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NO.32 NOVEMBER 1997

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All of the projects in this supplement have gone through rigorous listening and test procedures. The performance and specification of these projects can only be guaranteed on kits bought directly from World Audio Design Ltd.

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These pages contain the latest information concerning products and components in the world of DIY.

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£145 won't buy much in the way of quality vinyl spinners, but it will buy you this turntable kit from Origin Live which promises analogue bliss. Does it deliver, asks Jon Marks.

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KLS3 Gold, our top of the range kit 'speaker, just got better. Noel Keywood guides you through the improvements.

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Billington

Gold

Ω

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5R4WGB USA	9.00	125N7GT	2.25	E180CC Mullard	5.40
5U4G Rogers	24.00	13E1 STC UK	120.00	E182CC Mullard	9.45
5Y3GT	7.50	85A2 Mullard	4.50	EB91	1.50
6AH4GT USA	7.50	350B Chinese	14.25	ECC81/CV4024 Mullard UK	7.50
6AS7G Russian	2.93	4UA	12.00	ECC82/CV4003 Mullard UK	10.20
6AU5GT GE USA	3.75	807 USA	10.50	ECC86 Mullard	5.93
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6AU8A USA	0.75	2050W RCA	8.25	ECH81 Russian	1.48
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6CG7 Yugoslavian	6.75	6111WA Philips	1.50	EF86/CV4085 GEC UK	19.50
6CH6 Brimar	2.93	6336A Amperex	54.00	EF86 Russian/Svetlana	8.40
6CW4	7.80	6350 USA	1.50	EF95/CV4010 Mullard	1.95
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6J4/CV5311	1.20	6463 GE USA	2.25	EL38	13.32
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12AZ7A USA	2.70	ESSL/CV5808 Mullard	37.50	Z2b	27.00

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6550B-2	18.00
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SV572-3	105.00
SV572-10	120.00
SV572-30	105.00
SV572-160	105.00
SV811-3	27.30
SV811-10	27.30

For orders over £600.00 please deduct 33%.

[Does NOT apply to items marked *]

WHOLESALE SECTION

6AL5/EB91 Mullard government box	100 pieces @ £ 75.00 [£0.75 each]*
6J5GT Russian	10 pieces @ £ 9.00 [£0.90 each]*
9002 RCA USA audio triode	100 pieces @ £ 60.00 [£0.60 each]*
E180CC/7062 Mullard UK box anode GVT	100 pieces @ £360.00 [£3.60 each]*
EF37A Mullard UK Grey	50 pieces @ £125.00 [£2.50 each]*
EF86 Russian, Identical to Svetlana EF86 but no logo	50 pieces @ £210.00 [£4.20 each]*
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KIT NEWS

BETTER CONNECTED

The Parts Connection, based in Oakville, Canada, has just released two new amplifier kits on the market. The first is a valve line-level pre-amplifier radically named the Assemblage L-1. This kit is claimed to be sonically reminiscent of the acclaimed Sonic Frontiers SFL-1 pre-amp and contains a hybrid FET/tube circuit. The Assemblage L-1 features a fully regulated power supply, four line inputs, one tape loop and two paralleled outputs. Zero global negative feedback is claimed for the design, which offers approximately 20dB of gain and good drive because of its low output impedance. The complete package includes all valves, pre-punched chassis, face plates, knobs, hardware and of course instructions. The price is \$499.00.

The second new arrival to be announced is a stereo power amplifier called the Assemblage ST-40PP. This uses a triode input stage followed by a long-tailed, differential-pair driver stage, which feeds matched pairs of EL34/6CA7s in a push-pull configuration. Price for the ST-40PP is set at \$699.00.

The Parts Connection
2790 Brighton Road,
Oakville,
Ontario,
Canada
L6H 5T4
Tel: (001) 905 829 5858

WEAVING A SPELL ON CD

Technical Wizardry, whose products are now being distributed by AudioCom (UK), have announced the release of 'The Clock' for use in CD players and transports. 'The Clock' incorporates separate high-grade regulators for the analogue oscillator section and digital sine-to-square-wave converter. Using Sanyo Os-Con

decoupling capacitors and surface-mount components, 'The Clock' provides a high-quality square wave signal which ensures accurate clocking of the player or transport. The price for this unit is £150.00. Further CD upgrades in the pipeline are a separate power supply, an analogue output stage, a digital output stage and a high-performance regulator board.

On another note, AudioCom (UK) have moved to new, larger premises, and can now be contacted at the address below.

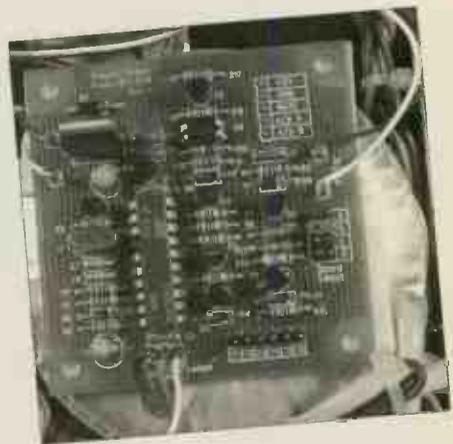
AudioCom (UK)
Unit 6,
Tindle Enterprise Centre,
Warren Street,
Tenby,
Pembrokeshire SA70 7JY
Tel: 01834 842803

NEW MAPLINS CATALOGUE

Maplins has launched a new edition of its bi-annual catalogue and in the

process introduced in excess of 2000 new products. The new catalogue covers audio-visual, computers, security, radio communications, electronic and electromechanical components. The catalogue also comes complete with a section of in-depth 'How To' guides on a wide range of topics from soldering to computer peripherals and networking.

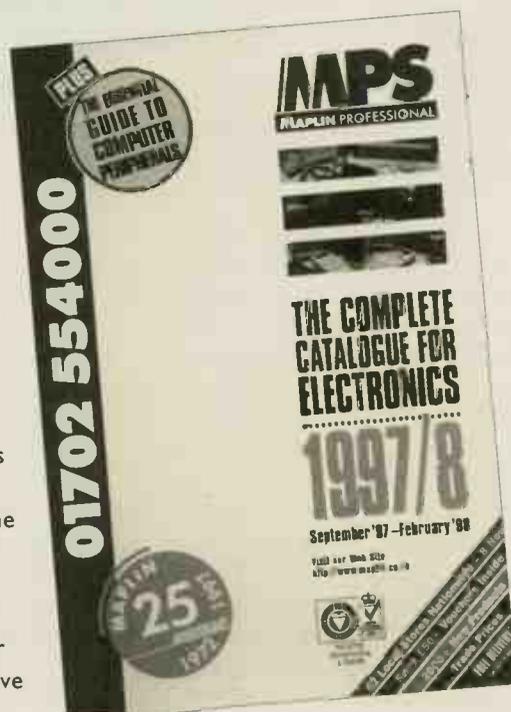
Maplins MPS
PO Box 777,
Rayleigh,
Essex SS6 8LU
Tel: 01702 554002



REMOTE POSSIBILITIES

Scunthorpe-based component supplier Audio-Links have developed a module that will allow the owner of any pre-amplifier or integrated amplifier to have the luxury of adjusting the volume by remote control. The module comes completely built and tested. The price to bring all this control to your finger tips is £62.10 plus P&P.

Audio-Links
7 Fairmont Crescent,
Scunthorpe,
North Lincolnshire DN16 1EL
Tel: 01724 870432



GOING FOR A SPIN



If you're a vinylphile who's handy with a spanner and a soldering iron, Jon Marks reckons you owe it to yourself to check out Origin Live's Standard turntable kit and Rega RB300 tone-arm modifications.

Imagine the situation: you're trying to track down a kit for a turntable. The response from the suppliers you've tried so far will probably have been, "Amp kit, DAC kit, 'speaker kit, sir? We have those. No turntable kits, I'm afraid." Step forward Origin Live and their two kits for record decks, the Standard and Ultra.

We first took a look at Origin's higher spec. kit back in August 1993's Supplement where we went for the complete Ultra kit of parts which cost £350 back then. At the time, Jonathan Jordan thought this was money very well spent. Now we're moving into budget territory with the Standard kit where

novice constructors should find themselves more at home. This kit will set you back £125 for the bearing, platter, motor, belt and basic power supply.

THE TECHNOLOGY

The bearing itself is the heart of any turntable. Most lower-priced decks tend to have low-tolerance bearings where the cost-cutting shows up as play - if you grasp the spindle and move it gently from side-to-side, you'll notice some movement. The results this has on sound quality are usually fuzzy imaging and a general lack of crispness and definition; speed stability and rhythm can also suffer.

Origin Live win themselves brownie points for not skimping on bearing tolerance. Technologically, OL's bearing toes the traditional line with a non-inverted design, unlike, for instance, Pink Triangle's predominantly inverted designs (which can be more difficult to manufacture and lubricate reliably).

The main housing is actually a large engineering bolt with its head cut off and a shaft sunk down its centre. At the bottom sits a small ball bearing (replacements are available from bicycle shops at around 75p for a pack of 10). Rotating atop this ball is the shaft, made of case-hardened, ground steel, which supports the grey PVC sub-

platter. Finally, resting on the sub-platter is an 11mm-thick glass platter with three small felt discs glued on to it to decouple the record.

Driving the whole assembly is the sort of AC synchronous motor you'd expect to find in decks like Linn's LP12, Pink Triangle's PT Export and Systemdek's 2X2. This is good news for tweekers because it means Linn's own Valhalla power supply will work with the Standard kit, according to Mark Baker, director of Origin Live.

If you decide to opt for a ready-made plinth to get you up and running, OL do a simple, solid one for £20. This consists of a slab of MDF pre-cut and drilled to take a Rega RB250/RB300, which was supplied. But this is no normal RB250. Mark has modified this budget favourite and claims its performance would give even super-arms like SME's Series V and Linn's Ekos pause for thought.

What makes this arm special are three tweaks. The stub that carries the counterweight is unscrewed and replaced with one that is held onto the arm-tube with a high-tensile steel bolt. This is claimed to give a much more rigid structure than before and, because the stub no longer screws into the end of the arm-tube, improved decoupling between it and the arm tube.

The second change is threading the weight to take a grub screw to hold it much more firmly onto the stub than the rubber o-rings normally fitted. In maximising rigidity like this, OL's RB300/RB250 mimics SME's Series V, where rigidity is paramount. Finally, the Rega is re-wired with silver Litz cable.

To find out what the Standard kit and revamped Rega have to offer, we decided to try out the Standard kit in two guises: with OL's own solid plinth and AC motor, as well as with a battery-powered DC motor.

SOUND QUALITY

Since it's a solid-plinth deck, the Standard will need to be sited on something more stable than a bookshelf. A dedicated wall-shelf is one idea, as is a low coffee table like the Lac from Ikea.

Bearing a Goldring 1042 Moving



Here you can see the modification to the counterweight with its threaded hole to take the grub-screw.

Magnet cartridge and working into Audio Analogue's Puccini SE integrated amp, this vinyl front-end had my jaw heading towards the floor with the solidity and transparency of the music it was making. Spinning a copy of Ray Charles and Betty Carter running through a selection of classic numbers, the Standard came up with crystal-clear images set in a broad sound stage. Stage depth was a little disappointing by comparison, but that width really was an unexpected bonus. Another was the obvious rhythmic ability of this turntable/arm combination, with upper bass notes crisp as a freshly ironed £50 bill giving whatever LP was sitting on those three felt discs a pleasantly up-beat feel.

The flip-side of this presentation was that bass had a slightly lower profile than usual which could make music sound a tad insubstantial at times. This didn't stop the Origin Live putting together a captivating performance with Ray and Betty, the mellow orchestral backing and laid-back mood of this LP undiminished. From an emotional point of view, the Standard/RB250 left CD as dead as the

proverbial dodo - even our Teac P-30/Pink Triangle Da Capo, a communicative digital source, sounded lacklustre next to this analogue pairing.

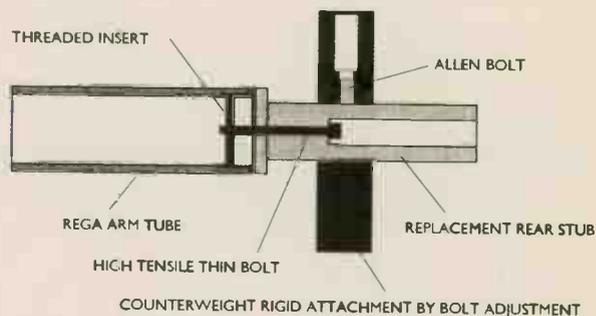
With a Mobile Fidelity Sound Lab audiophile pressing of Muddy Waters' Folk Singer there was that expansive sound stage and superb separation which made the Origin Live's imaging so convincing. Again, the only area not quite up to par was stage depth, which was mildly compressed. Still, for a turntable kit and arm that tip the scales at only £465 without a cartridge, this set-up

looks and sounds like great value for money.

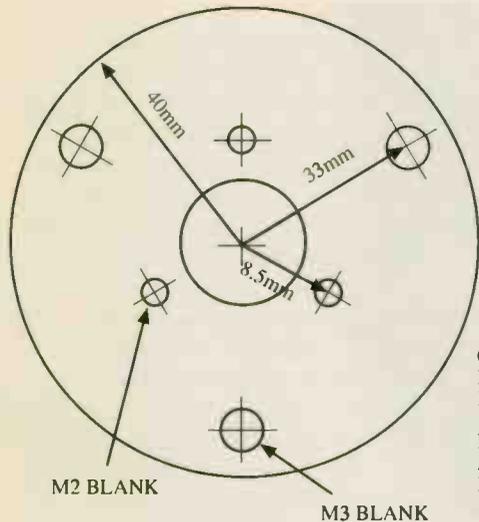
Sporting a cartridge of the Goldring's calibre, the Standard also proved that old maxim, "Less is more" by displaying a total lack of sibilance and dynamic compression. And with surface noise on an LP like the Muddy Waters' merely incidental, you can forget about it and concentrate on the music.

With its platter under Grace Jones' Warm Leatherette, the Standard continued on its roll. Again, in spite of the fact that basslines were a touch lightweight, their individual notes were just that, individual, making it possible to follow exactly what the bass player was doing. The powerful percussion on Warm Leatherette failed to provoke this deck into any brash nastiness, hi-hats remaining smooth and powerful in spite of a little groove damage on this old slab of the

CROSS SECTION OF ARM END



Inside the end of the arm tube a threaded insert holds the stub bolt in place under tension. This, along with the grub-screw mounting for the counterweight, gives a very rigid connection between arm stub and counterweight.



CENTRAL HOLE IS 11mm DIA

BOLT HOLES ARE EQUISPACED AT 120 DEG

The mounting plate is designed to work with OL's solid plinth.

black stuff. Even when faced by the Spice Girls on a rather rough pressing full of background warblings and clicks, the Origin Live showed its mettle by delivering polished results on a recording that can take your head off on the wrong turntable.

You can take things further than this with minimal outlay though. Try adding some mass to the counterweight, for example. You can do this by Blu-Tacking some small change to it and moving it in closer to the arm's pivot, which means the weight has less inertia as it swings around on the end of the arm, producing better perceived tracking, smoother treble and deeper, more precise bass.

Golden Oldie No2 is slipping a 20in. diameter bicycle inner tube (about £3.75) under the deck, sandwiched between two MDF shelves. This takes off a few remaining rough edges and yields truly three-dimensional imaging and sound staging. It can also lower background

dynamics have great speed and impact, and the sound stage is huge.

So, is there yet more quality to be squeezed from this kit? You bet!

MOTOR MANIA

The AC motor that comes with the kit is the same as the one used in Linn's LP12. The advantages of a motor like this are that it's easy to set up - it just takes a 0.15µF capacitor and two 6.8kohm resistors - and its speed stability is controlled by the mains, which gives fair if not amazing wow and flutter. The disadvantages are that you'll need a more complex power supply or a stepped pulley if you want to sample the joys of 45rpm, and that this basic motor puts out a lot of noise. The answer? Go

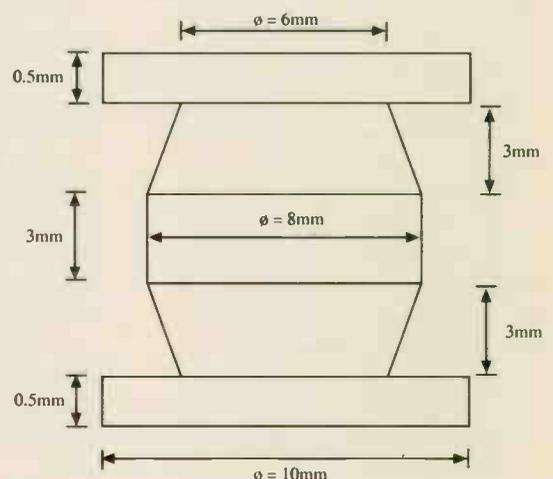
noise by reducing the amount of external vibration that gets into the deck.

With all these mods in place, the Standard kit sounds good enough to worry some of the turntable/arm/cartridge competition at up to about £800. I have to say the Rega modifications turn this humble arm into a real giant-killer. Gone is the rather grey, sterile sound of the cooking Rega. Instead, tonal colour is fresh,

in Southampton. Stocks vary as most components are surplus, and once they're all sold, that's it.

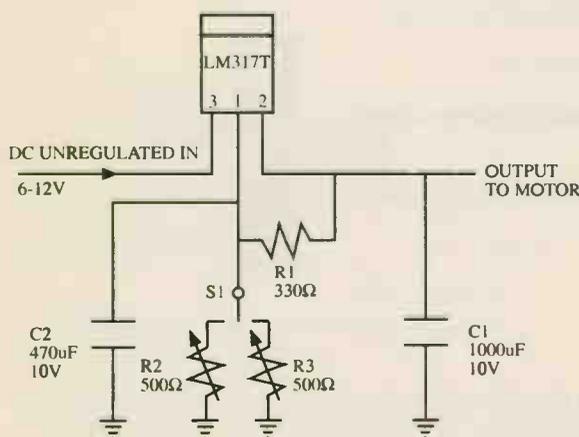
If you're prepared to spend a bit more money on the motor - and motor quality is absolutely critical - I'd recommend splashing out on a costly but impressive motor from Airpax who also make the bulk of AC synchronous motors used in turntables. This Airpax is actually the non-tachogenerator version of the unit Pink Triangle rely on in their Anniversary deck. It's available from McLennan Servos of Camberley (tel: 01276 26146) for a price of £39.80 inclusive of VAT and P&P. Please quote Hi-Fi World when calling as this price is set for the next few months in spite of currency fluctuations which normally affect pricing.

Be warned though. When fitting the pulley the end of the motor's shaft must



Ø=DIAMETER
CENTRE HOLE DRILLED TO MOTOR SPINDLE SIZE

The motor pulley only needs a tolerance of +/-0.1mm.



The heart of this simple PSU is the LM317T regulator.

DC, as Pink Triangle have done.

Finding a quiet, cheap DC motor is not always easy. I've managed to get some reasonable results from parts cannibalised from old record-sleeve-sized Midi-system turntables picked up for a few pounds because they're not otherwise working.

One company I've used in the past is Greenweld (tel: 01703 236363), who are based

be supported, otherwise the delicate commutators will either be damaged or destroyed. The same goes for removing the pulley - it mustn't simply be yanked off the end of the shaft.

PULLING POWER

You'll need to finish the motor off with a suitable pulley and mounting plate (see diagrams). Probably the easiest material to make these out of is brass. Take the motor with you when you get the pulley made (at a local engineering workshop) because it needs to be gently but firmly press-fitted onto the motor's spindle. The top-plate will need to be mounted on spacers to raise it about 5mm off the

plinth so the pulley sits at the right height.

A QUESTION OF SUPPLY

While an AC motor can work happily from an extremely basic PSU consisting of a mains supply, a capacitor and a couple of resistors, its DC brethren requires something a little more complex. A PSU for the Airpax can be constructed around the classic LM317T variable voltage positive regulator (see diagram).

Capacitor C1 acts as a storage device to help out the LM317T when current is

resistors (R2 and R3). Through S1, the switch, these give you separate pitch controls over each of the two speeds, 33rpm and 45rpm. If you're using an 8mm diameter pulley on the Airpax motor, you need to set R2 to 141-142ohms (33rpm) and R3 to 190-191ohms (45rpm).

Seeing as the motor draws relatively little current (40mA-50mA) heatsinking is not necessary. If the LM317T gets hot when you switch it on, check for wiring errors.

I wouldn't even bother thinking of

spinning for around 60hrs between charges. An appropriate charger would be the GU08J at £29.99. This adds up to a total of £43, which is less than the cost of the high-quality toroidal transformer, Schottky rectifiers, audio-grade reservoir caps and various regulators needed to come close to equalling a battery PSU's performance.

There's a few refinements you can make to the basic LM317T circuit. First of these is to bypass C1 and C2 with film capacitors to lower their impedance. 2.2µF to 10µF would be worth trying. Alternatively, you could make C1 and C2 Sanyo's Os-Con aluminium electrolytics which would give a clearer, firmer sound than industrial-grade types. Then there's Linear Technology's higher spec. version of the LM317T, the LT317AT which can be obtained from Audio-Links (tel: 01724 870432) and AudioCom (tel: 01834 814660). Going for bulk-foil resistors from the same two sources would also be a good idea. With all these goodies in place, the Standard would give turntables at the £1200-£1400 mark a hard time.

THE LAST WORD

And that's not all. While Origin Live's simple £20 solid plinth makes a fine starting point, there's vast extra untapped potential still in the kit. A four-plinth deck in Perspex or marble would offer outstanding sound. The motor could be mounted in a cylindrical block of marble or brass sitting on three spiked feet with their matching cups glued to the marble base plate. This method of decoupling motor noise from the plinth is similar to that used in Michell's massive £2000+ Orbe.

The main bearing could then be bolted to another larger slab of marble on its own spikes and cups, again sitting on the base plate. The arm gets its own spiked marble board as well. An arrangement like this would not only look gorgeous, it would sound it too, with very low background noise, razor-sharp dynamics and real rhythm and scale. The only limit is your imagination, and remember, hi-fi doesn't have to be a black box!

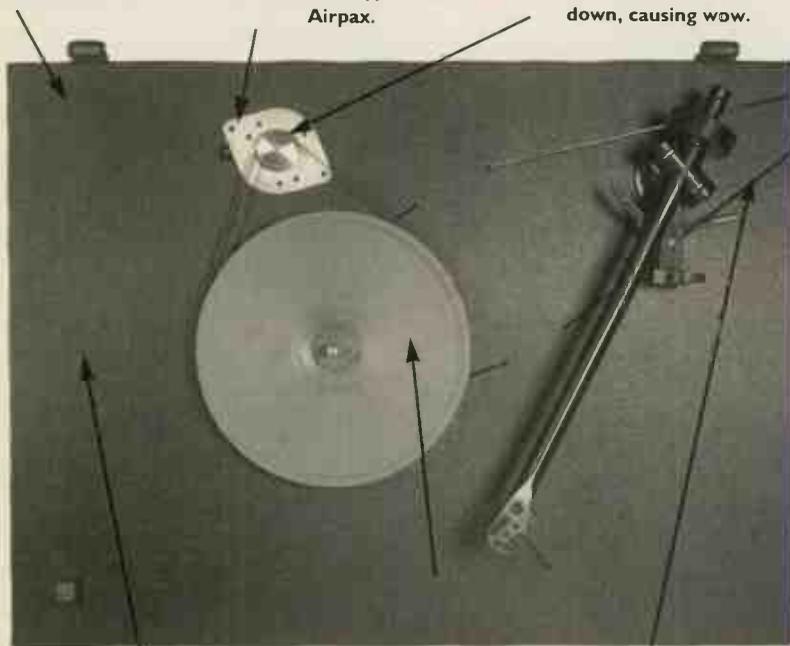
Origin Live
87 Chessel Crescent,
Bitterne,
Southampton
SO19 4BT
Tel: 01703 442183

THE STANDARD KIT

The plinth is a simple, solid slab of MDF.

The motor supplied with the Standard kit is an AC synchronous type from Airpax.

The pulley is machined from brass and has a curved crown which stops the belt wandering up and down, causing wow.



Set into the underside of the plinth is the power supply for the AC motor, consisting of a capacitor and two resistors.

The sub-platter is a disc machined from a chunk of PVC. It can be damped slightly with the addition of a thin sheet of Blu-Tack on its underside.

The plinth has cuts sawn into it to provide a certain degree of isolation for the arm and bearing from motor and external noise, a la Pink Triangle.

drawn from it, and it reduces the amount of ripple on the IC's output. C2 bypasses the adjust pin which sets the output voltage. With C2 in circuit ripple levels are further lowered. This is very important because the symptoms of excessive ripple are wow, flutter and raised background noise - three things you definitely don't want in your turntable.

R1 is one half of the potential divider that determines the voltage fed to the adjust pin and, therefore, the output voltage. The other half is a pair of variable

running the PSU from a mains supply - battery power is the only way to go. If you want to experiment you can actually run the circuit from a 9V PP9 for an hour or so before it goes flat.

A better bet because of its lower internal impedance and greater current capacity is a rechargeable 6V lead/acid type. You can get these from Maplin (tel: 01702 554000) or Electromail (tel: 01536 204555). For example, Maplins' XG70M costs £13.12 and is rated at 4Ah (Amphours). This would keep the motor

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Housed in the neat, black finished, Hart minibox it features the wide frequency response, low-distortion and 'musicality' that one associates with designs from the renowned John Linsley Hood. Volume and balance controls are Alps "Blue Velvet" components. Very easy to build, or available factory assembled, the kit has very detailed instructions, and comes with Hart audiograde silver solder. A valuable personal listening option and an attractive and harmonious addition to any hi-fi system.

K2100 Complete Standard Kit	£112.50
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CM2100 Construction Manual	£2.50

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Hart Super Audiograde Silver Solder has been specially formulated for the serious audiophile. Not only does it give beautiful easy-to-make joints but it is designed to melt at normal soldering temperatures avoiding the possibility of thermal damage to components or the need for special high temperature irons. A very low residue flux makes perfect joints easy but eliminates the need for board cleaning after assembly.

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CM400 Construction Manual	£4.95

'AUDIO DESIGN' 80 WATT POWER AMPLIFIER.



Our John Linsley Hood designed 80 watt Power Amplifier continues to amaze all who listen to it, and it is now finding new friends among speaker manufacturers who use it to show their own products to their best advantage. Its flawless performance is a result of the combination of inspired circuit design and the very best components, specified by the designer. Such innovations as the six rail fully stabilised power supply make great contributions to the overall reproduction quality yet are not found on even the most expensive run-of-the-mill designs in the High St shop window.

We have long known that the delicacy and transparency of sound from this amplifier placed it in the world class and side-by-side comparisons with amplifiers costing five times as much still show small performance advantages, which suggests that even the most expensive amplifiers will only equal rather than exceed, its sound quality. All amplifiers in the range have the same basic quality and the decision about whether to use a preamplifier is governed by the facilities you need. The STANDARD amplifier has switching for up to three inputs, if you need more than this then a preamplifier feeding a SLAVE power amplifier will give you up to seven inputs.

If you would like to hear this incredible amplifier in action then arrange a visit to Wilmslow Audio's new premises at Broughton Astley, near Leicester. Their phone number is 01455 286603, speak to Shaun or Terry.

All amplifiers are available in kit or factory assembled form.

K1100 Complete STANDARD Amplifier Kit	£415.21
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Super Audiophile (SA) Versions of all the above come with selected audiophile components at an extra cost of only £39.30 per channel. 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!

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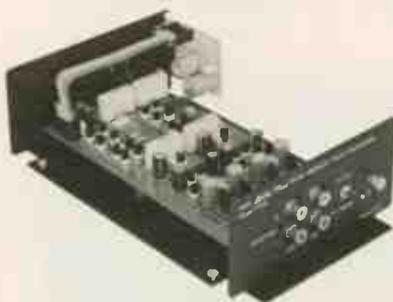
It employs the newly re-discovered single-ended circuit configuration to give total freedom from crossover artifacts and to give a sound that is indistinguishable from the famous 'Williamson' design, the undisputed leader of the field, with its triode connected KT66s and all-triode drivers. See our list for full details.

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CM4000 Construction Manual	£5.00

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This magnificent kit, comes complete with all parts ready to assemble inside the fully finished 228 x 134 x 63mm case. Comes with full, easy to follow, instructions as well as the Hart Guide to PCB Construction, we even throw in enough Hart Audiograde Silver Solder to construct your kit!

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K1450SA Audiophile Kit	£138.94
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There are two versions, K3550 has 2 $\pm 15v$ supplies and a single 15v for relays etc. K3565 is identical in appearance and has one $\pm 15v$. Both are in cases to match our 'Chiara' Headphone Amplifier and our K1450 'Shunt Feedback' Pickup preamp.

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ASM100 ACTIVE SUBWOOFER MODULE



This attractive module consists of a low pass filter and power amplifier ready for you to mount in a suitable sub-woofer cabinet. The combined unit can then be combined with any new or existing hi fi or home cinema speaker system to add in the real bass punch missing from most setups.

The ASM 100 module comes as a ready-to-mount unit on a solid diecast aluminium frame/heatsink. Input signal can be at line or speaker level for easy system integration. There are three separate stereo inputs at line level and the unit will use any signal presented or mix all inputs to add bass to any signal. The speaker level inputs are used by simply wiring the unit in parallel with the existing speakers to provide them with strong bass support. Crossover frequency can be selected to 50, 100 or 200Hz and the bass level can be adjusted by a front panel control. The "Green" power supply switches the unit to standby if no signal is present. Drawings are included free for the compact 418 x 380 x 303mm cabinet.

With its powerful 125 watt output and versatile filtering the ASM 100 is the ideal universal active driver module for all subwoofer requirements.

ASM 100 Module, complete with IEC mains lead, instructions and ASM - W20 cabinet drawings. Pl. No. V7000 £185.29
W 200 S 20cm Long Throw Drive unit for use in ASM - W20 cabinet £36.68

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Crossover Frequency 450Hz, 3KHz
Mean Sound Pressure 88dB
Box Volume 100Ltr. & 7Ltr.
Size/Height 1,300mm
Width 300mm
Depth 360mm

LK5965 Per Pair £538.70

ASM - T20 SUBWOOFER

An easy to build, but very effective, bass reflex cabinet design using the ASM 100 Active Sub-woofer Module and the W200S, high compliance, 8" driver, with its 20mm maximum cone displacement. Easy to incorporate into a modern living environment the size of the cabinet has been kept as small as possible at 418 mm high, 303 mm wide, and 380 mm long. To aid its ease of positioning in the room both the drive unit and the vent are situated on the front of the cabinet. Despite these compact dimensions, and with a volume of only 31Ltrs, the ASM T20 gives up to 106dB with an acoustical cut-off frequency of 25 Hz. The cabinet is made from 19mm MDF, and needs about 8 sq.ft.

W200S 20cm. Long Throw Drive unit. Part No. 9030 £36.68



COUPLED CAVITY SUBWOOFER.

An alternative design by David Purton, from his little "Coupled Cavity Handbook", using the same drive unit but requiring a bit more woodworking skill as the speaker is set on a baffle in the middle of the box. The total box size is even smaller than the ASM T20 at only 418 mm high, 303 mm wide, and 344 mm long. Construction Drawing £1.50

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VISATON SPEAKER PRO 6. Software (PC) for cabinet and crossover design and calculation with full extendable data bank of drive unit parameters with performance curves acquired in tests in VISATON's own anechoic chamber. This is the essential tool that turns you into a speaker designer! Full Version (3") £45.51

BASSBOX 5.0 for WINDOWS. Harris Technologies. This program aids the design of bass enclosures by allowing you to model how a speaker will sound in a variety of boxes and then modelling the maximum loudness of the speaker/box combination. It then helps to calculate the dimensions of the box and port, if vented. Needs Windows 3.1+, DOS 5.0+, 386 or better, 4MB RAM and 44MB hard disk space. With easy-to-use printed manual. Shipping Wt. 450g SOF-BAS £87.50

BASS HORN DESIGN. A.L.Senson. This program, patterned after Brian Smith's traxtrix horn design program, calculates dimensions for a catenoid, exponential or hyperbolic bass horn and prints out in less than a minute. Provides mouth and throat areas, back chamber volume, and dimensions to design your enclosure. SOF-HOR £17.95

X*OVER 2.0 for WINDOWS. Harris Technologies. This package helps in the design of two and three way passive dividing networks as well as load compensating circuits and calculates values for first, second, third and fourth order networks. Same computer requirements as above but only needs 1.5MB disk space. SOF-XOV £27.90

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CW470N	CAP PROPYL 470nF	£1.25
CW680N	CAP PROPYL 680nF	£1.25
CW100U	CAP PROPYL 1µF	£1.50
CW150U	CAP PROPYL 1.5µF	£1.50
CW220U	CAP PROPYL 2.2µF	£1.50
CW330U	CAP PROPYL 3.3µF	£1.85
CW47U	CAP PROPYL 4.7µF	£2.00
CW68U	CAP PROPYL 6.8µF	£2.50
CW100V	CAP PROPYL 10µF	£3.50
CW150V	CAP PROPYL 15µF	£4.50
CW220V	CAP PROPYL 22µF	£6.50
CW500V	CAP PROPYL 50µF	£9.95
CW1000V	CAP PROPYL 100µF	£20.00

Low value capacitors are extensively used in amps & preamps (especially in tone control, bass & treble etc). By changing to polypropylene you can enjoy an enhanced lighter, brighter sound especially in the treble and mid bass range, and a transparent lower bass improvement. Close tolerance & high stability ensure that both channels can be very closely matched.

Part No	Value	Voltage	Price
CP947P	CAP PROPYL 47µF	250V	£0.35
CP100P	CAP PROPYL 100µF	250V	£0.35
CP150P	CAP PROPYL 150µF	250V	£0.35
CP220P	CAP PROPYL 220µF	250V	£0.35
CP330P	CAP PROPYL 330µF	250V	£0.35
CP470P	CAP PROPYL 470µF	250V	£0.35

Low Impedance High Temperature (105°C) Radial Electrolytics ± 5%

Superior electrolytics at affordable prices. The low impedance end resistance minimises signal purity whilst the superior temperature characteristics allow the capacitor to remain very stable under the most varying conditions.

Part No.	Value	Voltage	Price.
1H50	LO 2 HI TEMP 1µF	50V	£0.25
2U2H50	LO 2 HI TEMP 2.2µF	50V	£0.25
4U7H63	LO 2 HI TEMP 4.7µF	63V	£0.25
10H63	LO 2 HI TEMP 10µF	63V	£0.25
22H63	LO 2 HI TEMP 22µF	63V	£0.30
47H63	LO 2 HI TEMP 47µF	63V	£0.35
100H63	LO 2 HI TEMP 100µF	63V	£0.50
220H50	LO 2 HI TEMP 220µF	50V	£0.75
470H63	LO 2 HI TEMP 470µF	63V	£1.25
1000H95	LO 2 HI TEMP 1000µF	35V	£1.50
2200H50	LO 2 HI TEMP 2200µF	50V	£2.25
4700H25	LO 2 HI TEMP 4700µF	25V	£2.50

Elna Solder Lug Reservoir Capacitor 0.000µF 80V

Choosing the right electrolytic for power supply use is a very important in keeping down hum whilst allowing maximum current flow for good transient & bass response. Elna capacitors are respected the World over for their exceptional audio attributes.

Part No	µF/Voltage	Price
1000DC80	CAL ELNA1 100µF 80V	£11.00

Monacor Air Cored Inductors.



A range of professional air cored inductors for 8Ω or 4Ω crossovers/filters for use up to 300W. 1.2mm enamelled copper wire wound on air spaced plastic cores.

Part No	Specification	Price
P15	150µH 0.15Ω 8x19mm	£2.00
P22	220µH 0.15Ω 48x19mm	£2.50
P33	330µH 0.2Ω 8x19mm	£3.00
P47	470µH 0.25Ω 50x19mm	£3.50
F68	680µH 0.35Ω 59x19mm	£4.50
P100	1mH 0.4Ω 59x19mm	£5.50
P150	1.5mH 0.5Ω 70x30mm	£6.50
P220	2.2mH 0.6Ω 70x30mm	£8.00
P330	3.3mH 0.75Ω 70x30	£10.00

Monacor Ferrite Inductors



A range of professional high permeability ferrite cored inductors with very low ohmic losses for 8Ω or 4Ω crossovers or filters for use up to 400W. 1.4mm enamelled copper wire (1.3mm on F100) wound on plastic bobbin.

Part No	Specification	Price
F220	2.2mH 0.15Ω 400W	£6.50
F330	3.3mH 0.2Ω 330W	£9.50
F470	4.7mH 0.25Ω 140W	£11.00
F680	6.8mH 0.35Ω 120W	£12.00
F1000	10mH 0.45Ω 100W	£13.50

Quality Valves Affordable range of High Quality Valves

Part No.	Description	Price
6550C	OUTPUT VALVE	£26.00
9L6GT	OUTPUT VALVE	£4.50
58X7GT	OUTPUT VALVE	£4.50
5Y6GT	OUTPUT VALVE	£3.95
6CC81	TRIODE	£4.50
6CC82	TRIODE	£4.50
6CC83	TRIODE	£4.50
EF86	LOW NOISE PENTODE	£3.50
EL34	OUTPUT VALVE	£8.50
EL84	OUTPUT VALVE	£3.50
2Z34	RECTIFIER	£6.50
KT88	OUTPUT VALVE	£20.00

Valve Holders - High quality valve bases. Chassis mounting with screw fittings.

Part No	Description	Price
B9AC	B9A VALVE HOLDER CERAMIC	£1.50
B9AU	B9A VALVE HOLDER CERAMIC + SCREENING CASE	£4.25
CC		

OCTC OCTAL VALVE HOLDER CERAMIC £2.00
OCTP OCTAL VALVE HOLDER PHENOL £1.50

Fully Gold Plated Phono (RCA) Plugs with spring coil cable grip.



Part No.	Description	Price
PPG5A2	PAIR GOLD PLUGS for up to 5mm CABLE	£1.50 pair
PPG8A2	PAIR GOLD PLUGS for up to 8mm CABLE	£1.50 pair

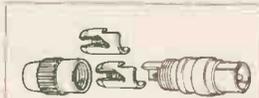
Very High Quality Phono (RCA) Plugs



Very high quality satin grey metal with heavy gold plated connections. Top collet cable grip & PTFE insulators. Very low noise.

Part No	Description	Price
PPG6H2	GOLD PTFE PLUGS for up to 6mm CABLE	£3.50 pair
PPG8H2	GOLD PTFE PLUGS for up to 8mm CABLE	£3.50 pair

Neutrik Pro-Audio Super Quality Gold Plated Phono (RCA) Plugs



Standard 18k gold plated ends. Includes 2.5mm & 3.5mm cable grip & 3.5mm screen marking. See website for more details.

For a wide range of cables. These connectors make contact with ground first at insertion to eliminate pop.

Part No	Description	Price
PPN2	NEUTRIK PRO AUDIO	£12.00/pair

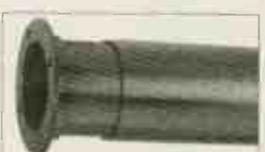
Extra High Quality Gold Plated Phono Oxygen Free (RCA) Leads (pairs)

Available in 2 colours & 3 lengths. Highly flexible oxygen free cable with extra moulded-in control & grounding wire.



Part No	Length	Colour	Price
LPP1QG	0.8 Metres	Green	£5.50
LPP1QV	0.8 Metres	Violet	£5.50
LPP2QG	1.5 Metres	Green	£6.50
LPP2QV	1.5 Metres	Violet	£6.50
LPP3QG	5 Metres	Green	£11.00
LPP3QV	5 Metres	Violet	£11.00

Bass Reflex Tuning Ports



A range of adjustable plastic ports for use in various sizes of loudspeaker cabinets. Diameter adjustable length (mm).

Part No	Dimensions	Price
R35	d=35L=110-210	£2.50
R50	d=50L=128-280	£3.00
R70	d=70L=128-245	£3.50
R100	d=100L=160-122	£5.50
R85	d=85 angled 45° for narrow cabinets=210-310	£6.50

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KLS3 GOLD MkII

It uses a unique piezo-electric gold-dome tweeter and high-tech. carbon-fibre drive units. This is our top loudspeaker - and we've improved it again. Noel Keywood cranks up the FFT.

The beauty of this loudspeaker remains untouched. It lies within the sweet sound of the high-technology Audax carbon-fibre drive units we use, topped off by the superb Audax HD3P gold-dome piezo-electric tweeter. It delivers treble that I can only describe as liquid honey, as pure and fast as the beautifully incisive Tonigen ribbon tweeter, but without reminders of Wilkinson Sword.

So why am I improving this combination? Broadly I decided to reconfigure the crossover in light of experience and others' views, as well as to tune the HD3P into the HMI30CO carbon-fibre midrange even more tightly in terms of phase response - a minor obsession. KLS3 remains an elegantly proportioned large floor stander, however, using separate bass and midrange units, plus what is arguably the world's best tweeter. Like any good three-way it has a sublime midband - great for vocals, which are projected right out of the 'speaker. It remains sensitive, needing little power and, as always, impedance has been kept under tight control to make sure it gets the best from any amplifier, transistor or valve.

The revised HD3P tweeter is still expensive, but at £130 apiece much less so than before. Audax tell us that enough are now being purchased to warrant full production, replacing the specialised assembly methods used initially. High price makes the HD3P a rare bird in commercial loudspeakers, where drive units are usually budgeted to cost no more than £10 or so, but it is appearing in up-market French loudspeakers (Audax are French) costing around £5000 or more.

THE MODIFICATIONS

There's nothing like a good three-way. My

ideal conception for this arrangement is to view the midrange unit as the bit that does most of the work and which must be, therefore, top quality. Small cones reach higher up the audio band more smoothly than the bass/midrange of a two-way loudspeaker, which must have a cone at least 6in.-8in. in diameter to produce decent bass. Trouble is, large cones 'break up' lower in the audio band, making vocals, violins, etc sound coarse.

The compromise between satisfactory bass output and clean midband behaviour faced by two-way loudspeakers is avoided by a three-way design. The HMI30CO midrange unit of KLS3 uses a 5in. cone (130mm) made from woven carbon-fibre mat impregnated with a polymer resin that is baked hard. This light but very stiff cone, with its polymer dust cap, reaches smoothly up through the part of the audio band, 2kHz-6kHz, in which bass/midrange drivers 'break up'. So the HMI30CO has a critical and important task to perform.

A couple of experienced industry engineers have suggested that it would benefit from handling less low-frequency content, for in the original design we decided to rely only upon an acoustical roll-off of low frequencies. This made the crossover simpler, which DIYers appreciate, but drives the HMI30CO harder and can produce a little chestiness, according to the effectiveness of damping used in the midrange chamber.

The MkII now has electrical attenuation in the form of a first-order filter to reduce this effect and to lessen cone excursion. Seeing as it's a bass/midrange with edge-wound, high-temperature Kapton voice-coil former the driver itself has no difficulty handling power, by the way. Audax rate it at 50watts - high for a midrange unit.



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Jason Kennedy on the Model 1 in Hi-Fi Choice
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BASS UNIT

We originally used the HM210CO bass unit as a fill-in driver working only below 100Hz. This under-utilises its abilities, because the 8in. carbon-fibre cone reaches up to 5kHz. I rearranged the low-pass filter feeding the bass unit, rewinding the bass inductor to reduce its value from 12mH to 2.7mH in order to make the HM210CO work up to 400Hz. The inductor required becomes more manageable and less deleterious in other areas. The 12mH used previously had a resistance of 0.45ohms, whereas the 2.7mH now required has a resistance of 0.21ohms, which will improve bass control a little with low output impedance solid-state amplifiers.

I should point out that the importance of damping and DCR often becomes over-inflated in discussion. Most damping is

applied acoustically by the cabinet, but mechanical damping exists too. Electromagnetic damping makes a contribution, but it is not great - putting foam in the ports has more effect.

I simply unwound the original inductor to achieve the new value, so there's no need for KLS3 owners to throw the old item away, providing an inductance meter is to hand of course. If not, let Falcon Electronics supply new items, because they are not expensive.

By running the HM210CO further up into the midband, cabinet behaviour becomes more critical. Ensure the rear wall behind the driver has a double layer of carpet felt, with the upper layer bunched up to dissipate sound waves, in order to prevent coloration occurring. If you cannot obtain natural carpet felt, use Deadsheet or Deflex Panels.

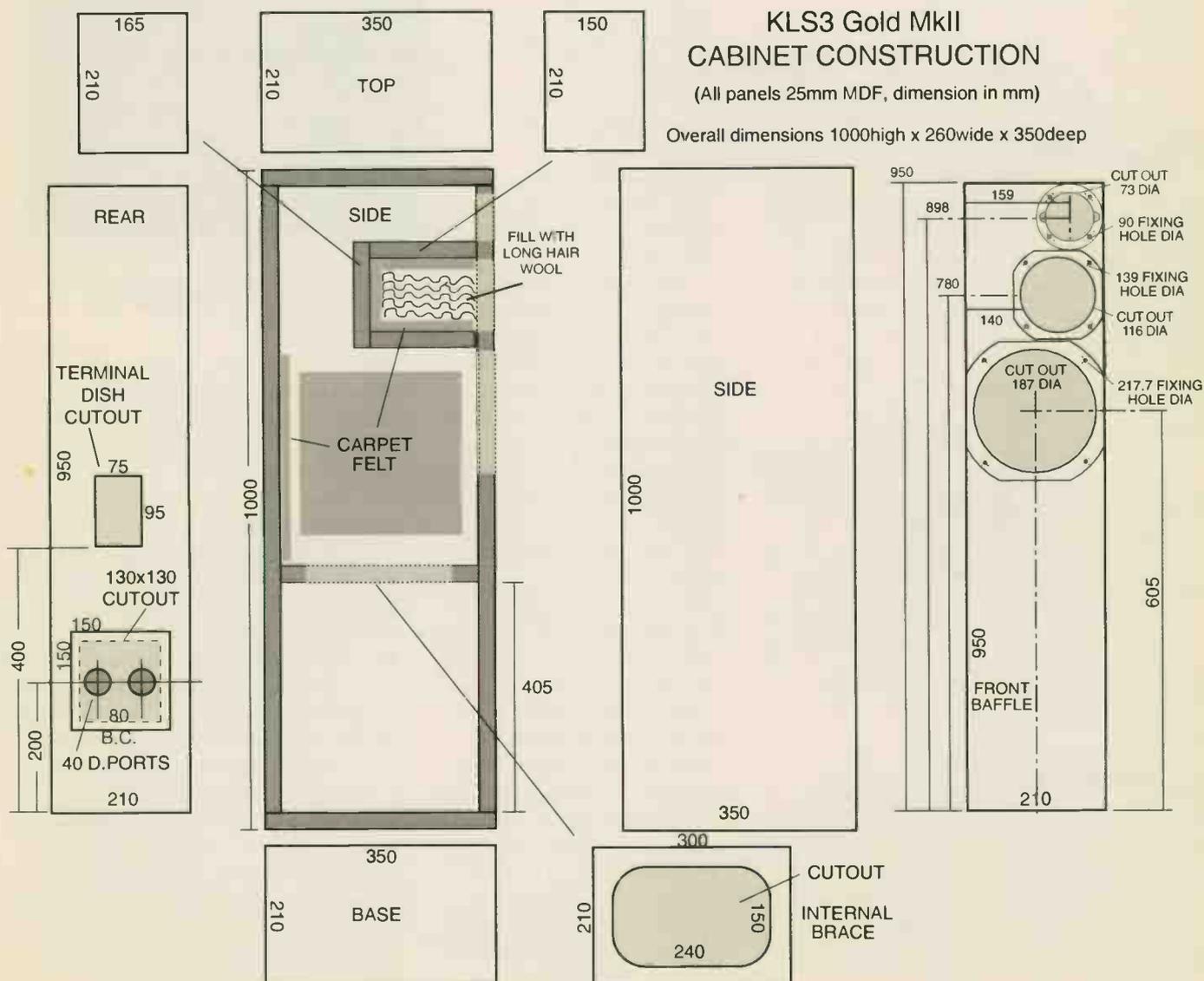
CROSSOVER

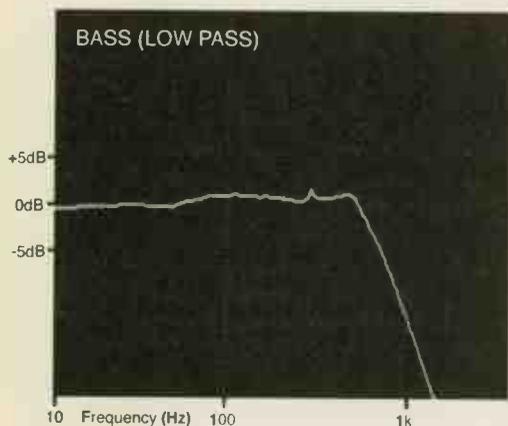
The electrical response curves show that the filters used were, by and large, well damped, having smooth rather than peaky roll-off characteristics. This helps keep the loudspeaker's overall impedance curve smooth, because filters that lift response do so by demanding energy from the amplifier over a narrow frequency band, lowering impedance to achieve this. The result is a wildly gyrating impedance curve with steep slopes and high reactance. Loudspeaker manufacturers largely remain oblivious to the fact that this exacerbates differences between amplifiers. We have found through experience that KLS3 tends to get the best out of amplifiers, flattering them you could say. Funnily enough, for this reason we never use KLS3 for amplifier assessment, because it gives better results than will be

KLS3 Gold MkII CABINET CONSTRUCTION

(All panels 25mm MDF, dimension in mm)

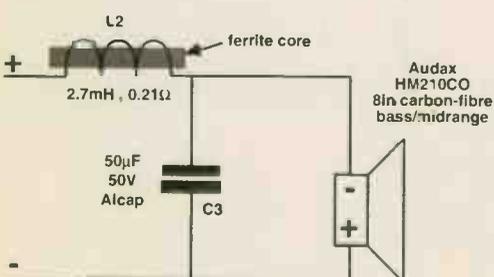
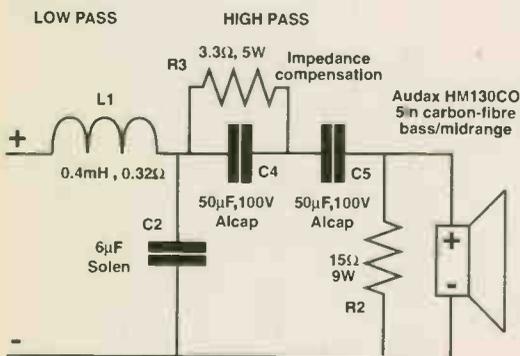
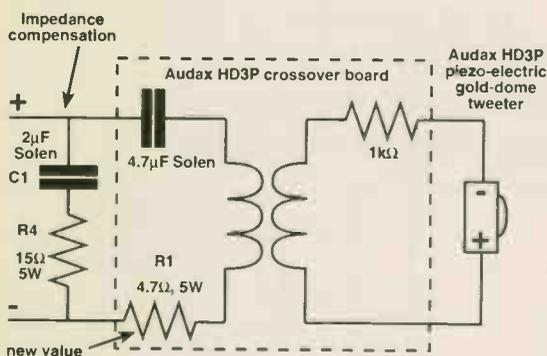
Overall dimensions 1000high x 260wide x 350deep





The bass section rolls down above 40Hz at -12dB/octave, shown by our analysis here.

KLS3 GOLD MkII CROSSOVER



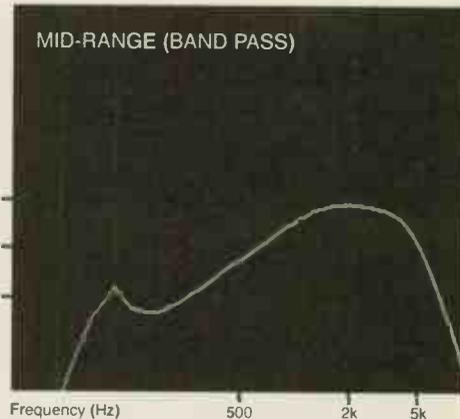
encountered with most commercial loudspeakers.

I reworked the crossover with inter-driver phase-angle matching and overall impedance characteristics very much in mind. It takes a number of passes to get the approach right, but there's always a solution that gets all factors into balance - and that's the right one.

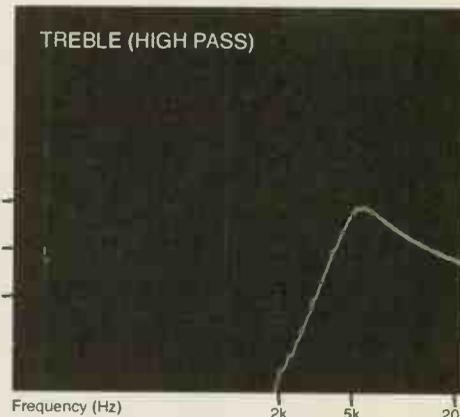
There are so many variables in the three-way system it has to be fine tuned by trial and error, using a fast test system, for which we rely upon the real-time display of our Fast Fourier Transform (FFT) analyser. It shows frequency response, impedance, electrical response and inter-driver phase matching, allowing them to be balanced against each other. Unfortunately, there's no way you can do this at home, until FFTs and measuring microphones become more affordable and common.

The impedance curve is now flatter than before, as our analysis shows, being very flat by the standards for any loudspeaker, but especially a three-way. It has dropped to around 5ohms which, with the inevitable rise at low frequencies caused by bass unit resonance, measures out at 6ohms overall.

The crossover needed a few tweaks to achieve this result, including the split high-pass capacitors feeding the HMI30CO with a resistor across one, and the resistor/capacitor network across the HD3P tweeter. This tames a rapid impedance rise above 10kHz, characteristic of the tweeter crossover network. It also rolls down high treble above 12kHz, which softens out the tweeter's sound a little. If desired, it can be removed or lessened in effect by increasing the resistor value (try 20ohms-30ohms). An alternative is to



The midrange section rolls out bass at -6dB/octave below 1kHz, and treble at -12dB/octave above 5kHz.



The treble unit filter rolls out all frequencies below 5kHz at -12dB/octave.

reduce the value of R1 to 2.7ohms, but then a resistive attenuator is needed to reduce tweeter sensitivity. This solution will, however, maintain output flat up to 20kHz.

CABINET PLANS

For those of you lacking KLS3 Gold cabinet plans, published in our December 1996 Supplement (No 26), we are reprinting them again here, with a few modifications. The twin front ports now move to the rear of the 'speaker and are mounted on a removable panel. This allows them to be changed and tuned for length more easily. The 150mm x 150mm mounting panel also gives access to the loudspeaker and the crossover network, which can be screwed down onto the base. However, it is better to have an external crossover network, bolted onto the rear panel. This removes it from acoustic vibration (important) and makes experiment easier (I'm likely to mod KLS3 again!) Although we specify the

terminal dish cut-out dimensions here, get the dish before cutting the hole because items like this can suddenly change in size or mounting method over a production run.

I will also re-tune the ports in future, showing the differences between small and large. By the way, there is no 'correct' port size, as some readers are wont to argue because an equation gives a set of dimensions.

Port equations make many assumptions about working conditions and damping. The ports on KLS3 were dimensioned to suit most rooms, a factor, like impedance, little considered by loudspeaker engineers (see our Group Test this month) and not reflected in port equations. I hope to look at alternative ports and what they offer next month. A removable panel makes port size experiments easy to carry out of course and this is probably the best way of tuning a reflex loudspeaker in any case, using listening tests, because it takes room excitation and personal taste into account.

DETAILS

Here are some important constructional details.

The tweeter board is modified by removing the green Seta R82 (0.82ohm) resistor and replacing it with a 4.7ohm resistor, 5W. The capacitor remains standard; do not add 2 μ F in parallel as before. This raises the crossover frequency a little. The resultant electrical response, with impedance compensation in place, clearly shows a steep roll-off below 6kHz.

Note also that the tweeter has its phase reversed. You can do this by connecting the tweeter unit the 'wrong' way around (i.e. positive to negative), or the input to its crossover board, but not both. The positive terminal of the tweeter is the lower terminal when looking from the rear with terminals at left. A red sticker is used to identify polarity, but it can come off.

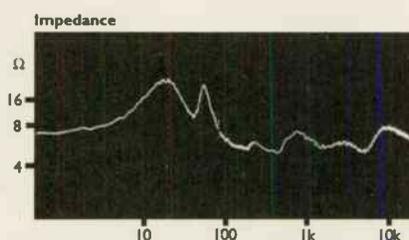
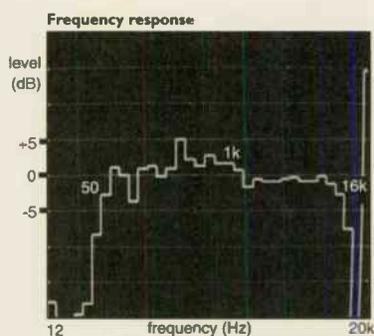
I re-tuned the low-pass section of the band-pass filter feeding the HMI 30CO midrange unit to improve its phase matching to the tweeter. This was aided by a new inter-driver phase measurement technique I have developed for the FFT. The phase matching was close before, but has now improved. The ear is very sensitive to

MEASURED PERFORMANCE

KLS3 Gold MkII remains as sensitive as before, giving 90dB Sound Pressure Level (SPL) for one nominal watt input power (2.84V).

Impedance averages out at 6ohms, but the loudspeaker consumes less bass power than before, the impedance over the bass region having risen considerably through decoupling of the midrange unit by a high-pass filter. The loudspeaker's DCR is now 6.8ohms, being that of the bass driver alone. The absence of steep slopes in the impedance curve indicates very low reactance (energy storage), which helps make the 'speaker amplifier friendly - transistor or valve. KLS3 Gold MkII can be run from as little as 10watts, but will accept up to 60watts.

Frequency response has been engineered for a slight lift below 1kHz to make sure there is plenty of 'body' in the sound, but the characteristic remains flat within 2dB limits. The ports operate around 40Hz to reinforce bass and the tweeter cuts in high up, above 5kHz. Removing the zobel network C1/R4 increases treble output above 16kHz. **NK**



phase in this region and I've noticed that instruments like bells, triangles and cymbals sound more solid and life-like as these drivers move more closely into phase. It's worth wringing every last ounce of performance from the HD3P and HMI 30CO combination because there's little that can match them. They are technically very advanced but also too expensive to be found in commercial loudspeakers. It would be a shame to just throw them together, which is why a lot of fine tuning work has gone into this crossover. The low-pass inductor decreases in value from 0.5mH to 0.4mH and the 8 μ F capacitor decreases to 6 μ F; small but useful changes. Again, you can just take turns off the original inductor if you have the ability to measure inductance.

The HMI 30CO midrange was also closely matched into the HM210CO bass unit. Note that the bass unit has its phase reversed too. To determine bass or midrange unit polarity, use a small 1.5V battery. When connected such that the cone moves forwards, by convention the positive terminal of the battery is connected to the positive terminal of the loudspeaker.

POWER HANDLING

This is purely a function of durability, mostly thermal, sometimes mechanical. It is not a measure of efficiency or maximum loudness, as many seem to think. The maximum power handling capacity of KLS3 is determined by the HM210 bass unit, rated by Audax at 70watts, so that is what we recommend as a limit for the entire loudspeaker. The HMI 30CO will not see its rated maximum of 50watts and the HD3P also has plenty of spare capacity.

You can use an amplifier of any power, but if, say, it is rated at 100watts, don't run it flat out. Because KLS3 delivers 90dB SPL from 1 watt, it will deliver around 110dB SPL from 70watts, which is very loud. Loudspeakers of this sensitivity in practice need no more than 60watts to suit most rooms and needs.

The Audax drive units are beautifully made and very tough. All the same, KLS3 Gold MkII is not a party machine and was not designed to generate continuous high sound-pressure levels

as a primary objective. If you listen very loud and find you blow loudspeakers, the best solution is to get a large multi-driver 'speaker from one of the major manufacturers, because the in-going electrical power and out-going acoustic power are spread over many drive units, lessening the load on each. Continuous high levels produce hearing damage, by the way, which in turn demands high levels - a vicious circle.

SOUND QUALITY

These modifications reduced a little chestiness that could sometimes be heard from the midrange unit, according to the effectiveness of the damping used in the midrange chamber. It also lessens cone excursion and Doppler distortion. Power handling is not really an issue, since the HM130CO can handle 50watts.

The bass unit now works further into the audio band. It is coupled more tightly to the driving amplifier and its efficiency has increased markedly, since SPL output remains the same whilst the impedance seen by the amplifier has increased. This has improved bass quality. Be aware only that rear-wall damping behind the HM210CO now needs to be paid some attention to prevent a coloration from this source. It is easier to apply damping here than in the

KLS3 Gold MkII PARTS LIST (per loudspeaker)

L1	0.4mH, 0.32Ω, air cored, 1mm wire (Falcon: Bobbin 3)
L2	2.7mH, 0.21Ω, ferrite cored, 1.25mm wire (Falcon: Super Super Power, or SSP)
C1	2μF, Solen (400V)
C2	6μF, Solen (400V)
C3	50μF, 100V wkg. min. Alcap
C4	50μF, 100V wkg. min. Alcap
C5	50μF, 100V wkg. min. Alcap
R1	4.7Ω resistor, 5W
R2	15Ω resistor, 9W
R3	3.3Ω resistor, 5W
R4	15Ω resistor, 5W

Input	bi-wire input terminal panel
Damping	long-haired wool (1lb)
Panel damping	natural carpet felt (or deadsheet)
Wood glue	Evode Resin W
Wood	25mm MDF
Wire	silver-plated copper, single strand

PORTS (2off/spkr.)

38mm internal diam.x 80mm long/40mm fixing hole
(35mm internal diam., 110mm long can be used)

limited space of the midrange chamber, one reason the crossover was reconfigured.

The tweeter's contribution has been softened. I have always been in two minds about this, in subjective terms. It is

necessary with most fabric-dome tweeters, which commonly sound coarse if extended up to 20kHz. With clean sounding ribbons like the Tonigen or the even more impressive HD3P used here, there's an option between total smoothness and apparent integration as given by the rolled-down response, and a pleasing shine and presence from a flat, extended response. Generally, the former sounds better initially but the latter is more engaging over a period, with some acclimatisation. The quality of the source will influence matters here too.

Otherwise, KLS3 remains big and easy sounding, with superb midrange clarity and projection - especially with vocals. Very few drivers can handle the human voice as well as Audax's HM130CO. The other strong feature of carbon fibre is that it possesses an innately sweet, amenable delivery. Couple this with the extraordinarily fast yet clean and sweet tweeter and you have a loudspeaker that is a delight to listen to. It is also technically better phase matched and has a flatter impedance than most commercial loudspeakers. It was once the most sensitive too (90dB SPL from one watt) but I'm glad to

say that now this sort of sensitivity is becoming less rare.

NEXT MONTH: Port tuning KLS3 Gold MkII.

UPDATING KLS3 GOLD TO MKII STATUS

It is possible to insert the high-pass filter (C4, C5, R3) for the HM130CO, and the low-pass filter comprising L2, C3 for the HM210CO bass unit without making any other changes. The HM130CO low-pass section and HD3P mods apply to the latest version of the HD3P, identified by the absence of hex screws on the front.

An upgrade kit will be available by the time this is in print. Please phone/fax Nick Lucas at 0171 221 0691 for details.

UPGRADING KLS3 TO GOLD MKII STATUS

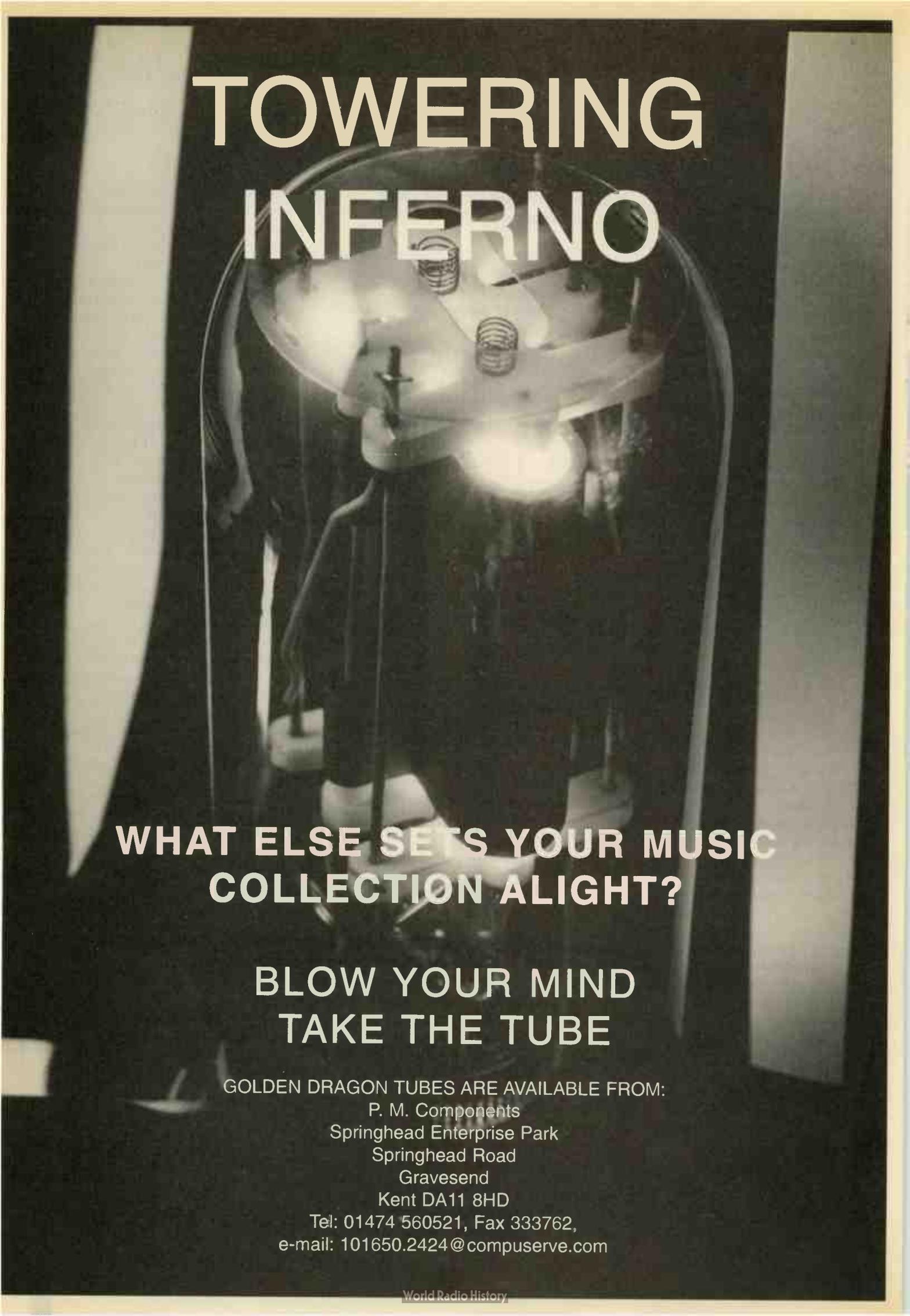
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Analog Electronics - Analog Circuitry Explained

by Ian Hickman

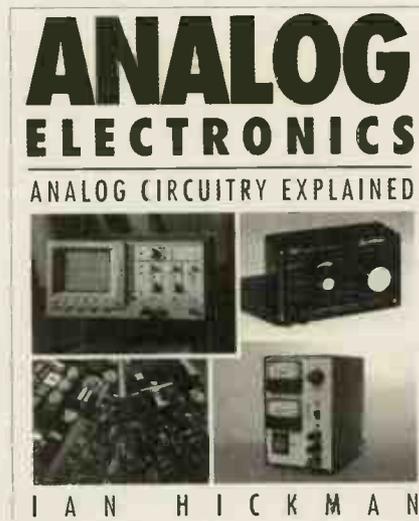
Reviewed by Haider Bahrani

Ian Hickman is a man after my own heart. His expedition through the analogue jungle begins with a quote from the inventor of the smart card, Roland Marenco: "Digital is easy. Analog, that's professional." As a mainly 'professional' engineer, I certainly feel quite at home with this tome. The book, as you might surmise from the subtitle, is a series of technical papers detailing the topic at hand.

The 11-chapter extravaganza kicks off with two chapters covering the three main passive components - resistors, capacitors and inductors - and circuits built from them. The descriptions of the components are certainly thorough, leaving the reader in little doubt as to the nature of each. Chapter Two stretches the boundaries of its brief a little to cover time and frequency-domain analysis, introducing the reader with a baptism of hot solder to several forms of the graphical representation of circuits and systems. Responses such as pole-zero diagrams, Bode plots (gain and phase representation in the frequency domain) and circle diagrams are dealt with too. Not only is the reader given a crash course in lead and lag networks (phase delay and phase advance compensation networks) but resonant circuits are thrown in for good measure. The author has thankfully avoided a complete Bode analysis (maths, maths and a little more maths).

Chapter Three takes us into active territory where valves, diodes, transistors, thyristors and op-amps are given the full monty. If you are not daunted by pages and pages of text written in a narrative fashion, then this chapter is a good way of brushing up and will suit the learner who has stamina and good concentration.

Chapter Four focuses on audio-frequency signals. It starts with basics like the gain of a single-ended Class A circuit and moves on to such things as amplifier efficiency, distortion, negative feedback, the Nyquist stability criterion and so on.



There's a quick glance over loudspeakers and signal sources too, although the latter is given more comprehensive coverage in Chapter Nine.

The following three chapters are devoted to signal processing and transmission. The first of these deals with passive components. From telephone cables across the ocean to the connection between a CD player and an amplifier, the principles are the same and are well explained here. Capacitance, inductance and aspects of delay and filtration are brought into the frame.

Chapters Six and Seven tackle active signal processing in the frequency and time domains respectively. The former concentrates on the use of operational amplifiers in active filters of various kinds, including Chebychev, Butterworth and Sallen and Key.

Chapter Seven on the other hand is less concerned with frequency response than it is with wave shaping. In this section there is more than a little crossover into the digital domain, which, after all, uses a great deal of analogue circuitry to achieve its ambitions. A vast array of circuit types (those involved in common-mode rejection, noise shaping, integrators, constant-current sources and even low-frequency harmonic generators for putting the harmonics

back into audio distortion) is examined. The only straying from the 'official' analogue field is in the interfacing of the digital domain with analogue circuitry, hence some light is shed on ADCs (Analogue to Digital Convertors) and DACs (Digital to Analogue Convertors).

The eighth chapter of this book is devoted to radio-frequency circuits, the uses of which stretch far beyond its original brief of information transmission, and include cancer treatment, plastic bag sealing, frequency modulation, amplitude modulation, the super-heterodyne receiver, and those are just for starters. There is actually more coverage of correlated topics here than in most texts and it's more coherent too. Again there is a lot to read through with little opportunity to pause for mental breath.

Ian Hickman returns to signal sources in Chapter Nine. Voltage reference sources, sinusoidal and non-sinusoidal wave-form generators are looked at, as are noise generators and voltage-controlled oscillators. This is followed by a chapter on power supplies, stopping off to dwell on batteries, AC supplies, DC supplies and power converters.

The final chapter, 11, is given over to explaining some 'tricks of the trade'. These are partly theoretical and partly practical - all in all a very useful section.

Analog Electronics appeals to me greatly as a source of invaluable information, but my approach is from a position of familiarity with the subject. Refreshingly unconventional in its approach, this book is highly recommended for the serious electronics enthusiast ●

Analog Electronics - Analog Circuitry Explained £19.99

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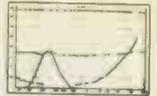
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AUDIO ELECTRONICS

by John Linsley Hood

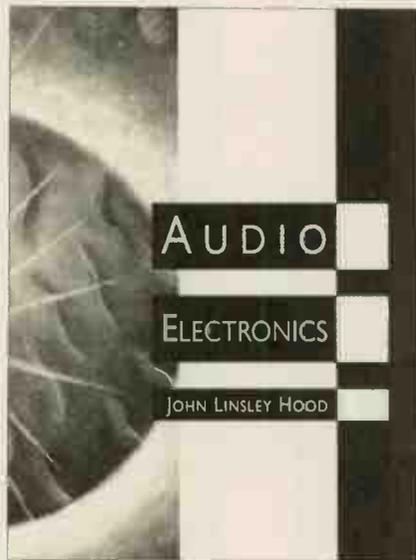
Reviewed by Noel Keyword.

I enjoy John Linsley Hood's writing and Audio Electronics proved no exception. It is as clear and forthright as *The Art Of Linear Electronics*, also by Hood, but aimed at a different need. Where the former is a bof-up for design engineers or anyone contemplating a bit of audio design work, Audio Electronics is a resume of the whole field. It seeks to provide background on all subjects, from tape recording through radio to Compact Disc. And who better to put them across; Hood has been designing, arguing and writing about audio all his life and his fluency in the subject shows.

One example of this is an easy writing style suffused with confidence, reminiscent of audio's greatest writer, M. G. Scroggie. Hood knows his stuff, like Scroggie, and having designed innumerable circuits for enthusiast consumption, also knows he knows - that's where the confidence comes from. The result is a book freer from obfuscation and technical gobbledegook than most. Witness Chapter 6: The Compact Disc And Digital Audio.

By the third page of this chapter (p235) Hood has reached the horrors of quantisation error produced by digital sampling and the coarse sounding noise it produces. Over the page he quickly identifies the need for no less than 1.4MHz of transmission bandwidth for a two-channel, 16-bit stereo signal that reaches just 20kHz. In other words, digital in this form needs 70 times more bandwidth than analogue, a little-known fact.

It is this ability to alight on crucial underlying principles that distinguishes Hood's writing from most others'. It comes across as lucid exposition free from the irritatingly naive, "Isn't digital wonderful" approach that always suggests to me the author is simply re-writing corporate product data, as so many do. There's no substitute for long-term, hands-on experience; it usefully illuminates Audio Electronics in a way that is becoming increasingly rare.



Chapter 6 on CD is short but succinct and probably one of the best introductions to digital I have read. This underlines the strength of Audio Electronics as an excellent introductory book. It covers a wide range of topics, although some are looking a bit peripheral to high-fidelity these days. Analogue tape recording occupies the first chapter, covering the basics as well as the arcane side of this subject, such as tape MOLs (Maximum Output Levels). A few pages at the end touch on digital recording systems, but not in any detail.

Tuners and radio receivers occupy the second chapter. There's plenty of information on modern synthesiser tuning systems using phase locked-loops and such like, but this chapter remains analogue, not touching DAB. The current view amongst many in audio is that because DAB offers little perceivable benefit over conventional VHF/FM it stands little chance of success, so this is perhaps not a consequential omission, but a few words would have been useful.

Hood is an amplifier specialist, so it is hardly surprising that Chapter 3, entitled Pre-amplifiers And Input Signals should be followed by Voltage Amplifiers And Controls and then Power Output Stages, all amplifier-related topics that together

cover a fair expanse of paper.

Practising audio engineers have to get into Test Equipment. Measurement is a whole area of theory in itself, and a vital one, if tests are to clarify rather than confuse issues of performance. Audio Electronics moves its appeal toward engineers here though. I have seen more useful and illuminating explanations, as far as the average experimenter is concerned, about using multimeters and modern budget test equipment, than Hood's explanations of diode stabilising circuits and such like. There's a missed opportunity here, because modern test instruments, including computers, offer incredible ability at low cost compared to that available a decade ago. Only the oscilloscope, with its expensive CRT and power supplies defies this trend, but LCD displays are slowly becoming more common. It might have been better to devote more space to this topic, because there is a lot of important basic theory to be covered when measuring voltages, currents, inductors, capacitors and resistors, etc (as Scroggie well knew). In my view Hood wastes his talents by diving off into circuits here again.

Audio Electronics ends with a short chapter on loudspeaker crossovers, followed by power supplies. Neither are very comprehensive. The book has lost its focus by this stage and peters out. There's room for improvement in a second edition here. This apart, I found Audio Electronics strong in its coverage of audio theory and basic working principles, John Linsley Hood showing his talents and experience here ●

Audio Electronics £18.99
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D.I.Y. Letters

SIZE IS EVERYTHING

I am constantly amused by your references to such things as, "very sizeable 500VA" toroidal transformers (p13, Sept 1997). I thought that you'd like to see a really sizeable transformer. Its 90000000VA and supplies half of Norfolk with electricity. The voltage? 132000V stepped down to 33000V!
Nick Sheldon
Norwich.

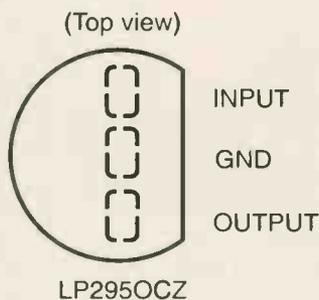
TWEAKING TECHNIQUE

As an owner of the Technics SL-1000/MkII turntable and plinth combination featured in July's Hi-Fi World second-hand feature, I was very interested in the power supply upgrade. Is there any possibility of supplying details of the modifications in the magazine?
David Fellows
Cheltenham,
Glos.



Putting hi-fi in perspective - if a 500VA transformer sounds chunky, then try 90000000VA as used by electricity companies!

There's a lot that can be done with the SP-10MkIIP (note the "P" suffix. These mods don't apply to "A" suffix versions) motor unit and outboard power supply unit to improve their performance. One of the cheapest, swiftest and most effective mods is to fit the main ICs in the crystal oscillator section of the PSU with their own regulators. You don't need to do this for all the chips, as beyond the five marked in diagram No1 there's



National Semiconductor's LP2950C 5V regulator may be more expensive than standard 7805 ICs but it brings a higher level of performance for the extra outlay.

little or no improvement when extra regs are added.

You can get good results with regs like National Semiconductor's LP2950C 5V low-dropout voltage IC. At £1.99 from Maplin (order code: AV35Q) it's considerably more expensive than standard 7805 chips which normally cost about 30p a throw. Then again, it sounds considerably better in this application.

To fit the LP2950C you need to cut the tracks on the Technics' PCB which supply +5V (see diagram No1) and then solder the output leg of the new reg directly onto it. Sanyo's Os-Cons make excellent PSU decoupling caps and are available from Audio-Links (tel: 01724 870432). Don't worry if you forget to cut one of the tracks,

you're unlikely to do any damage - the new reg will just work alongside the Technics' own. In any case, the motor unit and PSU are fairly tolerant of wiring mistakes, unlike my Pioneer PD-91 CD player which recently went up in a puff of smoke.

The other areas ripe for regulation are the control and drive circuits within the base of the motor unit. Remove the unit's bottom cover and you'll see the control, drive and logic circuits in front of you. The drive board is numbered SFDP102-02A and carries the three pairs of drive transistors bolted onto a small aluminium heatsink.

The drive and control sections run from 32.5V DC supply provided by the main regulator in the PSU case. There is very little decoupling between stages in the motor unit. While the Technics' original regulator is pretty good, the circuitry really benefits from separately regulated supply lines.

This part of the mod is a bit more complicated than the previous one and, if you forget to cut the right tracks on the PCB, you can end up with a platter that's either gathering speed as it heads towards about 100rpm or hunting around left and right for the right way to rotate. Both are quite frightening to watch because the Technics' high-torque motor can spin the 2.9kg platter extremely quickly.

LM317T positive variable voltage regulators work well in this application. Again, these can be bought from Maplin (prices vary with manufacturer, Sanyo's version retailing for 80p, order code: AV30H). As bypass and output decoupling caps on the IC's adjust pin tantalum capacitors are a good

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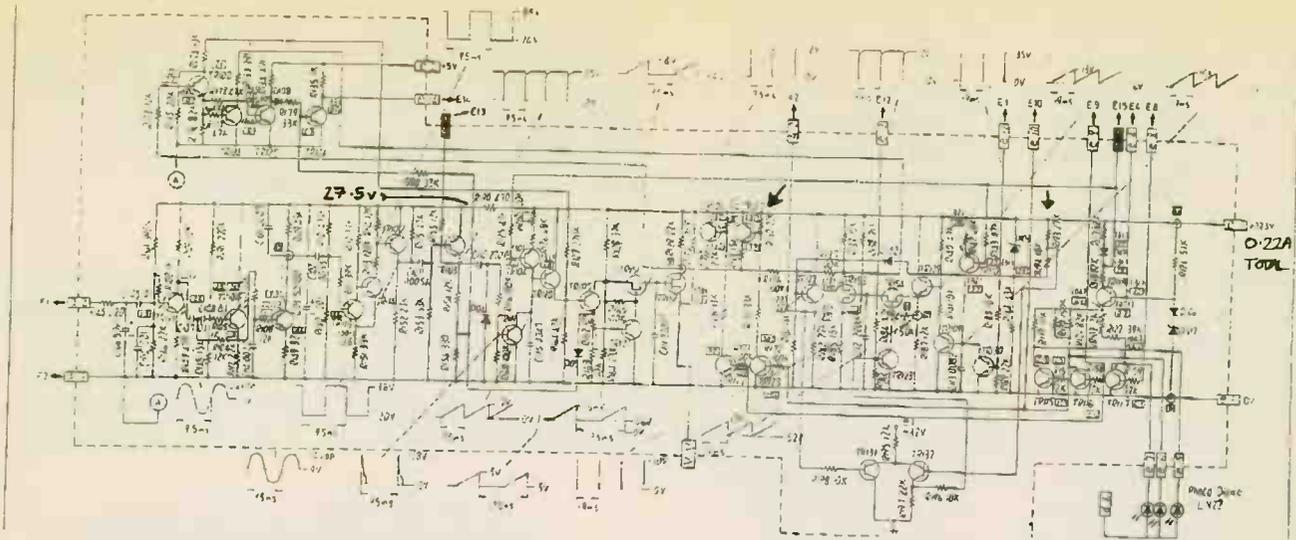


DIAGRAM NO1: fitting extra regulation to the crystal oscillator board at the points marked X boosts sound quality dramatically.

choice. These are widely available in 35V ratings up to about 22µF. You can also try larger electrolytics, like

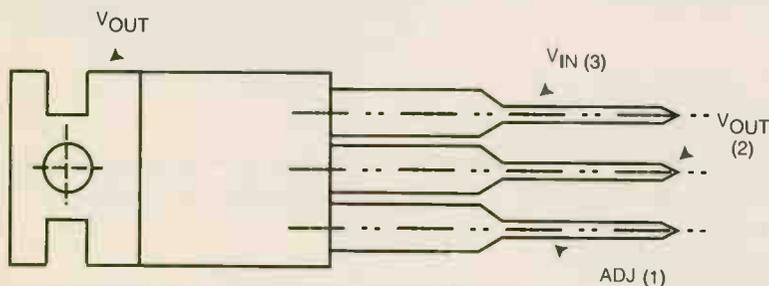
unit's cover and are actually easier to work with in this case than non-surface-mount types. And if you choose to opt for the

modifications in place, the SL-1000/MkII produces a much more dynamic, involving and rhythmic sound than before.

to-back depth you could almost step into. **JM RADFORD REVAMP**

I read your article in the August issue on the Radfords with interest, having a SC22/STA25. Only one aspect of the design was sometimes considered inferior; the use of solid-state devices in the power supply instead of valves. Despite this I still think it is as good as or better than the Quad valve amp.

However, my STA25 needs a rebuild. Is there



National Semiconductor's LM317T regulators can be used to improve the performance of Technics' SP-10MkIIP direct drive motor unit.

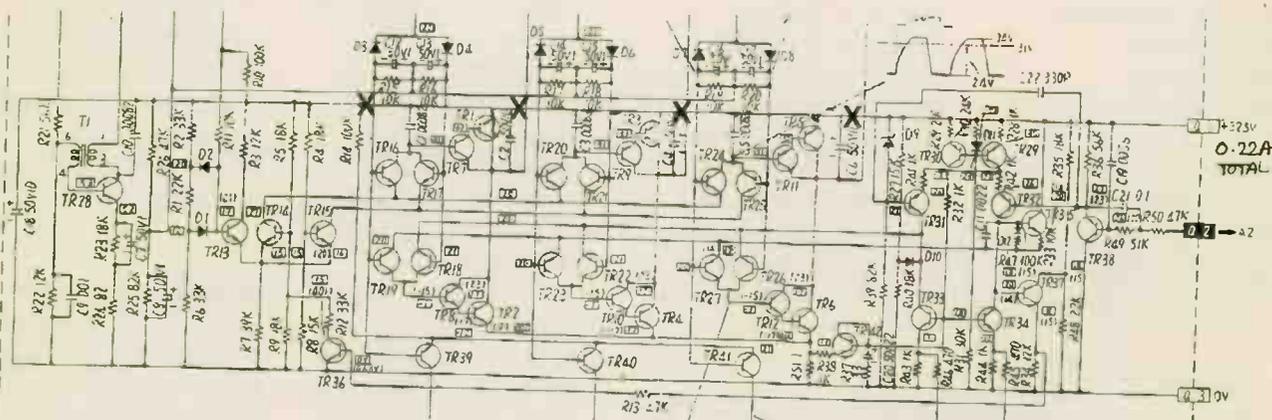


DIAGRAM NO2: LM317T regulators can be inserted at the points marked X to reduce interstage interference in the drive circuitry and improve sound.

Rubycon's YXB, at about 470µF.

The only other parts you'll need are a 180R 1% metal film resistor (R2) and a 5kohm variable resistor (R1) to trim the output voltage for each LM317T. Small surface-mount variable resistors fit easily under the motor

LM317T in any other circuits, the output voltage can be calculated from: $V_{out} = 1.25 \times (R1 + R2/R2)$ where R2 is connected between pins 1 (adjust) and 2 (output) and R1 is connected from pin 1 to ground when the IC is viewed from above.

With these

Background noise is also considerably lower, and there's a solidity, smoothness and definition to music which many belt-drive decks have a hard time emulating. And if you're using an arm like SME's Series V, sound staging is truly holographic, with a front-

anyone who offers a kit of components for this purpose, as there was 10 years ago? I can't see any obvious ones in your ads. I am quite capable with a soldering iron and circuit diagram. Otherwise, as I have reservoir capacitor induced noise, can you suggest a source of suitable smoothing capacitor

replacements? I think that other components are probably easily available from Maplin or similar suppliers.

By the way, mine runs with KT77s, rather than EL34s, which, on listening, I thought better. It's quite possible that I was replacing old with new valves, or that I have cloth ears. Not that KT77s seem available nowadays.

Finally, can you give me the name of a supplier of your recommended (World favourites) Ortofon VMS-2E cartridge? I am overhauling a Thorens TD150 turntable for someone with a CD-only system, who is reluctant to spend money, and wants one to put in it. I am fed up with going into hi-fi shops of varying poshness and being treated like an amusing idiot when I ask for one.

By the way, the Thorens TD150 is a good boot-fair buy, at around £5 or less, though the standard arm is dubious. Do you have any tips, ideas or simple mods for this basically well-designed turntable? I put STP in the bearing which should help with its reputed rumble potential (anachro-tip?)

Chris Wigzell
106201.666@compuserve.com

Because your Radford uses solid-state rectifiers the first thing to do is replace the standard diodes with Schottky rectifiers. There's

basically a trinity of rectifier diodes: bog standard, fast recovery and Schottky. Because Schottkies don't produce switching spikes like the other diodes they tend to produce a smoother, cleaner sound.

The STA25 uses a twin-section main reservoir capacitor of 100µF + 100µF at 500V which is very prone to failure. Following this is another 8µF 500V cap. These should be replaced with new electrolytics bypassed with 1µF and 0.1µF film caps. This will give you sound quality close to that you'd get from a polypropylene at a lower cost. Try Electromail (tel: 01536 204555) for these caps.

Henley Designs stock the entire Ortofon range of cartridges, with a brand new VMS-2E costing £13.95. You can contact them on tel: 01753 889949.

If you picked up a copy of the September issue you'll have seen Haden Boardman's recommendations on tweaking Thorens' TD125. Replacing the TD125's original rubber mat with either a glass mat or a cork one worked well and will do so on the TD150 too. You can also try the old stalwarts of damping the plinth and sub-chassis with car-body damping



The reservoir caps in Radford's vintage STA25 power amp often fail and should be replaced with modern equivalents.

panels (check this won't over-stretch the springs though). JM

TACKLING TRANSFORMERS

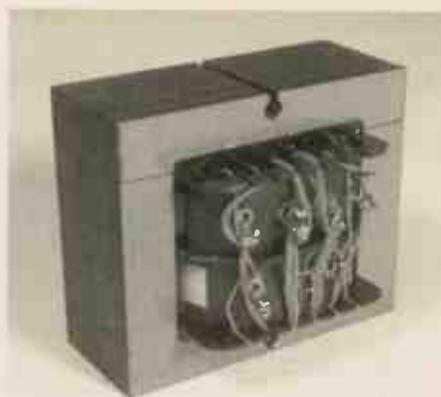
I write with reference to Mr Sirignano's question about measuring the impedance of output transformers in Supplement No30, the August edition.

The output transformer is only an impedance-matching device. The anode load is

25 years and with so many excellent transistor designs about I don't see the point of using them anymore.

Ron McQuade
Heywood,
Lancs.

If "I haven't used valves for over 25 years" equates to "I haven't listened to valves for over 25 years" then you certainly owe it to yourself to hear a well-



Finding out the impedance of an unmarked output transformer is easy with the advice above.

derived from the valve's load lines or manufacturer's data. The important factor is the turns ratio of the transformer. This is equal to the square root of the impedance ratio it is matching. For a 6k anode load to a 15Ω 'speaker it would be $\sqrt{(6000 \div 15)}$ to 1, which is a 20:1 turns ratio. For a 3Ω or 4Ω 'speaker it would be 40:1

Mr Sirignano would have to determine the turns ratio of his transformers. This could be done by applying a low AC voltage, say 3 volts, to the secondary and measuring the primary voltage (or a higher voltage to the primary and measuring the secondary). The turns ratio would be equal to the voltage ratio (ignoring losses).

I am amazed by the current interest in valve amps. Over 30 years ago I built practically every Mullard design and designed many high-powered amps myself. I haven't used valves for over

designed valve amp working with modern loudspeakers of useful sensitivity, which are thankfully becoming increasingly common. This combination possesses the kind of powerful, seductive sound that rarely emanates from a solid-state amp. JM

SUGDEN SOUP-UP

I read with interest the article in the June '97 issue about Sugden amplifiers by Haden Boardman. I have owned a CS1/A51 combination for the last 25 years and while on a 'speaker upgrade quest (to Castle Chesters) have had the opportunity to listen to a number of modern amps.

Although many were highly recommended and one was even in the £2000+ bracket, the Sugden compared very well. As stated in your article, the bass is weak - I find that a bit of bass boost (HORROR!!)

improves things. But this is still the area I wanted your advice on. Would it be possible or practical to replace the output capacitors

These could then be bypassed with smaller value polypropylenes (say, one at about 10uF and one at 1uF for each Cerafine).

Audio-Links, tel: 01724 870432). With these mods in place your Sugdens should sound superb. JM

lines, GEC must have been anxious to phase out the 'obsolescent' members of the KT range since the well-known 'Approach To Audio Frequency Amp Design' relegates KT61 to a brief mention whilst EL84, a miniaturised near-equivalent, is plugged unmercifully! Leak himself later produced the TL12+ amp which uses EL84 in an otherwise very similar circuit to the TL10.

What Matt's enquiry really highlights is the growing difficulty in servicing equipment not 'dead-centre' in the mainstream of vintage audio. Looked at uncharitably, the suppliers seem to have no problems with components still manufactured or those so plentiful that you can



With a little tweaking to bring them up to date, Sugden's C51 pre-amp and A51 power amp can sound impressive.



with better-quality modern components?

My second question concerns my CD player which is an Aura CD-50. As you know the standard CD output is 2V and this is enough to drive the power amp directly without the help of a pre-amp. Can you give me a design using a minimum of components, say a volume pot, perhaps an Alps, and a few resistors to match impedances, or is this too simplistic?

Following your advice I have used Brasso on all the sockets - as you can imagine they were unbelievably dirty after 25 years. The difference was amazing! I've also put the amp as close to the 'speakers as possible and then bi-wired. Both these changes gave a better sound. My main source is a Rega Planer 3 with the original S-shaped tone-arm.

**Mike Noble
Silksworth,
Sunderland.**

After 25 years' use the output caps on the power amp are likely to be in a real state - electrolytics aren't like wine, they don't improve with age. You could really push out the boat and go for a pair of Elna Cerafine caps which can be bought from either Maplin or Electromail.

These should prove a massive improvement over the caps currently resident in your Sugden.

CD players are designed to be able to work into impedances as low as 10kohm so the Sugden C51's 50kohm impedance shouldn't prove a problem for the Aura.

If you want to take your tweaking a level higher, replace the Sugden's volume potentiometer with a better one like Alps' Blue or Black ones (prices about £15.20 for the former and £27.60 for the latter from

Leak TL10 I've a little more information to add.

The TL10 is historically interesting, being an early example of a high-quality, commercial ultra-linear amp. In choosing the KT61 for the driver stage, Leak no doubt adjudged the superiority of the beam-power valve for audio. Uniquely, the service sheet does not give alternatives. Although details are given for modifications to allow use of the 6L6, and it is possible to use EL33, 6P25 and CV2938 as alternatives, as JM rightly says, they do not sound the same.

Reading between the

practically find 'em in the nearest skip. But just try finding the 'rarities', once-common components made by the million - where have they all gone? I've rung many firms ostensibly catering for vintage needs and finished up doubting my own sanity! 5Mohm stereo pot? . . . 600pF 5% caps? . . . 100kohm volume-with-mains switch? . . . KT61? . . . No mate, sorry!

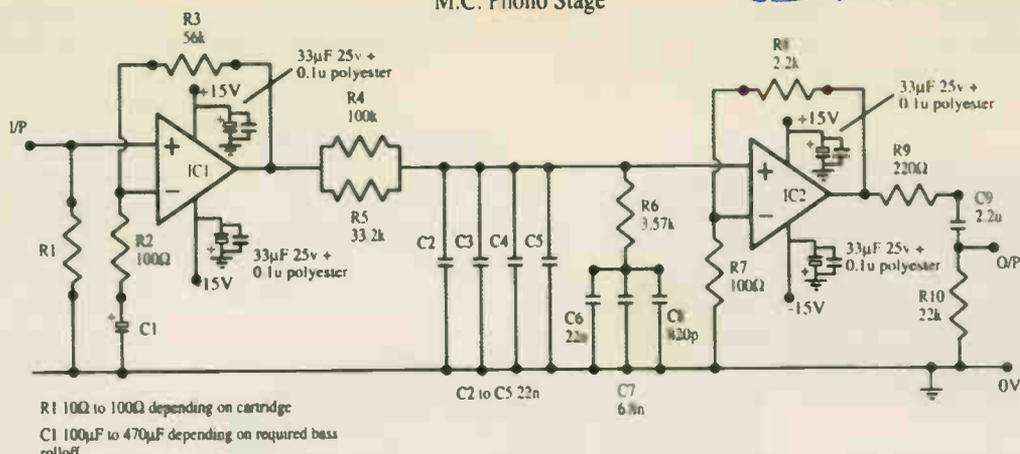
While I accept the fact that large-scale manufacturers cannot be expected to slew their output for a handful of retro-thinking idiots, 'specialist' ought to imply a recognition that many very



As the EL84 power pentode replaced the KT61, so the TL10 was phased out and the TL12+ introduced.

M.C. Phono Stage

WRONG CURRENT
SEE APRIL 1996



By changing ICs to an OP37 and an OP604 our solid-state phono stage can be operated from power supplies with a higher output voltage than the specified +/-15V.

worthy bits of equipment pre-date the preferred-value system that covers components. Such items might just be worth the odd limited-batch, premium-price production run.

I can foresee this letter drawing a righteously indignant response from the new SE class-A-only school; the new-style circuits are admittedly superb and it is indeed unfortunate that high-end makers were sidetracked by Ultra-Linear working and whacking negative feedback as 'the way forward' all those years ago. They did, however, manage to produce some very charming sounding amps which are certainly well worth preserving.

As I listen to these old fossils of a vanished audio civilisation, I wonder if I and any other users should really be obliged to scabble for ever-dwindling supplies of KT61 and (for God's sake!) 57kohm resistors, not to mention pots with 3/16in. shafts. Perhaps I am insane! Be that as it may, I still don't want to compromise the gear for want of such a little thing as a non-preferred wire-wound! (System: two Leak TL10s, Vari-slope stereo, Lenco L75. . . God! What a loony!)
Richard White
London.

A STEP UP
After many years of relying on the MM stage of my Hafler pre-amp and Lentek MC stage for amplification of an Audio Technica AT-F5 (now the last one of a batch bought cheaply when the model was discontinued) I bit the bullet and decided to have a go at building your disc pre-amp.

It has been constructed on a budget of less than £45 using components available from Maplins and the results are stunningly solid, with real attack and tonal colour to the music.

Fortunately the Hafler was designed to have its own optional internal MC stage with power supply capacity for it. Unfortunately it's +/-18V so the ICs used had to be able to withstand the higher supply voltage. I settled on the OP37 and OPA604 op amps, which, according to the Maplin catalogue, are capable of running off up to +/-20V and +/-24V rails.

The circuits were built on Maplin's plugblock YR87U, one per channel, and the whole housed in their aluminium extruded box YN51F (there is no sign of any RF interference or hum). The circuit boards were laid out with the assistance of TurboCad.

Because of the greyness of the previous sound I had

decided to rewire my Rega using van den Hul internal arm wiring, taking the opportunity to fit a socket at the base of the arm so that various leads could be plugged in. As a result of this the silver-plated copper leads from the arm were soldered direct to the PCB so as to have as few connections as possible.

On first powering up the phono stage its sound was fine but there seemed to be too much gain and at high levels there appeared to be overload. So R7 was replaced with 470 ohms to reduce gain through IC2 by about 12dB (there is still really too much gain for many cartridges) but it is quiet with no discernible hiss.

Thanks for an excellent project. I can now hear every instrumental line of my old Captain Beefheart LPs projected with superb clarity! My listening extends to Jazz and 20th-century Classical and the overall effect is much the same for all genres - the impact on the likes of Varese is stunning!

PS - The Hafler has an Alps volume control with improved socketry and capacitors and will probably soon be fitted with better switching!
L. Hopkins
Billesley,
Birmingham.

If you want to go beyond the standard Alps' blue and black potentiometers, there's a couple of options. The first is Panasonic's For Audio pot from Audio-Links (tel: 01724 870432) which sells for £64. Alternatively, AudioCom stock Danish Audio Contact's CT1 switched attenuator, which is built up from surface-mount resistors. We hope to review the CT1 within the next couple of months. JM

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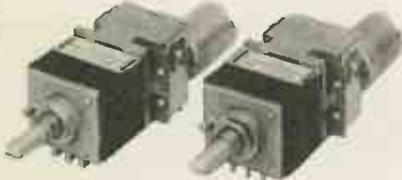
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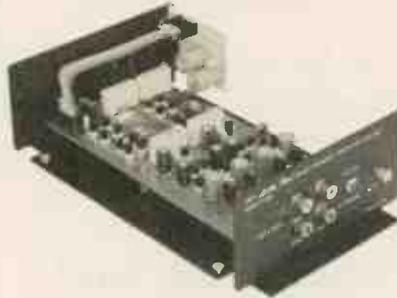
Special set of toroidal transformers, 2 output & 1 mains for the "Hot Audio Power" valve amplifier design described in the Oct. 1995 issue of "Wireless World". Total Wt 4.8kg. Special price for the set. £99. Post £8

RJMf. Photocopies of the Article by Jeff Macaulay. £2

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If you want the very best sound out of vinyl discs then you need our high quality preamplifier with Shunt Feedback equalisation. The K1450 also has an advanced front end, specially optimised for low impedance moving coil cartridges as well as moving magnet types. Selected discrete components are used throughout for ultimate sound quality. The combination of John Linsley Hood design, high quality components and an advanced double sided printed circuit board layout make this a product at the leading edge of technology that you will be proud to own. A recent review in "Gramophone" magazine endorsing this view. Bought in kit form our step by step instructions it is very easy and satisfying to assemble, or you can buy a factory assembled version if you wish.

This magnificent kit, comes complete with all parts ready to assemble inside the fully finished 228 x 134 x 63mm case. Comes with full easy to follow, instructions as well as the Hart Guide to PCB Construction, we even throw in enough Hart Audiograde Silver Solder to construct your kit!
 K1450 Complete Kit £116.58
 K1450SA Audiophile Kit £138.94
 A1450SA Factory assembled Audiophile unit £188.94

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Highest quality, purpose designed, 'single ended' class 'A' headphone amplifier for 'stand alone' use or to supplement those many power amplifiers that do not have a headphone facility. Easy installation with special signal link-through feature, the unit uses our 'Andante' Ultra High Quality power supply.

Housed in the neat, black finished, Hart minibox it features the wide frequency response, low-distortion and 'musicality' that one associates with designs from the renowned John Linsley Hood. Volume and balance controls are Alps "Blue Velvet" components. Very easy to build, or available factory assembled, the kit has very detailed instructions, and comes with Hart audiograde silver solder. A valuable personal listening option and an attractive and harmonious addition to any hi-fi system.

K2100 Complete Standard Kit £112.50
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 A2100SA 'Series Audiophile', Factory Assembled £115.46
 CM2100 Construction Manual £2.50

"Andante" Linear Technology AUDIOPHILE POWER SUPPLIES

The HART "Andante" series power supplies are specially designed for exacting audio use requiring absolute minimum noise, low hum field and total freedom from mechanical noise. Utilising linear technology throughout for smoothness and musicality makes it the perfect partner for the above units, or any equipment requiring fully stabilised $\pm 15v$ supplies.

There are two versions, K3550 has $2 \pm 15v$ supplies and a single 15v for relays etc. K3565 is identical in appearance and has one $\pm 15v$. Both are in cases to match our "Chiara" Headphone Amplifier and our K1450 "Shunt Feedback" Pickup preamp.
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Ever heard, or rather felt!, a speaker that is still only -3dB down at 15Hz? Normally you would expect to have to move out of the house and live in the speaker, but no, this one is in an enclosure only 380 x 335 x 335mm, that's about 15" x 13" x 13" in old money. Clever electronics and a pair of GF250 Visaton drivers with a 35mm maximum cone displacement combine to really kick some air about and bring some real presence to the hi-fi experience. Send for further details.

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VISATON "Speaker Pro 6" is a complete speaker design program for use on IBM machines. Covers cabinet and crossover design and contains a full expandable database of drive units. Earning a "most recommendable" accolade it tests this program is ideal for the professional speaker builder or serious audiophile.
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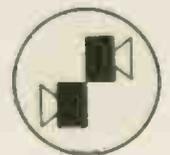
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