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**Kit News**
All the news on new products - valves, drive units and everything to do with DIY hi-fi.

**Class A Power Amplifier**
A unique Class A monoblock power amplifier designed by our in-house team. Using special new transistors, this amplifier offers super quality sound.

**Learn to Solder**
Hart electronics, recognising the increasing interest in DIY hi-fi, have put together a simple kit to teach the novice how to solder. We assess its worth.

**Build Your Own Interconnects**
If you're not quite ready for a kit valve amplifier just yet, why not have a go at building your own interconnects. We show you how.

**Two-Way Kit Speaker from Wilmslow Audio**
David Harris builds Wilmslow Audio's SPL-1 two-way, Morel drive unit loudspeaker kit.

**Book Review**
*The Art of Electronics*
The Art of Electronics could be described as an electronics bible, such is the depth and breadth of its coverage. Dominic describes its impact on his life.

**DIY Letters**
Answers to your problems, be it a speaker design or just some advice on which kit to build.
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- REF PL10 main cable £25.00 per foot
- PRO 16* Chassis hook up wire £1.00 per foot
- REF 16* Chassis hook up wire £10.00 per foot

Connectors
- Neutrik gold plated XLR male £6.00
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- XLO pro phono plugs (4 pack) £25.00
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* Note that the chassis wire is excellent for loudspeakers internal wiring or to replace the jumper connectors used when Bi-wire speakers are used in single wire mode. When using the wire to carry signals of less that 100Hz a double run should be used. High quality preamps should be wired with 16T.

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HI-FI WORLD SUPPLEMENT OCTOBER 1994

World Radio History
A comprehensive radio valve guide

Book 5

Characteristics and Base Connections for English, European, American, USSR and Japanese valves 1960-1963

Including voltage and current stabilisers, tuning indicators, Hvetrons, thystrons, wetlids and colour and black & white TV tubes

RADIO VALVE GUIDES REPRINTED

The original Bernard's Radio Valve Guides (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,
Broadstone,
Dorset.
BH18 8BJ
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
P. O. Box 33,
Corby,
Northants. NN17 9EL
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 converter, 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: 0562 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

HI-FI WORLD SUPPLEMENT OCTOBER 1994

World Radio History
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 Class A amplifiers are 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 36 watts up to 64 watts, 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...
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 cranky 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
WORLD AUDIO DESIGN CLASS A AMPLIFIER

The amplifier is basically an all-direct coupled design, possessing no series capacitors in the signal path, other than an input block. 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.

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 spurious concept - but a top quality solid-state design that offers advanced performance from a balanced, sensitive, yet puny 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

Distortion

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 affect and infect solid state circuits. 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 input 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

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.

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36W Solid State Class A Amplifier

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 TR1/TR3/TR4 the other by TR2/TR5/TR6. TR1 is type BD230 and TR2 type BD231, complementary transistors of wide bandwidth and high gain. TR3/TR4 are type SM0718, TR5/TR6 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.

TR1 and TR2 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 TR1 and TR2 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 provide 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 Shortky 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
Audio valves with famous Brand Names of yesteryear such as MULLARD, MOV, GEC, RCA etc. are in very limited supply and their scarcity also makes them very expensive.

We at Chelmer Valve Company however provide high quality alternatives to these old makes. We have over 30 years experience in the supply of electronic valves of all types and during this time have established close ties with factories and sources worldwide.

For high fidelity use we further process valves from these sources using our specially developed facilities. After rigorous testing - including noise, hum, microphony, post burn-in selection and matching as needed - we offer this product as CVC PREMIUM valves.

A selection of the more popular types is listed here.

### Price list & Order Form for CVC PREMIUM Audio Valves

<table>
<thead>
<tr>
<th>TYPE</th>
<th>UNIT PRICE</th>
<th>QTY.</th>
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*MATCHING, if required; state valve types & if PAIRS, QUADS or OCTETS - Allow £1.00 per valve for this service.

Make CHEQUES payable to:
'CHELMER VALVE COMPANY or pay by ACCESS/MASTERCARD/VISA, give details:

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Expiry
Name
Address
Post Code

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Wilmslow Audio

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- No overdrive!!!

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Wilmslow Audio Limited, Wellington Close, Parkgate Trading Estate, Knutsford, Cheshire, WA16 8DX, England. Tel: 0863 650595 Fax: 0863 650088

---

### Capacitors

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P&P £3.50 + VAT up to 6 valves

---

Sowter Transformers

Sowter Transformers have been used by the Professional Audio Market throughout the world for at least the last twenty-five years.

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- Good valves at economical prices
- Desired acoustic properties
- High purity tinned copper leads
- Tight wound thick dielectric for resonance elimination.
- Low dissipation factor
- All units proof voltage tested at 150% rated voltage for 15 mins

### Valves

- **ECC81**
  - Price: £4.50
  - Options: 6L6G, 6.50
- **ECC82**
  - Price: £4.50
  - Options: 6L6GT, £5.00
- **ECC83**
  - Price: £4.50
  - Options: 6V6GT, £4.50
- **EF 86**
  - Price: £4.50
- **EL 34**
  - Price: £8.50
- **EL 84**
  - Price: £4.50

**P&P £3.50 + VAT up to 6 valves**

### Reservoir Capacitors

- Extremely low distortion
- Detailed acoustic properties
- High purity tinned copper leads
- Tight wound thick dielectric for resonance elimination.
- Low dissipation factor
- All units proof voltage tested at 150% rated voltage for 15 mins

### Reservoir Capacitors

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**P&P £2.50 + VAT**

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### World Radio History
Golden Dragon

Retail Price List

Golden Dragon Pre-Amplifier Tubes

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Special Quality Golden Dragon Pre-Amplifier Tubes

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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 wooden 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 330µF will reduce the bandwidth to about 2kHz (-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 220µF, 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 0.047µF 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 1µF 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 1000Ω potentiometer in the emitter circuits of TRI/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 the 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 TRI/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 (3000Ω) controls the voltage developed across TR8 while TRI and TR12 sense the voltage across R2S and R26. An increase in voltage across TR8 means there is an increase in voltage across R2S/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 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
A selection of our stocks of New Original Mullard - Brimar audio types made in UK.

<table>
<thead>
<tr>
<th>STANDARD TYPES</th>
<th>SPECIAL QUALITY TYPES</th>
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<tbody>
<tr>
<td>ECC88 MULLARD</td>
<td>E88CC - GOLD PIN MULLARD</td>
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<tr>
<td>ECH81 MULLARD</td>
<td>ECC81 - M8162 / CV4024 MULLARD</td>
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<td>ECL86 MULLARD</td>
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<td></td>
<td>12BY7A G.E 7.00</td>
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AMERICAN TYPES GE.

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<tr>
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<td>12BY7A G.E 7.00</td>
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All speakers have BIWIRED crossover kits containing high quality components and terminals.

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A2 RIBBON KIT
M2 MINI-MONITOR

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TOTAL KIT . . . £226.00

PLUS KIT . . . £222.00
TOTAL KIT . . . £291.00

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I.P.L. Acoustics, 2 Laverton Road, Westbury, Wiltshire, BA13 3RS. Tel: 0373 823333
Parts List

Resistors:

<table>
<thead>
<tr>
<th>Resistor</th>
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<td>12V Reg</td>
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<td>Comparator</td>
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<td>TR8</td>
<td>22V-0-22V 160VA</td>
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<tr>
<td>TR9</td>
<td>12V coil</td>
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<tr>
<td>TR10</td>
<td>6A relay</td>
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<tr>
<td>TR11</td>
<td>5A Quick Blow fuse</td>
</tr>
<tr>
<td>TR12</td>
<td>12V coil</td>
</tr>
<tr>
<td>TR13</td>
<td>5A Quick Blow fuse</td>
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<tr>
<td>TR14</td>
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Transistors:

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<tr>
<td>TR2</td>
<td>SSM2210P Dual</td>
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<tr>
<td>TR3</td>
<td>2SC2240</td>
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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 36 watts into 8 ohms and 64 watts into 4 ohms (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.

Distortion 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.

Distortion (%)

<table>
<thead>
<tr>
<th>Power (W)</th>
<th>1W</th>
<th>Full</th>
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</thead>
<tbody>
<tr>
<td>1kHz</td>
<td>0.003</td>
<td>0.005</td>
</tr>
<tr>
<td>10kHz</td>
<td>0.008</td>
<td>0.04</td>
</tr>
</tbody>
</table>

At 1W, 1kHz distortion measures 0.003% second harmonic.
**Audio Note**

**TOPCAPS**

For use in critical low level applications.

- **Type**: 6% Value, 5% Tolerance, 500V, 500mA, 1000mA, 2000mA
- **Capacitance Values**: 0.01µF, 0.022µF, 0.033µF, 0.047µF, 0.068µF, 0.1µF, 0.15µF, 0.22µF, 0.33µF, 0.47µF, 0.68µF, 1µF, 1.5µF, 2.2µF, 3.3µF, 4.7µF, 6.8µF, 10µF, 15µF, 22µF, 33µF, 47µF, 68µF, 100µF, 150µF, 220µF, 330µF, 470µF, 680µF, 1000µF

**Solderless TOPCAPS**

- **Type**: 3%, 5%, 10%, 16%, 20%, 22%, 47%, 56%, 75%, 100%, 110%, 120%, 150%, 170%, 200%, 250%, 275%, 300%
- **Capacitance Values**: 20pF, 22pF, 47pF, 56pF, 75pF, 100pF, 150pF, 200pF, 220pF, 330pF, 470pF, 680pF, 1nF, 2.2nF, 3.3nF, 4.7nF, 5.6nF, 10nF, 15nF, 22nF, 33nF, 47nF, 68nF, 100nF

**Recommended Uses**

- **For critical low level applications: 6% Value, 5% Tolerance, 500V, 500mA, 1000mA, 2000mA**
- **Solderless TOPCAPS: 3%, 5%, 10%, 16%, 20%, 22%, 47%, 56%, 75%, 100%, 110%, 120%, 150%, 170%, 200%, 250%, 275%, 300%**

**Key Features**

- High precision, low ESR, low ESL
- Excellent high frequency performance
- Strongly damped, low noise
- Wide range of values and tolerance options

**Applications**

- Audio crossovers
- Filter networks
- Buffer capacitors
- Decoupling capacitors

**Advantages**

- Superior performance compared to traditional capacitors
- Increased reliability and longevity
- Enhanced system performance and stability

**Contact Details**

For more information, please visit Audio Note's website or contact your local Audio Note dealer.
**MR RANGE**

The MR range is designed for use in high-quality audio systems. It includes a variety of components tailored for professional applications. The range is known for its reliability and performance in critical listening situations. Component values and specifications are provided to help users select the components best suited for their projects.

**AUDIO NOTE**

Not only is the range of high-quality copper and silver solder suitable for excluding irreducible mis-haps in audio hi-fi, but also for the soldering of cables, which perch on the overall & we speaker and rump cables. We are proud to offer the MR range of lush quabh copper and anodes etc.

**CABLES**

- Round silver solder 0.2mm
- Round silver solder 0.01mm
- Round silver solder 0.06mm
- Round silver solder 0.003mm
- Round silver solder 0.001mm
- Round silver solder 0.000mm
- Round silver solder 0.0000mm

**SOLDERS**

The solder range is designed for use in high-quality audio systems. It includes a variety of solders tailored for professional applications. The range is known for its reliability and performance in critical listening situations. Component values and specifications are provided to help users select the solders best suited for their projects.

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- Military type capacitors
- Electrolytic capacitors

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- Linear power supplies
- Switching power supplies

**POWER AMPLIFIERS**

- Solid-state power amplifiers
- Tube power amplifiers

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- Motherboards for general use
- Motherboards for professional use

**TELEPHONE HANDSETS**

- Standard telephone handsets
- High-quality telephone handsets

**TELEPHONE CABLING**

- Telecommunications cables
- Audio cables

**POWER CORDS**

- Standard power cords
- High-quality power cords

**OTHER COMPONENTS**

- Transformers
- Inductors
- Ferrite beads

**AUDIO SYSTEMS**

- Turntables
- CD players
- DVD players

**AMPLIFIERS**

- Stereo amplifiers
- Monoblock amplifiers

**ENGINES**

- Internal combustion engines
- Electric motors

**BATTERIES**

- Lead-acid batteries
- Lithium-ion batteries

**USES**

- Applications in professional audio systems
- Applications in high-end consumer audio systems

**REFERENCES**

- Literature on high-fidelity audio
- Technical papers on audio engineering

**CONTACT**

For further information or to order components, please contact Audio Note at their address or phone number provided.
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 in 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: 069 I 652892
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.

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.

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.
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K1500 Features a totally discrete component implementation of the Direct Feedback concept. Audiophile grade components fitting to an advanced double sided printed circuit board make this a product of 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 its matching case. This Supplies the preamplifier and final power amplifier stages separately and features a fully regulated toroidal transformer with a special external shift 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.


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1947. Registered 1940. Pages. 09624-1913D 0.95

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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.

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!
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. 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'.

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 gluing the back panel to the rest of the cabinet, the loudspeakers were tested to

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

SOUND QUALITY

The most striking aspect of the SPL-Is 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-Is exercise great control as far as low frequencies are concerned. 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-Is 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-Is 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-Is 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-Is.

**Frequency Response**

![Frequency Response Chart](chart.png)

**Impedance**

![Impedance Chart](chart.png)
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**Single Ended Output Transformers**

<table>
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<th>Type</th>
<th>Primary Z</th>
<th>Max St</th>
<th>Max Power</th>
<th>Suggested Valve Type</th>
<th>Price (inc)</th>
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<td>sv100</td>
<td>2K5</td>
<td>50mA</td>
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**Push Pull Output Transformers**

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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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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 crossover 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 MAS50s - 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 crossovers, 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 shortened 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 crossovers (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 off 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...
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 standpoint. 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 practical standpoint. This 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, difficult 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.

### 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 Troubline Stereo tuner, Leak TU/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 eg electrolytic, polyester, polypropylene, paper in oil, silver foil, 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 type of resistance, capacitors, wire etc. must have an effect on the sound?

The RATA upgrade data sheet lists recommended parts, some values are different to the original ones. RATA suggest 32µF = 32µF Ansar (metalised 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 GT 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 polyproplyenes in the signal path made the sound very clean, but also a touch bright and lack bass. 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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**Letter of**

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, difficult 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.

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**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 requiring 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 caboodle on my record box (not ideal but the best I can do in a student flat). My amplifier is a Nait Mk1 with HBW Mid1 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...
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 being so helpful during my budget is a mere £350. My problem, with which I wish to ‘improve’ the sound or anything passable. You also need to consider the next option is obviously possible Happy hunting. NK

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 Isobanks 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.

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

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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 resale 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

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 lose 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.

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The writer of the most interesting DIY letter each month will receive a superb Maplin soldering iron kit complete with a length of silver solder. Write in to: Hi-Fi World DIY letters, 64 Castellain Rd, Maida Vale, London W9 1EX.
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 Dickenson 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 LS500. 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 Isobank 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 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.

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The crossover values I calculated, using a network analyser, are shown in diagram 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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