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No. 10 OCTOBER 1994

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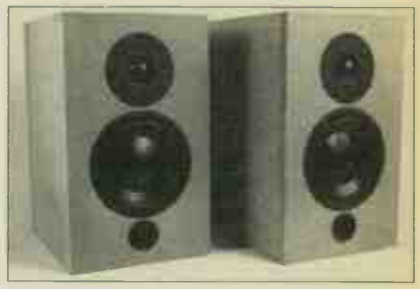

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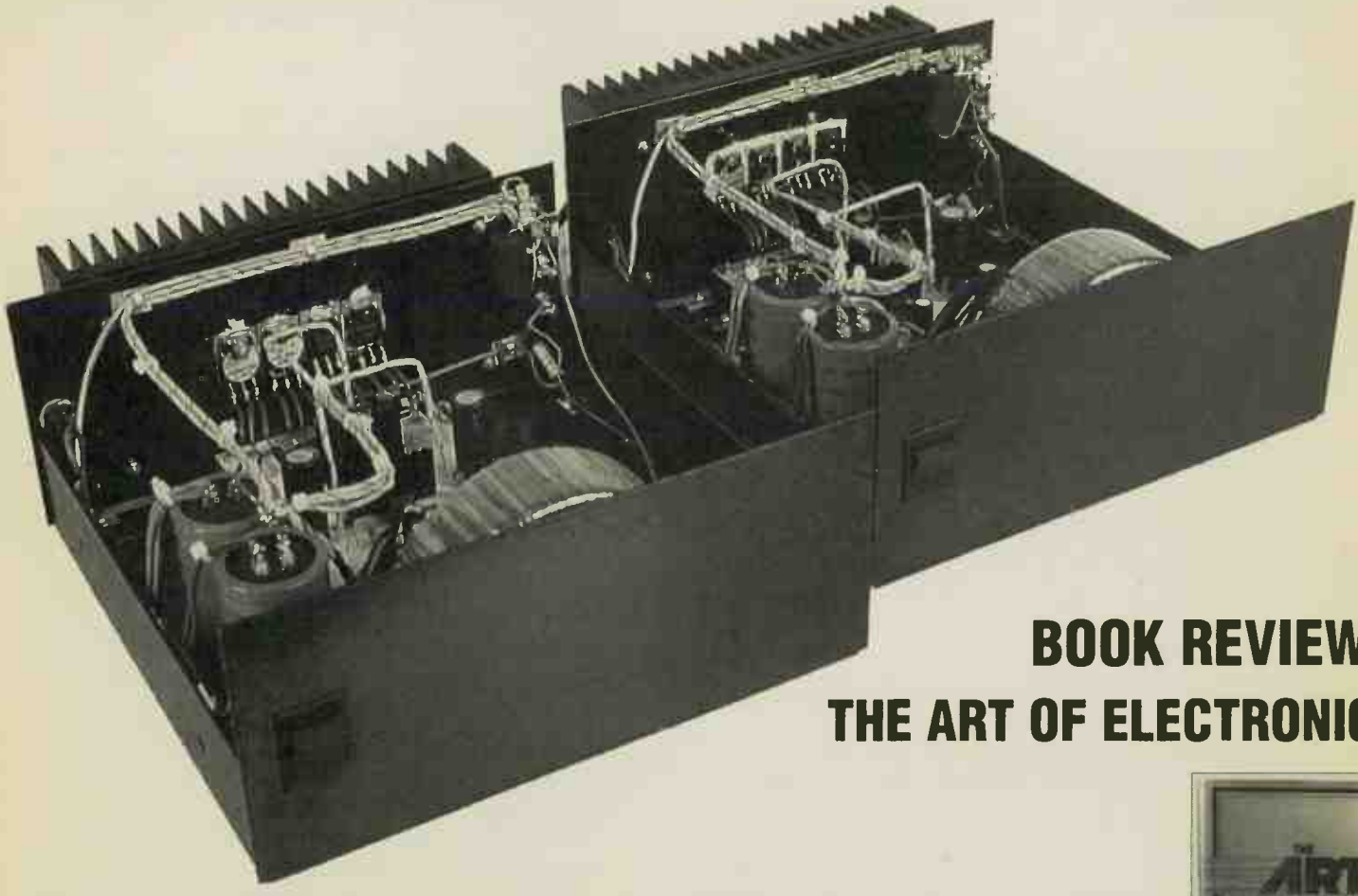

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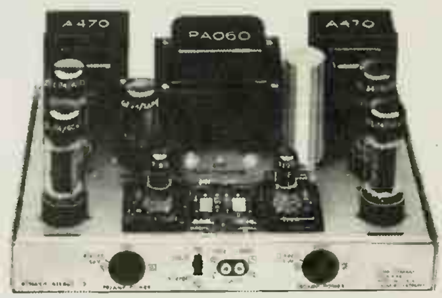
VINTAGE VALVE

DYNACO STEREO-70



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World Radio History

D.I.Y. Supplement

Contents

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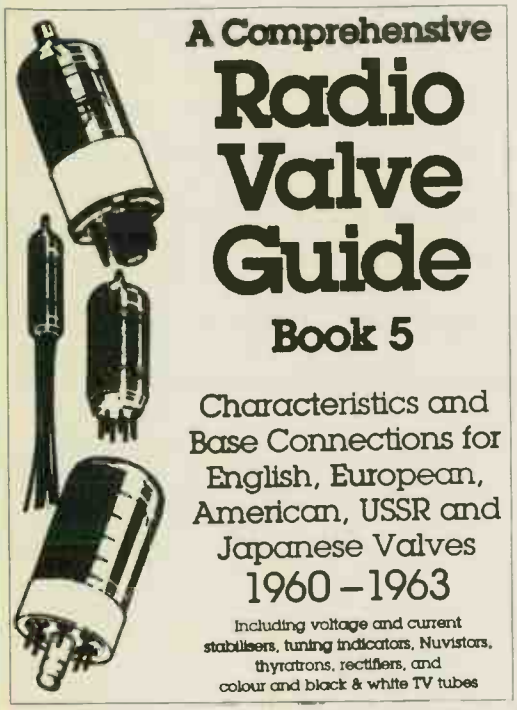
KIT *NEWS*



RADIO VALVE GUIDES REPRINTED

The original Bernards Radio Valve Guides (Bernards later became Bernard Babani publishers Ltd) published in the 1950s and '60s are now being reprinted by G. C. Arnold Partners. There are five Radio Valve Guides spanning from 1934 to 1963, with the majority of valves produced during this period listed complete with working voltages and base connections.

The Radio Valve Guides are available for £2.95 each including p&p in the UK (£3.25 overseas) and the whole set of five for £14.00 (£15.50 overseas). There is also an Equivalents Book reprinted from the 1974 third edition of the Handbook of Radio, TV, Industrial & Transmitting Tube and Valve Equivalents, again originally produced by Babani Press.

G. C. Arnold Partners
9 Wetherby Close,
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BH18 8JB
Tel: 0202 658474

VALVES RETURN

The latest RS Components trade catalogue (or Electromail for the public) sees a return to valves: RS now stock a small range of tubes from National. In their new products guide there is an article devoted to how valves are seen as the enthusiast's dream come true, and much is said of their ability to generate a warm, smooth sound.

The tubes which they will be stocking are ECC81, 82 and 83 double triodes and the EF86 pentode which are all low signal input valves and EL84, 34 and 6L6GC output pentodes and KT88 output tetrode.

Electromail
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Tel: 0536 204555

KIT DAC FROM AUDIO TECHNOLOGY

A new kit DAC, the Sorcerer, featuring Burr Brown convertor chips has just been launched by Audio Technology. The Sorcerer uses 20bit colinear DACs and audiophile components throughout. It can also be sync-locked to compatible Arcam transports.

The kit includes all the components necessary to complete a high quality CD convertor, including neat custom casework and 'computer grade' circuit boards. The Sorcerer is built on two separate boards, one which receives and decodes the digital signal, and one which carries out the digital to analogue conversion and filtering. This enables either board to be upgraded as technology advances.

The Sorcerer is available in kit form for £595 + VAT, and fully built and tested with a two year guarantee for £895 + VAT. An AT&T input is available as an option for £69 + VAT.

Audio Technology Ltd,
PO Box 147,
Bedford.
MK41 8PR
Tel: 0585 225693

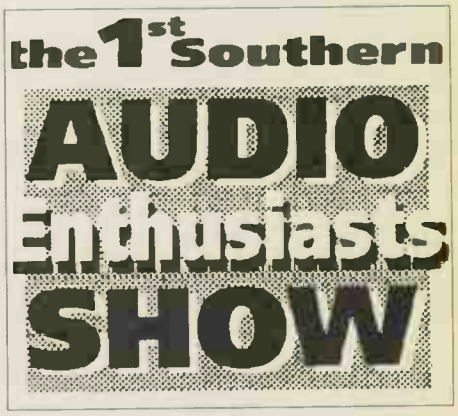
AUDIOPHILE COMPONENTS SALE

AP Electronics are currently holding their annual stock-taking sale, where audiophile components are offered at discount prices. For example, Holco precision resistors are half price, audiophile capacitors are reduced, there are cable bargains, professionally finished amplifier front panels, switches, connectors, transistors etc.

AP Electronics have also just started a new hotline for constructors, available between 9-10am. The service is available all week, but on the odd occasion when there is nobody to answer queries, there will be an answering service for messages.

A component list for our Class A headphone amplifier featured in the August '94 DIY Supplement is also available from AP Electronics. There are two component packs available: standard £7, upgraded £36. There are also component packs and circuit boards for a suitable power supply.

AP Electronics
Unit 15,
Derwent Business Centre,
Clarke Street,
Derby. DE1 2BU
Tel: 0332 674929



SOUTHERN AUDIO ENTHUSIASTS SHOW

The first ever Southern Audio Enthusiasts Show is to be held over the weekend of 29/30th October. The show is open from 10am-6pm on Saturday and from 10.30am-4pm on Sunday.

The show is aimed at the true enthusiast seeking to upgrade, improve or construct their own hi-fi system. It is mainly for smaller specialist manufacturers, as indicated by the current list of exhibitors: RATA, Bandor, IPL, Audio Synthesis, Loricraft etc.

The show will take place at the Master Robert Hotel, Great West Rd, Hounslow, Middlesex, situated on the A4 and close to two London Underground stations. Parking for visitors to the show is free.

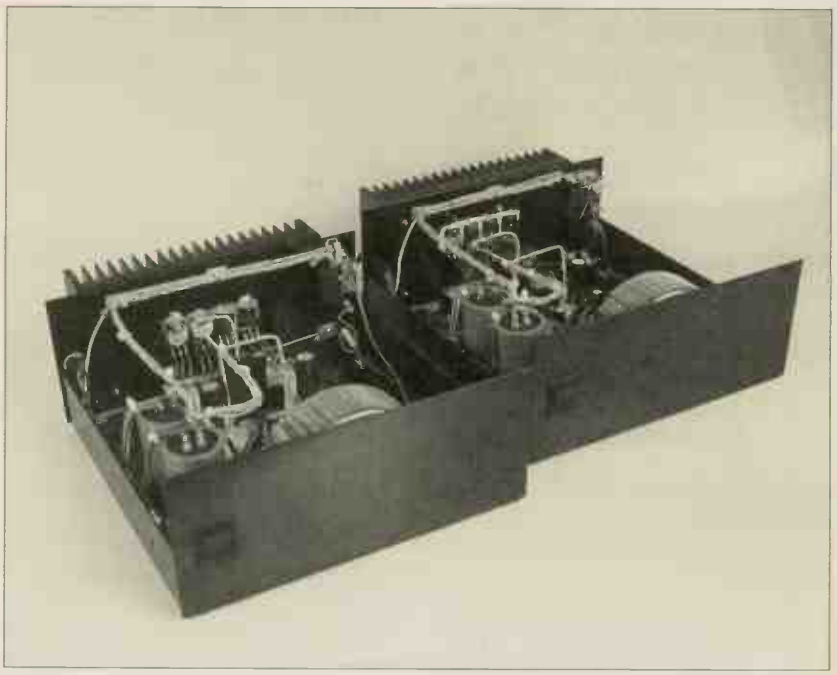
For further information contact either Geoff Mead or Brian Stenning at:

4 Plough Farm Close,
Bury Street,
Ruislip, HA4 7GH
Tel: 081 748 7489/0895 637846

World Radio History

CLASS A SOLID STATE AMPLIFIER

Hi-Fi World develops a super high quality 36W Class A solid-state power amplifier. Andy Groves does the designing, drilling and soldering. He also describes circuit operation and tweaks. Noel Keywood looks on in wonder and describes the thinking behind the project.



Sacrilege! As arch valve heads, with a host of valve amplifier designs already published and available in kit form, going solid-state could seemingly question our beliefs. Yet perhaps the rigours of valve amp design could be made to bring benefits to solid-state, hopefully yielding a better amplifier. What we did know was that all the industry standard practices we dislike, especially the use of cheap silicon chips, unsatisfactory components and excessive feedback to conceal inadequate basic design, had to be avoided. Given all this, perhaps we could get better results from solid-state and justify our sacrilege. On the basis that you don't know until you've tried, we decided to try.

Another point of concern was the safety and practicability of the amplifier designs we have published in the Supplements. A solid-state amplifier on a circuit board is easier to build and safer to test than a valve amplifier. Providing all the mains connectors are covered, something over which we take care in our kits, it is just about impossible to receive an electric shock from a solid-state amplifier. Fuse protection is then sufficient, in a good design, to protect against shorts. Contrast this to our 300B amplifier that runs at 560volts on its H.T. line, causing us to supply a pair of electrical safety gloves in our kit. This solid-state design offers the highest sound quality, but it may well be less daunting to build and test for many people.

Since our valve amplifiers run in Class A mode, which gives fine sound quality, it was inevitable that we should turn to Class A for solid-state. This forces the output devices to be mounted on a large heatsink to dissipate heat, but to every apparent drawback there's a benefit and with Class A it's become apparent to us there are many. Because a Class A amplifier is stressed to run flat out all the time it has to be designed to take it. In this respect a Class A shows clear advantages over A/B working.

High standing output current, no less than 1.6A in this design, keeps the solid state junctions at a high temperature, lessening the thermal cycling of A/B mode as music changes in intensity. We decided to let the heatsink run hot, but not scalding hot. It was dimensioned to reach thermal equilibrium at around 70degrees centigrade, the resultant size making a monoblock package most convenient.

Monoblocks also ensure there's no interaction between the channels and, being compact, they are usually more convenient to site in the home than one large power amp.

Because Class A draws high power all the time, load changes make no difference. It was a surprise, on the test bench, to switch from 8ohms to 4ohms load and see little change in output voltage and no change in distortion. This means that power output nearly doubles, going from 36watts up to 64watts, as load halves (8Ω to 4Ω) and distortion products are not modulated by this effect. Since most commercial loudspeakers have strongly varying impedance and a majority of solid-state amplifiers change their distortion pattern and output level when more current is demanded, this eliminates one potential problem.

Not that any of this guarantees anything. Valve amplifiers are load matched devices, not ideal constant voltage sources like this amplifier, yet they still sound great. But it does show that solid-state can be pushed to yield superb measured performance in Class A mode, beyond that of a majority of Class A/B designs. It gives this design the potential to do well.

Silicon chips like TL071s and NE5534s that cost 35p or so, the great love of so many British hi-fi manufacturers, measure perfectly yet have a sonic signature. Much of this is down to colouration, we believe, which certainly exists in components like

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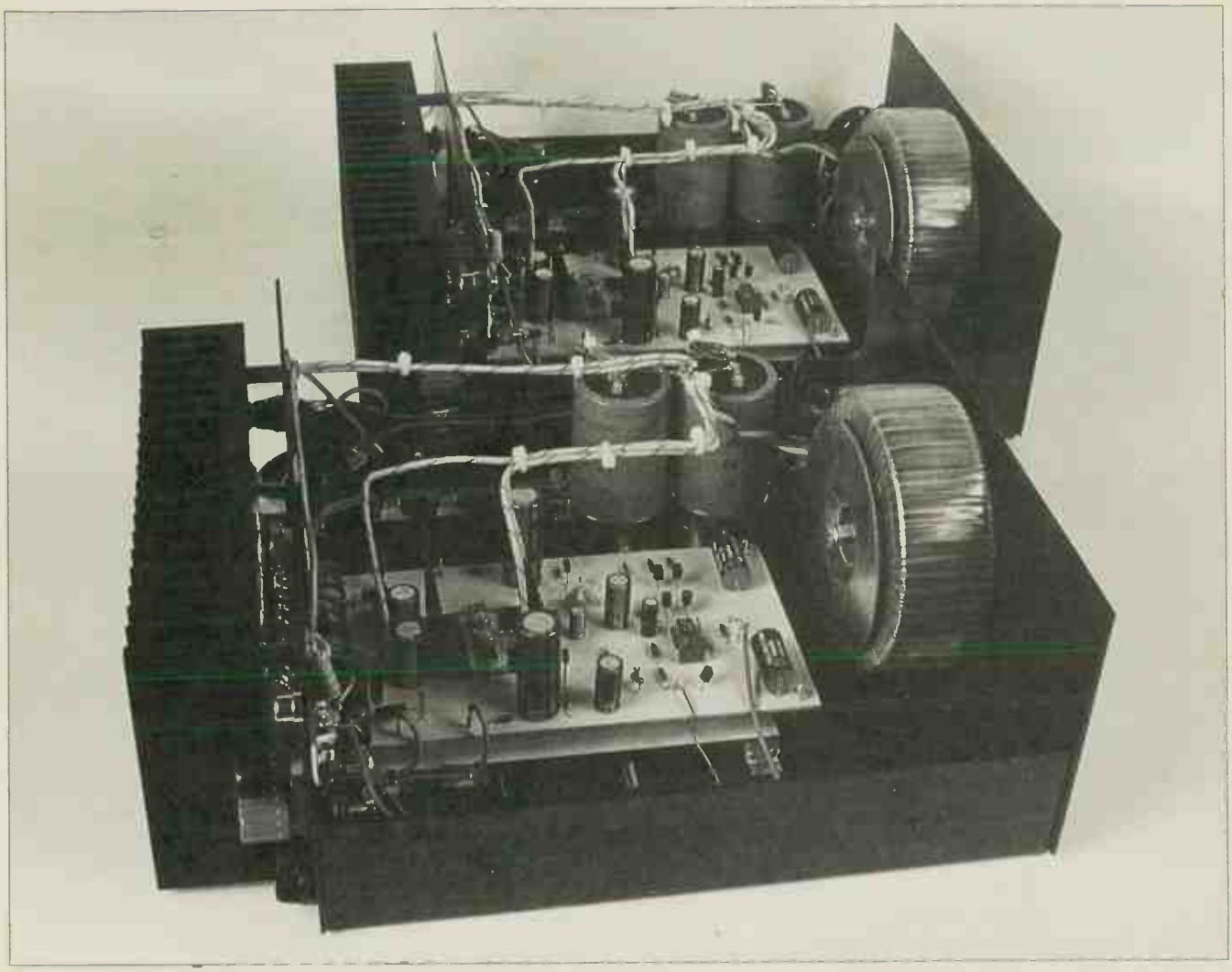

resistors and capacitors, and also exists we believe in solid state devices (and valves), which have radically different topologies and current densities to valves. To a degree this is illustrated by output transistor failure. The energy concentration at a silicon junction, when a short is applied, is so great that output transistors blow quite violently, with a flash, a sharp crack and flying remnants.

A valve can't do this, the current density just isn't great enough and the internal impedance is too high. That's why valves are so rugged; they can withstand enormous short term abuse. But the difference illustrates why, we believe, transistors - including FETs - cannot be made to sound like valves and never will. They're of radically different material composition and operating behaviour. In fact, that the FET, which so many claim is valve-like, in practice sounds little different to any other solid state device, tends to support our view, I feel.

Because of this we did not expect our solid-state amplifier, even in valve-like Class A operating mode, to sound anything like valve amps, even though we did hope that the use of quality components might alleviate some of the subjective drawbacks of solid state, such as graininess and glare. In our first assumption we were largely correct: these amplifiers sound like very good solid state designs: clear, crisp and strongly etched. Use of components of appropriate quality - audio grade components in fact - also brought the benefits expected, if not to the degree hoped for. Paper-in-oil capacitors, we found, had less impact on the sound than expected, so Solen audio grade polypropylenes were used widely. If experimenters want to use paper-in-oils, which generally give a strongly damped sound with good inter-transient silences and clear, clean treble, just remember that they are somewhat variable in their leakage performance and some will pass a significant d.c. leakage current. In certain positions this can cause problems.

With component quality a big issue, transistors included, it was inevitable that our choice of output device had to be judicious. There's little point in trying to build a super amp around cronky old transistors, as sometimes happens to keep costs down. 'Phoning around transistor manufacturers we had the good fortune to locate a new, high quality audio output transistor in development for two years and nearing release. We can supply these parts, which may not be widely available.

The circuit is relatively straightforward for an all-discrete design. In spite of this, and the absence of silicon chips, it has sufficient input sensitivity (350mV) to be used without a preamplifier. This improves the cost effectiveness enormously for home constructors, since with just a volume control in front, a pre-amplifier is unnecessary.

The circuit uses feedback and we found there was an optimum level for this particular circuit and its transistors. Regular readers will know that valves can be run without feedback, but with solid state the picture seems a little more complex. Distortion does not dominate amplifier sound quality unless it is severe. It can add unpleasant colouration, however, grittiness, greyness or even overt roughness resulting from high frequency crossover components possessing an extended harmonic structure. The importance of this to us lies in the corollary, namely that distortion suppression need not - in fact must not - become a dominant

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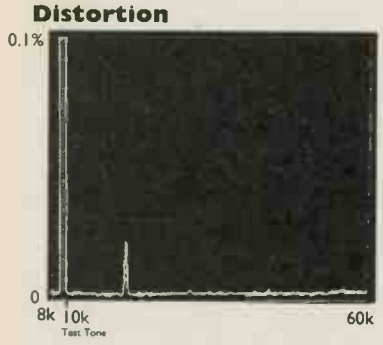
concern. It has to be kept in sensible proportion. A senseless proportion would be a zero-distortion amplifier (easy to achieve) full of cheap chips and poor components; that's very much the sort of unbalanced approach we wanted to avoid. It makes for good specs but it ain't hi-fi.

Luckily, measuring amps day in, day out and listening to them does give us some experience in this matter. We aimed to get distortion at 10kHz and 10V (12W) output down to no more than 0.1%, preferably second harmonic. In the event this was achieved quite easily, because the output devices are very linear and well matched. Operating parameters elsewhere in the amplifier proved to be of some importance in achieving low distortion.

The amplifier also had to maintain its distortion pattern into low and high loads, at all output levels to avoid distortion modulation. The ability to make high speed, contiguous distortion measurements with our 3561A Hewlett Packard spectrum analyser again proved crucial in optimising this aspect of performance. Around 30dB of a.c. feedback is applied, a very modest amount by solid-state standards, considering that this results in just 0.02% second harmonic distortion at 10kHz/10V output into 8ohms. At lower frequencies, distortion decreases until it sinks below the noise floor to become unmeasurable (i.e. less than 0.003%).

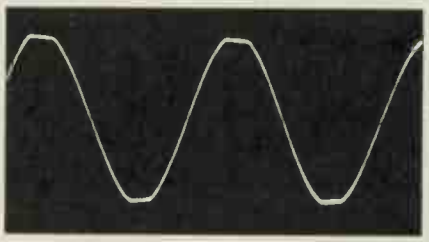


Distortion at 10V/10kHz measures 0.02% second harmonic into 8 and 4 ohms

Experienced designers will know all about the gremlins and funnies that can affect and infect solid state circuits. Transient oscillations, especially at clip (full output), switch on/off squeals, and curious instabilities or persistent oscillations lie in wait to haunt and taunt the inexperienced. Andy Groves, master of long-tailed, constant current sourced pairs, worked his way confidently through this design, carefully making sure it is bug free, totally civilised and balanced, right up with or ahead of commercial designs. There are absolutely no funnies, even under the most arduous conditions. It clips (moves into overload at full output) cleanly and symmetrically, for example. Even switch-on/off thumps are minimal; the muting circuit is a final flourish we added at the last moment; it's not essential.

One of the great delights of any DIY amplifier is that the constructor is entirely free to experiment at will. Once this amplifier is up and running, numerous important operating parameters normally fixed by a designer can be adjusted at will. This puts the constructor in the driving seat; you don't get what's given, you choose what you want. See Tweaking.

The amplifier is basically an all-direct coupled design, possessing no series capacitors in the signal path, other than an input blocker. In truth, the signal is developed across plenty of other capacitors, most of them in fact, so this rather simple model is a little misleading when it is used to suggest freedom from capacitor effects. All-direct coupled amplifiers are not free from capacitor effects. We felt justified in including an input blocking capacitor for safety, to prevent possible d.c. output from a source causing a similar output offset on the loudspeaker terminals. Since the d.c. feedback loop rolls off low frequency gain, reducing it to unity at d.c., this capacitor can be left out if desired.



Clean overload (clip) performance

I believe our sacrilege was justified. This amplifier offers a very high standard of performance in every area, especially in sound quality. Best of all, I like to think that it opens up serious DIY to all those who may feel a little doubtful or intimidated by valves. We're not touting this design as a solid-state amplifier that sounds like a valve amplifier - a specious concept - but a top quality solid-state design that offers advanced performance from a balanced, sensible, yet purist approach. Definitely a different regime from valves, all the same solid-state has a lot to offer and, these days, there's plenty of latitude for a great job to be done at home. Going solid-state is not sacrilege, but a broadening of the faith. **NK**

Continued on page 13 ...

HOW THE CIRCUIT WORKS

This amplifier has essentially three stages. The input stage is a "Long Tailed Pair" differential amplifier formed by TR1/TR2, TR3/TR4, TR5/TR6 and the FET current source CS1. There are two simple filters at the input, C1/R1 sets LF rolloff and R2/C2 limits the maximum slew rate of the incoming signal helping to prevent saturation of the input stage.

TR1/TR2 is an SSM2210P dual NPN transistor, which has both devices etched onto the same piece of silicon giving excellent thermal and parameter matching. These transistors also have a very high gain and low noise due to special manufacturing processes used in its construction. TR3 and TR4 are type 2SC2240 low noise, high gain, wide bandwidth NPN transistors and form cascode amplifiers with TR1/TR2.

ZD1 gives a reference voltage of 5.6V, thereby holding the collectors of TR1/TR2 at 5V. This protects the relatively delicate input device from the main power supply voltage and keeps the collector voltages of the TR1/TR2 transistor pair constant over an AC cycle, improving linearity and common-mode rejection.

TR5/TR6 are type 2SA970, which is the electrical complement to type 2SC2240. These transistors are arranged to form a current mirror as the load for the cascode amplifiers. This forces the current through each transistor of the pair to be accurately matched and, together with the FET current source as the tail load, ensure that this slightly more complicated long-tailed pair operates as a very precise difference amplifier maximizing the effectiveness of the global feedback.

The potentiometer R3 allows any residual DC errors, such as microscopic leakage currents through C6, to be trimmed out and gives a small amount of local feedback.

The main voltage amplifying stage is formed from TR7 and TR9/TR10. TR7, type ZTX705, is a Darlington Pair in one package with a wide bandwidth, high dissipation and high voltage. R15 provides local feedback at DC and AC. TR9, type ZTX694B and TR10, type 2SC2240, form a current source load for TR7. TR10 senses the voltage across R18 and keeps it at around 0.65V by controlling TR9's base, thereby keeping the current through TR9 constant. This current source is set to around 20mA, a larger value than would normally used, to minimize the effect of fluctuations in current drawn by the output stage over an AC cycle. This type of discrete current source allows a greater voltage swing because the limit is not reached until TR9 saturates, about 0.5V from the negative rail. Compensation components R11/C7 and C9 guard against high frequency instability and R11/C7 add further protection against overloading of

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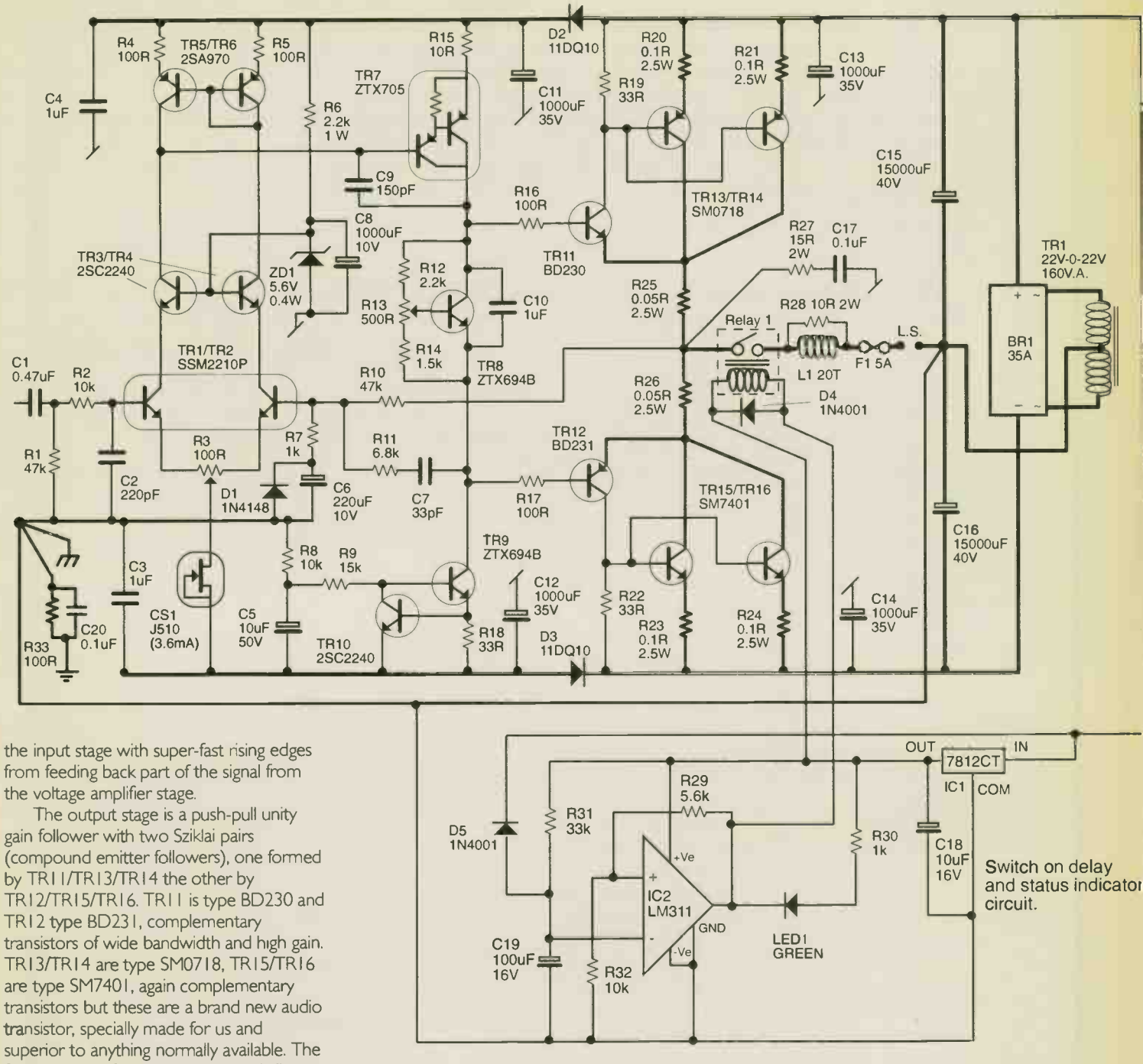
36W Solid State Class A Amplifier



Switch on delay and status indicator circuit.

the input stage with super-fast rising edges from feeding back part of the signal from the voltage amplifier stage.

The output stage is a push-pull unity gain follower with two Sziklai pairs (compound emitter followers), one formed by TR11/TR13/TR14 the other by TR12/TR15/TR16. TR11 is type BD230 and TR12 type BD231, complementary transistors of wide bandwidth and high gain. TR13/TR14 are type SM0718, TR15/TR16 are type SM7401, again complementary transistors but these are a brand new audio transistor, specially made for us and superior to anything normally available. The Sziklai pair configuration is extremely linear and has good thermal stability because there is only one base-emitter junction in the signal path.

TR11 and TR12 are run at 20mA with lower than usual collector resistors, again to keep the current through them more constant than would usually be the case. R20/R21/R23/R24 are emitter resistors for the output transistors to avoid current hogging in the output stage. C13/C14 decouple the output circuit on the circuit board, bypassing the inductance of the power supply leads.

TR8 is configured as a Vbe multiplier which provides the bias for the output stage and is mounted on the same heatsink as TR11 and TR12 to ensure thermal stability. Global feedback is taken from the junction of the bias current sensing resistors R25 and R26 and fed via R10/R7/C6 to the base of TR2.

C6 provides 100% feedback at DC to minimize any output drift and D1 protects C6 from high reverse voltages. R27/C17 form a Zobel network at the output and together with R28/L1 give extra protection into highly reactive loads. D2/D3 and C11/C12/C3/C4 decouple the low current stages from the main power supply. This is done so that if, under difficult load conditions, the main power rails droop, the voltage amplifying stage rails remain at their full voltage because the reservoir capacitors C11 and C12 cannot discharge back through the diodes. D2 and D3 are Shottky types as the forward voltage drop is only about 300mV.

To eliminate thumps at switch-on there is a simple delay circuit with a high current relay in series with the speaker. The LM311 is a comparator IC (similar to an op-amp), R29 and R33 form a potential divider, drawing a very small current through the relay coil at the comparator's output. C19 charges via R32 and after about 3 seconds the voltage on C19 just exceeds the voltage formed by the potential divider. When this happens the comparator output goes low, switching the relay on and at the same time removing the voltage from the potential divider ensuring a clean transition from off to on state. LED1 indicates the amplifier is ready. D5 discharges C19 when the amplifier is switched off. **AG**

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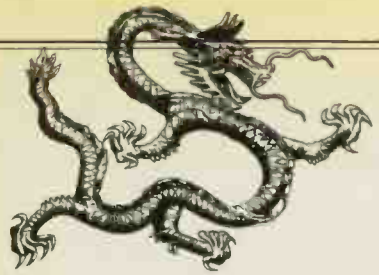

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KT66	TEONEX	6.00	6DQ6B	PHILIPS	3.50	6189W	SYLVANIA	6.50
KT88	TEONEX	£12.50	6K7G	RCA	3.50	6201	GE	6.50
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World Radio History

... Continued from page 8

SOUND QUALITY

- by Eric Braithwaite

If Class A is synonymous with classiness, then these monoblocks exude a fair amount of it. They produced a very tight, clean sound, a wee bit in the DPA style with good frontal attack and extended treble, though mercifully without without exaggerated projection. The general tautness kept everything very rhythmical and on-the-ball, with instruments pleasantly large and true to scale and of convincing tonal colour. Female vocals and strings in the upper part of the scale could be on the bright side, but without any associated nasties of sibilance and anaemia. This is not the rich, warm kind of Class A sound, although woodwinds did have a good woody quality representative of the marque. E.B.

TWEAKING

HIGH FREQUENCY LIMIT

The H.F. feedback compensation capacitor C9 sets the H.F. bandwidth to about 75 kHz (-1dB) which is high, but increasing C9 will cause problems under transient conditions. An effect known as Slew Induced Distortion may manifest itself if C9 is made too large, due to the differing speeds at which the various stages of the circuit can react to an input signal with a very fast rising edge. This is because C9 introduces what is known as a dominant pole in the amplifier's open loop frequency response, giving a well defined high frequency rolloff which gives good stability but slows down the second (voltage amp) stage of the amplifier. As a result there will be a delay before the signal can pass through the amplifier and therefore before the feedback signal can return to the input stage. This means that for a short time the input stage will be running open loop and will clip severely as it tries to charge C9. The amplifier will remain hung up until C9 is charged (about 1µS) after which it returns to normal, but during this time any musical information will be lost.

If we make C9 smaller to lessen this effect then stability suffers so we must take other precautions. One of these is the network R11/C7, which speeds up the feedback to the input stage and keeps it operating linearly, more or less eliminating the problem, but there is an extra element of protection in the form of a simple R/C filter at the input of the amplifier R2/C2,. This serves the dual purpose of limiting the maximum slew rate of the input signal and setting the upper bandwidth limit. With the values shown the bandwidth is about 35kHz (-1dB). Making C2 smaller will extend this further up, but is not recommended, especially with CD. Making C2 larger, say 330pF will reduce the bandwidth to about 24kHz (-1dB). You should hear the amplifier sound warmer as C2 is increased, which may well compensate for bright speakers.

LOW FREQUENCY LIMIT

The low frequency closed-loop bandwidth limit is set by the d.c. feedback capacitor C6. Its impedance is infinite at d.c. so the d.c. feedback is 100%, giving the amplifier a gain of 1. Full d.c. feedback is applied to minimize d.c. output drift caused by any input d.c. offset voltage. With C6 set at 220uF, in combination with R7 gain rolls off at 1.5Hz (-1dB).

Decreasing the value of C6 will limit audio gain at low frequencies, but the capacitor will start to develop an A.C. voltage across it in the audio band and because electrolytic capacitors have an asymmetric characteristic non-linearities will be introduced into the feedback loop. Also, the protection diode D1 will start to introduce distortion.

Conversely, if C6 is increased then this distortion will be reduced, but the extra bandwidth will start to cause problems by amplifying very low frequency noise from the preamp etc. and the leakage current through it may upset the balance of the input stage. Also the amplifier will take longer to settle down after large amplitude LF signals.

To overcome the over-extended bandwidth problem there is a high quality capacitor at the input. This not only protects the amplifier and speaker from a D.C. fault in the preamp, but also allows the amp's bass rolloff to be controlled. C1 is set at 0.47uF which gives a -1dB point at around 14Hz. A smaller value will cut low frequencies further, speeding the bass and reducing cone flap with L.P. Making C1 larger to 1uF will extend the bass to -1dB at about 6.5Hz allowing subsonics from CD through. In a nutshell then, you can tune the low end of this amplifier to suit your listening tastes and your system, but do bear in mind how such tuning affects the basic workings of the amplifier. Beware of extremes in particular.

D.C. OFFSET

D.C. offset must be trimmed by R3, the 100Ω potentiometer in the emitter circuits of TR1/TR2. Large D.C. offset voltages on the output of an amplifier will cause the loudspeaker bass unit to displace from its centre position. All amplifiers with direct coupling to the loudspeaker will develop a d.c. output offset, especially when they are all-direct coupled like this one. Basically, any input offset, voltage is multiplied up by the d.c. gain of the amplifier to appear as an output offset.

In an ideal amplifier there would be no input offset, but in practice minute imbalances in the characteristics of the front end devices always exist. Even though we chose a high quality dual-transistor to minimise d.c. offset, minute imbalances exist and to a greater degree there are imbalances in the currents flowing into the bases of TR1/TR2 due to leakage currents in C6. Trimming R3 allows output offset to be reduced to a millivolt or less. Most amplifiers give an offset of 3mV to 10mV and some up to 100mV, which is unnecessarily high. You will have to beg, steal or borrow a d.c. millivoltmeter and hook it up to the output terminals to adjust R3.

QUIESCENT CURRENT

The amplifier is designed to run fully into Class A with an output stage quiescent current of 1.6A. This gives 36W class A into 8Ω with both transistors still conducting over the full signal cycle. The bias generator is TR8 in a configuration commonly called a Vbe multiplier. Potentiometer R13 (500Ω) controls the voltage developed across TR8 while TR11 and TR12 sense the voltage across R25 and R26. An increase in voltage across TR8 means there is an increase in voltage across R25/R26, therefore a greater current will flow.

An increase in bias current will proportionately increase the dissipation of the output stage, at 1.6A it is 90W whilst at 2.0A it will be over 110W. The heatsink will start to get very hot at this sort of bias current. The output transistors will be safe, with a junction temperature of around 100Deg C (160Deg C max.) but the heatsink will be very painful to touch at around the 90Deg C mark, a point to bear in mind with animals or children in the house. The gain of the output transistors will also start to fall because of the very high current density. Generally then, beware of increasing bias current any further.

We found that reducing the bias current below 1.25A had a detrimental effect on sound quality, making the sound less full and warm. I took the quiescent current to over 2A on the prototypes to see if there was any advantage, but sonically there was very little improvement after 1.75A which is the maximum I would recommend due to excessive heatsink temperatures and gain droop in the output transistors.

AG

World Radio History

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6V6GT	BRIMAR	4.25	7581A.G.E	12.00	12BH7A G.E	6.50
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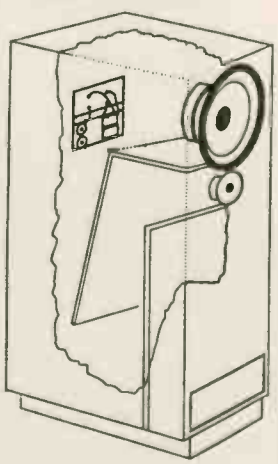

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World Radio History

Parts List

Resistors:

R1	47k	1/4W
R2	10k	1/4W
R3	100R	Trimmer
R4	100R	1/4W 1%
R5	100R	1/4W 1%
R6	2.2k	1W
R7	1k	1/4W 1%
R8	10k	1/4W
R9	15k	1/4W
R10	47k	1/4W 1%
R11	6.8k	1/4W
R12	2.2k	1/4W
R13	500R	Trimmer
R14	1.5k	1/4W
R15	10R	1/4W
R16	100R	1/4W
R17	100R	1/4W
R18	33R	1/4W
R19	33R	1/4W
R20	0.1R	2.5W
R21	0.1R	2.5W
R22	33R	1/4W
R23	0.1R	2.5W
R24	0.1R	2.5W
R25	0.05R	2.5W
R26	0.05R	2.5W
R27	15R	2W
R28	10R	2W
R29	5.6k	1/4W
R30	1k	1/4W
R31	33k	1/4W
R32	10k	1/4W
R33	100R	2W

Capacitors:

C1	0.47uF	Polypropylene
C2	220pF	Polystyrene
C3	1uF	Polypropylene
C4	1uF	Polypropylene
C5	10uF	50V
C6	220uF	10V
C7	33pF	Polystyrene
C8	1000uF	10V
C9	150pF	Polystyrene
C10	1uF	Polypropylene
C11	1000uF	35V
C12	1000uF	35V
C13	1000uF	35V
C14	1000uF	35V
C15	15000uF	40V
C16	15000uF	40V
C17	0.1uF	100V
C18	10uF	16V
C19	100uF	16V
C20	0.1uF	100V

Diodes:

D1	1N4148	
D2	11DQ10	Schottky
D3	11DQ10	Schottky
D4	1N4001	
D5	1N4001	
BR1		35A Bridge
ZD1	5.6V	400mW
LED1		GREEN
CS1	J510	3.6mA FET current source diode.

Transistors:

TR1/TR2	SSM2210P Dual
TR3	2SC2240
TR4	2SC2240
TR5	2SA970
TR6	2SA970
TR7	ZTX705
TR8	ZTX694B
TR9	ZTX694B
TR10	2SC2240
TR11	BD230
TR12	BD231
TR13	SM0718
TR14	SM0718
TR15	SM7401
TR16	SM7401

I.C.s:

IC1	7812CT	12V Reg
IC2	LM311	Comparator

Other:

Relay1 6A relay 12V coil

L1 20 turns 0.75mm wire wound on R28.

TR1 22V-0-22V 160VA toroidal transformer.

F1 5A Quick Blow fuse.

OBTAINING PARTS

We are offering a pack of crucial parts and a full kit.

PARTS PACK

This offers only those specialised parts not widely obtainable: eight output transistors (4/monoblock) and two circuit boards, cost £129.40 inc P&P & VAT. Individual output transistors can also be obtained from us at £9.80 each, the 2SC2240 and the 2SA970 at 80p each. We regret that we cannot offer advice or help at this level and only those with a good electronics knowledge and test equipment should attempt to build the circuit. A power output of 36W is achieved using a 22V-0-22V toroidal transformer; our specs are with a 160VA rating, but 120VA would do, giving lower 4ohm power.

THE KIT

The kit comes with all parts needed to build two professionally finished monoblock power amplifiers with chromium plated chassis and top covers. The circuit board can be accessed from top and bottom whilst in the chassis, for easy experimentation. Our custom designed toroidal mains transformer gives in excess of 40W output and superb regulation. Full instructions make construction relatively easy, but all the same we recommend you have some knowledge of electronics. Alternatively, get a local expert to build it or we can provide a build service.

Price £580 - see p83 for ordering details.

MEASURED PERFORMANCE

The amplifier delivers 36watts into 8ohms and 64watts into 4ohms (22V-0-22V, 160VA mains transformer). Due to the use of a quiet input device, the noise level is low and hum is negligible. Frequency response limits quoted above are the maximum possible. They should be trimmed down to around 5Hz-40kHz (-1dB) to begin with, using the techniques described in Tweaking. Those using CD should consider a 5Hz-25kHz response within -1dB limits; those with LP may like to curtail the low frequency response to 20Hz to avoid amplifying warps, but possibly take the high frequency response to 40kHz or so.

Distortion levels are very low and comprise second harmonic only, except at full output at 10kHz when low-level higher order components appear. However, second harmonic still predominates, measuring just 0.04%. Midband distortion measures 0.003% or so.

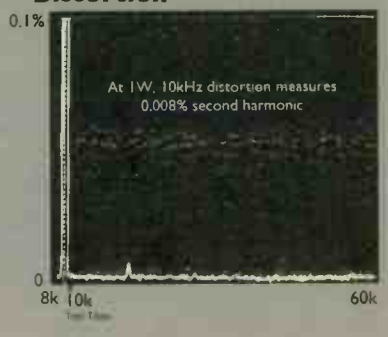
Sensitivity was set to allow the amplifier to give full output with modern sources, the lowest output from tuners and cassette decks coming from budget models that deliver around 350mV, equal to the sensitivity of this amplifier. NK

Power (8Ω)	36watts
Frequency response*	1 Hz-50kHz max
Noise	- 104dB
Sensitivity	350mV
d.c. offset	3mV max.

Distortion (%)

	1W	FULL
1kHz	0.003	0.005
10kHz	0.008	0.04

Distortion



World Radio History

Audio Note

TOPCAPS

Topcap For 807 pentode etc Nickel 9 75 You may want to start your project with less overall cost, and for this purpose we can offer the following "industrial grade" ceramic valve bases

Type	Mounting	Price Ex UK Vat
8-pin for EL34, 6550, KT66, 6L6G	Chassis with bracket	1 45
9-pin for ECC83, ECC88, 5687 6350	Chassis with shroud	1 85

AUDIO NOTE AUDIO COMPONENTS PARTS & PRICELIST.

We have decided to offer a range of the ultra high quality components used in most of the AUDIO NOTE amplifiers to the discerning "do it yourself" valve amplifier enthusiast These components include specially made valve bases, paper in oil signal capacitors copper & silver foil signal capacitors Black Gate graphite electrolytic capacitors, acid corrosive free silver solder, audio output transformers valves and many other useful bits and pieces for upgrading old or constructing of new valve amplifiers

All prices are excluding Vat, which if you live inside the EEC UK Vat will be added to your purchase after the addition of postage and packing costs

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Delivery is normally about 7 days from receipt of cleared funds but please allow up to 60 days for some items, if not stock at the time or order

If any of you reading this have possession of any books which contain information relevant to the subject of Audio Design and which would be useful to share with others, please let us know either by fax or telephone, there is an award of £ 20.00 (payable in valves or other bits positive) to anybody who sends us a book which contains useful information about valve amplifier design or theory

Circuits valvedata & Basic Technical Information

If you would like some suggestions which to base a future project around then we shall be happy to provide you with a circuit pack containing good circuits like ONGAKU KEGON/KASSAI NEIRO, GAKU ON plus several other power amplifier circuits and the M7Tube pre-amplifier which is the best pre-amplifier circuit we have come across Just send a stamped self addressed A4 size envelope, together with 5 00 pounds in small denomination, or if you live outside the UK a US$ 15 00 in $ bills will do please do not send International Response Coupons or International money orders, as they cost more to cash than their value

We can also supply a set of data sheets for the most commonly used valves ECC82 ECC88/6922 1 2AY7/6072A 7025/12AX7WA/ECC83, 65N7 300B, 211/VT4C, 845, EL34/6CA7, 2A3, 6X4, 5U4G, GZ34/5AR4 EL84/6BQ5 6V6GT 6L6G 5881/6L6WGC/KT66 Again send a stamped self addressed A4 envelope together with – 4 00 in small denomination stamps or if outside the UK another US$ 15 00 will suffice

Since nothing really exists which gives a reasonable background to the subject of valve amplifier circuit design Guy Adams and I have written and assembled a number of articles and extracts from old books which give some background to the subject, do not expect to become an instant expert but it will serve as a useful reference for the beginner as well as the more advanced, we have expanded this info-pack to include even more useful information so if you have already bought the old pack just send £ 2 00 or US$ 5 00 For the full pack a small charge is required, this time £ 7 00 in small denomination stamps with a stamped self addressed envelope, or outside the UK, please send US$ 25 00

We do accept a UK cheque or bankers draft in Pound Sterling for the above charges as well

SOUND PRACTICES.

If you are seriously interested in the subject of valve amplifier design without the usual preconceived notions of what is "good" amplifier design and technology (the traditional view which has brought us the blessings of the transistor amplifier has obviously disqualified itself quite monumentally) then SOUND PRACTICES is the magazine to read here you will find articles about design parameters DIY articles for amplifiers and speakers reviews of new and old in other words the very subjects that none of the self serving advertising led traditional press will touch as they do not enhance the business of their current advertisers You can buy SOUND PRACTICES from us at – 5 00 per copy (there are currently 4 issues available) or by subscription from SOUND PRACTICES P O Box 180562 Austin TX 78718 USA A regular modern world bargain and there are practically none of those in Audio today With enough subscription support SOUND PRACTICES may just bring about the "sound practices" that the hifi industry has abandoned for so long So get a subscription!!

SOUND PRACTICES issue 5 is HERE so your next weekend is saved! Buy a copy for £ 5 00 + postage (or self addressed envelope with order if you live in the UK) serious stuff like build your own ONGAKU copper version etc etc

POSITIVE FEEDBACK.

This is one type of feedback that we are not arguing against Positive Feedback is the club magazine for the Oregon Triode Society with aspirations towards greatness, not unlike the great underground magazines of the 1 970's It is a quarterly publication of lively controversial commentary by in-house writers, members, as well as various industry doyens on the subjects of music, audio, technology and the quest for musical satisfaction I for one think it is an excellent read and provides a good alternative view to most of the established press, which tends to view the world in the context of what new product is available right now without giving much perspective backwards Positive Feedback is available at £ 6 00 per issue

COMPLETE KITS.

At the current moment the following kits are under development and should be available during 1994 the sequence of introduction may be different from the number as we expect the KIT THREE to become available in March 1994

KIT TWO 6550 single-ended 15 watts Class A, on a stereo chassis expected cost £ 599 00 incl Vat KIT THREE 300B parallel single-ended, mono chassis 16/17 watts Class A expected cost about £ 1,450 00 Inc Vat KIT FOUR 6V6 push pull, 10 watts Class A, stereo chassis, expected cost £ 179 00 Incl Vat KIT FIVE 6550 push pull Class ABI 60 watts mono chassis expected cost £ 799 00 If you are in doubt as to whether a kit project is suitable for you we suggest you spend £10 00 on buying the instructions for the KIT ONE single 300B amplifier this will give you a good idea whether a kit project is for you if you decide to buy a kit then the £10 00 will be refunded against the cost of the kit As the other kits become available their instruction manuals will also be available at £ 10.00 each

OUTPUT TRANSFORMERS Specifications PP = Push-Pull PPP = Parallel Push-Pull SE = Single-ended PSE = Single-ended Parallel UL signifies 43 % ultralinear taps, as a general rule we do not condone the use of UL-taps, as we consider these detriment to sound quality – • Dynaco replacement

All primary impedances are calculated for Class A operation the main consideration given to maximum dynamic power transfer ability and minimum distortion rather than meaningless steady state sine or squarewave conditions

All our single-ended output transformers are air-gapped and the maximum standing current allowed before saturation is shown in column 5

All our output transformers have a frequency response well beyond the audio range typically 20Hz – 40 KHz minus 1 5dB all are IF-cored with high grade silicon steel laminations wound with oxygen-free copper wire and supplied with either bell-ends or frames both with flying leads

We generally over-specify our transformers by 50% power in Push Pull (which means that a transformer stated as 25 watts will allow about 35-38 watt peaks all single-ended outputs are generally over specified by 100% which means that they will instantaneously allow peaks of double the given maximum power through undistorted

We do not give any further technical information on our output transformers, as we do not wish to take part in technical competitions our products are designed to criteria which are and will be understood once they are listened to!

In addition to the output transformers offered below we offer a design service, where we can supply almost any requirement for wideband transformers whether for microphones, moving coil cartridges, line input phase splitter interstage driver or power output, we design and manufacture prototypes in house the cost for the paper design is £ 200 00, prototype cost is calculated on a per case basis We can also produce production quantities

Sizes are given as Width/Height/Depth, where depth is the depth of the coil itself and width is the length of the core

AUDIO NOTE CHOKES & INDUCTORS

Value	Size	Price Ex UK Vat
0 5H/400mA		18 00
3H/1 00mA		14 00
3H/250mA for ONGAKU/Cu		24 00
5H/150mA		21 00
5H/400mA		31 00
10H/125mA	63x74x76 mm	26 00
10H/200mA	98x65x83 mm	33 00
20H/50Ma	68x56x58 mm	24 00

Other values can be supplied by order ask for quote

UDIO NOTE PAPER IN OIL COPPER & SILVER FOIL SIGNAL CAPACITORS

We are currently developing a two further ranges of paper in oil capacitors where instead of using aluminium foil as in the above paper caps in the first range we use an oxygen free copper foil with 99 99% pure solid silver lead out wires, these copperfoil paper signal capacitors are considerably better than the standard offerings Secondly to "bridge" the price quality gap between the more standard paper/oil caps and the Japanese handmade Silver foil signal capacitors, we will be offering our own 99 99% pure silver foil signal capacitors which are pretty staggering in quality, even if I have to say this myself (as I am the only one who have heard the samples so far) the silver foil caps will also have solid silver lead out wires To start with there will be a few values/voltages of each available

AUDIO NOTE COPPER FOIL PAPER IN OIL CAPACITORS

Value	DC Voltage	Size	Price ex UK Vat
0 047mF	630 volt	28x1 6 mm	12 35
0 1mF	630 volt	33x22 mm	14 65
0 15mF	630 volt	35x22 mm	16 45
0 22mF	630 volt	56x25 mm	19 75
0 47mF	630 volt	56x38 mm	27 45
1 mF	630 volt	65x44 mm	46 85

AUDIO NOTE SILVER FOIL PAPER IN OIL CAPACITORS

0 047mF	630 volt	14x46 mm	41 00
0 1mF	630 volt	16x46 mm	74 00
0 15mF	630 volt	22x36 mm	101 00
0 22mF	630 volt	19x46 mm	135 00
0 47mF	630 volt	25x46 mm	196 00
lmF	630 volt	38x46 mm	486 65

AUDIO NOTE SILVER FOIL SIGNAL CAPACITORS

Best signal capacitors available quality really speaks for itself used in amplifiers like ONGAKU KEGON GAKU-ON and M7Tube Silver handmade in very limited quantities at Audio Notes facility in Tokyo, Japan These capacitors use a fine mylar film dialectric and are manufactured using considerable tens on on the foil and dialectric to give the best possible contact and the least scope for internal resonance

Value	DC Voltage	Price ex UK Vat
0 01 mF	500 volt	177 00
0 02mF	500 volt	211 75
0 05mF	500 volt	346 75
0 1 mF	500 volt	645 75
0 2mF	500 volt	995 75

AUDIO NOTE PAPER IN OIL RESERVOIR CAPACITORS Mainly for use in inductor power supplies but have other uses

Value	DC Voltage	Size	Price Ex UK Vat
2mF	400 volt	30x40x55 mm	26 75
2mF	630 volt	35x45x72 mm	33 65
2mF	1000 volt	45x45x72 mm	41 75
2mF	1600 volt	50x70x72 mm	45 95
4mF	1000 volt	45x45xl 20 mm	49 95
4mF	2500 volt	70x70x120 mm	265 75
10mF	1000 volt	70xl00xl00 mm	96 75
12mF	1000 volt	70xl00x120 mm	109 95
12mF	1600 volt	100xl00x120 mm	136 75
12mF	2000 volt	100xl00x220 mm	159 75

POTENTIOMETERS

Best available from sound quality – price viewpoint made by Alps in Japan high quality conductive plastic film Volume Controls Impedance Construction Price Ex. UK Vat

1 00KOhm Stereo	Frame type PCB mounted	3 45
100KOhm Stereo	Encapsulated type PCB mounted	12 65

A better alternative is the KO-ON volume controls which are used in pre-amplifiers like the M7Tube M7Line and in a mono version on the input on the NEIRO KASSAI KEGON and GAKU-ON these are very good sounding pots by any standard

Impedance	Construction	
100KOhm Stereo	Encapsulated	32 25
100KOhm Mono	Large Encapsulated	70 65
100KOhm Stereo	Large Encapsulated high quality	107 45

Balance Controls

1 00KOhm	Frame type PCB mounted	3 95
100KOhm	Encapsulated type PCB mounted	14 15

KO-ON also makes a very good quality 100KOhm balance control, similar to the encapsulated 100K pot this costs £ 32 25

AUDIO NOTE PRECISION CARBONFILM RESISTORS

In addition to the non-magnetic tantalum resistors, we are going to stock a range of precision goldplated carbon film resistors, in many cases the carbonfilm resistor is preferable if you are building an amplifier based on an old circuit, like for example the WE91 or another circuit of similar vintage We shall be stocking values suitable for projects like the WE91 in 1/2 and 1 watt values, these resistors are made especially for us by a major manufacturer

They cost for the 1/2 watt £3'30 each
1 watt £4 85 each
2 watt £6 89 each

AUDIO NOTE CERAMIC STAND-OFFS.

In most hardwired valve power amplifiers it is frequently difficult to get the HT and heater rails properly suspended and separated safely and neatly from the chassis this especially applies when building amplifiers using the really high voltage directly heated triodes like 211, VT4-C, 845, 849, 304TL, DA100 etc When planning design like this it is important to incorporate suitable layout from the start and the AUDIO NOTE stand-offs should be more or less mandatory in that context They are screw in type with steatite insulator and either a wrap-round turned "head" on the single way version or separated solder slots on the multi way versions

Type No	Number of Tags	Height/Length	Solder Connection	Chassis Fixing	Price Ex UK Vat
AN-421	1	25 5 mm	Wrap-round	Screw-in bolt	1 41
AN 422	1	17 4 mm	Wrap-round	Screw-in bolt	1 41
AN-423	1	22 6 mm	Solder slot	Screw-in	1 41
AN-452	2	Adjustable 17mm	Solder slots	Dual bolt screw-in	2 42
AN-453	3	Adjustable 24mm	Solder slots	Dual bolt screw-in	3 05
AN-455	5	Adjustable 32mm	Solder slots	Dual bolt screw-in	4 04
AN-458	8	Adjustable 58mm	Solder slots	Dual bolt screw in	5 79
AN 460	10	Adjustable 72mm	Solder slots	Dual bolt screw-in	7 31
AN-476	6	25mm/45mm	Solder slots	Screw-in bolts	5 35
AN-479	9	25mm/66mm	Solder slots	Screw-in bolts	7 53

AUDIO NOTE AUDIO QUALITY OUTPUT TRANSFORMERS

Suggested Valve	Max Cl A Power	Prim-Sec Impedance	Size/Weight	Max Current	Price ex UK VAT
Single-ended Circuits					
EL84/ECL86/6V6	20 watts	2K6 – 4/8 Ohms	117x98x90 mm	llOmA PSE	87 00
300B/2A3/6B4G	25 watts	2K5 – 4/8 Ohms	117x98x90mm	90mA SE	91 00
EL34/6CA7	30 watts	1 K5 – 4/8 Ohms	11 5x98x95mm	1 80mA PSE	113 00
2A3/6B4G	30 watts	1 K25 – 4/8 Ohms	98x82x95mm	1 30mA PSE	97 00
5881/KT66	30 watts	2Kl – 4/8 Ohms	115x98x95mm	140mA PSE	106 00
211NT4C	30 watts	10K – 4/80hms	117x98xl00mm	150mA SE	114 00
211NT4C/845	50 watts	l0K – 4/8 Ohms	112xl34xl-50mm	150mA SE	124 00
300B	50watts	lK25 -4/80hms	135xll5xl25mm	180mA PSE	151 00
845	50 watts	2K5 – 4/8 Ohms	1 37xl 1 4xl 30mm	1 80mA PSE	172 00
21 INT4C	75 watts	5K–4/8 Ohms	137xl 15x145 mm	240mA PSE	237 00
New SE Product					
EL34/6550/KT88	20 watts	3K – 4/8 Ohms	117x98x92 mm	130mA SE	104 00
300B/2A3/6B4G	25watts	2K5-4/8/160hms	117x98x90mm	90mASE	102 50
6L6G	30 watts	3K-4/8 Ohms	115x98x95 mm	140mA PSE	107 00
Push-Pull Circuits					
EL84/ECL86/6V6	15 watts	8K-4/8 Ohms	80x67x68 mm	PP	42 00
EL34/6L6G/5881	25 watts	6K-4/8 Ohms	88x73x80 mm	PP	59 00
2A3/6B4G/300B	30 watts	5K-4/8 Ohms	88x75x80 mm	PP	63 00
KT88/6550	50 watts	6K6 –4/8 Ohms	108x91x90 mm	PP	73 00
EL34/KT66/5881	50 watts	3K –4/8 Ohms	98x82x83 mm	PPP	74 00
845	50 watts	6K8 –4/8 Ohms	108x91x90 mm	PP	114 00
KT88/6550	60 watts	4K3 -4/8/16 Ohms	125xl00xl 13 mm	UL PP	111 00*
KT88/6550	100watts	2K2-4/8/160hms	150xl47xll8mm	UL PP/PPP	134 60*
Pure Silver Wired Outputs					
300B/2A3/ 6B4G	25 watts	2K5 – 4/8 Ohms	117x98x90 mm	90mA SE	1,645 00
211NT4 C/845	50watts	10K – 4/80hms	112xl34xl50mm	150mA SE	1,975 00

The **AUDIO NOTE** silver wired outputs listed here are designed and made in the UK we can supply the AUDIO NOTE Japan manufactured outputs for the ONGAKU or the KEGON, but they are exceptionally expensive as you would expect from items that take upwards from 100 hours each to make, for example an output transformer for an ONGAKU costs £16 500 00

AUDIO NOTE MAINS TRANSFORMERS

This range relates to our finished products mains transformers are notoriously difficult items to offer as the number of permutations of HT and Heater voltages are almost endless We have added mainstransformers for making replicas of the KASSAI and ONGAKU as there has been considerable call for these, likewise we are preparing mainstransformers for the WE9 1 described in Sound Practices Issue 1 we shall continue to expand the range as opportunities and our experience with your requirements improve

Primary Voltages	Secondary HT Windings	Secondary Heater Windings	Price Ex UK Vat
0v/100v/1 10v/120v	0v – 230v at 350mA	0v-12 6v at 1 Amp	34 00
0v/220v/230v/240v		3 1 5v-0v 3 1 5v at 4 Amp	
120v/1 10v/100v/0v	0v – 230v at 0 4 Amp	0v-12 6v at 1 A	41 00
0v/100v/1 10v/120v		3.15v – 3 15v at 4 Amp	
120v/1 10v/100v/0v	300v – 0v- 300v at 60mA	12 6v – 0v at 1 5A	46 00
1 00v/11 0v/1 20v		6 3v – 0v at 600mA	for M7Tube Pre-amp with 50H choke input filter
0v/100v/1 10v/120v	0v – 290v at 40mA	12 6v-0v at 1 5A	26 00
0v/1 00v/1 0v/1 20v		0v – 6 3v at 300mA	
0v/1 00v/1 0v/1 20v	3 1 0v-244v-0v-244v-3 1 0v at 3 1 5v -0v-3 1 5v at 4 5 Amp		72 50
0v/1 00v/1 0v/1 20v	320mA	1 2 6v at 1 5 Amp	
1 20v/11 0v/1 00v/0v	0v-920v at 1 60mA	0 – 1 0v at 4 Amp, 0v-6 3v at	98 00
0v/1 00v/1 0v/1 20v	1 50v-1 50v at 50 mA	1 5A, 0v – 5v at 2.5A	
120v/1 10v/100v/0v	390v-0v 390v at 200 mA	3 15v-0v-3 15v at 1 2Amp, 7v	86 70
0v/1 00v/1 0v/1 20v	1 70v at 50mA	at 3A, 7v at 3A, 5v at 2A	
120v/1 10v/100v/0v	425v-0v-425v at 220mA	3 15v-0v-3 15v at 2 5A	95 60
100v/1 10v/120v		7 0v-0v at 2A, 7 0v-0v at 2A,	for KIT ONE a KIT
		5 0v-0v at 3A,	THREE MONO channel
		3 1 5v-0v-3 1 5v at 750mA	
1 20v/11 0v/1 00v/0v	390v-0v-390v at 200mA	1 70-0v at 50mA, 7 0v -0v at	1 07 00
1 00v/1 0v/1 20v		3A 7 0- 0v at 3A, 5v – 0v at	
	–		2A,
For KASSAI replica			
		3 1 5v-0v-3 1 5v at 1 2A	
1 20v/11 0v/1 00v/0v	380v – 0v 380v at 200mA	1 50v-0v at 1 50mA 1 0v-0v	1 37 00
1 00v/1 0v/1 20v		3 25A, 1 0v-0v at 3 25A,	
		5v – 0v at 3A, 5v – 0v at 3A	For ONGAKU replica
		5v – 0v at 3A, 5v – 0v at 3A	
		6 3v – 0 6 3v at 1 25A	

We also have a mainstransformer/choke kit for the WE91 power amplifier as shown in Sound Practices, this combined with our single-ended output transformers with 3KOhm primary impedance, will make a very fine replica of this classic amplifier

AUDIO NOTE PAPER IN OIL SIGNAL CAPACITORS

These handmade signal capacitors are sonically superior to any of the plastic or other paper types we have come across If you have never experienced the difference that a really good paper/oil capacitor can make in a valve amplifier, then you really should try Our specially made paper/oil caps have a life, colour lack of harshness and evenness of dynamic behaviour across the frequency range which is guaranteed to brighten up your day! Recommended as replacements in old and new valve amplifiers alike (and even in the odd transistor amplifier), and essential for DIY projects In line with environmental standards all **AUDIO NOTE** paper in oil capacitors contain only non-toxic, biodegradable vegetable oil, the paper is a specially treated and impregnated by a method that enhances longevity and sound quality, to ensure optimum performance all round

Value	DC Voltage	Size	Price ex UK Vat
0 015mF	400 volt	21x9 mm	2 85
0 022mF	400 volt	35x10mm	3 75
0 047mF	400 volt	32xl 1 mm	4 10
0 082mF	400 volt	33xl4mm	4 25
0 12mF	400 volt	33x14 mm	4 75
0 18mF	400 volt	32x16 mm	5 15
0 22mF	400 volt	35x18 mm	5 85
0 33mF	400 volt	43x18 mm	6 75
1 4mF	400 volt	70x24 mm	14 95
0 001 5mF	630 volt	1 7x9 mm	2 85
0 022mF	630 volt	20x10 mm	3 25
0 056mF	630volt	33x15 mm	4 25
0 082mF	630 volt	33xl 6 mm	4 55
0 18mF	630 volt	43x18 mm	5 45
0 22mF	630 volt	52xl9 mm	5 75
0 33mF	630 volt	52x22 mm	7 25
0 39mF	630 volt	52x26 mm	7 95
0 47mF	630 volt	52x26 mm	8 85
0 22mF	1000 volt	56x26 mm	6 95
0 39mF	1000 volt	61x26 mm	11 65
1 2mF	1000 volt	72x40 mm	16 75
0 22mF	1600 volt	60x26 mm	9 65
0 22mF	2000 volt	70x29 mm	11 55

All **AUDIO NOTE** paper in oil signal capacitors are axial type We are preparing a range of very small picofarad value paper in oil capacitors at the moment in addition to the above The range of **AUDIO NOTE** paper in oil signal capacitors is steadily expanding, so ask for values that you do not see

World Radio History

UDIO NOTE ACID & CLORIDE FREE SILVER SOLDER

The best solder we have been able to find, does not contaminate the junction which over time increases junction resistance. Used in all our amplifiers from OTO to the GAKU-ON

Weight/Measure	Price Ex UK Vat
50 grammes or about 8 meter 1 mm diameter	19.95
1 kilo roll of 1 mm diameter	210.65

AUDIO NOTE CABLES & WIRES

We are proud to offer the **AUDIO NOTE** range of high quality copper and silver coax, speaker and wiring cables, which, depending on the overall price of the project, will do justice to any hifi system, regardless of price

Solid 99.99% Pure **AUDIO NOTE** Silver Wire

Gauge	Insulation Material	Price per Meter Ex UK Vat
0.05mm	Polyurethane	16.75
0.2mm	Polyurethane	22.75
0.35mm	ML	24.95
0.6mm	ML	27.85
0.8mm	ML	31.75
1 mm	ML	36.75

The above solid silver wires are suitable for inductors for speaker crossovers, both active and passive or for internal wiring in tonearms amplifiers etc

AUDIO NOTE Coax Interconnect Cables

Type/Colour code	Construction	Price per Stereo Meter Ex UK Vat
AN-A yellow	symmetrical 6N copper litz coax	15.32
AN-C red	symmetrical OFH Copper litz coax	29.79
AN-S dark grey with yellow stripe	symmetrical 99.99% silver litz coax	84.25
AN-V silver grey with yellow stripe	symmetrical 99.99% silver litz coax	152.35
AN-Vx silver grey	symmetrical 99.99% silver litz coax	382.98

It is recommended to use the internal twin silver wires in the AUDIO NOTE coax cables as internal wiring cable, this is what we do in amplifiers like the ONGAKU, M7Tube etc

AUDIO NOTE Speaker & Wiring Cables

Type/Colour code	Construction	Price per Mono Meter Ex UK Vat
AN-D green	single core 6N copper speaker wiring	6.85
AN-B blue white writing	double strand, screened 6N speaker wire	12.34
AN-L blue black writing	double strand, screened 6N litz copper speaker wire	25.11
AN-SP silver	single core 15 strand 99.99% litz silver speaker wire	106.38
AN-SPx silver	single core 20 strand 99.99% litz silver speaker wire	382.98

PTFE insulated Silver Plated Copper Wires

We can also provide less expensive wiring wires for hard wiring circuits, these PTFE insulated silver plated copper wires are 19 strand of 0.15 mm wire and come in brown, black, blue, pink, red, green, orange, violet, white and red/white, they cost £1.60 per meter in any colour

AUDIO NOTE HIGH QUALITY STEPPED ATTENUATORS & SWITCHES

These handmade attenuators and switches are manufactured by a friend of Mr. Kondo of **AUDIO NOTE,** and represent the best available volume controls and switches you can use in your pre-amplifier, the attenuator is 48 steps and with silver/rhodium plated contacts/brushes made with an array of tantalum film resistors. The switches feature silver plated contacts and self cleaning action

Type	Value	Price Ex UK Vat
Stereo Potentiometer /Attenuator	50KOhms	198.75
Stereo Potentiometer /Attenuator	100KOhms	207.75
2 Channel switch	6 – way adjustable	78.75
4 Channel switch	6 – way adjustable	101.75

AUDIO NOTE SELECTED AUDIO VALVES

Our valves are selected from the best available sources and are tested to the same stringent standards that we apply in the production of our own amplifiers, they fall into two categories, standard production items and rare, mostly NOS (New Old Stock) valves which are no longer in production. We have compiled a special list of the NOS items, which is available on request, beware the valves on this list are NOT cheap.

Standard Stock Items.

Type No	Type	Price Ex UK Vat
ECC835/12AX7 WA/7025	double triode	2.95
E88CC/6922/6DJ8WA/7308	double triode	3.95
EF86/6267/Z729	pentode	2.45
ECC82/12AU7/5814a	double triode, mil spec	5.75
6SN7GT	double triode, U8X base	1.75
6SL7GT	double triode, U8X base	2.85
6SJ7	pentode	1.75
5687WA	double triode very powerful	4.56
6350WA	double triode	4.75
EL84/6BQ5	small power pentode	1.55
EL84M/6BQ5WA	small power pentode, mil spec version	4.75
6V6GT	small power pentode	2.45
6L6G	medium power pentode	2.75
5881/KT66/6L6V/GC	medium power tetrode	4.95
EL34G	power pentode	7.45
6550/KT88	large power tetrode	12.45
6C33	powerful regulator, indirectly heated triode	24.65
6A57/6080	strong regulator, indirectly heated triode	6.45
2A3 4-pin	directly heated small power triode	17.95
300B	directly heated power triode	57.95
5U4G	HT-rectifier	3.25
5Y3GT	HT-rectifier	2.25
5V4GT	HT-rectifier	2.25
GZ34/5AR4	HT-rectifier	8.75
6X4	HT-rectifier, very good for pre-amplifiers	2.65

RESISTORS

Beyschlag

We offer three quality levels of resistor quality, all are 1%, starting with the Beyschlag metalfilm, which are slightly magnetic (as are the vast majority of other makes of metal film resistors), but nonetheless very good sounding, as used in all our UK-made amplifiers, up to quality level 3 (the MEISHU/P3) no-feedback triode amplifiers

Beyschlag 1 watt, 1% resistors up to 500KOhm, £0.11, above 500KOhm £0.13 each

HOLCO

Better sound quality can be achieved with the H2, 1 watt, 1% non-magnetic resistors which we regard as the best industrial grade metalfilm resistors available. They have one small drawback, as they are quite fragile, and require careful handling, do not bend the legs too close to the body, they may become noisy

HOLCO resistors type H2 50PPM cost £0.36 each from 100Ohm to 500KOhm, higher and lower values are all £0.63 each.

AUDIO NOTE HIGH QUALITY CERAMIC VALVE BASES

All of our valve bases are of the highest possible quality, made from steatite and using the best metal parts from alloys which retain their spring tension around the valve pin for longer. They are recommended as upgrades to most old valve amplifiers and should be an essential part of any DIY project

Type	Mounting	Plating	Price Ex UK Vat
4-pin UX4 for 300B/2A3/801A	Chassis	Gold	8.25
4-pin UX4 for 300B/2A3/801A	Chassis	Nickel	7.25
4-pin UX4 WE-type for 300B/2A3/801 A	Chassis	Silver	14.75
4-pin Jumbo 4 for 211/VT4C/845	Chassis with bayonet	Silver/chrome	159.95
5-pin UY5 for 807	Chassis	Gold	9.75
7-pin B7 for 6X4, OA2	PCB	Silver	6.15
7-pin B7 for 6X4, OA2	PCB	Gold	7.85
7-pin B7 for 6X4, OA2	Chassis from above	Silver	6.75
7-pin B7 for 6X4, OA2	Chassis from above	Gold	7.95
8-pin U8X for EL34, 6550, 5U4G GZ34, 6L6G, etc	Chassis	Silver	5.65
8-pin U8X for EL34, 6550, 5U4G GZ34, 6L6G, etc	Chassis	Gold	8.65
9-pin B9 for ECC83, ECC88, 5687, 6350, etc	PCB	Silver	3.85
9-pin B9 for ECC83, ECC88, 5687, 6350, etc	PCB	Gold	5.75
9-pin B9A for ECC83, ECC88, 5687, 6350, etc. etc	Chassis from above	Silver	4.45
9-pin B9A for ECC83, ECC88, 5687, 6350, etc. etc	Chassis from above	Gold	6.75
9-pin B9A for ECC83, ECC88, 5687, 6350, etc	Chassis from below	Silver	4.95
9-pin B9A for ECC83, ECC88, 5687, 6350, etc	Chassis from below	Gold	7.15

TOPCAPS

Topcap For 807 pentode etc. Nickel 9.75. You may want to start your project with less overall cost, and for this purpose we can offer the following "industrial grade" ceramic valve bases

Type	Mounting	Price Ex UK Vat
8-pin for EL34, 6550, KT66, 6L6G	Chassis with bracket	1.45
9-pin for ECC83, ECC88, 5687, 6350	Chassis with shroud	1.85

AUDIO NOTE CERAMIC STAND-OFFS

In most hardwired valve power amplifiers it is frequently difficult to get the HT and heater rails properly suspended and separated, safely and neatly from the chassis, this especially applies when building amplifiers using the really high voltage directly heated triodes like 211, VT4C, 845, 849, 304TL, DA100 etc. When planning design like this, it is important to incorporate suitable layout from the start, and the **AUDIO NOTE** stand-offs should be more or less mandatory in that context. They are screw-in type with steatite insulator and either a wrap-round turned "head" on the single way version or separated solder slots on the multi-way versions

Type No	Number of Tags	Height/Length	Solder Connection	Chassis Fixing	Price Ex UK Vat
AN-421	1	25.5 mm	Wrap-round	Screw-in bolt	1.41
AN-422	1	17.4 mm	Wrap-round	Screw-in bolt	1.41
AN-423	1	22.6 mm	Solder slot	Screw-in	1.41
AN-452	2	Adjustable, 17mm	Solder slots	Dual bolt screw-in	2.42
AN-453	3	Adjustable, 24mm	Solder slots	Dual bolt screw-in	3.06
AN-455	5	Adjustable, 32mm	Solder slots	Dual bolt screw-in	4.04
AN-458	8	Adjustable, 58mm	Solder slots	Dual bolt screw-in	5.79
AN-460	10	Adjustable, 72mm	Solder slots	Dual bolt screw-in	7.31
AN-476	6	25mm/45mm	Solder slots	Screw-in bolts	5.35
AN-479	9	25mm/66mm	Solder slots	Screw-in bolts	7.53

BLACK GATE ELECTRON TRANSFER. High Performance, Graphite Electrolytic capacitors

There are very few audio parts that promise a guaranteed improvement when replacing practically any other part, but this is what the **BLACK GATE** capacitors actually do. Exchanging any electrolytic capacitor anywhere in the circuit of an amplifier or in the crossover of a speaker will greatly improve sound quality. We are working on some guidelines as to where, how and which types of Black Gates to use in different circuits, the first such technical guideline is available now and is called "Improving your CD Player" and can be obtained by sending a stamped addressed envelope to us requesting this leaflet. All **AUDIO NOTE** Level 2 Signature products use **Black G-t El-ecltron Tra-nsf-r** in critical signal/power supply junctions

It is very important to note that all **BLACK GATE** capacitors take time to charge-up or stabilize when first put in circuit, depending on type and application this "maturing" time can be between 100 and 300 hours

Value	Voltage	BG-Type	Suggested Use	Price Ex UK Vat
47mF	25volt	PK	Anywhere	1.65
33mF	35volt	PK	Anywhere	1.75
0.47mF	50volt	PK	Anywhere	1.05
1 mF	50volt	PK	Anywhere	1.12
2.2mF	50volt	PK	Anywhere	1.23
3.3mF	50volt	PK	Anywhere	1.38
4.7mF	50volt	PK	Anywhere	1.68
10mF	50volt	PK	Anywhere	1.87
22mF	50volt	PK	Anywhere	2.68
100mF	50volt	Standard	Anywhere	5.47
100mF	100volt	Standard	Anywhere	7.75
1000mF	16volt	Standard	Anywhere	8.22
1000mF	50volt	Standard	Anywhere	24.55
220mF	16volt	Standard	Anywhere	4.35
470mF	16volt	Standard	Anywhere	6.35
2200mF	50volt	Standard	Anywhere	13.45
10,000mF	80volt	Standard	PSU smoothing	234.65
4700mF	16volt	Standard	Anywhere	14.25
47mF + 47mF	500volt – 550v surge	SK-Type	PSU filter capacitor	85.95
100mF + 100mF	500volt – 550v surge	SK-Type	PSU filter capacitor	101.95
100mF	500volt – 550v surge	SK-Type	PSU filter capacitor	72.75
220mF + 220mF	350volt – 400v surge	SK-Type	PSU filter capacitor	92.65
100mF +	100mF-350volt – 400v surge	SK-Type	PSU filter capacitor	75.35
22mF	350volt	VK-Type	Decoupling or filter capacitor	18.95
220mF	16volt	F-Type	Low ESR version	6.75
220mF	16volt	FK-Type	Ultra low ESR version, comparable to film caps	9.95
1000mF	50volt	FK-Type	As above use anywhere	43.95
2200mF	50volt	FK-Type	As above use anywhere	98.85
2.2mF	50volt	C-Type	For circuits with DC potential difference	2.07
4.7mF	50volt	C-Type	For circuits with DC potential difference	3.35
1 mF	50volt	N-Series	Bipolar for use in negative feedback circuits etc.	4.95
4.7mF	50volt	N-Series	as above	5.75
10mF	50volt	N-Series	as above	6.95
47mF	50volt	N-Series	as above	13.75
100mF	50volt	N-Series	as above	18.95
6.8mF	50volt	Bipolar	For loudspeaker crossover networks	8.95
10mF	50volt	Bipolar	as above	10.85
22mF	50volt	Bipolar	as above	17.45
47mF	50 volt	Bipolar	as above	27.95
220mF	6.3volt	BG-NxType	For super low noise PSUs	11.85
100mF	16volt	BG-N Type	For super low noise PSU's	24.65
470mF	16volt	BG-N Type	as above	28.95
4700mF	35volt	BG-N Type	as above	210.45
4.7mF	50volt	BG-N Type	as above	6.65
1000mF	50volt	BG-N Type	as above	99.95
2200mF	100volt	BG-N Type	as above	423.35

In our component list you will find a listing of all available Black Gate values, together their sizes, best usage etc

Lastly, we can supply a range of more modestly prices components, still good quality, but more industrial grade, if you like

SHINKOH Tantalum Film Resistors

This is definitely the best sounding resistors available, forget the VISHAY which may be ok in high feedback transistor amplifiers, but in our opinion quite uncomplimentary to the qualities of real Audio Amplification (i.e. directly heated triode amplifiers running feedback free in single-ended Class A), this is where you will need the tantalum film resistor for the best results

The 1/2 watt Shinkoh tantalum resistors are non-magnetic and cost £2.06 each

AUDIO NOTE 1 WATT TANTALUM RESISTORS

Up to now the tantalum film resistors have been extremely difficult to get, however, after much persuasion and against a minimum quantity guarantee from **Audio Not UK** the manufacturers have agreed to widen the range of 1/2 watt and reintroduce the 1 watt range which becomes an exclusive range for **AUDIO NOTE,** we consider this to be major breakthrough, since without a reasonable range of values at the 1 watt rating it is pretty difficult to get the very best out of the best circuits. As with most handmade specialist items, which covers most on this list, delivery can be quite long on some values, so be prepared to wait if the value is not in stock

The **AUDIO NOTE** 1 watt 1% tantalum resistor values are £3.70 each

We shall now be working on getting the 2-watt tantalum resistors made available as well, and who know perhaps we will be able to build amplifiers in a year's time that have all tantalum resistors in all parts of the circuit

STANDARD TYPE SWITCHES.

This switch is adjustable 2 – 6 – way, it has gold plated contacts and a stainless steel ball for best possible corrosion protection and contact, price ex UK Vat £3.30

Again, KO-ON offers a very nice quality sealed switch 6 way 2 channel at £90.65 each

STANDARD ELECTROLYTIC CAPACITORS Good quality standard industrial types

Value	Voltage	Size	Price Ex UK Vat
100mF	10volt	18x6 mm axial, 11x7mm radial	0.23
100mF	16volt	15x6 mm axial	0.29
220mF	16volt	11x8 mm radial	0.31
220mF	40volt	13x10 mm radial	0.42
100mF	63volt	13x10 mm radial	0.47
4700mF	16volt	38x18 mm radial	0.82
2200mF	50volt	35x18 mm radial, 41x16 mm axial	0.87
10mF	160volt	15x10 mm radial	0.56
22mF	350volt	25x12 mm radial	1.25
22mF	450volt	41x16 mm axial	1.89
47mF	385volt	25x21 mm radial	2.16
56mF	400volt	30x21 mm radial	2.37
68mF	400volt	30x22 mm radial	2.68
100mF	400volt	30x25 mm radial	3.26
220mF	385volt	52x30 mm radial can	4.45
220mF	450volt	40x30 mm radial can	5.85
220mF	550volt	112x35 mm radial screw terminals	27.65

RCA, BNC, BANANA PLUGS, RCA SOCKETS, SPEAKER & GROUND TERMINALS & LOUDSPEAKER SPADES

RCA Plugs

Standard Gold plug	1.55
AN-C Gold plug	3.65
AN-GP AUDIO NOTE gold plug	8.51
AN-P **AUDIO NOTE** Silver plug, teflon insulated, non-magnetic	25.53

RCA Sockets.

Type	Mounting	Price Ex UK Vat
RCA socket nickel plated	Chassis mounted	0.41
RCA socket gold plated	Chassis mounted	0.65
AN-CS **AUDIO NOTE** non-magnetic, teflon insulated socket, gold plated	Chassis mounted	3.65

BNC Plugs & Sockets

Type	Price ex UK Vat
Standard BNC plug	3.45
BNC Silver plated socket chassis mounted	2.05

Banana Plugs, Loudspeaker Cable Spades, Chassis Loudspeaker Terminals

Type	Price Ex UK Vat
Banana plug, gold plated, spring loaded tension	2.45
AUDIO NOTE Loudspeaker Cable spade, silver plated, non-magnetic	4.65
AUDIO NOTE AN-STSpeaker Terminal, chassis mounts, nickel plated, red or black	1.85
AUDIO NOTE AN-ST/G Speaker Terminal, chassis mounts, gold plated, red or black	2.75
AUDIO NOTE AN-STR Speaker Terminal, chassis mounts, fully gold plated, non-magnetic, red or black4	75
Ground Terminal, chassis mounted and nickel plated	1.45

Our range of components is constantly expanding, as we find new or better suppliers, so stay in touch by reading our adverts in Hifi World and Hifi News

FERRITE RINGS.

In many systems, especially ones using transistor based amplification there is often a problem of incoming RF mixing into the feedback loop, especially from connected CD-players, clamping a ferrite rings around the cable between the CD-transport and the DAC or the output of the DAC or CD-player and the pre-amplifier input yields surprising results

A set of two Ferrite rings costs £8.50

AUDIO NOTE COMPLETE KITS.

We are developing a range of complete kits, to give those of you who have the ability, but do not have the time to develop a project from the ground, so to speak. Inorder to be able to offer the best possible quality – price relationship the kits we offer will be good basic circuits, with no-frills power supplies and components, all kits have input volume control to allow use of a single source, like CD-player direct in

KIT ONE.

Based around the justly famous 300B directly heated triode, we see this kit as the introduction to real Audio Amplification, as it covers all the important aspects of design necessary, Single-Ended, No-Feedback, Class A, Directly Heated Triode, to become a member of this exclusive club of amplifiers

Kit One has one 300B per channel running at 420 volts with 75mA current giving 9/10 watts of the cleanest power you will ever hear, the inputstage consists of a 6SN7GT with a 5687 double triode driver stage running in SRPP. The power supply is a capacitor-choke-capacitor with a 5U4G HT rectifier, the heaters are AC heated. Component quality is similar to our Level 2 finished products. AUDIO NOTE paper in oil signal capacitors, Beyschlag 1watt 1% metalfilm resistors, good quality electrolytics (sorry NO Black Gates!) and a simple, attractive stereo chassis in grey paintwork. Protecting cover is extra

Price £750.00 incl. Vat, which includes all valves (yes, also the 2 x 300B needed) but not postage/packing which to UK customers is £12.00, topcover is £99.00 extra. The Kit One is available now

KIT TWO.

Kit Two features a single 6550WA Sovtek tetrode running in Single-Ended mode, yielding some 17 watts of pure Class A, valve rectified HT for the output stage, stereo chassis, and 6SL7GT input and 6SN7GT SRPP driver stage, componentry and chassis as Kit One

Price £599.00 incl. Vat, includes valves, but not postage/packing, cover is extra at £99.00. Available in June 1994

KIT THREE.

Kit Three features 2 x 300B per channel running in single-ended parallel yielding 16/17 watts in pure Class A, this kit is on two mono chassis with valve rectified HT supplies, no signal feedback, it uses a 6SN7GT double triode as input valve and a pair of 5687 double triodes running in SRPP as drivers

The KIT THREE is essentially a mono version of the KIT ONE with double the power, the same component choices and on two chassis instead of one

The KIT THREE costs £1,450.00 and will be available in March 1994

Write to,

AUDIO NOTE (UK) Ltd. Unit 1, Block C, Hove Business Centre, Fonthill Road, Hove, East Sussex, BN3 6HA, England. Telephone +44 0273 220511 1. fax +44 0273 731498. Direct Line to sales +44 0273 885511 1

HUNGARY please contact, Merlin Audio, 54, U. Raday tsz 2, H-1092 Budapest, HUNGARY, Tel/Fax 01 215-2612

HOLLAND please contact, de Jong Components, 2 Reggestraat, NL-5704 MT Helmond. Tel 0492014661 Fax 14773

Tel. +44 0273 220511
Fax. +44 0273 731498
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Audio Note

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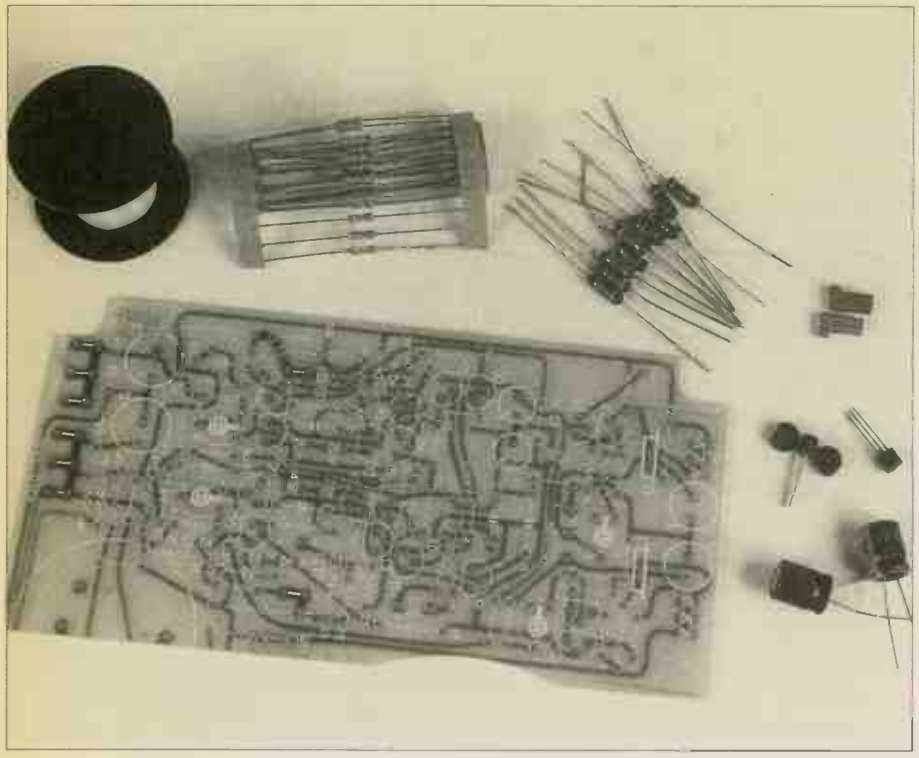


The HART Guide to PCB Construction.

Want to learn how to solder? Hart have put together a kit to help the beginner.

The art of soldering is a skill that relies entirely on practical experience. You can read about soldering techniques or get advice from friends, but until you actually hold an iron in your hand and start to melt the solder into place you haven't started learning. Recognising the increasing interest in DIY hi-fi kits and projects, and the ever rising numbers of people who want to have a go at building them, Hart Electronic Kits have just added a new product to their range - a Guide to Printed Circuit Board (PCB) construction.

For £4.99 + £1.50 p&p you get a five page booklet describing what tools you will need, e.g. soldering iron and snips, the general practice of soldering and then in more detail how to solder different components: resistors, diodes, presets, axial capacitors, transistors, radial capacitors. But most importantly, you get something to practice on. Supplied in the kit are a handful of components, a practice PCB and some 22swg (standard wire gauge) solder.

The instructions are clearly written and easy to understand, although a little further explanation wouldn't go amiss in some instances. They cover everything you need to know about PCB assembly and even describe the hierarchy of component insertion. Components are inserted smallest first, so that when the board is overturned for soldering they are pushed firmly against the board. Hart recommend that the board is overturned onto a book for soldering, but I always find a dry foam dishcloth, which has a little more give in it, holds the components against the board better.

The components shouldn't be standing proud of the board on their component legs for a number of reasons. Firstly, the wires standing up on the board act like miniature aerials, receiving RF interference, which can prevent some projects working altogether and is undesirable for high quality audio projects. Secondly, the components shouldn't be supported by their legs, the component body should be supported by the board and the lead out wires soldered for electrical contact only, rather than for mechanical support. If you solder your boards in this manner, they will be strong and more resistant to vibration and other forms of abuse. In some cases however, components have to be held clear of the board, say power resistors, which would otherwise scorch the board's surface. In these instances, the components should be supported with ceramic tubes over the lead out wires.

To test its worth, I decided to give the kit to a complete novice and see how they got on. If, after a couple of hours reading and soldering, they could complete a neatly and accurately soldered PCB, then the kit would prove its worth. The guinea-pig for this had to be someone who had never soldered anything before, someone who would describe themselves as a technophobe. Our marketing manager, Richard Johnson, a man who, last time he tried, took 40 minutes to wire a plug and then fused the house, was the ideal candidate.

PROVING ITS WORTH

After an hour or so, Richard presented me with a board. Although possessing some knowledge of the difference between a capacitor and a resistor, he did have difficulty working out what the circuit symbols were for each component. So, the board had some resistors soldered where diodes or capacitors should have been and vice-versa. Having said that, the board was very neatly soldered, with only the occasional messy joint. It had taken around an hour for Richard to solder all of the components in, which is a long time for the handful of components supplied, but by taking his time the result was surprisingly good for a first effort. Some of the components were a little high off the board, and he'd burnt himself slightly trying to melt the solder and manipulate the hot wires with his fingers, but even a professional finds a couple of components on each board that need to be held into place.

The Guide to PCB construction isn't for the complete novice. For someone who's been reading up on the theory of electronics, can follow a circuit diagram, recognise components and their symbols, the Guide to PCB construction allows them their first hands-on experience. For the complete novice this guide is of little use, since it explains how to solder components to a board without explaining what they look like or where they should go. Read up on the basic theory first and learn what the components look like, their basic operation and their circuit symbols, then have a go at this before you start your project and you should have every chance of completing a neatly soldered working project with the aid of this kit ●

Hart Electronic Kits,
Penylan Mill,
Oswestry,
Shropshire.
Tel: 0691 652892

World Radio History

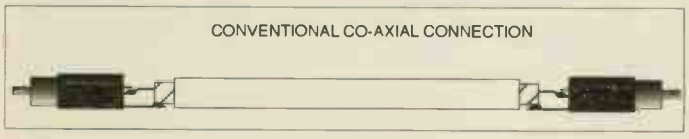
MAKE YOUR OWN INTERCONNECTS

Dominic Baker shows you how.

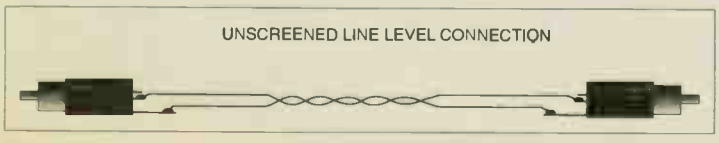
Everyone knows the importance of good interconnects these days, I'm sure you've all heard the oft-used phrase "your system is only as good as its weakest link". Of course, shortly after this phrase was invented we were hit by a barrage of expensive 'bits of wire', and the weak links became the hi-fi equipment in between the cables.

So, how far do you go? Is copper good enough? Is silver plated copper worth the extra? Is pure silver as good as everyone says? Well a lot will depend on your system, but for the DIYer there is a cheap way to experiment and save money - build your own.

There are three basic configurations of construction for interconnects. The most common uses a conventional co-axial type cable. The centre core is connected to the centre pin of the phono plug, and the screen soldered to the outer barrel. This method is cheap, easy and offers a degree of protection from interference and such-like afforded by the screen. ▼

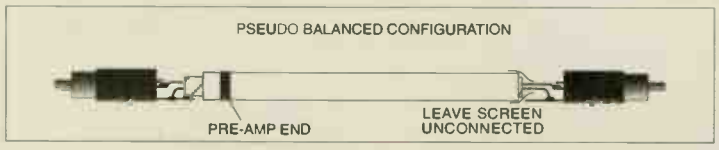


A simpler method is to simply twist two unscreened, but insulated cores together and solder them to the phono plugs. Get a friend to hold the two strands whilst you twist them with a drill. This gives the most consistent and professional finish. This cable will be unscreened, and therefore should only be used for line (high) level signals over short runs (say, less than 3m). Because of its simple construction it is relatively cheap to use silver plated copper or pure silver strands for this type of interconnect. The construction uses high quality cable for both 'hot' (+) and 'cold' (-) signal paths, so sonically it is very good. ▼

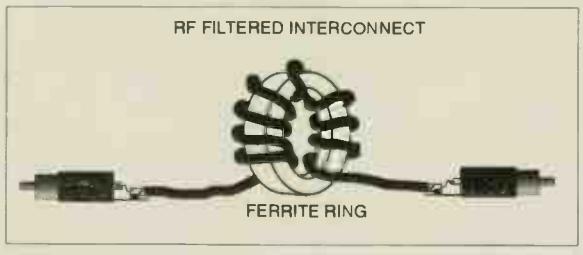


The third type of construction is a pseudo balanced configuration. Here, there are two cores inside an overall screen. At the pre-amp end the screen and one of the cores are soldered together to the phono plug's outer barrel, the remaining central core to the phono plug centre pin.

At the other end construction is similar, but the screen is left 'floating' and is insulated from the plug barrel with heatshrink. This type of connection has lower noise than the co-axial type and because a high quality core is used as the 'cold' or '-' connection to the barrel rather than the lower grade screen braid, this combines the sonic advantages of the unscreened cable, with the screening properties of the co-axial type. ▼



If you are using either a thin twisted pair of unscreened wires, a thin co-axial or thin twin core co-axial, a few turns of the cable can be wrapped around a ferrite core to form a simple 1:1 transformer. This means that anything that is common to both screen and centre core, such as RF noise, will be cancelled out. This is a cheap trick that is very easy to implement and can make a system sound considerably smoother and cleaner in the treble. ▼



It is wise to always use silver solder when making interconnects. Silver solder is a much wetter solder than the normal tin/lead type, making it virtually impossible to leave a dry joint. It also makes a far stronger mechanical join, which is especially important for interconnects that will be pulled in and out regularly.

Another useful tool is adhesive heatshrink. This plastic tubing shrinks when heat is applied and the glue inside melts. It can be used to mechanically join the cable to the plug so that the cable doesn't break where there is most stress.

There is no general method for making interconnects, much will depend on the cable and plug type you choose. It usually takes me a couple of attempts to decide on the best way to terminate a particular plug to a particular cable, so be prepared to have more than one attempt. But once you've sorted it out you should be able to solder up your own super quality interconnects for a fraction of the price of a finished cable ●

Sources:

Maplin Tel: 0702 554161
Copper, silver plated copper and silver wire as well as silver solder, gold plated phono plugs, adhesive heatshrink and ferrite rings.

AP Electronics Tel: 0332 674929
Silver plated copper and pure silver wire.

Wollaton Audio Tel: 0602 284147
Suppliers of high quality XLO cable and plugs.

Audionote Tel: 0273 220511
Audionote cable and silver plated copper.

World Radio History

Hart Audio Kits - Your Value for Money Route to Ultimate Hi-Fi

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Hart Audio Kits and factory assembled units use the very best audiophile components in circuit designs by the renowned John Linsley Hood to give you unbeatable performance and unbelievable value for money. We have always led the field for easy home construction to professional standards, even in the sixties we were using easily assembled printed circuits when Heathkit in America were still using tagboards!. Many years of experience and innovation, going back to the early Dinsdale and Bailey classics gives us incomparable design expertise in the needs of the home constructor. The current range of Hart kits is designed to give you the important core components of a system as a matching ensemble of audio excellence

1100 Series. LH80W "Audio Design" Mosfet Power Amplifier.

Another masterpiece from the drawing board of John Linsley Hood and another opportunity to give a system mega sound performance for only a few hundred pounds cost. A host of advanced features, in the hands of the skilled designer, give this amplifier a performance that really is only equalled, not exceeded, by the 4 or 5 figure price tagged exottica.

As always with a HART kit you have the pleasure of building selected, state of the art equipment, allied to the knowledge that your money has all been spent on quality components, you save all the costs of building and testing, plus the dealers margin on top of these by doing it yourself!.

To give an idea of the measures taken to achieve ultimate quality and linearity in this amplifier each of the four output devices is only called upon to work at one NINETY-SIXTH part of its ultimate power rating.

We are proud to offer this latest John Linsley Hood masterpiece, the flagship of our range, which we believe is truly the ultimate design for the perfectionist, combining as it does the best circuit design, the best engineering and the best components, surely the only recipe for REAL sound fidelity. The HART KIT concept also makes it possible to build an amplifier with the facilities YOU want and we offer no less than three variations with options on the basic theme to suit your needs. One of these versions will, we feel sure, cater for your requirements. Should your requirements change at a later date then upgrades or alteration to a different version are no problem, try doing that to your High St store amplifier!.

The Standard version has a passive input selector circuit with Alps Precision Low-noise volume and balance controls, switchable CD, Tuner and Pre-amp inputs and an optional stereo bargraph output level display. The 'Slave' version has stereo power amplifiers and standard power supply. The 'Monobloc' version again has the standard power supply but since it is only driving one power amplifier higher than normal output power is achieved with total channel separation. The slave and monabloc versions enable very sophisticated bi-amping and active crossover systems to be constructed.

K1100 Complete STANDARD Amplifier Kit, two power amplifier channels and one power supply module, direct input passive signal selector stage, Construction Manual and RLH11 Reprint.
SPECIAL DISCOUNT PRICE FOR COMPLETE KIT IS ONLY**£395.21**
A1100 Factory Assembled **£499.21**

K1100S Complete SLAVE Amplifier Kit, as above but without passive input stage.
SPECIAL DISCOUNT PRICE FOR COMPLETE KIT IS ONLY**£333.62**
A1100SC Factory Assembled **£422.62**

K1100M Complete MONOBLOC Amplifier Kit, consists of all parts for one power amplifier
channel and one power supply module and all chassis parts.
SPECIAL DISCOUNT PRICE FOR COMPLETE KIT IS ONLY**£261.20**
A1100M Factory Assembled **£329.20**

All HART kits are designed for easy home construction to the very highest standards, and can be built by anyone of average manual ability. If you are still not convinced how easy it is to build it yourself with a HART kit you can order the Instruction Manual to read for yourself and we will refund the cost when you buy your kit!.

PROBABLY THE LAST VINYL PREAMP YOU EVER BUY.

For those who love the vinyl medium the listening pleasure can only be enhanced by using the very best phono preamplifier available. The Hart range of phono preamps feature a special shunt feedback circuit topology and are designed by John Linsley Hood. This circuit format gives audibly superior sound to the standard series feedback system normally used and gives a performance that will exceed or equal that given by the best of the mega priced offerings. Our range includes units to suit everyone from the occasional user to the serious audiophile. All can be changed to suit moving coil or moving magnet cartridges at the flick of a switch.

K1500 Series. This is an integrated circuit version of the shunt feedback concept, using so little power that it may be run from

batteries. An ideal "first kit" project as it is very simple to put together and no mains voltages are involved.
K1500 Complete Kit With Full Instructions
(Battery Powered) **£73.76**
A1500 Factory Assembled **£118.76**

K1450 Features a totally discrete component implementation of the Shunt Feedback concept. Audiophile grade components fitting to an advanced double sided printed circuit board make this a product at the leading edge of technology that you will be proud to own. Nevertheless with our step by step instructions it is very easy and satisfying to assemble. Due to the higher current consumption this unit is powered by our mains driven K1565 Audio Power Supply, itself an advanced piece of technology in a matching case. This supplies the superbly smoothed and stabilised supply lines needed by the preamplifier and features a fully potted Hi-grade toroidal transformer along with a special limited shift earth for hum free operation. Suitable for all moving coil and moving magnet transducers this unit is especially recommended for, and will extract the very best from the modern generation of low output high quality transducers.

K1450/1565X. Complete RIAA Phono preamplifier, Power Supply and power connect cable Kit form ..... **£196.29.**

1450/1565X Factory assembled & tested. ..... **£285.29.**

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On the motorised versions the 5v DC drive motor is coupled to the normal control shaft with a friction clutch so that the control can be operated manually or electrically.

Our prices represent such super value for pots of this quality due to large purchases for our own kits.

MANUAL POTENTIOMETERS

2-Gang 100K Lin **£15.67**
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Are you sure your tape recorder is set up to give its best? Our latest triple purpose test cassette checks the three most important tape parameters without test equipment. Ideal when fitting new heads A professional quality, digitally mastered test tape at a price anyone can afford.
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Top quality, Full Digital (DDD) Compact Disks of the great classical favourites. Like everyone else we didn't like the idea of paying silly prices for CD's. After a long search we have now located a source of top quality classical recordings at prices that make you suspect the quality - until you try them! Send for our list of titles.

TECHNICAL BOOKSHELF

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J.L.Linsley Hood.
Just Out! Hot Off the Press, the definitive electronics and audio book by the renowned John Linsley Hood. This 300+ page book will give you an unparalleled insight into the workings of all types of valve and solid state audio circuits. Learn how to read circuit diagrams and understand amplifiers and how they are designed to give the best sound. The virtues and vices of possive and active components are examined and there are seporate sections covering power supplies and the sources of noise and hum. As one would expect from this writer the history and derivation of audio amplifier circuitry have an entire chapter, as does test and measurement equipment. Copiously illustrated this book is incredible value for the amount of information it contains on the much neglected field of linear, as opposed to digital, electronics. Indeed it must be destined to become the standard reference for all who wark, or are interested in, this field.

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Don't forget most of our kits have reprints of articles by John Linsley Hood that you can purchase seporately.

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2nd Edition. Baert, Theunissen and Vergult. (SONY Europe)
A thoroughly well written book covering the field of recording media starting with the Phonograph right through to modern professional PCM digital recording systems with particular and extensive coverage on the compact disc. All aspects of the recording and reproduction processes are explained with seporate chapters on such things as compact disc encoding and the use of cross interleave Reed-Soloman error correction code (CIRC). This book is of course essential reading for engineers and students involved in the field but its very low prices makes it ideal for the enthusiast of recorded music who wants to know more about the hidden processes going on his CD player.
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All the information you need to build the loudspeaker system you've always wanted but could not afford. Easy ways to pick the exact box size, the ideal drivers, and the correct way to feed the music to your new super loudspeaker system. Over 140 pages packed with important design data.

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Postage on Single Books is £1.50 except for The Art Linear Electronics, Digital Audio and Compact Disc Technology and The Loudspeaker Design Cookbook which are £3.50. Two, or more books are only £4.50, any size, any quantity.

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1947, Reprinted 1990. 40 Pages.
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LOUDSPEAKERS; THE WHY AND HOW OF GOOD REPRODUCTION. G.A.Briggs This easy-to-read classic, last revised in 1949, introduces the reader to concepts such as impedance, phans and decibels, frequency response, reponse curves, volume and watts, resonance and vibration, cabinets and baffles, horns, room acoustics, transients, crassovers, negative feedback, Doppler and phase effects, and much more. A provocative survey of the right questions about sound reproduction.

1949 Reprinted 1990. 88 Pages.
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World Radio History

WILMSLOW SPL-1 SPEAKER KIT

Built and listened to by David Harris.

Wilmslow Audio have been producing loudspeaker kits for many years now, most of which are larger than the small, two-way SPL-1s which retail for £196 plus a £10 carriage charge.

For those people wishing to own a pair, but hesitate at constructing their own, Wilmslow will assemble the SPL-1 for an extra £30 on top of the kit price.

A full range of spares are available should anything go wrong, and upgrades are offered. If anyone wishes to audition the finished kits, they can do so in one of Wilmslow's four demonstration rooms.

THE SPL-1 LOUDSPEAKER

This is a small two-way reflex design with an internal cabinet volume of 11 litres. It uses a Morel MW142 bass unit which has an unusually large voice coil (75mm in diameter) which surrounds the magnet, and a damped polymer composite cone. The high frequencies are delivered by a Morel MDT29 28mm soft dome tweeter, which receives its signal from a high quality crossover circuit incorporating Solen polypropylene capacitors and air cored inductors for maximum sound quality.

The sturdy 18mm thick MDF panels were machined very accurately in the kit I built, fitting together very neatly - a characteristic I'm sure is shared by their other kits. The instructions supplied were fairly easy to follow, though might prove difficult for a complete novice who has never seen inside a loudspeaker before or possesses no understanding of electronics whatsoever. Still, I don't think Wilmslow have aimed their kits at the complete novice and I doubt if such a person would want to build a pair anyway.

CONSTRUCTION

The first thing I did was to check that everything was there - nothing's worse than discovering that a binding post is missing minutes away from completion!

World Radio History

Everything is supplied with this kit, right down to grille cloth and fixings.

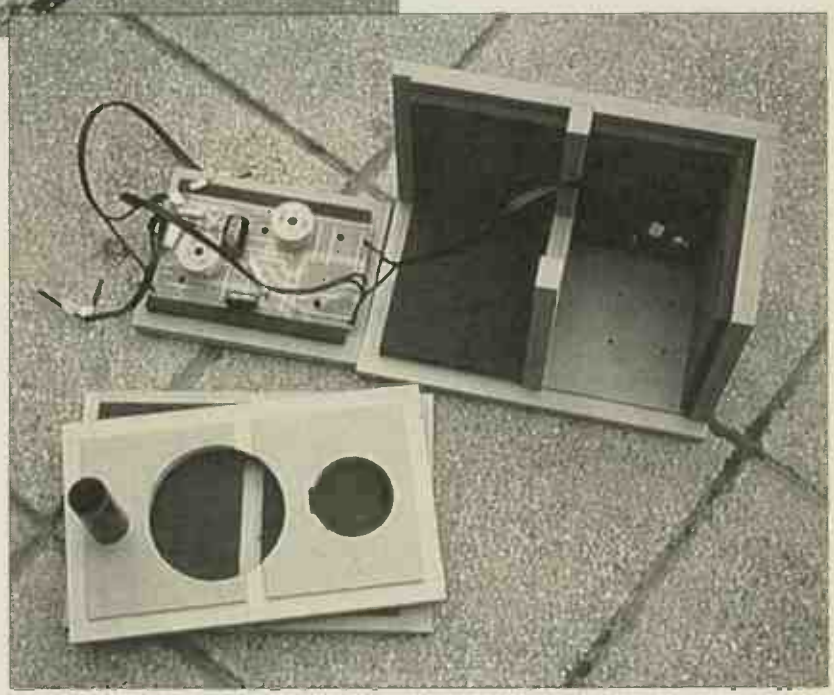
Secondly, I soldered the crossover components to the PCBs supplied and divided the connection cable into eight even lengths which I then soldered to the circuit boards. I checked, double-checked and finally asked Dominic to check the made up crossovers against the printed diagrams in the instructions before screwing them inside the top of the cabinets.

NOTE: There is only just enough room inside the cabinet for the crossover, so make sure that the leads to the drive units and the binding posts do not stick out past the ends of the circuit board too much (as mine did originally), or you'll have difficulty in squeezing them in. It's also a good idea to label and tin the ends of the leads in advance, or it'll be more time consuming later.

I then cut the supplied acoustic laminate to size, using a ruler and sharp knife (Warning: Always cut away from your body and precious fingers). This gives a nice accurate cut, but did cause problems with the blade continually 'gunging' up, making it sticky and more difficult to use. Keep checking that they are correctly sized by holding the panels together, before removing the protective paper on the self-adhesive backing and sticking them in place. When this is done, the made up crossovers can be screwed to the top panel, the screws going through the acoustic laminate and self-tapping into the MDF, then the cabinets are ready to be glued together.

I found that the easiest way to do this is to first lay the front baffle board (with the port already in place) face down on a flat surface and put into position the top, bottom and side panels, with the centre brace helping to align everything. Removing one side panel at a time, I then squeezed a trail of Evo-stik Resin 'W' wood glue (not supplied) along the three recesses to make contact with the top, bottom and brace pieces.

After doing this for both side pieces (the front baffle still keeping everything in alignment, although not yet glued to anything) I wrapped two lengths of stretched carpet tape around the cabinet to pull the panels tightly together. I then lifted everything off the front baffle, being careful to keep the shape, (watch the central brace - it may slide out) and put a trail of glue on the baffle's recesses before attaching the remaining taped-together cabinet, which then experienced a similar amount of stretched parcel tape to press everything firmly together. That doesn't sound like an 'easy' way, I hear you say. Okay, there are probably easier ways, but this gives an accurate construction and minimises 'glue-drip'!



It is best to fix the crossover and panel damping before gluing the cabinet together.

"The two drive units integrate well to produce an open, transparent midrange."

The cabinets were left to dry for several hours, then the 'Tessamel' strip was cut to length and stuck to the flange of the recessed panel for the bass/mid unit. Both bass driver and tweeter were then soldered to the labelled connection leads and screwed tightly in place. Before glueing the back panel to the rest of the cabinet, the loudspeakers were tested to

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Apply an even layer of glue to the cabinet seams.

check that they were working correctly, fortunately all was well. It would be extremely difficult to remove (and replace) the crossover circuit once the entire cabinets have been stuck together, so it is most important that everything is working properly before finally assembling them.

The soft dome tweeter protrudes from the front baffle and it would be crushed if the speakers were to rest face down on a flat surface, so in order to fit the back panel, which required some force, I doubled up the grill frames and rested the speakers (one at a time) face down on them to protect the tweeter. After connecting the cables to the correct binding posts and inserting the gameted acrylic waste into the top half of the cabinets, the back could then be fitted. In my case, the back was such a tight squeeze that I had to gently and carefully tap it into place with a hammer. Again, a lot of stretched parcel tape ensured that a good strong join was made between the MDF panels.

Several hours later when the glue had fully dried the speakers endured a running in period as suggested by Wilmslow before their sound quality could be properly assessed.

Use stretchy tape to pull the cabinet firmly into shape and leave to dry.

SOUND QUALITY

The most striking aspect of the SPL-1s is their ability to create a soundstage of such great width and depth that it completely belies their size. Their imagery is excellent, vocalists appear in the centre so convincingly that you cannot comprehend the fact that their voice is coming through the speakers, creating a real sense of presence in the music.

They kick out a reasonably powerful bass which has a certain amount of warmth to it without sounding bloated, the SPL-1s exercise great control as far as low frequencies are concemed. The huge toms heard at the end of Private Investigations by Dire Straits had an impressive amount of scale and power, again giving the impression that larger speakers were performing. Listening to a Seal CD proved to me that the bass could sometimes be a bit overpowering, although this might be attributable to the recording in this case.

The two drive units integrate well to produce an open, transparent midrange. Vocalists keep that real human quality of 'breath' that many other speakers fail to provide. Occasionally I thought that the midrange was a little harsh; violins could glare at you rather than play to you. This was less apparent with vocals, which mostly sounded unstrained and had a good quality of freedom to them. Pianos had a warm, full presentation and came across quite to scale, a factor that is seldom seen in loudspeakers of this size.

The treble got progressively smoother as the speakers ran in, but was still sounding quite sharp when I listened to them. The MDT29 tweeters gave a lot of insight into the detail of the music, complementing the middle frequencies with a fine amount of clarity. Cymbals 'rang' quite naturally, but did seem a touch lightweight in presentation.

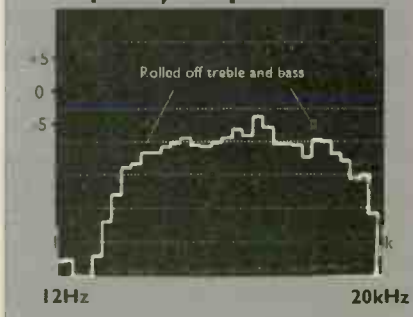
For just over £200 and about 4 hours work the SPL-1s offer high quality at a relatively low cost for the DIY enthusiast. As well as the satisfaction gained from constructing them yourself, I think you'll be equally happy with the level of sound quality at this price level ●

MEASURED PERFORMANCE

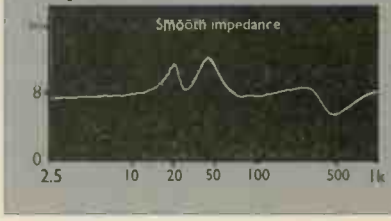
The SPL 1s have an interesting measured performance. The frequency response is strongly biased towards the midband with rolled off treble and bass. I would expect them to have a soft treble and light bass as a result, although the bass may be bolstered well by near-wall placement. I would expect the SPL 1s to have a forward midrange and the peak in the midband around 1kHz may also add a little hardness to instruments such as violin.

The impedance curve is a smooth one hovering around 5-8Ω throughout the majority of the audio band, only dipping low (3Ω) in the treble. But sensitivity, measured using a nominal watt (2.83V) of pink noise and at a distance of 1m, was desperately low at 83dB. A large and powerful solid state amplifier will be required to get decent levels from the SPL 1s. **DB**

Frequency Response



Impedance



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se105	2K6/43% UL	110mA	25W	parallel EL34, 300B	£68.14
se106	10K0	75mA	50W	211	£166.85
se201	1K25	150mA	30W	parallel 2A3/300B	£82.24
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pp104	5K6	100mA	25W	EL34	£60.51
pp105	7K0	100mA	30W	EL34	£62.28
pp106	4K0	100mA	30W	EL84	£62.39
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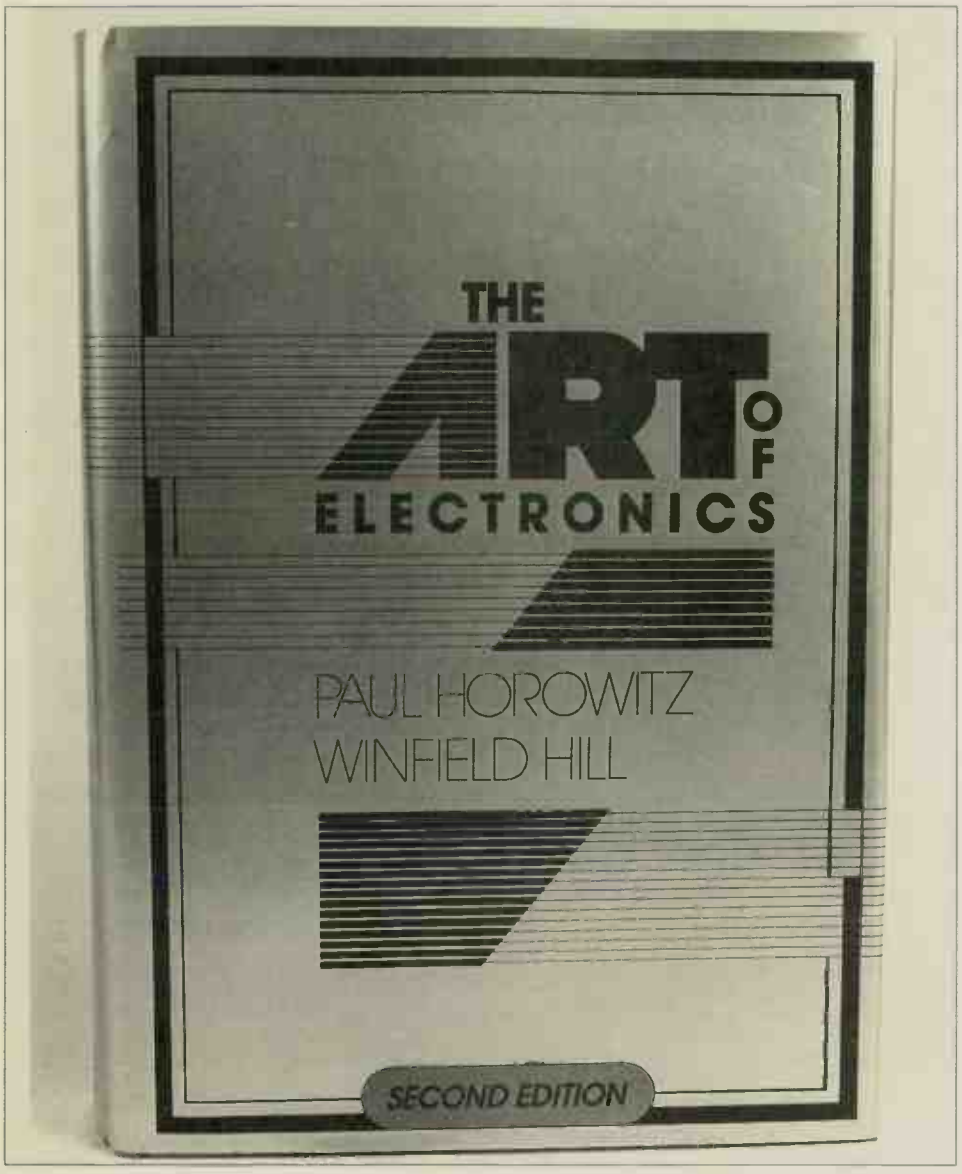
The Art of Electronics

Paul Horowitz and Winfield Hill, Cambridge University Press, reviewed by Dominic Baker.



I first came across The Art of Electronics whilst studying at Salford University. At the beginning of term the tutor gave out a list of books that would be required for the course. There were several on each topic we were to cover, some with quite obscure and bizarre titles. But at the bottom there was The Art of Electronics, described as the essential general electronics book for all engineering students. And how right they were.

The Art of Electronics is by far one of the most useful, understandable and practical books on the subject of electronics I have ever come across. I have my battered copy sitting on the bookshelf, and it is regularly called upon.

The book is written in plain English, albeit with an American accent, since this is a U.S. publication. Credits link Paul Horowitz with Harvard University and Winfield Hill with the Rowland Institute of Science, Cambridge, Massachusetts.

The first chapter, Foundations, covers the basic principles of electronics such as the meaning of voltage, current, resistance and what have you. It then moves on to passive components and how they are used to form the basic building blocks used in all electronic circuits. Foundations goes further than just this, giving the novice a thorough background in many other important areas they will come across in later chapters.

Following Foundations are ten chapters that go into greater depth on various electronic topics. Chapter 2 starts with the basics of transistors, from a simple transistor switch through the common configurations like emitter follower and common emitter, as well as covering biasing and other key techniques of transistor application. By the end of the chapter the reader should be familiar with amplifier building blocks and have a good understanding of how transistors work.

In a similar fashion, Chapter 3 continues with Field-Effect Transistors (FETs) and by Chapter 4 enough theory has been covered to enable the principles of feedback and the function of operational amplifiers to be approached. Chapter 5 then shows how transistors and op-amps can be used to make active filters and oscillators. The book progresses on like this right up to Chapter 11, where it reaches microprocessors.

The way the book builds up from the initial Foundations chapter, following on from one topic to use the information in the next, is the key to its success. A lot of thought has obviously gone into structure, so if you read the book in order, whenever a new topic is approached, the background is already in place. Additionally, at the end of each chapter, there are circuit ideas, good and bad, demonstrating what will actually work in practice and what won't.

The final four chapters have a much more practical bias, with advice on circuit board fabrication, construction hints, power supplies, and measurement. But it's not over yet, because the appendices describe how an oscilloscope functions, has some basic maths, resistor colour code charts, how to draw schematic diagrams and load lines etc, etc.

This really is one of the most comprehensive electronics books available today, one that everyone interested in electronics, be they novice or professional engineer, should have in their collection; it's a modern day electronics Bible ●

Available from technical bookshops or mail order from Hi-Fi World, see page 101 in the main issue.

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D.I.Y. Letters

ACTIVE CROSSOVER

I've recently been converted to your magazine by the excellent practical advice you give. As a consequence I've had my interest in building some equipment re-kindled. I'd like to start with an active cross-over as I'm at a stage where I'm sorting out pre-amp to power amp interconnects and speaker cables. To save money I wondered if companies supplied cable and plugs to make them up myself.

The rest of the system comprises Meridian CD 208-Deltec Black Slink - Exposure XI Pre-Amp with X11 PSU - 4X Musical Fidelity MA50s - TDL Studio 3s firing down a room with suspended floors and solid walls 22' x 16'.

I like the qualities of silver cables and suppose the natural choice would be to stick with DPA, although I wondered if Silver Sounds would suit my system and allow me to use AudioNote components with the money I saved. I thought 12/2 speaker cable hard wired onto the drivers and 12/3 interconnects hard wired into the cross-overs, the lengths are in pre-amp to power amp to power amp 1.5m and 0.7m and power amps to speakers 1.5m.

I don't have a budget as such, but will need to save more if you feel the system would really benefit from DPA Black Slink and 16. If possible, I would like to open up the midband, smooth the treble and add more scale and detail to the bass. I'm using interconnects as supplied with the pre-amp which I was told by the shop were Exposure's own and the best to use. I was also told the pre-amp would benefit from shorted phono plugs inserted in the spare inputs and mains cabling and earthing care was essential. Could you help me with this?

I would appreciate any help you could give me or any books you could recommend on cross-overs (active) and any other areas which might be improved. I'm very pleased with the system so far, but am a bit lost with the cables, as this seems to be quite an ambiguous and elusive subject in this part of the country.

And finally, what directions are open to me on the upgrading ladder? I'd like to hear a Concordant Exillerant which I tried unsuccessfully to audition before buying the Exposures and I'd also like to hear a pair of Pentacolumns. One day perhaps.

Robert P. Littlewood
Leeds.

PS: Do power amps benefit from floor or shelf mounting, as I'm building an isolating table at the moment?

Maplin Electronics (Tel: 0702 554161), who are a large mail order supplier of electronic components supply the cable and plugs you would need to make your own interconnects. They sell pure silver screened interconnect cable for £16/mono metre, silver solder which makes the best contact to the plug for £7.90/metre, Gold plated phono plugs for between £1.60 and £2.20 each and adhesive lined heatshrink for £3.95 for a 1.2m length which will ensure that the plug and cable don't separate under stress.

Solid silver interconnects certainly do seem to smooth treble and increase midrange detail and presence, so I think that these should fit your system quite nicely.

If you are looking at building an active crossover there is really only one book you need, the Active-Filter cookbook by Don Lancaster. This contains all of the relevant theory and practical advice. It is available by Mail Order from The Modern Book Co, Tel: 071 402 9176. DB

HOW ABOUT A HORN?

I have taken Hi-Fi World for the past three months and I must applaud you for encouraging your readers to have a go at building it themselves. I thought the 1980s had killed of this fruitful pastime. The pursuit of DIY guarantees the esoteric.

A couple of questions. My speakers are Spendor S100s, driven by an Audiolab 8000P. After reading your review of the Sugden A21a, I was interested and contacted Sugden who said, at 20 watts, it would not drive my speakers effectively. Yet, the valve brigade are adamant that a 15wpc valve amplifier would walk away with the job. Would Noel care to comment. Sensitivity of the S100s is 89.5dB.

Back to DIY. Having built my own car and having fitted a ▶▶

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kitchen, bathroom, toilet and bedroom I've found you can end up with that which suits both functionally and visually. The great bonus being that it is hardly likely that anyone has precisely the same.

As you have started the ball rolling, how about starting a new wave 'lunatic fringe?' I refer, of course, to the building of horn loaded speakers. (Mr. G. Welford of Billingham I hope you read this.) Over the years, there have been numerous designs published in the hi-fi press. But three have always stayed in my mind. Firstly, the concrete variety built into the alcove each side of the chimney breast. Secondly, some enterprising chap used the wall cavity of his house as bass loading. But the third alternative is the most appealing from the domestic and practical stand-point. This entailed slinging a pair of horns underneath the suspended floor.

Come on Hi-Fi World, the gauntlet is down. Thinking caps on. Let us have some theory and background information together with dimensions etc for some gorgeous beasts. Also, of course, possible drive unit line up or should they be used best purely as sub-woofers? A much better arrangement than having a cabinet sub bass unit taking up precious living room.

These speakers are, apparently, guilty of reproducing subterranean bass. A marvellous expression.

Since the late fifties I have always owned a decent system. My collection of music is mostly classical, but I have a good many rock, reggae and pop records.

D.C. Fairbairn
West Yorkshire

The Spendor S100s use a heavy Homopolymer 5" midrange unit and a similarly weighty 12" Bextrene bass driver. They are extremely clean and detailed in their sound, but I'm surprised they are so efficient. Spendor confirmed that sensitivity was 89dB and characteristic impedance nominally 8ohms, so the AU21a would be able to drive them to healthy levels without too much problem. What Sudgen may be worried about is that the AU21a won't have enough power to drive them to party levels though. I'd suggest you get a demonstration first, then you can judge for yourself whether 20watts is enough.

A 15watt valve amplifier would be able to drive the S100s to moderate levels, but you need to check this match first.

We would love to do a horn loudspeaker and have talked at length about such a design many times in the past. To produce a good horn loudspeaker that is easy enough to build for the home constructor, affordable and domestically suitable is, however, dificult and we do have a great number of projects already running that have to be finished first. But we are still giving the matter serious consideration. DB

TURNTABLE COMEBACK

I have not yet seen any comeback on the Origin Live Ultra turntable kit you built and reviewed in the DIY Supplement No. 4 so I thought you might be interested in my experiences with it.

The version I have has the motor mounted on a steel sub-chassis (the steel sub-chassis is well finished, unlike your description of the aluminium version) and features the improved power supply. It also arrived partially built with the motor and power supply circuit in place. Despite this, I still had to level the bearing housing, which sure enough was quite a tricky job needing a little patience to get right and a few readings of the instructions.

When finally built, the Ultra looked very smart and professional in appearance. I fitted an RB300 tonearm and Linn K5 and sat the whole kaboodle on my record box (not ideal but the best I can do in a student flat). My amplifier is a Nait Mk1 with HB1 MkII loudspeakers.

When I finally had everything checked and double-checked I sat down to listen to a few records. To say I was impressed would be a distinct understatement. For the first time an image appeared between the speakers and the copy of

Letter of

VINTAGE EQUIPMENT

I have been a reader of your magazine from its first issue and have read with growing interest your articles on vintage equipment, so much so that I am now the proud owner of Leak Troughline Stereo tuner, Leak TL/12+ and Quad II power amps - all sound superb, especially the Leaks.

However, in trying to locate smoothing capacitors for the Leaks (C13 & 14 - 100/60µF) I have become increasingly confused as to what type to buy. Scouring catalogues etc. there are numerous types of capacitors available e.g. electrolytic, polyester, polypropylene, paper in oil, silver foil, etc., etc. - all purporting to be the best. The original circuit diagrams are no help as they only give values - your kit details do the same. Types of resistors and connecting wiring are also not given. Surely the types of resistors, capacitors, wire etc. must have an effect on the sound?

The RATA upgrade data sheet lists recommended parts, but some values are different to the original ones. RATA suggest 32µF + 32µF Ansar (metallised polypropylene film) for the above whereas Graham Tricker recommends an electrolytic - he reckons the polypropylene would sound too bright and lack bass.

I know as a non-electrical engineer I could just buy upgrade kits from G T Audio but I am intrigued by this issue - which are the best types to go for? (Incidentally I have ordered a pair from GTA - I hope I did right?)

R Bould
Winchester,
Hants.

Our experience with the effect that components have on the overall sound of an amplifier suggests that a combination of several different types of capacitor works best. Others have found likewise. For example, in our 300B design we decided to use a combination of polypropylene and paper-in-oil capacitors. Too many polypropylenes in the signal path made the sound very clean, but also a touch bright and hard. Paper-in-oils add a damping effect on the sound.

In many cases, the value of the capacitor decides what you can use. For example, at low values Polystyrene capacitors seem to be sonically best, but 47nF is about the largest polystyrene capacitor you'll find. Between here and a few

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Hergest Ridge by Mike Oldfield I own which is in bad shape was made listenable. Other albums were fabulous. The Breeders and Shonen Knife got a large injection of excitement and drive, whereas classical was simply a pleasure to listen to. Everything, from instruments to voices was clearly reproduced, even in my temperamental system.

In short I am very impressed with both the sound quality and build of the kit. I think this turntable kit would be hard to better at many times its cost and nothing can better the fun of building and fiddling with something normally so shrouded in hi-fi mystery. So thanks a lot Hi-Fi World for introducing me to this kit and to Mark Baker of Origin Live for being so helpful during panic attacks when building it. And keep up the kit reviews – they're great!!

James R. Breeze
Edinburgh

READER'S DIY SPEAKER DESIGN

I am currently studying design at Sheffield Hallam University and have just recently started reading your magazine with enthusiasm as it seems to be one of the few aimed at the novice DIY hi-fi enthusiast - a category into which I fall, mainly due to my love for music and lack of funds as a student.

My problem, with which you may be able to help, is the vast world of speakers, specifically floorstanders. I wish to build a new pair of speakers. However, most of those on the market that I feel sound competent start from around £500-£600 upwards; my budget is a mere £350.

I have toyed with the idea of a transmission line, but these seem to be something of a black art, so my attention has turned towards Isobariks such as the successful top of the range Linn Keltiks.

I wish to use some Audax 6.5" fibreglass cones, one for midrange, and two assembled for the Isobarik bass. For the treble I had in mind either Audax Titanium tweeters or a SEAS polyamide tweeter (H297). The choice of cones are both performance and aesthetic based. My initial designs using infinite baffle looked quite promising.

However, when reading Vance Dickason's Loudspeaker Cookbook it would seem that the drivers are better suited to ported enclosures. This is where my problems begin. Having two enclosures, one for bass the other for treble/mid, I do not know which should be ported, or if both should be and in what ratio lengths? I am also uncertain as to the Isobarik chamber. This is half normal enclosure size, but does this include or exclude the volume created by the two linked drivers and tube? Also can this enclosure be "tuned" by altering its volume, like infinite baffle, or does it have to remain half Vas whatever?

Would it be worthwhile just remaining infinite baffle (like the Linns)? This would be far simpler as it is only my second Hi-Fi project. However, if the benefits are greater with a tuned port then I am prepared to continue the endeavour with my design.

Finally, another thought occurs when using only two

The Month

µFs (microfarads) polypropylene and paper-in-oils take over. The paper-in-oil capacitors are expensive, but we've found, as I mentioned earlier, that they seem to work well in combination with polypropylene types.

As far as reservoir capacitors go, large values restrict you to electrolytics. Small reservoir capacitors, such as the 32µF ones you were looking for, can be found in polypropylene, but they are expensive and don't have the same influence on the sound as coupling caps. The one major advantage of using polypropylene capacitors in the power supply is that they loose their charge as soon as the power is turned off, making them much safer for DIY than electrolytics that hold their charge long enough to be dangerous.

As far as resistors go, we've found that in most cases plain old carbon resistors have a smooth and detailed sound. Many recommend metal films as being better, but we found that the cheaper ones add a sharpness to the sound. Vishay bulk foils sound superb, but at around £5 each they are expensive if any more than a handful needed.

Graham Tricker at G.T. Audio uses very good quality components that are reliable and most are military spec, so I think you did right. **DB**

You also need to consider what you want to achieve with your Leaks - an improved sound, the original sound or anything passable. The last option is obviously not for you. Do you then want to 'improve' the sound of the Leaks, always remembering that what you think constitutes an improvement may be deemed unacceptable by others, or do you want to restore them to originality, in so far as this is possible? Restoration retains the re-sale value. Ask yourself - would you like to buy a Leak in as-new condition or one that had been got at and modified by someone of uncertain ability? I'd suggest you renovate something that is old, battered and beyond restoration, by using modern components. Otherwise, restore vintage equipment by using original parts in so far as this is possible. Happy hunting. **NK**

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6.5" units in a conventional design. If they are in separate enclosures, one for bass the other mid, could I tune them (by altering cab size) so the mid produces tight focus and the bass is strong/deep? Vance Dickason suggests a Qtc of 0.8-1.1 for bass (around 7 litres) and 0.65-0.8 for focussed detailed sound (around 13 litres for mid/treble cab). Should this be attempted or am I just rambling.

Can you help a stricken student? I eagerly await your comments, criticism or ridicule.

Amendment to the previous letter.

After typing the previous letter to you I have received information on a design for a floor standing Transmission Line speaker using twinned Focal drivers, like the Harman LS0500. I am wary of this design and so would prefer if they were altered to a three way design, retaining the two 6.5" drivers but having one dedicated to the bass and the other the midrange. I would then consider constructing this over the Isobarik design. Using the drivers in the three-way design might alter the cabinet dimensions and construction. Could you advise me as to the possible changes this might have dimension wise when using two 6.5" Focal 6K 412L or 6K 011DBL drivers in the design. I have included the existing design and dimensions when used with Focal 6V415 drivers. Once again I would be grateful for your help and advice.

Adam Norbury
Nether Edge,
Sheffield

You seem more than a little unsure as to which loudspeakers you wish to build, so if you don't mind, I will decide for you. The easiest, and most likely design to give good results would be a three-way using a ported enclosure for the bass, similar to the design in last month's supplement (August 1994 issue). As you seem keen to stick with two 6.5inch drivers I will incorporate these in my suggestions with a suitable tweeter.

The Focal units you suggest are around £60 each, and I suspect that this will put them out of your budget, or compromises would have to be made elsewhere, i.e. tweeter, crossover and cabinets. I'd stick with the Audax 6.5inch units which are easily available and cost a more affordable £25. These give a crisp and detailed sound, but they do break up above 2kHz or so, so the tweeter used should cover the range above 2kHz smoothly.

There are a wide range of tweeters you could select, but the one I'd go for would be the SEAS H398. This is a metal dome tweeter who's sonic character should suit the crisp and lively fibreglass Audax drivers well. Its response is smooth and a simple series capacitor of 15.5µF gives a -3dB point of 1.7kHz.

I ran the Thiele-Small parameters of the bass units through a computer and the plotted the response and impedance curves into a network designer to arrive at the following results:

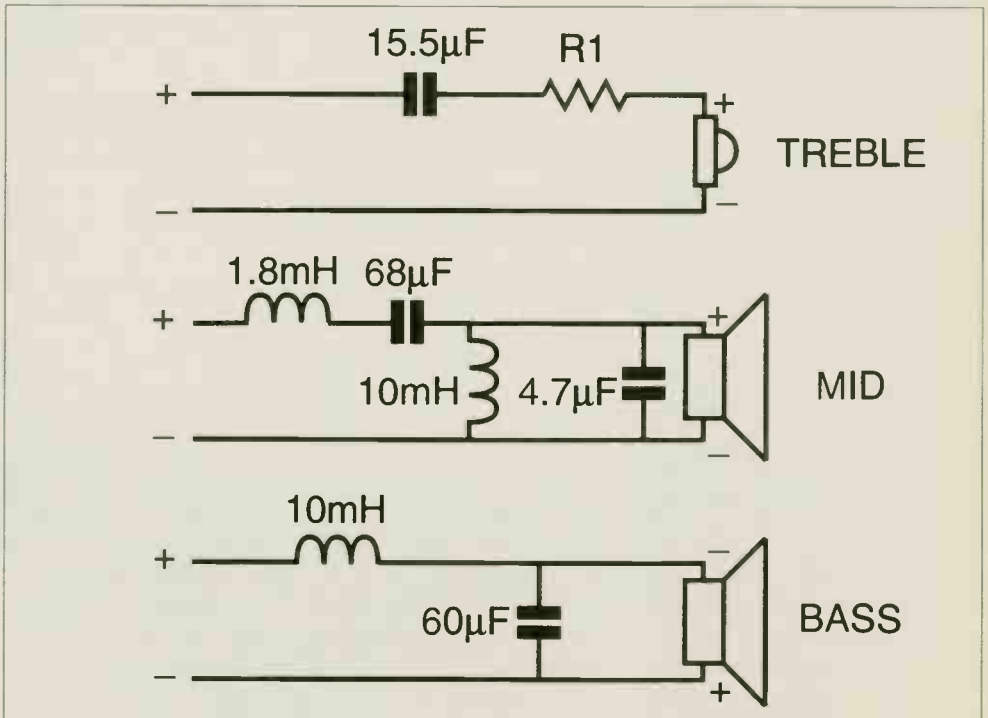
The bass cabinet should be 20 litres internal volume and tuned with a port 2inches in diameter and 4.5inches long. This gives a -3dB point of 40Hz, plenty low enough to play bass fundamentals properly. You can fine tune the port by ear once the 'speakers have been built. Lengthening the port up to 6inches will extend bass further down, but removes the peak which adds subjective punch and speed to bass. Making it shorter, say 4inches, will make the peak stronger, but some depth will be lost.

Use a 3 litre sealed enclosure for the midrange unit. This gives the flattest response down to 200Hz. Make sure that a thick layer of carpet felt is used behind this unit to stop reflections from the back of the enclosure reflecting and passing back out through the cone. The chamber should also be lightly stuffed with long haired wool.

The crossover values I calculated, using a network analyser, are shown in digram below.

The money you'll have saved by using the Audax units rather than the Focals can be spent on high quality components for the crossover. I'd suggest using Solen polypropylene capacitors for the midrange and treble. These give a much more focused and precise sound than reversible electrolytics like Alcaps.

Remember that although these values have been calculated using a combination of computer aided design and practical experience, they will only give you a workable starting point. It may take some time to fine tune them into something you like. If you do decide to have a go at building this design, please write in and let us know how it turns out. Good luck. **DB**



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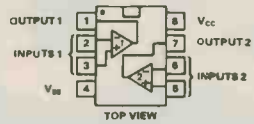

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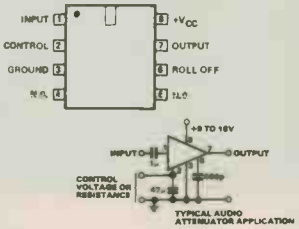

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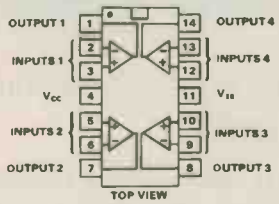

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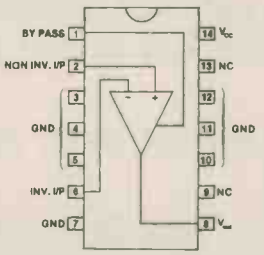

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