

# Hi-Fi WORLD SUPPLEMENT

No. 16 AUGUST 1995

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Hart Audio Kits and factory assembled units use the very best audiophile components in circuit designs by the renowned John Linsley Hood to give you unbeatable performance and unbelievable value for money.

We have always led the field for easy home construction to professional standards, even in the sixties we were using easily assembled printed circuits when Heathkit in America were still using tagboards! Many years of experience and innovation, going back to the early Dinsdale and Bailey classics gives us incomparable design expertise in the needs of the home constructor. The current range of Hart kits is designed to give you all the components for a matching ensemble of audio excellence.



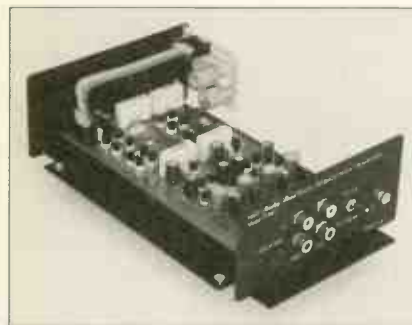
### K1100 AUDIO DESIGN 80 WATT POWER AMPLIFIER.

This fantastic John Linsley Hood designed amplifier is the flagship of our range, and the ideal powerhouse for your ultimate hi-fi system. This kit is your way to get EX performance at bargain basement prices. Unique design features such as fully FET stabilised power supplies give this amplifier World Class performance with startling clarity and transparency of sound, allied to the famous HART quality of components and ease of construction. Useful options are a stereo LED power meter and a versatile passive front end giving switched inputs, with ALPS precision Blue Velvet low-noise volume and balance controls. Construction is very simple and enjoyable with all the difficult work done for you, even the wiring is pre-terminated, ready for instant use! All versions are available with Standard components or specially selected Super Audiophile components at £29.60 extra per channel, plus £2.40 if you want to include Gold Plated speaker terminals.

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A1100B Factory Assembled	£499.21
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A1100SC Factory Assembled	£422.62
K1100M Complete MONO/BLO C Amplifier Kit	£261.20
A1100M Factory Assembled	£329.20
RLH10 Reprints of latest Amplifier articles	£2.70
K1100CM Construction Manual with full parts lists	£4.50

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Standard Kit	£343.49
K1400T Kit with Tri-range tone controls	£398.41



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

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	£111.58
K1450SA Audiophile Kit	£133.94

### "CHIARA" SINGLE ENDED CLASS "A" HEADPHONE AMPLIFIER.

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K2100 Complete Kit	£109.50
K2100SA Series Audiophile version with selected audiophile components	£112.46

Why not buy the reprints and construction manual for the kit you are interested in to see how easy it is to build your own equipment the HART way. The FULL cost can be credited



### ALPS "Blue Velvet" PRECISION AUDIO CONTROLS.

Now you can throw out those noisy ill-matched carbon pots and replace with the real hi-fi components only used selectively in the very top flight of World class amplifiers. The improvement in track accuracy and matching really is incredible giving better tonal balance between channels and rock solid image stability.

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The size of modern components makes the right soldering equipment essential for good results. Everything we offer we actually use in our own workshops! See our Lists for the full range.

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**845-080 ST4 Lightweight Soldering Iron Stand.** This has provision for the classic damp sponge for bit wiping. **£3.95**

### HART SUPER AUDIOGRADE SILVER SOLDER

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 flux 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.

845-007 3mtrs 22SWG in Hart Mini Tube	£3.90
845-008 100g Reel Special Valve Grade, 20swg	£12.90
845-009 100g Precision PCB Grade, 22swg	£14.75
845-110 100g Reel Superfine 24swg for ultra precise control and easy working	£21.45

### PRINTED CIRCUIT BOARD SOLDERING PRACTICE KIT.

Unsure whether you can construct a HART kit?, this is your chance to try! Your HART

Printed Circuit Board Soldering Practice Kit comes with a range of modern components, a typical Hart quality PCB, a roll of the correct grade of solder and full instructions. It enables the enthusiast who is uncertain of his, or indeed her, ability to put together and solder a printed circuit to try their hand at minimum cost! The instructions explain the right technique and guide even an absolute beginner through the seemingly daunting, but in fact very simple, art of making a good soldered joint. Excellent value for money at only **£4.99**  
Super Version with Hart Silver Solder. **£6.95**

### TECHNICAL BOOKSHELF

**NEW! "AUDIO ELECTRONICS"** And now, hot off the press, yet another classic from the pen of John Linsley Hood. Following the enormous ongoing success of his "Art of Linear Electronics" the latest offering is the all-new edition of "Audio Electronics", now entirely re-written by the master himself.

Underlying audio techniques and equipment is a world of electronics that determines the quality of sound. For anyone involved in designing, adapting or using digital or analogue audio equipment understanding electronics leads to far greater control over the reproduced sound.

The subjects covered include tape recording, tuners, power output stages, digital audio, test instruments and loudspeaker crossover systems. John's lifetime of experience and personal innovation in this field allow him to apply his gift of being so familiar with his subject that he can write clearly about it and make it both interesting and comprehensible to the reader. Containing 240 pages and over 250 line illustrations this new book represents great value for money at only **£18.99\***

### "THE ART OF LINEAR ELECTRONICS."

The definitive linear electronics and audio book by the renowned John Linsley Hood. This 300+ page book will give you an unparalleled insight into the workings of all types of audio circuits. Learn how to read circuit diagrams and understand amplifiers and how they are designed to give the best sound. The virtues and vices of passive and active components are examined and there are separate sections covering power supplies and the sources of noise and hum. As one would expect from this writer the history and derivation of audio amplifier circuitry have an entire chapter, as does test and measurement equipment. Copiously illustrated this book is incredible value for the amount of information it contains on the much neglected field of linear, as opposed to digital, electronics. Indeed it must be destined to become the standard reference for all who work, or are interested in, this field. Latest reprinted edition with extended index. 1994. 344 Pages. 247 x 190. 1Kg. 0-7506-0868-4 **£16.95\***

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"THE LOUSPEAKER DESIGN COOKBOOK" Vance Dickason, (4th Edn.) 0-9624-191-7-6 **£22.95\***

ELECTROSTATIC LOUSPEAKER DESIGN AND CONSTRUCTION Ronald Wagner **£18.95**

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"AN INTRODUCTION TO LOUSPEAKERS & ENCLOSURE DESIGN" **£2.95**

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"LOUSPEAKERS FOR MUSICIANS" BP297 **£3.95**

"THE HART PRINTED CIRCUIT BOARD CONSTRUCTION GUIDE." This is included **£2.50**

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### VALVE & EARLY CLASSIC BOOKS

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LOUSPEAKERS; THE WHY AND HOW OF GOOD REPRODUCTION. G. Briggs, 1949 **£8.95**

0-9624-1913-3

MULLARO TUBE CIRCUITS FOR AUDIO AMPLIFIERS **£13.95**

BKA427

"THE WILLIAMSON AMPLIFIER." 0-9624-1918-4 **£6.95**

AN APPROACH TO AUDIO FREQUENCY AMPLIFIER DESIGN. GEC 1957, 1-882580-05-2 **£18.95**

AUDIO ANTHOLOGIES, articles from Audio Engineering. Six volumes covering the days when audio was young and valves were King!, BKA431 to 6. All £13.95 each. "A SIMPLE CLASS A AMPLIFIER" J.L. Linsley Hood M.I.E.E. 1969, RLH12 **£2.50**

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# HART

# D.I.Y. Supplement

## Contents

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The only place to write to for design and build advice on all aspects of audio. Our experts will answer your questions and steer you in the right direction.

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# Connect the dots.



Introducing The Parts Connection's first complete DIY kit: the Assemblage DAC-1 Digital Processor.

It comes in a small package (24cm x 5cm x 18cm chassis), but packs a big punch and a very musical sound. Designed for the rookie or first time kit builder, the only tools required are a pencil tip soldering iron, a screw driver, a wrench, a pair of electronics pliers, and a wire stripper or hobby knife. With only 21 solder joints and a handful of nuts and bolts, this kit goes together in one evening (typically about an hour). It's as easy as connecting the dots.

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

At \$449 US, the Assemblage DAC-1 offers an outstanding value in digital conversion and comes with a *Satisfaction Guarantee* (return it with-

in 30 days of purchase for a full refund) and an *Assembly Guarantee* (if you can't get it running, we will!). We challenge you to find a DAC anywhere near this price with better measured performance, component quality, and most importantly, sound quality. Call us for more specific information on the performance or construction features.

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

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**AUDIO ENGINEERING**

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Tel: 0181 558 4266

# KIT NEWS

## NEW VOICE COIL

Audio Amateur Publications have just announced the June '95 relaunch of Voice Coil, a periodical for the loudspeaker industry. The 12-16 page monthly issues of Voice Coil will now include product reviews, show reports, industry events and more.

Audio Amateur Publications  
PO Box 576,  
Peterborough,  
☎ 02458-0576  
Fax: (603) 924 9467

## STUDIO 12 UPGRADE DECODER

Studio 12 have been working on a couple of tweaks to improve the performance of their stereo decoder. These involve removing the input capacitor and direct coupling the tuner to pin 2 of the module via a new 1MΩ potentiometer and increasing the values of the capacitors in each output leg to 10μF. Still having the decoder I built for the review in Supplement 15, I decided to give these new tweaks a go. See my column on page 69 of the main issue. DB

Studio 12  
12 Nanjivey Terrace,  
St Ives,  
Cornwall TR26 1BQ  
☎ 01736 798393

## NEW VALVE PREAMPLIFIER FROM MAPLIN

Maplin have recently introduced a new valve preamplifier to go with their Millennium valve power amplifier. The Newton is available in a number of different forms, a full spec. version including RIAA phono stage and tone controls coming in at £119.97.

Full articles describing the design and construction of the Newton preamplifier can be found in issues 85 and 86 of Electronics, The Maplin Magazine.

## ELECTRONICS FOR BEGINNERS

Written by Keith Brindley, Starting Electronics provides an important

introduction for the newcomer to electronics. With a practical approach this book available from Maplin is intended to give a thorough grounding in all of the basics.

Maplin Electronics  
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## SILVER WIRE SALE

If you're looking for top quality cable for DIY interconnects and 'speaker cable, give Audio-Links a call. Why? They're offering a range of solid silver wires from 0.2mm to 2mm diameter at special sale prices until the 31st July or until stocks clear.

Audio-Links  
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## WESTERN ELECTRIC 300B IS BACK

Westrex Corp. is planning to re-release the WE 300B triode valve, regarded by many as the best 300B ever made. It is said that the new WE 300Bs will be made using the same original tooling, materials and manufacturing processes, the only difference will be the date code. Availability is expected to be September '95. The Parts Connection in Canada are already advertising the WE 300B in the main issue of Hi-Fi World, price \$350.

The Parts Connection  
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Oakville,  
Ontario,  
Canada L6H 5T4  
☎ 905 829 5858

## NEW CATALOGUE FROM CRICKLEWOOD

Cricklewood Electronics have just finished their latest catalogue of electronic components and hardware. It includes loudspeaker drive units, books, audio grade polypropylene capacitors up to 100μF from Ansar, projects cases, valves, power supplies and more. Call to get your copy.

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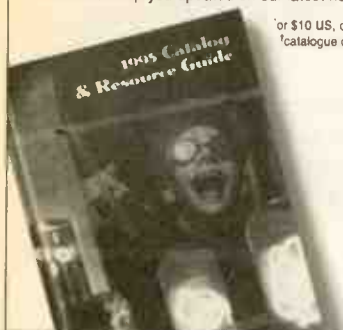


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## The Tube Preamp CookBook by Allen Wright

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## VACUUM STATE ELECTRONICS



# KLS6

**A UNIQUE HIGH TECHNOLOGY LOUDSPEAKER  
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Looking around at the loudspeaker market, you could be forgiven for thinking that things haven't advanced much over the last twenty years. Modern loudspeakers still use paper and plastic cones, and the conventional two-way bass reflex system is still the most common, by far. For a truly high performance design, using modern materials with a higher performance is important, but the penalty here is cost.

DIY is the only answer.

The drivers used in KLS6 are some of the best money can buy; if they were incorporated into a commercial design they would be prohibitively expensive. But for all of you keen DIYers, these drivers, when used in a well designed and engineered system, will rival loudspeakers costing five times as much as KLS6 - or more!

Briefly, KLS6 uses Audax's super new gold piezo-electric tweeter for outstanding clarity and transient response, a High Definition Aerogel (HDA) midrange driver, mounted on a simple open baffle to completely eliminate cabinet colouration, and a powerful 8inch HDA bass driver in an efficient bass reflex system for deep, taut and powerful lows. With such high quality drivers and a well engineered cabinet and crossover, the results are nothing short of breathtaking.

KLS6 is aimed at audiophiles using well matched and set up hi-fi systems. It is a very revealing loudspeaker, designed to resolve as much detail as possible, whilst being free of colouration. These days, sophisticated hi-fi systems can provide fantastic musical results, but all too often the end performance is let down by the loudspeakers, because they are still a long way behind what a good source and amplifier are capable of resolving. KLS6 will get the very best from your system, and has been designed to be compatible with a wide

range of equipment, valve, solid-state, zero feedback, etc.

This 'speaker's high 90dB sensitivity and smooth impedance means it will always get the very best out of partnering equipment. It's not just valve amplifiers that benefit from high sensitivity loudspeakers, the less power it takes to drive the 'speakers, the less distortion your amplifier will produce and the smoother it will sound.

## THE DRIVE UNITS

For KLS6 we have necessarily chosen to use some of the most advanced drivers available. They aren't cheap of course, but this is not a budget design; it's a top quality loudspeaker system capable of revealing as much as possible from a well sorted high-end system. The drivers are far too expensive to be used in commercial products.



### THE TWEETER

Although expensive, Audax's HD-3P piezo electric gold dome tweeter offers state-of-the-art technology and performance. This unit uses a piezo electric polymer film, coated on both sides with pure gold and clamped to an elliptical ring former. The dome shape of the HD-3P is formed by a pressurised gas chamber behind the diaphragm.

The HD-3P uses no magnet or voice coil, the signal is applied to the gold deposit on either side of the dome and this makes it flex in proportion to the signal. Sound waves are produced by this motion. Because the HD-3P tweeter has no moving parts its moving mass is approximately twenty times lower than a conventional 20mm dome tweeter, giving it unmatched transient ability.

The sound quality from the HD-P3 is similar in character to an electrostatic or ribbon tweeter. It is clear, open and extended, as well as being extremely fast and detailed.



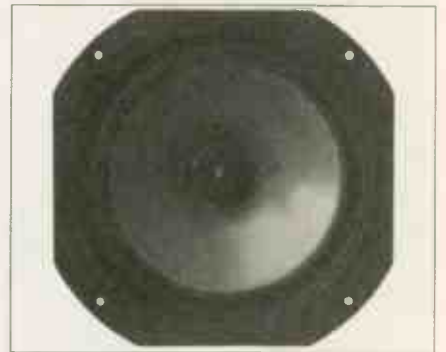
### THE MIDRANGE DRIVER

Because the HD-3P tweeter only reaches down to 5kHz or so a very high quality midrange driver capable of smoothly extending at least this far upwards is needed. Audax's HMI00Z0, a

small dedicated midrange unit, is ideal for the purpose. It uses a High Definition Aerogel cone, which is light and consequently fast, giving super detail and a crisp and open quality well suited to the HD-3P.

High Definition Aerogel is another Audax innovation. It's made from a controlled matrix of acrylic polymer gel, in which a carefully optimised proportion of Carbon and Kevlar fibres are embedded. It is light and stiff, with good internal damping properties.

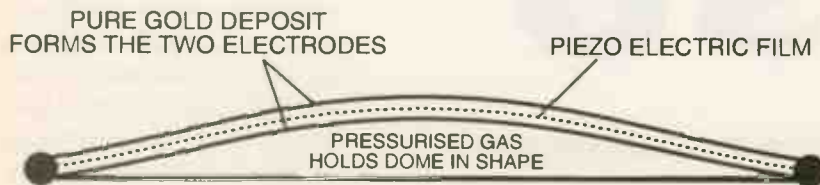
HDA has a smooth, neutral and highly detailed sound, making it ideal for top-end systems. The HMI00Z0 uses a die cast chassis, which is ideal for DIY constructors, because it's near impossible to over-tighten screws and twist the chassis, which can misalign a voice coil.



### THE BASS DRIVER

For powerful and taut bass an 8inch HDA driver with a powerful magnet assembly was chosen. By using HDA for the bass - the same cone material as the midrange driver - there is no character change between the two, making for a cohesive sound. The cone is extremely light and stiff for fast and detailed bass, and again comes on a die cast chassis for strength and rigidity.

### AUDAX HD-3P TWEETER



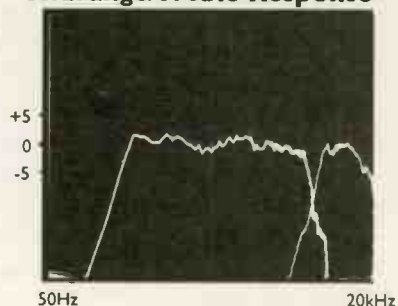
## THE CROSSOVER

Audax's HD-3P tweeter comes complete with its own dedicated crossover and matching transformer. As supplied, it comes set with a -3dB lower roll-off point at 6kHz, and a sensitivity of 89dB. This turned out to be ideal for

matching with the HMI00Z0 midrange unit, as Audax suggested.

The crossover for KLS6 was kept as simple as possible to ensure maximum sensitivity and detail; fewer components means lower selective signal losses. The HMI00Z0 HDA

### Midrange/Treble Response



The midrange driver rolls off around 6kHz where the HD-3P tweeter takes over.



midrange driver is fed from a 3rd order crossover filter at its upper cut-off point, comprising one capacitor and two inductors. This filter operates at 6kHz, rolling off frequencies above this point to avoid cone break up, giving a smooth

and accurate response. Most midrange drivers get no further than 3kHz, by the way; this one manages one octave more.

Because the HDA midrange unit is mounted on an open baffle, its low response will start to roll off at -6dB/octave, due to phase cancellation, where the baffle radius is half a wavelength; imagine the front wave reaching around (in effect) to cancel the rear output. The baffle radius of KLS6 is equivalent to 400mm, so cancellation will occur at wavelengths of 800mm or more. This corresponds to a frequency of 426Hz, causing the midrange to gently roll-off below this frequency. A series capacitor increases the roll-off rate to 12dB/octave (2nd order) to improve power handling by limiting the amount of bass this driver must cope with. It also matches into the 2nd-order roll off rate of the bass unit properly.

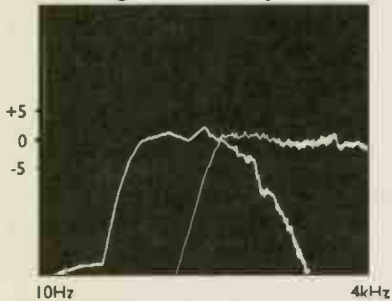
Below this the powerful 8inch HDA bass unit is fed from a 2nd order low-pass filter. This driver is reflex loaded

by a large 40litre cabinet to ensure bass reaches down low enough to produce the deepest fundamentals.

To smooth the 'speaker's electrical impedance, and to reduce output a little from the midrange and treble in order to match the bass unit, an L-pad attenuator is used, which employs just three resistors.

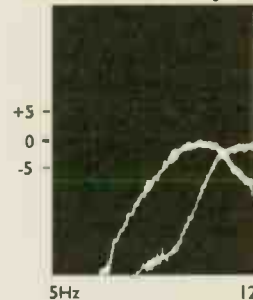
Of course, for best results KLS6 uses Solen polypropylene capacitors throughout, and all inductors are high quality air-core types.

## Midrange/Bass Response



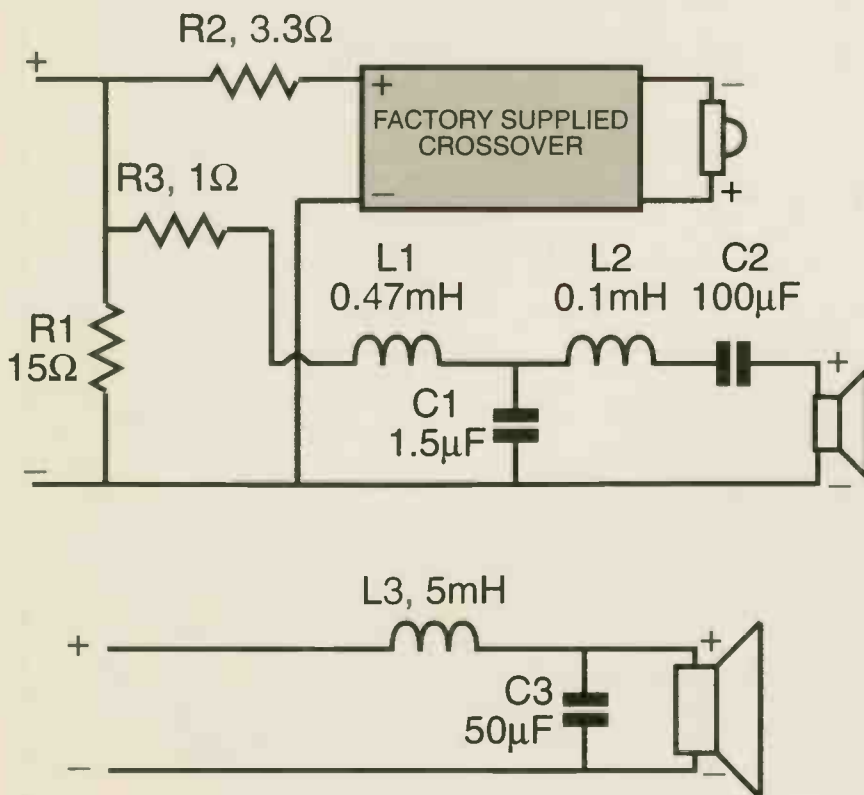
Measuring near field (less than 1m from the baffle) the midrange and bass drivers overlap. Because the midrange driver is mounted on an open baffle though, further back in the listening position some of the lower midrange will cancel out to give a flat response.

## Bass/Port Output

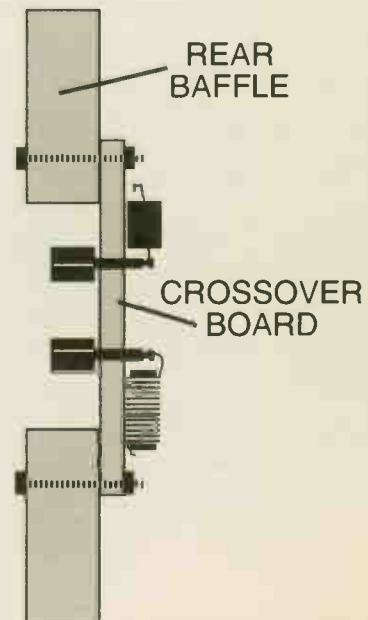


Output from the port extends bass low to 28Hz (-3dB), 22Hz (-6dB).

## CROSSOVER CIRCUIT



## CROSSOVER FIXING



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## THE CABINET

To get the very best out of the expensive drivers used in KLS6, the cabinet is a little different to that of most designs, including our own to date. It doesn't use concrete, plastics, exotic materials, or even a complex internal structure. Instead it is extremely simple, but devastatingly effective.

So what is this special cabinet construction? Well, because the HM100Z0 midrange driver uses a stiff cone surround it lends itself particularly well to use on an open baffle. Rather than invest in overly elaborate cabinet materials, why not do away with cabinet problems in one go? In one fell swoop, standing waves, reflections from the rear wall and other horrid things that make up "box colourations". As a result, an open baffle design such as this goes a long way towards achieving electrostatic-like neutrality and lack of colouration. The sound is open, with

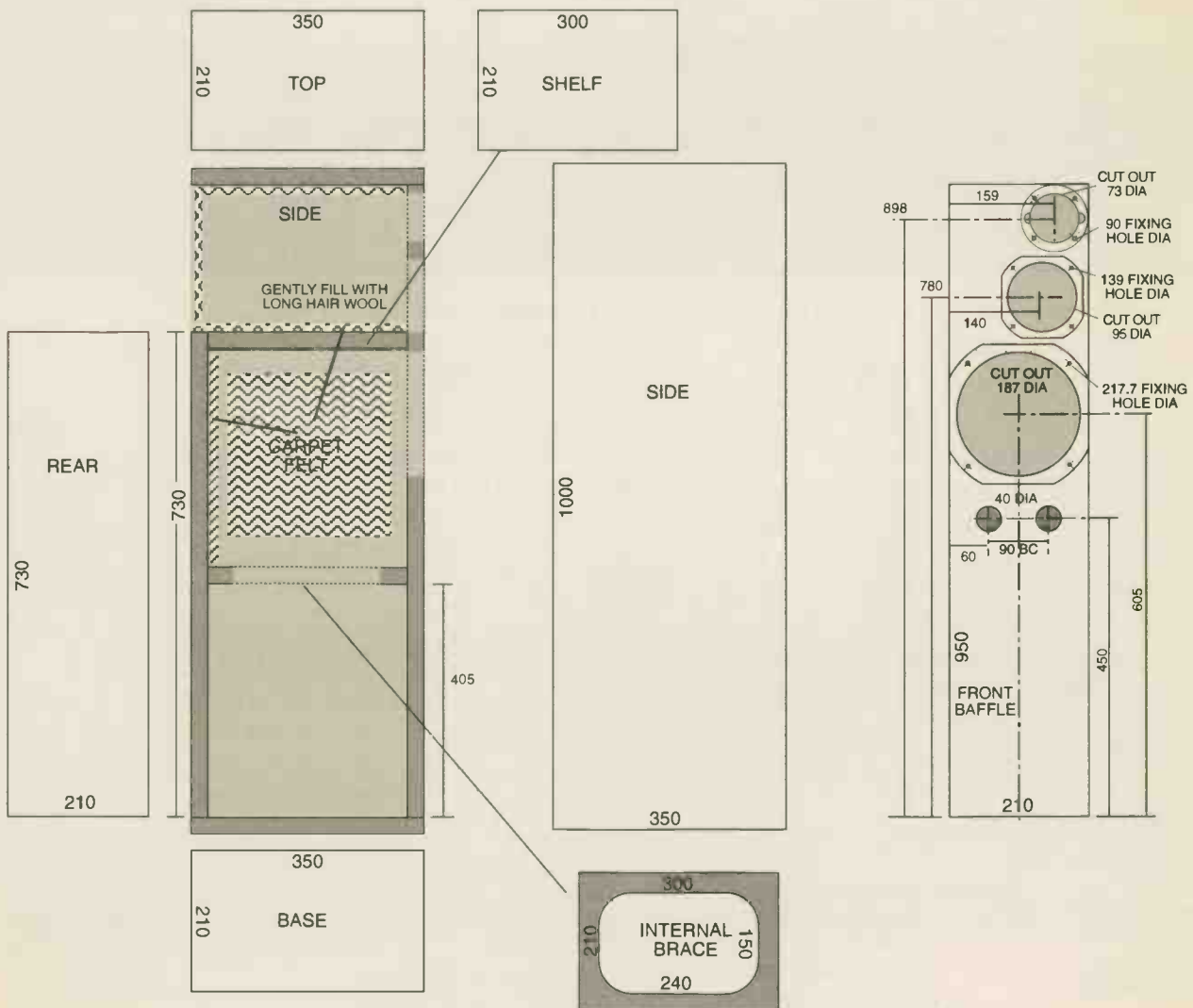
great stage depth and width, and because there is no body of air acting like a spring behind the driver, transients are crisp and clean. Our design is essentially a cabinet with the back left off, the front and the sides giving the necessary distance required between front and rear of the cone for full output down to the bass crossover point. This also allows the front of the cabinet to be kept as narrow as possible, improving image definition, a property we are careful to nurture.

Behind the driver the cabinet is lined with soft carpet felt and lightly filled with long hair wool. In addition, a curtain of felt is hung at the back of the open box to ensure that as much of the rear radiation as possible is absorbed. So, KLS6 possesses the see-through clarity of a true open baffle 'speaker, but it absorbs a significant amount of the rear radiation which would otherwise reflect off a rear wall and compromise imaging.

It is a simple idea, but one that gets the very best from the drivers by removing from the cabinets unwanted contributions to their efforts. When you are spending so much for top quality drivers, this only makes sense.

In the bass, to keep the size of the cabinet domestically acceptable (an open baffle bass system designed to reach down to 40Hz would need a baffle diameter of 14ft!) efficient bass reflex loading is used. Carefully tuned, this gives excellent bass quality, together with high efficiency.

The result of combining the latest technology, super quality drivers, with a cabinet designed to get the very best from them and a well designed, simple crossover using high quality components is quite something. It shows just what an amazingly high level of performance is possible from a loudspeaker nowadays, when cost is not allowed to restrict drive unit quality.



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## KLS6 CONSTRUCTION

The cabinets for KLS6 are made from 25mm MDF, which gives a very solid, inert enclosure. It is easier and far quicker to cut all holes for drive units, ports, terminal dish, etc, before you start to glue the cabinet together. It also reduces the amount of dust inside the cabinets which can find its way into the open voice coils of the drive units.

The plans below show the general construction. The speakers can conveniently be built up on one side panel, laid flat. After the front, rear, top and bottom panels are glued into position, I put on the other side panel and held it down with weights until the glue set. Remember to do a dry run first to check that all the panels fit snugly together. In my case, even though the MDF was cut by a professional woodworker, it had to be sanded to size for a perfect fit.

Using Evostick Resin-W, apply the glue to the edges of the panels. They can then be slid into place, their 25mm thickness being enough to stand steady without panel pins. Any excess glue that oozes from the joins can be wiped away lightly with a damp cloth.

To ensure the panels are firmly pressed together, either place suitable heavy implements on top of the cabinet, or use thick, stretchy carpet tape wrapped around the cabinet to pull the pieces together. After this last step, check that the cabinet is square and that all the sides are square. The glue should still be wet enough to allow the panels to be gently pushed into line.

Once the glue is dry - overnight is normally enough for it to reach full strength - the cabinets are ready for their internal damping to be fixed into place. Carpet felt should be glued to each of the surfaces in the open baffle midrange chamber with a curtain hanging down at the back, and onto the sides and back of the main bass enclosure. As a finishing touch, I cut a neat square of black felt and glued it over the back of the open baffle chamber. Make sure you have finished wiring up first though, and that everything works, otherwise you will have to tear it off and start again.

The whole cabinet, including the open baffle midrange enclosure, is then lightly stuffed with long hair wool, to further absorb reflections and reduce the effects of standing waves. The long hair wool normally comes in knotted bundles, tease it out gently for best effect. Of course, you are free to experiment with other forms of panel treatment: BAF and Deflex pads for example. But we find that the combination of soft carpet felt glued to the panels together with long hair wool stuffing to be extremely good, as well as being cost effective.

Mount the crossover as shown in the diagram below. Because inductors, being magnetic components, have a field around them, they need to be spaced well apart and at right angles to each other to minimise inductive coupling. Again, a recommended layout is shown below. The components can be fixed to the crossover board with PVA glue, but I find a hot-melt glue gun holds them in place just as well, but the glue is more easily removable.

The wires for the midrange and treble unit have to pass through a small hole in the open baffle midrange chamber. It is very important to seal this hole either with hot-melt glue or PVA. The drive units can now be soldered to these wires and screwed into the front baffle. The tweeter should have wires attached using slide-on terminals to prevent heat damage from a soldering iron. A foam gasket made from draft excluder (you can get it in any hardware shop) should be stuck to the rear of the drive unit frames where they mate with the cabinet, to give a good air-tight seal.

### WARNING!

The dust you get when working with MDF is carcinogenic. If you are going to make the cabinets yourself, purchase a good mask that covers your mouth and nose and work in a well ventilated area. Otherwise get a professional woodworker who will have appropriate safety equipment to cut the panels for you.

### TESTING

A simple test to reduce the risk of any damage to your amplifier when you first plug in, is to check the impedance of the

loudspeaker using a simple multimeter. Using the resistance setting they should measure around  $5.2\Omega$  across the terminals. This simple test will indicate a short with a reading below  $1\Omega$ .

## TWEAKING KLS6

There are several tweaks that will affect the overall sound of this loudspeaker. Firstly, the reflex ports can be made either longer or shorter to change the box tuning. Making the ports longer moves the tuning frequency downwards, giving a flatter and deeper bass response. But this will tend to excite small rooms, resulting in a boomy or overblown sound. In smaller rooms the ports should be shortened, which reduces bass depth and peaks bass up higher, but gives greater subjective speed and punch.

Spiking the cabinets to the floor with a suitable spike kit will improve bass definition too. Spike kits are available from most kit loudspeaker suppliers and from stand manufacturers such as Apollo and Target.

More precise treble can be had by gluing a thin piece of soft foam or felt cloth around the tweeter to restrict surface waves and refraction from the front of the cabinet, and also to reduce dispersion angle, lessening off-axis treble energy that will bounce back off walls and ceiling. Images will come into better focus as a result.

Being a three-way speaker, KLS6 can be either single, bi or tri-wired. We'd recommend bi-wiring, connecting the tweeter and midrange together and driving the bass with a separate cable run. But for those with plenty of spare cable around, tri-wiring will bring a subtle improvement.

Good quality internal cable should be used to connect the crossover to the drive units. I used silver plated copper, which combines the sweetness of silver with the weight and power of a solid core copper cable. Because of the small quantity used it makes sense to use silver solder for all connections. We do not advise you to solder the wires to the tweeter however, as a touch too much heat will damage them, and replacement is costly.

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220nF	0.85	1.00
470nF	0.85	1.00
1uF	1.00	1.25
2u2	1.35	1.50
3u3	1.50	1.75
4u7	1.75	2.00
6u8	2.25	2.50
10u	3.00	3.50
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22u	6.25	6.95
25u	6.25	6.95
50u	10.00	11.00
75u	15.00	17.00
100u	19.00	21.00
125u	20.00	22.00

**P&P £2.50 +VAT**

**Axial polypropylene capacitors, signal level. Tolerance + - 2.5%**

	Price		Price		
47pF	630V	.50	1nF	250V	.65
68pF	630V	.50	1.5nF	250V	.65
100pF	630V	.50	2.2nF	250V	.65

150pF	400V	.50	4.7nF	160V	.65
220pF	400V	.50	10nF	63V	.75
330pF	400V	.50	22nF	160V	.85
470pF	400V	.65	47nF	160V	1.00
680pF	400V	.60			

**High quality 400V Axial Polyester capacitor very suitable for replacing those in valve (& other) amps. Tolerance + - 10%**

1nF	.50	68nF	.75
1.5nF	.50	100nF	.75
2.2nF	.50	150nF	.75
3.3nF	.50	220nF	.85
4.7nF	.65	330nF	1.00
10nF	.65	470nF	1.00
15nF	.65	680nF	1.25
22nF	.65	1nF	1.50
33nF	.65	1.5nF	2.00
47nF	.65	2.2nF	2.55

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## SOUND QUALITY

Having used a pair of exotic Sony carbon fibre coned monitors for a good long time, I've a general distaste for paper and plastic cones. So to date, one of my favourite loudspeaker designs has been KLS3. But along comes a design to put even this to shame.

Carbon-fibre cones, for all their strengths, have a tendency to sound 'dry'. Of course, this can be excused in the light of what else they can do, but here's a 'speaker that needs no excuses. With KLS6, you get the uncanny sensation of not hearing the drivers working. They are outstandingly neutral and clear, superbly cohesive from bass to treble and have deliciously sweet, tactile high frequencies thanks to that gold piezo-electric tweeter.

Teenage Fanclub's 'About You' is a severe test of any 'speaker - a super clean, bright recording which shows up any nasties with a vengeance. But KLS6 delivered a near-electrostatic

smoothness, yet with the subtlest of rhythmic and dynamic inflections brought into sharp relief. The HDA midrange acquitted itself very well indeed, sounding even smoother than the carbon fibre equivalent in KLS-3, while bringing a greater palette of tonal colours.

But it wasn't until Rimsky Korsakov's Scheherazade (Chicago Symphony Orchestra/Daniel Barenboim) found its way into the Da Capo CD player that KLS6's full talents became obvious. String tone was just about the best I've heard on a moving coil loudspeaker, totally devoid of grain or hardness. Imaging was excellent, but not quite in the gasp-inducing KEF/Tannoy point source league. KLS6 is weakest in the bass, where it can't quite match the outstanding performance higher up, being merely 'very good', with a tight, clean, tuneful punch devoid of boxiness.

*David Price*

## PARTS LIST

Drive Units	
Tweeter	Audax HD-3P
Midrange	Audax HM100Z0
Bass	Audax HM210Z0

### Crossover

Tweeter crossover factory-supplied with Audax HD-3P.

R1	15Ω/5W
R2	3.3Ω/5W
R3	1Ω/5W
C1	1.5μF Solen
C2	100μF/100V Alcap
C3	50μF/100V Alcap
L1	0.47mH air core 0.5ΩDCR
L2	0.1mH air core 0.2ΩDCR
L3	5mH air core 1.3ΩDCR

### Reflex ports

38mm diameter x 85mm length.

## WARNING

Be extremely careful when screwing drive units in and out of the cabinets. One slip with a screw driver and they're useless. We recommend using cross head screws or Allen bolts which reduce the chance of this happening.

Do not try and solder wires to the terminals on the tweeter. They are fragile and easily damaged and the fine wires connecting the diaphragm will vaporise, rendering the unit useless. Use small, push-on receptacle clips.

**A KIT OF PARTS FOR  
KLS6 WILL SHORTLY  
BE AVAILABLE,  
PLEASE CALL WORLD  
AUDIO DESIGN FOR  
DETAILS  
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### MEASURED PERFORMANCE

The third-octave frequency response plot below shows the smooth and flat response of KLS6 through the midrange and treble. Upper treble is rolled off slightly which ensures a smooth and pleasant balance with CD.

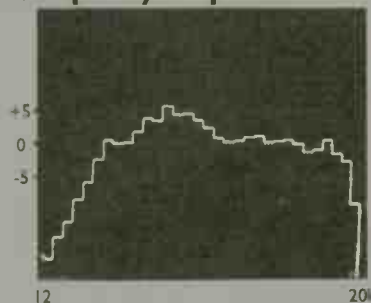
Between 200-400Hz there is a lift in the response (+4dB) where the midrange and bass are overlapping in the near field. Further back in the listening position the response will flatten out due to cancellation around the open baffle midrange. There is still a slight lift left in this area in the far field, but this serves to add a pleasant warmth to the sound. A dryer balance can be engineered if desired by increasing the capacitor on the bass crossover network to 100μF.

The HD-3P tweeter is a 4Ω driver, and the HDA drivers' impedance falls to around 5Ω in places, making overall impedance a low 6Ω. However, impedance varies little across the audio band, essentially residing between 4-8Ω, so is smooth enough to match well with zero feedback amplifiers such as our 300B. If they are used with a valve amplifier

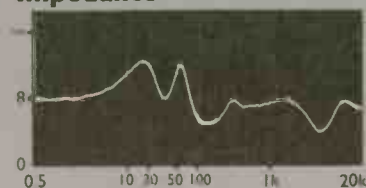
though, best matching will be with the 4Ω tap selected.

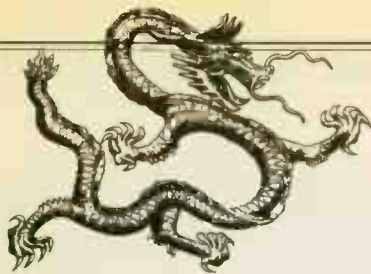
Again the HD-3P tweeter has an influence on the overall sensitivity possible, being an 89dB driver. Sensitivity measured at 1m using a nominal watt (2.83V) pink noise signal was 89dB, sensitive enough to be used with amplifiers capable of producing 20watts or more. **DB**

### Frequency Response



### Impedance





# Golden Dragon

## RETAIL PRICE LIST

Golden Dragon Pre-Amplifier Tubes	Singles
6AQ8/ECC85	£6.50
12AT7A/E81CC/ECC81	£6.95
12AU7A/E82CC/ECC82	£6.95
12AX7A/E88CC/ECC83	£6.95
6DJ8/E88CC/ECC88	£10.95
6SN7GT/ECC33	£8.95

## Special Quality Golden Dragon Pre-Amplifier Tubes

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## Golden Dragon



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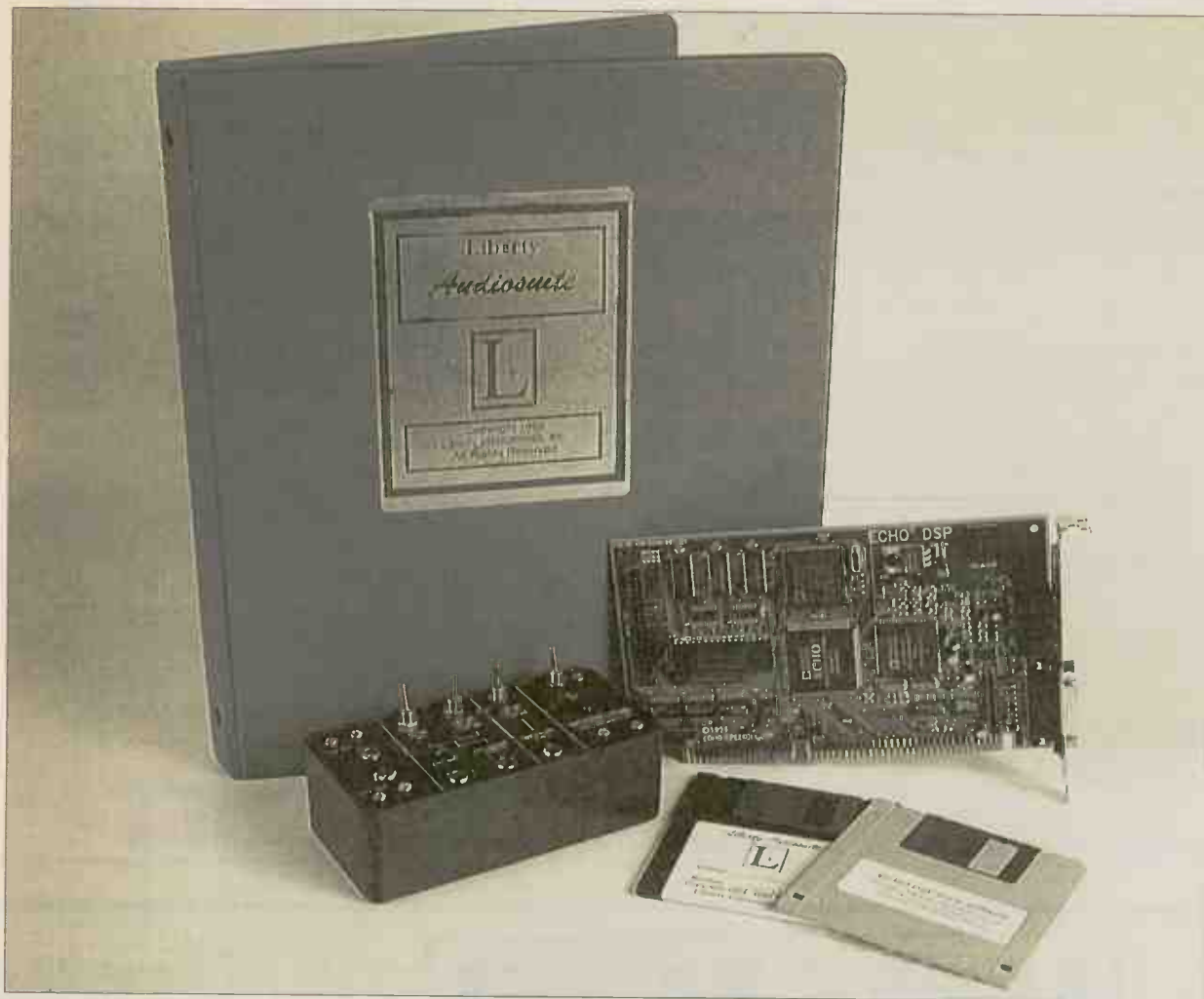
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# ANGELA 1995

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measurement package that is deeply complex at a theoretical level, yet at the same time absurdly cheap by current standards, as far as test equipment goes, that is. It all comes down to the plummeting cost of digital processing (e.g. computers).

Nowadays, FFT analysers are becoming available at prices of less than £1000, providing you already have a powerful PC computer to do the

number crunching. That's what I'm testing here: something so powerful and sophisticated that it's a bit breathtaking. There are two snags: it's slow to use compared to dedicated industrial test instruments like our own Hewlett Packard 3561A FFT, and it relies on concepts that are obscure for those not versed in maths and measurement principles. This Liberty Audiosuite is no digital AVO. You might be able to afford it; beware that you can understand it.

The handbook is written in unusually friendly and informal prose; it's a good effort. Yet the concepts it must cover are so broad ranging and measurement-specific that some prior

knowledge is virtually a must. If you haven't mastered the difference between time and frequency domains, there's a lot to take on board here, and not all of it is explained. For example, the instrument has two channels, but cross-analysis using maths processing is barely mentioned and no explanation is provided of window properties.

The package is aimed strongly at loudspeaker measurement and has some fantastic powers, such as L/C determination from impedance and phase angle information (something we do manually), as well as Thiele-Small parameter analysis of drive units. Although the A/D processor is 16-bit, and the dynamic range in theory 96dB, reckon on a useable 80dB minimum in

practice, because of Soundcard limitations. Maximum bandwidth is 22kHz and both X & Y axes are scaleable in lin. or log. form. Zoom analysis is not possible, only baseband, but four 'windows' are provided: None (for a clean pulse), Blackman, Hamming and Bingham, the last three offering progressively less weighting on a 'continuous' signal, and useable full or just with trailing edge smoothing. Cumulative decay spectra can be shown (waterfall plots), Energy-Time curves and even the Hilbert Transform can be applied. The two channels can be multiplied or divided against each other, which can be enormously useful for comparative (difference) analyses, a technique we use in tape testing, for

example, to derive a relative frequency response.

All this is impressive modern day stuff capable of placing enormous analysis power in an owner's hands. Yet as the power of modern day digital measuring systems increase, so does their theoretical complexity. It's important to bear in mind that at heart the Liberty Audiosuite is a seriously complex piece of kit by any standards and no handbook in the world, however well written, will ever makes its abilities easy to understand and exploit. Apart from this proviso, the Liberty Audiosuite package offers signal processing power as advanced as anything available today, but at a knockdown price (see p21).

Liberty's Audiosuite CAD package is essentially a collection of audio test instruments all controllable from within one package. The use of a Soundcard means that a wide range of test signals can be generated and then analysed by various different software systems, making Audiosuite highly flexible. The instruments that are included in Audiosuite are as follows.

**MLS/FFT** - Essentially an up-rated version of Liberty's well known and popular IMP loudspeaker test system, MLS/FFT uses the Soundcard to generate the test signal rather than a dedicated IMP module. MLS is a sophisticated variation of impulse response testing. A pseudo-random noise signal subjects the item under test to every frequency in the audio band at the same instant. The 'time domain' plot that Audiosuite then generates can be transformed, through calculation by the computer, into frequency response and phase information.

This section is very similar in operation to IMP, but with improvements made to both the measurement accuracy and graphical display. For a more detailed explanation of how MLS works, see the review on IMP in Supplement 13.

**SINE** - This instrument is similar to MLS, but uses a gated or continuous sine wave test signal. The sine wave signal is set to a chosen frequency and a

measurement is taken which will reveal phase (gated sine) and magnitude. Obviously, if you were measuring a loudspeaker you would have to plot many points to build up a useful response curve, but SINE does have more energy at low frequencies and consequently better signal-to-noise ratio.

**SINE** - The sine instrument has a gated facility, which injects a sine wave into the loudspeaker and takes a measurement before any of the reflections from the room have a chance to reach the microphone. This is a very accurate way of measuring exactly what the loudspeaker is doing, without being influenced by the room, at least down to a certain frequency determined by the room dimensions.

**SCOPE** - A real-time, digital, dual-channel triggered oscilloscope instrument, combined with a sinewave and squarewave generator. The Oscilloscope is AC coupled, so can't be used to measure DC voltage levels. Both the oscilloscope and the signal generator are band limited to 22kHz, because of the use of a soundcard. The display is shown in a 'join-the-dots' format, because SCOPE samples the input signal rather than continuously monitors it as an analogue 'scope does. So where the horizontal scale gets close to the sampling rate set, the waveform displayed will be very jagged. Because of

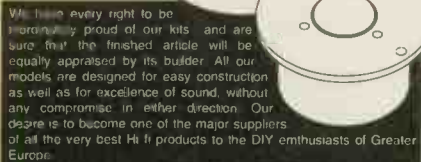
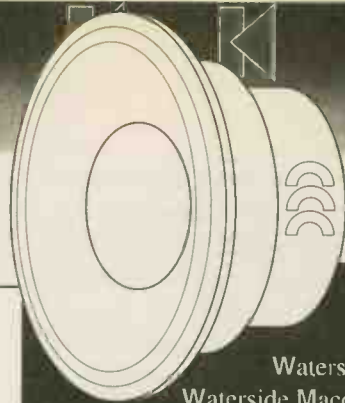
this care needs to be taken when interpreting the SCOPE's display. The sampling rate can be set between 5.12kHz and 48kHz.

**SPEC\_AN** - This is an FFT based spectrum analyser and matching white noise generator. The spectrum is displayed at multiples of the sample rate, divided by sample size. A useful feature of SPEC\_AN is the ability to perform power averaging of the spectrum. This average power level across a spectrum, measured at different microphone positions, can be used to determine the typical or average response of an audio system within a room.

**DIST\_AN** - Harmonic distortion analyser with low distortion sinewave source. This instrument is used for measuring and observing the characteristics of distortion that a piece of equipment produces. DIST\_AN will analyse harmonics from second through to ninth, and measure the THD percentage relative to the fundamental applied. It can be used to measure amplifiers and other electronic equipment as well as loudspeakers.

DIST\_AN also includes a feature called 'Visualizer'. The Visualizer measures the THD and displays a plot of the waveform tested. At low distortion levels the plot would be indistinguishable from a sinewave, but the Visualizer allows you to 'turn up' the distortion to make its effect on the sine wave visible.

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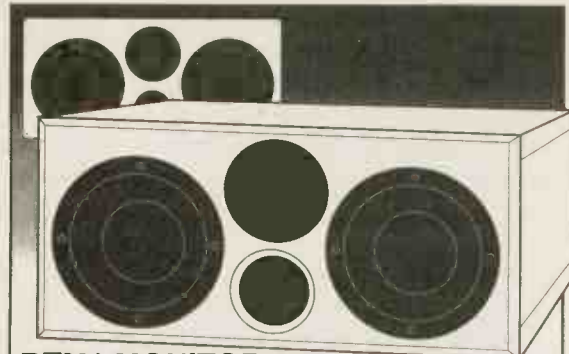
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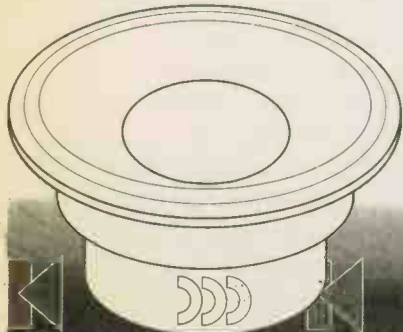


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## BUILDING THE AUDIOSUITE PREAMP

I chose the kit version of Audiosuite, which entails building the main preamplifier where the probes and microphone are connected yourself. It is very quick and simple to build, all of the components being mounted on one good quality printed circuit board (PCB).

I had the very first version of the build instructions, but although I managed to complete a working preamp first time, there are a few areas that would benefit from attention. The instructions rightly suggest that you solder all resistors to the board first. These are least sensitive to excessive heat, and being low height components shouldn't get in the way later on. I use a thick foam 'dishcloth' under the board which ensures the components are pushed tight against the PCB surface.

At this stage, it is very wise to also solder in an IC socket for U1, a quad CMOS op-amp. It is suggested that this static sensitive device can be carefully

soldered to the board after the resistors and capacitors. But I found it almost impossible to get the damn thing in without dropping it several times trying to get it past the closely packed surrounding resistors/capacitors. Solder in a suitable IC socket, and gently plug it in last - it's much easier and safer.

Another small point worth attention I discovered when fitting capacitors C1-3. The one that sits closest to J4, a PCB mounting phono socket, is too wide and doesn't fit. Luckily I had a 330µF electrolytic in my parts bin with a taller, slimmer can, and it fitted just fine.

A small note also needs to be included in the instructions on how to fit the LED. I had to scour the RS catalogue to remind myself that the short lead is the cathode before I could work out which way it went, a simple sketch would remove any confusion for novice builders.

Lastly, when you install the four toggle switches, I found the best way was to start by screwing them into their

correct location on the front panel. This holds them in perfect alignment, and the PCB can then be guided onto the switches from behind to ensure that the two line up. This saves having to bend the pins to get the switches through the front panel mounting holes.

The preamp took me around 40 minutes to complete, and it worked first time which, given the above, shows how clear and easy-to-follow the instructions are.



## SETTING UP AUDIOSUITE

The version of Audiosuite supplied by Bill Waslo of Liberty Instruments came complete with an Echo DSP Soundcard. Before you even start to install Audiosuite to your PC, it is best to install the soundcard and ensure that it is working properly. The Echo Soundcard I was using came with clear installation instructions.

Once you are sure the Soundcard is properly connected and running, Audiosuite can be installed. Again, this is a simple process, helped by clear instructions and on-screen prompts.

A little note about the hardware you will need is necessary at this point. Your PC will need to be a 386, 486 or Pentium with at least 4MB of memory and a VGA/SVGA monitor and mouse. This is quite a heavy spec. so older PCs may well have to be upgraded before Audiosuite can be used. Audiosuite needs a Personal Sound Architecture DSP type soundcard. These include: Orchid Soundwave 32 (or 32 Plus) and Gamewave 32 Plus, Cardinal Digital Sound Pro 16, Wearnes Beethoven 16-DSP, Adaptec DSP, Paradise DSP16 and Echo DSP.

Once installed, you will need to

calibrate Audiosuite for the microphone and the gain of the Soundcard and preamp you are using. This is fairly straightforward if you are using a calibrated microphone. If you are using your own preamp and microphone, the procedure is a little more complex. I won't go into it here, other than to say that it is possible, allowing meaningful, sensitive measurements to be made.

To measure hi-fi equipment you will need to make up your own special test leads. You will also need to make up the two probe leads, which need a phono plug at one end, and your choice of probe at the other.

For testing loudspeakers you will need an accurate microphone or one with a calibration chart. This, once loaded into Audiosuite, compensates for the microphone's response to give near 'perfect' accuracy. The output from the Soundcard is fed to an amplifier, which drives the loudspeaker. You can use your existing hi-fi amplifier for this, but Audiosuite must be used with an amplifier that has its negative terminal at ground potential (earth), so bridged amplifiers and many valve amplifiers are not acceptable.

## CONCLUSION

Audiosuite is a very well put together package. The manual is excellent, with plenty of pictures and diagrams to help you set the system up and get measuring quickly. In the next Supplement, No.17, free with the October issue of Hi-Fi World, I will explain more about the individual instruments within Audiosuite and give examples of how they can be used to develop your own designs. Liberty have also just added a new feature to Audiosuite's repertoire under the MLS instrument, called Cepstral Analysis. This is used to detect the presence of echoes or reflections in the response of a loudspeaker, such as those caused by grilles or the edges of a loudspeaker baffle. More on this in the next Supplement.

Liberty Audiosuite	£310
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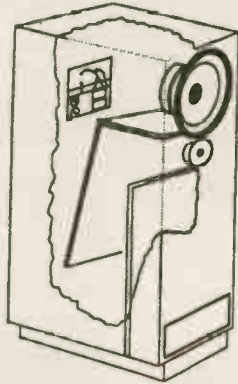
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# The Tube Preamp Cookbook

Allen Wright

First Edition

VACUUM STATE ELECTRONICS

## TUBE PREAMP COOKBOOK -

reviewed by tube-meister Andy Grove

This is a home-brew book with large print, hand-drawn diagrams and a rather unusual widthways layout. It progresses from author Allen Wright's basic philosophies on audio design to complete preamp circuits marketed under the Vacuum State Electronics brand.

Allen's intuitive grasp of the subject allows him to explain in everyday language, rather than trying to make arguments look impressive with reams of unnecessary mathematics or abstruse gobbledegook. However, this book could cause a few problems for both those "new to electronics", as well as boys from the old school. It is assumed the reader already has a strong grasp of electronic theory and will understand why some of the unusual modifications work.

This is the only book I know which dares to take audio design onto a more metaphysical plane. Most like-minded thinkers either keep their knowledge a closely guarded secret or are too afraid of criticism to voice their opinions. There are plenty of cranks about spewing pseudo-science, but here the information presented is derived from solid reasoning and experimentation, albeit with a modest sprinkling of fairy dust.

Allen gives examples of human perception beyond the mechanics of eyes and ears, states his Basic Philosophies and then heads off into outer space at Warp Factor 9. His 'Building Blocks' section covers just about everything you need to know about what goes into an amplifier and even gives advice on selecting valves.

The following section is where steam will start to issue from some people's ears. Here, the reader is led through the 'Circuit Modules' Allen uses, starting off with the simple common cathode stage right up to fully differential mu followers, RIAA e.q. networks and choke input power supplies, with advice on the sonic qualities of each. Again, it is assumed the reader will not need to be nurse-maided through each circuit block; the emphasis is on the audio application, so electrical details are left to you.

Next, Allen leads the reader through the reasoning behind his 'Super Reg' shunt regulator, the differences between series and shunt types, why the shunt is superior, finally giving the outline of the Super Reg.

Using a more practical approach, he then gives examples of classic preamps and possible mods and improvements to them, illustrating different approaches to preamp

design and the good and bad points of each. He goes on to cover the development of two earlier preamp designs, describing the mistakes and discoveries he made and passing his experience on to the reader.

In the penultimate chapter he shows how to fully "hot rod" valve circuits, giving a modification checklist and useful advice on the modification procedure. The last section covers the development of two considerably more complex preamps. Full circuits are also given for those who want to produce clones.

Overall *The Tube Preamp Cookbook* is an excellent, if somewhat wacky look at audio design. The emphasis is definitely on sound quality rather than outright specifications, but all the same, sonic improvements are brought about by better electrical performance.

There are some mistakes in the book: for example the 12B4 valve is listed as a "12 volt heater octal base 2A3". It is in fact a B9A-based indirectly heated TV triode, nothing like a 2A3. The reader has to be aware of small hiccups like this, and take into account that this is only one person's view of the world.

I thoroughly recommend this book to anyone Interested in either modifying or building valve equipment. It's a worthwhile addition to any library on the black art of valve audio ●

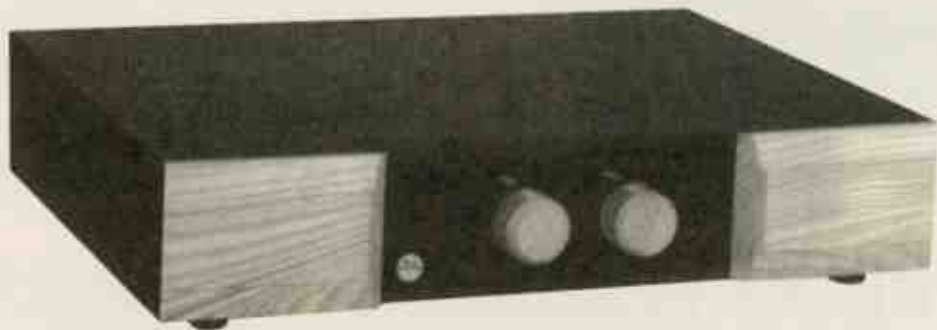
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**T**oday valve data books are becoming rare and sought after. Valve suppliers often have no data or only "one line" of basic characteristics which can only really be used as a guide. Colomor Electronics have taken the initiative and reprinted a very comprehensive data book - Electronic Universal Vade Mecum, the first of a two-volume set; the second part is as yet unavailable.

Vade Mecum (Latin for General Guide) is a Polish book but the data is presented in pictorial and symbolic format that is very easy to interpret. The two indexes at the front of the book are arranged in alpha-numerical orders, one uses Roman (e.g. English) and the other Cyrillic (e.g. Greek or Russian) script, so finding the particular valve in question is quick and easy.

The valves are arranged into sections of similar types, so when you are looking at the data for one particular valve you are in exactly the right section to examine possible alternatives, although equivalents aren't always listed. Basic "one liner" information is presented in clear tables listing principle electrical characteristics, manufacturer and so on, with more detailed information below. Where abbreviations and symbols are used their meaning is usually obvious. If not, you can turn to one of the glossaries in the front of the book for an explanation. There are seven of these glossaries, each in a different language, including English, German and Russian.

Full characteristic curves are given for the more common valves and are very clearly presented. Compared with original data from manufacturers like General Electric or Mullard though, the graphs are small and have rather large graduations, making precise graphical analyses difficult. For very accurate design work it may still be necessary to get the original manufacturers data.

Other useful charts are given in some cases, for example distortion versus power for output valves or conversion conductance versus anode current for hexodes and heptodes intended for mixer use. Physical parameters such as base type, pin-out and physical dimensions are given, usually with an outline drawing showing the overall shape.

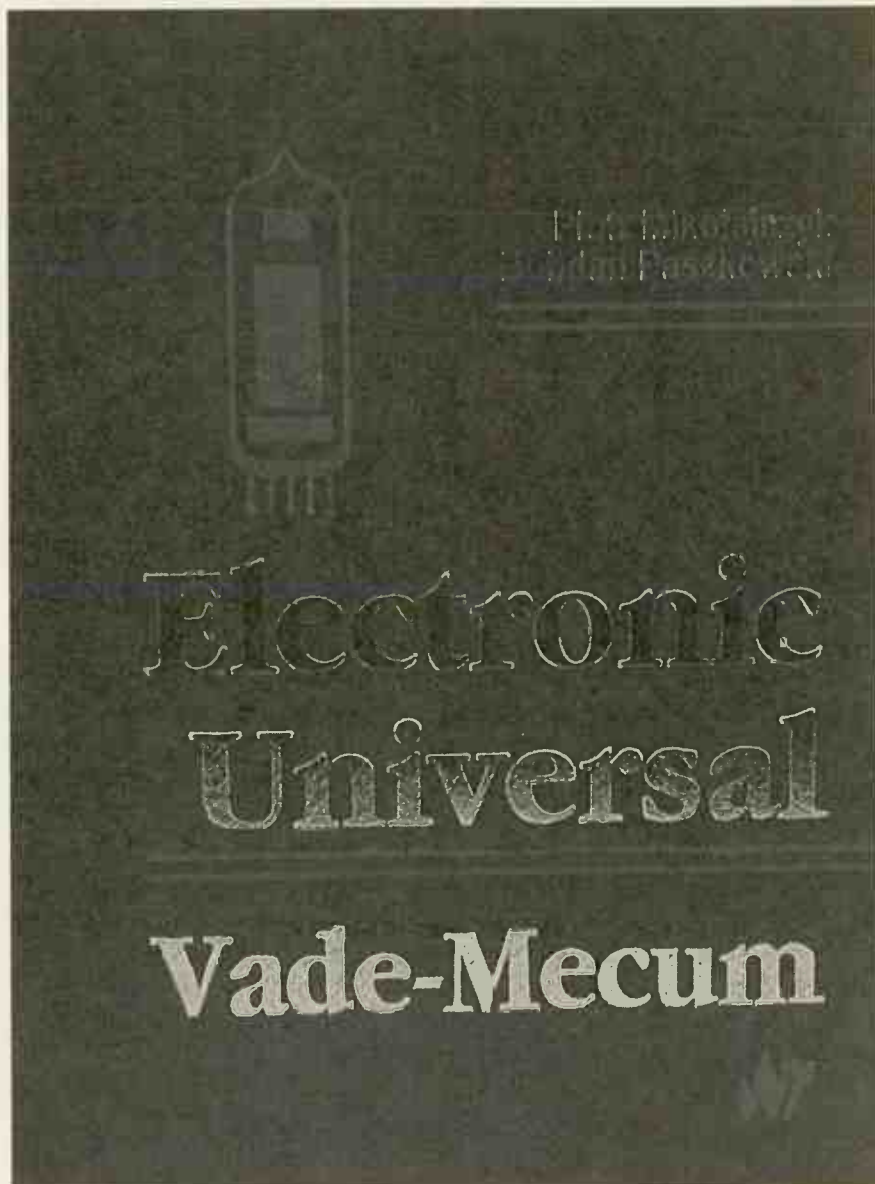
Unfortunately, because this book is about 'receiving valves', the meatiest

output valve you are likely to find is the 6550 (yawnarama) or maybe the EL156 (?). There are no big triodes or transmitter pentodes whatsoever. I think most people will find the power valve section rather disappointing, although there are the old faithfuls like EL34 and KT66. The mansize valves like 211, 828 or even 300B etc. are sadly absent; I assume these will be in the second volume, as and when it becomes available.

The book, although expensive, really

is essential, unless you already have a very comprehensive library of valve data. Even then Vade Mecum contains some very strange Russian and European types which I haven't seen data on before. The overall quality of the book is excellent, bound in a cherry red leather effect finish with gold lettering. Inside the printing and paper are first class. This is not a workshop data manual, more a library reference book which, I'm sure, will become classic. I hope Volume 2 comes out soon ●

## ELECTRONIC UNIVERSAL VADE MECUM reviewed by Andy Grove





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# D.I.Y. Letters

## EARTH EXPLORER

I would very much appreciate your advice about earthing and electricity supply safety. I am using a pair of old (late 1950s) valve power-amps that have recently been renovated by RATA (original circuit diagram enclosed). I like the sound generally, but a persistent problem has been the relatively quiet, but annoying hum which was reduced by the renovation, but not eliminated.

The interconnects I mainly use are the pseudo-balanced configuration-type described in the October supplement; I have also tried Tandy interconnects that Eric Braithwaite enthused about for valve amps last year and find no difference as regards the hum problem. I have experimented with the use of different power sockets (one for each amp/both from the same 4-way socket etc.) which has some effect, but have

discovered recently that disconnecting the earth lead at the mains (13amp) plug for each amplifier brings about almost a complete 'cure' (the residual hum is only audible very close to the loudspeakers, and for any normal listening position is below the ambient noise level).

In normal operation there are no 'live' points on the amp, so eliminating the earthing seems quite safe. As part of the renovation (mainly new passive components) a small magnetic circuit breaker was put in to replace the mains fuse and act as a switch (when I had the mains amps they had no on/off switch). I expect the circuit breaker to handle the problem on the mains side of the power supply transformer, but presumably a potential risk is a failure in the HT line making the chassis live - is that right?

I assume the hum is

associated with an earth loop and the mains supply of my house which has conventional ring main wiring and, I believe, permanent multiple earthing (PME) wiring at the electricity supply company's junction box i.e. the earth circuits in the house are connected to the neutral (return) lead to the sub-station.

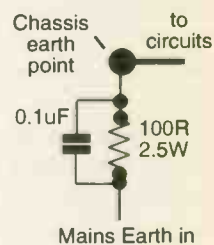
Rewiring the house is not a realistic option, but would a different kind of earthing of the power amp chassis, or providing a guard be possible moves? Currently I am putting up with the hum (i.e. earth wires are re-connected), but any thoughts, or suggestions which would justify my 'cure' would be very welcome

**Guy Woolley,  
Thurgarton,  
Notts.**

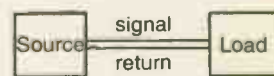
*Sounds like you've got a classic hum loop problem. There are two sources.*

*Most common is that of*

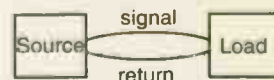
*multiple earths and recirculating earth currents. This occurs when a system is earthed to the mains through two components, in your case preamp and power amp, which are also earthed together through the signal lead ground, forming a loop. As you've found, breaking the loop (anywhere, but in your case at the mains plug) stops the hum. The usual solution is to use an 'earth lift' resistor (i.e. resistor in the earth lead) - see diagram. It goes between the incoming mains earth and the amplifier.*



*The other less well understood source of hum comes from an induction loop. This is formed when signal and return are separated to form a loop, which will pick up hum when close to a mains transformer. We've found left and right signal leads from preamp to power amp will cause hum when drawn apart to form a loop, when a mains transformer is nearby that is. In amplifiers, signal and return wires must not be separated, but run alongside each other, as our diagram shows. NK*



a) Signal & return parallel



b) Signal & return form a loop

## DIGITAL UPGRADE

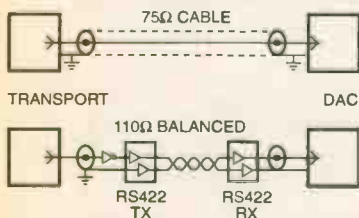
My Arcam I70.3 CD transport doesn't have a XLR AES/EBU ▶▶

(RS422) digital output. An easy way to work with this format without modifying your CD transport is to build an external RS422 driver with phono input and a RS422 receiver with phono output. The 74HCU04 (see schematic) is used as a signal buffer with 75Ω impedance (S/PDIF format). The RS422 driver is capable of driving a balanced 110Ω cable (AES/EBU format). The driver is built into a small box with phono input. The AES/EBU cable is attached without any plugs to the RS422 receiver box. This box has a 75Ω phono output. External power supply must be capable of supplying +5V/300 mA DC. The RS422 IC's are made by National Semiconductor and perfectly made for this application. The AES/EBU cable I use is made by Gotham, I don't have any experience with other AES/EBU cables. Comparison between several digital 75Ω cables and the Gotham AES/EBU cable using the RS422, I find the sound a bit more relaxing and open. By the way this RS422 set is not a copy of the Audio Alchemy DST (Data Stream Transceiver).

**W. de Haan**  
**Leiden,**  
**The Netherlands.**

*Mike Martindale, Chief Designer, Arcam says -*

*Your reader is suggesting extra electronics be used at the sending and receiving end of the digital*



*connection between transport and DAC. There are two reasons for this:*  
**1) An assumption that a balanced AES/EBU cable is going to sound better than a**

**75Ω cable and -**  
**2) A balanced connection will break the earth path return line between between the two units.**  
*These are reasonable things to consider, but it is a complicated way of going about things. Undoubtedly, it will sound different than a straight 75Ω cable and this may be taken as sounding 'better'. Personally, I would be more inclined to spend my money and time making up experimental 75Ω leads from wire samples and evaluating them! MM*

### STICKY SUBJECT

1. Hi-fi manufacturers use an aluminium glue which apparently produces joints as strong as the metal itself. For example Linn assemble the Ekos in such a way. Where can I buy such glues?
2. In the last issue in his article on stereo, Noel Keywood had

an illustration in which 'speakers were turned inwards about 45degrees rather than facing fully forwards. The instructions that accompanied my Ruark Talisman IIs says all Ruarks should be positioned facing fully front on. Please ask him to discuss this aspect of positioning speakers in a later article. (He said he was writing a series on the subject). Thanks.

**John Williams**  
**London.**

*Linn did not want to divulge the name of their aluminium adhesive, identifying it only as an Epoxy Resin. We suggest you trawl through the ever fascinating Electromail catalogue, price £4.99 ('phone 01536-204555), where you can get anything RS Components sells to industry - which seems to be everything, including hi-fi digital-to-analogue convertor evaluation*

*boards and valves, amongst a sea of special adhesives. How about 2-ton Clear Epoxy, an "extremely strong water resistant adhesive that bonds non-ferrous metals", RS-price £3.50, or Plastic Welder that has "high shear, peel and impact strength over a wide range of temperature", price £5.60. Then there's Loctite Structural Adhesive 326 at £18.56, fast drying and for close fitting metal surfaces, or Loctite Multi-bond 330 at £9.16. The list is enormous.*

*On the matter of 'speaker orientation, I have to admit that my diagram was a representation, not drawn to convey exact angles. However, there's quite a lot in this topic, so here goes.*

*Broadly speaking, some tweeters, especially those that fire through a port or horn, like KEF Uni-Q, Tannoy Dual-Concentric*

# Letter of

## BUILDING A VOIGT TRACTRIX

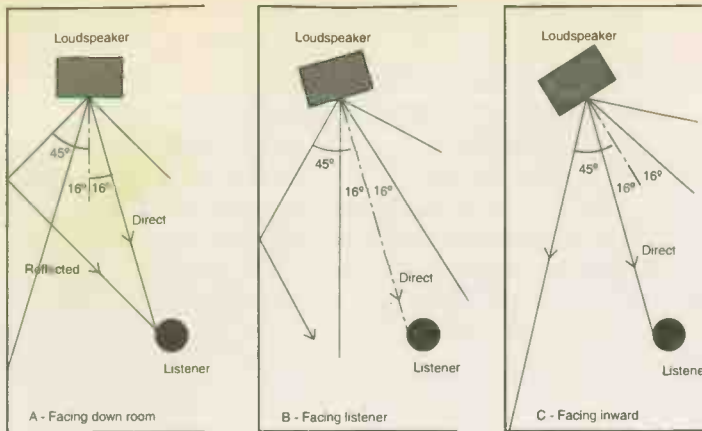
I applaud your intention to examine the design of good but cheap audio equipment. It did seem to be a pity that whilst your sensitive speakers could be built for a little over £200 the 4W amplifier designed to power them cost £385. Would the Mullard 3W amplifier provide the basis for development into a good modern design, much as you have based K5881 from the Mullard 20W design? It has the advantage of a low component count, which reduces need to compromise on component quality. It is also sensitive (100mV for 3W). Would this permit design of a simple dedicated preamp for

moving magnet cartridges, powered from the main amplifier to keep down cost? The Mullard 3W has been praised on a number of occasions in your columns and a project of this type would seem to be consistent with your aims.

In D.I.Y. Supplement 11, Andy Grove presented a simple design method for the Voigt Tractrix horn but is clearly afraid of the difficulty of building one. I suggest he should look at the method of joining large profiled sheets of plywood which was invented by the designers of the Mirror-class dinghy. The hull of this boat is made from four 10ft long plywood panels forming the bottom and sides, with two smaller panels for the bow and

stern.

These panels are first stitched together with short lengths of copper wire, inserted from the outside through holes drilled along the edges to be mated. These are twisted-together on the inside with pliers, drawing the plywood panels together. When all the panels have been joined in this manner, a strip of woven glass-fibre tape is bonded along the outside of the joint with resin. Once this has cured, the twisted wires on the inside of the joint are cut off, flush with the surface of the panel. A second length of tape is then bonded along the inside of the joint. The resultant joint is very strong and will be air-



and Tonigen ribbon tweeter, all give a smoother frequency response off-axis, our measurements show. This is because on-axis, left/right mechanical symmetry results in cancellation effects. They should be positioned so as not to point directly at listeners (diagram B). In this circumstance, manufacturers usually advise users to point the 'speaker straight down the

room (A). This puts the listener, in my diagram, 16degrees (anti-clockwise) off-axis.

This situation faced me with the Heybrook Sextets, even though differences between listening on and off axis are small. I pointed the speakers straight down my lounge, as in A, and got a more muddled and vague soundstage than B. This was perplexing, because this particular room, in a

flat on short term rental so acoustic treatment is out, has never provided the excellent results of our in-house listening room. I knew from experience the Heybrooks could sound a lot better, but moving them to A from B made a poor situation worse.

I reasoned that if the Sextets were swung further inward (C), rather than outward, such that I sat 16degrees off-axis still, but this time clockwise, less treble energy would reach the nearside wall and more would be directed to the far side wall. Travelling further, it would experience greater attenuation, making far wall reflections less of a problem. The diagrams show how an imaginary loudspeaker

with a 32degree (+/-16°) listening window and a 90degree (+/-45°) total forward radiation angle can be swung through 32degrees with no change in perceived forward radiation pattern (i.e. frequency response) to the listener, but a significantly different radiation pattern into the room. Facing down the room (A) directs much more treble energy to the near wall, which bounces off to give a lot of reflected energy. The key point is that reflected sound from a wall is very "dirty", having a ragged frequency response caused by selective absorption. For a clean sound, the listener shouldn't be in a strong reflected sound field, or it should be diffused by a randomly varying surface.

My scheme worked better than I could have hoped, giving the sort of pin sharp imaging to which I'm

# The Month

tight. A square piece of MDF can be screwed and taped in the throat for mounting the driver and a stiffening batten pinned and glued along each side of the mouth of the horn. This method of fabricating large plywood structures is simple, if tedious, not requiring any great skill in woodworking. Would Andy, with a patient helper, care to have a go?

**David Andrews  
Cheltenham,  
Glos.**

Most of the cost of both valve amplifiers and loudspeakers lies in their casework. The sensitive 'speaker cost little because we don't supply cabinets, not even in flat pack form. The 4W valve

amp on the other hand has expensive transformers and chassis. A 3W amplifier like the Mullard would be no different price wise, except with much cheaper casework and/or transformers. Maplin's Millenium (based on the Mullard 5-20) costs £200, but for this you get thin, unpunished aluminium casework and the smallest transformers possible.

This well illustrates the compromises that must be juggled with. We have in truth been working on a low cost kit valve amplifier for some time now, output 40watts per channel. Hopefully, the design will published in DIY

Supplement No17, with our October 1995 issue. This was brewed up in direct response to reader's requests.

We aren't so much "scared" of horn 'speakers as limited by time and budget. Andy is incredibly busy designing and developing products to demanding schedules, as well as answering queries, etc. We work on those things that are likely to appeal to most people. A proper horn loudspeaker is huge, very awkward to handle but of limited appeal we feel. I hope we can tackle such things in the future, but right now I'm afraid it isn't possible (like the valve synthesiser tuner I dream of!). NK



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*addicted. The amount of benefit will depend upon room width, wall characteristics (i.e. reflective or absorptive) and speaker dispersion characteristics. All the same, it appears to me that toeing-in heavily is more likely to give good imaging than pointing a 'speaker straight down the room.*  
NK

## AN ACTIVE APPROACH

Firstly, thanks for a most informative and worthwhile magazine. It's a refreshing change to find a mag actually concerned with its readers and what they want - not just a platform for the latest 'black box' release.

I'm an avid DIY'er, and am hoping you can point me in the right direction for my latest project: first optimising for bi-amping then building an active cross-over for my system.

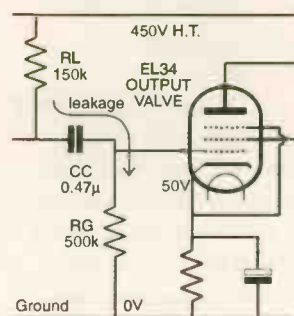
This currently consists of an Audiolab 8000CDM and DAC, Mark Levinson MLI pre-amp, Plinius SA100 (Class A, 100 watts per channel) transistor amp driving the bass with a somewhat modified Leak Stereo 20 on the high end. Speakers are Lambert 300Ts: built locally, utilising 2 Tonigen tweeters and 4 bass midrange drivers in parallel, in a 2-way configuration.

As noted, the Stereo 20 has been partially modified, all bar the power caps being changed for Wimas and the input slugged to match the power amp. Is it possible to optimise it for high frequency response? Likewise, can it be modified to run in Triode mode, and is this advisable?

The next step will be to look at an active crossover. Unfortunately, the only Hi-Fi World edition I've missed (ever!) is the April edition with your active crossover! Are back-copies of the article available, or alternatively, where would you suggest I look to develop a design? My

speakers are electrically 2-way, with a crossover point at 4 kHz. Slope rates are 6 dB/octave on the woofers, 12 dB/octave on the tweeters.

On a different note, some topic suggestions for future articles: how about an article on resistor and capacitor types that could be used in upgrades - for example, when



**A leaky coupling capacitor could cause the grid to become positively biased, burning out the valve.**

should electrolytics be replaced with similar - (say) Black Gates, when should polypropylenes and/or other varieties be used, etc. Likewise, precision metal film verses wirewound resistors and comparisons/scoring of 'audiophile' ICs and transistors etc. What about a piece on valve symbols, their meanings, pin recognition and numbering systems?

All of my (woefully inadequate I'm sure) valve knowledge comes from avid reading of your magazine and supplements. Even so, I'm in the dark about many of the basics: while I don't have a problem reading and interpreting 'modern' circuit diagrams, none of the valve symbols (and functions) were covered at School or Tech.

I realise I've asked a lot in a long and fairly boring letter: my apologies! I've been reading your magazine since it first appeared and have watched with interest the increase in the number of copies at the local newsagents. You certainly have a loyal following here at the other end of the world (even though

we have to wire 180 degrees out of phase from your circuits to allow for our inverted orientation and compensate for frequency time delays due to the 4-month delivery time!)

It's great to see that a little time and patience can result in substantial improvements on 'the latest and greatest' - and that others like yourselves have enough time and patience to show us 'plebs how. Keep up the good work: after the last few years, I feel like I know the team personally!

**Darl Singh  
Auckland,  
New Zealand.**

*Putting an active crossover ahead of the Leak Stereo 20 will remove all low frequencies from it and this in itself will give the amplifier a much easier time. We generally do not recommend you do anything to any old valve amp. other than restore it, although to be realistic if the casework is shot - damaged or rusty perhaps - then mods aren't sacrilegious.*

*Replacing the capacitors with Solen audio-grade polypropylene or, better sounding, modern Jensen (Denmark) paper-and-oils from Audionote (UK) (Tel: 01273-220511/Fax: 01273-731498), will clean things up. However, because of the variable nature of the beast, some paper-and-oils can be leaky. Ideally, you need to check that current leakage isn't altering d.c. conditions after installation, especially with critical coupling capacitors (see diagram) where just 0.2mA would bias the grid positive (i.e. above the 50V on the cathode), cause the anode to glow red and the valve to burn out. These capacitors sound gorgeous however: gloriously sweet, yet with beautifully damped, dark inter-transient silences.*

*Don't rip out every*

*capacitor at once though; change just a few at a time and listen. Subjective component selection is a matter of achieving balance; filling an amp with metal film resistors, paper-and-oils or polyprops. can swing its character too far in one direction, so be careful.*

*Putting a solid-state active crossover in front of a valve amplifier seems a bit contradictory to us purists, although it isn't so bad since valves always seem to add in their character even after solid-state has done its worst, although they can't retrieve what has been lost. My own recommendation for solid-state crossover design is Don Lancaster's renowned Active Filter Cookbook, published by Howard Sams & Co, Indianapolis, Indiana 46268, USA. The Modern Book Co., 19-21 Praed Street, London W2 1NP (Tel: 0171 402 9176/Fax: 0171 724 5736) can supply this mail order to you. If you want the circuit of an active valve crossover, contact Old Colony Sound Lab, P.O. Box 243, Peterborough, New Hampshire NH 03458 (Tel: (603) 924 6371/Fax: (603) 924 9467. I spotted this fairly amazing idea in one of their publications, so you will probably be looking at a book purchase here.*

*We'd love to do basic theory articles, but are desperately short of space at present. I think you ought to put your head into The Art of Linear Electronics, by John Linsley Hood, a new book that - unusually - covers valves as well as all other things audio. See page 101 in the main issue.*

*I hope all this is of some help to you. I thought they invented CD for New Zealand 'cos records kept falling off the turntables.*  
NK

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