shown in the above table. This necessitated replacement of about half of the resistors. My solder-sucker came in very handy at this point! All that remained was to install the attenuator permanently in the amplifier.

Was it worth it? Well, yes, definitely. The sound was noticeably more detailed and the sound sources more accurately placed between (and indeed, behind) the speakers. If anything, the sound was slightly brighter than with the Alps Blue. This was not surprising as metal film resistors typically have a bright sound. There was certainly greater clarity to the sound with individual instruments within an orchestra being more clearly identifiable.

Finally, it is worth mentioning that, apart from saving money and the satisfaction of having built an attenuator yourself, another advantage of the do-it-yourself approach is that it allows for experimentation. Not only can you change the attenuation of any step to suit personal preferences, but also use different qualities of resistors in the chain, although I haven’t experimented with that yet.

Maybe I can add a list of Shinkoh resistors to my next year’s Christmas present list!

A 23-way, 2 pole, shorting switch (part number OPZ51201-2) can be obtained from:

Blore Edwards Limited, Pontcynon Trading Estate, Abercynon, Mid Glamorgan, South Wales. CF45 4EP
Tel: 01443 742202

Neville Roberts
Metal resistors do give a bright sound. Cheap ones can sound nasty, so care is needed here. Vishays are well known as a good choice, but are expensive. Carbon film resistors give a neutral sound and represent an alternative.

With a two-pole, multi-way switch it is possible to switch between twin-resistor attenuator pads, rather than down a long chain of resistors. It uses more resistors, but there are just two in the signal path, instead of twenty two. NK

HOT 5881
I have a problem with an over-heating resistor (R17) on the LH channel only of my K5881 MkII. I have checked and re-checked the wiring to both board and valves and this looks ok. I have changed the offending resistor and C3 and C7 and also swapped output transistors to see if the fault changes channel, however the fault stays with the resistor. HT voltages measured correctly 460V.

I am at the point of changing all components on the board to

of this amp but looking at the circuit diagram would tend to make me think you possibly have a faulty 5881 valve, as there is nothing after this resistor that would draw sufficient current to cause R17 to overheat except the G2 grids of the 5881s. I suggest you measure the voltages around the 5881, especially the G2 (pin4) volts approx 420V, the G1 (pin5) volts approx 0V and the cathode (pin8) volts approx 34V, which should be within +/-10% of the norm.

It is also possible that you have a leaky/shorted capacitor C6/7 which will show up as positive volts on the 5881 G1 (pin5), and another option is a shorted/leaky cathode bypass capacitor C6/7 which will show up as low volts on the cathodes.

Regards, Dr John
An very high rated F60 10uF capacitor may be desirable.

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