Hi-Fi WORLD
SUPPLEMENT
NO.23 AUGUST 1996

**BOOK REVIEWS:**

**VALVE AMPLIFIERS**

**ELECTRONICS CONSTRUCTORS GUIDE**

# WE BUILD AND TEST KEF'S K90 KIT LOUDSPEAKER

## MOTIONAL FEEDBACK: CAN IT GIVE US THE PERFECT LOUDSPEAKER?

## FREE D.I.Y. SUPPLEMENT No. 23

# CHELMER VALVE COMPANY

for

## High Quality Audio Valves

We offer below a selection of our CVC PREMIUM range of audio valves. These CVC BRAND valves are from selected world wide sources, processed in our special facility to provide low noise/hum/microphony PRE-AMP valves and POWER VALVES burnt-in for improved stability and reliability. Use this sheet as your order form. If you require matched pairs, quads or octets etc. Please allow £1.00 extra per valve for this service and mark alongside the valve type number 'M2,M4, M8' etc as required.

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

| **PRE-AMP VALVES** | **Unit Price** | **Qty** | **Total Price** |
|---|---|---|---|
| ECC81/12AT7WA | 5.00 | | |
| ECC82/12AU7WA | 4.50 | | |
| ECC83/12AX7WA | 5.00 | | |
| ECC85 | 5.00 | | |
| ECC88 | 4.50 | | |
| ECF82 | 5.00 | | |
| ECL82 | 5.00 | | |
| ECL86 | 5.00 | | |
| EF86 | 4.50 | | |
| E80F Gold Pin | 9.00 | | |
| E81CC Gold Pin | 6.20 | | |
| E82CC Gold Pin | 6.20 | | |
| E83CC Gold Pin | 6.20 | | |
| E88CC Gold Pin | 7.20 | | |
| 6EU7 | 6.00 | | |
| 6SL7GT | 4.00 | | |
| 6SN7GT | 4.50 | | |
| 6922 | 5.00 | | |
| 7025 | 6.20 | | |
| **POWER VALVES** | **Unit Price** | **Qty** | **Total Price** |
| EL34/6CA7 | 7.50 | | |
| EL34 (Large Din) | 8.50 | | |
| EL84/6BQ5 | 4.00 | | |
| E84L/7189A | 5.50 | | |
| KT66 | 9.20 | | |
| KT77 | 12.00 | | |
| KT88 | 12.50 | | |
| KT88 (Gold Special) | 19.80 | | |
| 2A3 (4 or 8 Pin) | 14.50 | | |
| 211 | 22.00 | | |
| 300B | 50.50 | | |
| 6C33C-B | 27.00 | | |
| 6L6GC | 6.50 | | |
| 6L6WGC/5881 | 8.00 | | |
| 6V6GT | 5.00 | | |
| 6080 | 12.00 | | |
| 6146B | 10.20 | | |
| 6336A | 46.00 | | |
| 6550A | 11.00 | | |
| 6550WA | 13.50 | | |
| 6550WB | 13.50 | | |
| 7581A | 11.00 | | |
| 807 | 8.00 | | |
| 811A | 10.50 | | |
| 812A | 34.00 | | |
| 845 | 30.00 | | |
| Total carried forward ... | | | |

| **RECTIFIERS** | **Unit Price** | **Qty** | **Total Price** |
|---|---|---|---|
| EZ80 | 4.00 | | |
| EZ81 | 4.25 | | |
| GZ32 | 7.00 | | |
| GZ33 | 7.00 | | |
| GZ34 | 6.00 | | |
| GZ37 | 6.00 | | |
| 5U4G | 5.00 | | |
| 5V4GT | 4.00 | | |
| 5Y3GT | 3.50 | | |
| 5Z4GT | 3.50 | | |
| **SOCKETS ETC** | **Unit Price** | **Qty** | **Total Price** |
| B9A (Chassis or PCB) | 1.60 | | |
| B9A (Ch or PCB) Gold | 3.00 | | |
| Octal (Ch or PCB) | 1.80 | | |
| Octal (Ch or PCB) Gold | 4.20 | | |
| 4 Pin (For 2A3, 300B) | 3.30 | | |
| 4 Pin Jumbo (For 211 Etc.) | 11.00 | | |
| 4 Pin Jumbo Gold (For 211 Etc.) | 15.00 | | |
| 5 Pin (For 807) | 3.00 | | |
| 7 Pin (For6C33C-B) | 4.50 | | |
| Screening Can (For ECC83 Etc.) | 2.00 | | |
| Anode Connecter (For 807 Etc.) | 1.50 | | |
| Anode Connecter (For PL519 Etc.) | 1.60 | | |
| Retainer (For 6L6WGC Etc.) | 2.00 | | |

| | | |
|---|---|---|
| MATCHING CHARGES | £ | |
| POST & PACKING (UK) | £3.00 | |
| TOTAL EXC VAT | £ | |
| VAT @ 17.5% (UK/EEC ONLY) | £ | |
| TOTAL TO PAY | £ | |

Please make cheques payable to:
'CHELMER VALVE COMPANY' or pay by
ACCESS/MASTERCARD/VISA Please give details:

☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

SIGNATURE: .................. EXP. DATE: ..........................
NAME: ..........................................................................
ADDRESS: ......................................................................
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**VALVE AMPLIFIERS SOUND BETTER STILL WITH CVC PREMIUM VALVES!**

130 New London Road, Chelmsford, Essex. CM2 0RG. Tel: 01245 355296/265865 Fax: 01245 490064

# D.I.Y. Supplement Contents

## KIT NEWS

5

All the latest bits and bobs to help you get the very best out of your home brewed designs.

## KEF K90 KIT LOUDSPEAKERS

7

We put together a pair of KEF's K90 kit loudspeakers, using their Uni-Q drive unit. With KEF's engineering experience behind them, we're expecting great things.

## MEET YOUR CAPACITORS

14

A strange pastime it may be, but Dominic Baker has been listening to different brands of capacitor for loudspeaker crossovers. Here are his findings.

## AUDIOCAD PRO - PART 2

17

A comprehensive loudspeaker modelling package for the IBM PC is put through its paces by Dominic Baker.

## ELECTRONICS CONSTRUCTORS GUIDE

21

Aimed at students and enthusiasts as well as professionals, Paul Cuthbertson, an experienced electronics engineer himself, brings you his words of wisdom in the world of electronics design and construction.

## VALVE AMPLIFIERS

23

Written by Morgan Jones, Valve Amplifiers contains theory, hints on modifications and upgrades and new designs you can build yourself.

## LETTERS FEATURE - MOTIONAL FEEDBACK

25

Three pages devoted to the art of motional feedback. This mechanism promises deep bass with fantastic quality and low distortion. Why isn't everyone using it?

## DIY LETTERS

29

Write in for advice on your DIY project - here's where we provide the help you've been looking for.

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

**CRICKLEWOOD ELECTRONICSANSAR SUPERSOUND**
**Audio Polypropylene 400VDC±5%**

The secret's in the metalised film!

Manufactured specifically for high end audio, these polypropylene capacitors offer exceptional value for money as they use a specially imported high purity metallised polypropylene film, ensuring smooth, detailed and transparent sound quality and extremely low distortion, whether they are placed directly in the signal path such as in crossovers or for decoupling etc ideal for replacing old, stale and leaky capacitors.

| Part no | Value | Price |
|---|---|---|
| CW100N | CAP PROPYL 100nF | £1 25 |
| CW150N | CAP PROPYL 150nF | £1 25 |
| CW220N | CAP PROPYL 220nF | £1 25 |
| CW330N | CAP PROPYL 330nF | £1 25 |
| CW470N | CAP PROPYL 470nF | £1 25 |
| CW680N | CAP PROPYL 680nF | £1 25 |
| CW1U0N | CAP PROPYL 1µF | £1 25 |
| CW1U5N | CAP PROPYL 1 5µF | £1 50 |
| CW2U2N | CAP PROPYL 2 2µF | £1 50 |
| CW3U3N | CAP PROPYL 3 3µF | £1 85 |
| CW4U7N | CAP PROPYL 4 7µF | £2 00 |
| CW6U8N | CAP PROPYL 6 8µF | £2 50 |
| CW10UN | CAP PROPYL 10µF | £3 50 |
| CW15N | CAP PROPYL 15µF | £4 50 |
| CW22U | CAP PROPYL 22µF | £6 50 |
| CW50U | CAP PROPYL 50µF | £9 95 |
| CW100U | 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 aand 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 |
|---|---|---|
| CPP47P | CAP PROPYL47pF250V | £0 35 |
| CPP100P | CAP PROPYL100pF250V | £0 35 |
| CPP150P | CAP PROPYL150pF250V | £0 35 |
| CPP220P | CAP PROPY220pF250V | £0.35 |
| CPP330P | CAP PROPYL330pF250V | £0.35 |
| CPP470P | CAP PROPYL470pF250V | £0 35 |
| CPP1N0 | CAP PROPYL1nF250V | £0 35 |
| CPP1N5 | CAP PROPYL1 5nF250V | £0 35 |
| CPP2N2 | CAP PROPYL2 2nF250V | £0 35 |
| CPP4N7 | CAP PROPYL4 7nF63V | £0 50 |
| CPP10N | CAP PROPYL10nF63V | £0 65 |
| CPP22N | CAP PROPYL22nF63V | £0 85 |
| CPP47N | CAP PROPYL47nF63V | £1 00 |

**Low Impedence High Temperature (105° C) Radial Electroytics ± 5%**

Superior electrolytics at affordable prices. The low impedance and resistance maximises 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 Z HI TEMP1µF50V | £0.25 |
| 2U2H50 | LO Z HI TEMP2 2µF50V | £0.25 |
| 4U7H63 | LO Z HI TEMP4 7µF63V | £0 25 |
| 10H63 | LO Z HI TEMP10µF63V | £0.25 |
| 22H63 | LO Z HI TEMP22µF63V | £0.30 |
| 47H63 | LO Z HI TEMP47µF63V | £0.35 |
| 100H63 | LO Z HI TEMP100µF63V | £0 50 |
| 220H50 | LO Z HI TEMP220µF50V | £0 75 |
| 470H63 | LO Z HI TEMP470µF63V | £1 25 |
| 1000H35 | LO Z HI TEMP1000µF35V | £1 50 |
| 2200H50 | LO Z HI TEMP2200µF50V | £2 25 |
| 4700H25 | LO Z HI TEMP4700µF25V | £2.50 |

**Elna Solder Lug Reservoir Capacitor 10,000µF 80V**

Choosing the right electrolytic for power supply use is 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 |
|---|---|---|
| 10000C30 | CAL ELNA1000µF/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 bobbins

| Part No | Specification | Price |
|---|---|---|
| P15 | 150µH0 15Ω48x19mm | £2 00 |
| P22 | 220µH0 15Ω48x19mm | £2 50 |
| P33 | 330µH0 2Ω8x19mm | £3 00 |
| P47 | 470µH0 25Ω50x19mm | £3 50 |
| P68 | 680µH0 35Ω59x19mm | £4 50 |
| P100 | 1mH0 4Ω59x19mm | £5 50 |
| P150 | 1 5mH0 5Ω70x30mm | £6 50 |
| P220 | 2 2mH0 6Ω70x30mm | £8 00 |
| P330 | 3 3mH0.75Ω70x30 | £10 00 |

**Monocor Ferrite Inductors**

A range of professional high efficiency 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 F1000) wound on plastic bobbin

| Part No | Specification | Price |
|---|---|---|
| F220 | 2 2mH0 15Ω400W55x31mm | £6 50 |
| F330 | 3 3mH0 2Ω330W65x39mm | £9 50 |
| F470 | 4 7mH0 25Ω140W65x30mm | £11 00 |
| F680 | 6 8mH0 35Ω120W65x39mm | £12 00 |
| F1000 | 10mH0 45Ω100W65x39mm | £13 50 |

**Quality Valvas**
**Affordable range of High Quality Valves**

| Part No. | Description | Price |
|---|---|---|
| 6550C | OUTPUT VALVE | £26 00 |
| 6L6GT | OUTPUT VALVE | £4 50 |
| 6SN7GT | OUTPUT VALVE | £4 50 |
| 6V6GT | OUTPUT VALVE | £3 95 |
| ECC81 | TRIODE | £4 50 |
| ECC82 | TRIODE | £4.50 |
| ECC83 | TRIODE | £4 50 |
| EF86 | LOW NOISE PENTODE | £3 50 |
| EL34 | OUTPUT VALVE | £8 50 |
| EL84 | OUTPUT VALVE | £3 50 |
| GZ34 | 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 + | 2 00 |
| CC | SCREENING CAN | £2 25 |
| 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.**

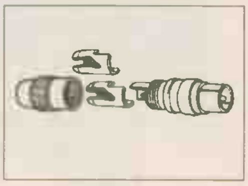
| Part No | Description | Price |
|---|---|---|
| PPG5A2 | PAIR GOLD PLUGS for up to 5mm CABLE | £1 50 pair |
| PPG8A2 | PAIR GOLD PLUGS for up to 8mm CABLE | £1 50 pair |

**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**



Superior pair of phonos each includes 2 cable grips pairs 3 5 5 5mm & 5 5-7 3mm making them suitable for a wide range of cables. These connectors make contact with ground first at insertion to eliminate pop.

| Part No | Desription | Price |
|---|---|---|
| PPN2 | NEUTRIK PRO AUDIO | £12 00/pair |

**Extra High Quality Gold Plated Phono (RCA) Leads (pairs)**

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

| Part No | Length/Colour | Price |
|---|---|---|
| LPP1QG | 0 8 Metres/Green | £5 50 |
| LLP1QV | 0 8 Metres/Violet | £5 50 |
| LPP2QG | 1 5 Metres/Green | £6 50 |
| LPP2QV | 1 5 Metres/Violet | £6 50 |
| LPP5QG | 5 Metres/Green | £11 00 |
| LPP5QV | 5 Metres/Violet | £11.00 |

**Bass Reflex Tuning Ports**

A range of adjustable plastic ports for use in various sizes of loudspeaker cabinets d=diameter L=adjustable length (mm)

| Part No | Dimension | Price |
|---|---|---|
| R35 | d=35L=110-210 | £2 50 |
| R50 | d=50L=150-280 | £3 00 |
| R70 | d=70L=128-245 | £3 50 |
| R100 | d=110L=160-122 | £5 50 |
| R85 | d=85 angled 45° for narrow cabinetsL=210-310 | £6 50 |

High Quality Components at the right price. Ask for our free catalogue. Please ad £2 00 carriage + VAT to all orders. Credit Card phone orders accepted

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# F. Langford-Smith
## Radio Designers Handbook

**Langford-Smith Radio Designers Handbook is recognized as being the most important reference work ever Published.**

Vintage Audio are pleased to be able to reprint this important work and bring it to you in its original format. The Book contains 1500 pages, in 38 chapters, on every aspect of Valve Amplifier Circuits. Such is the extent of the subjects covered it would be impossible to list them all here. It is best summed up in the author's preface to the book:
"It has been written as a comprehensive self explantatory reference handbook for the benefit of all who have an interest in the design and application of Audio Amplifiers"

To order your copy at £59 Please Call or Fax us on (01144) 1734 451737

**Vintage Audio**
850 Oxford Road, Reading, Berks.
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**nva**

## BLACK BOX RANGE KITS

***A range of easy to assemble solid state kit amps, with fully tested and fitted printed circuit boards. If you are competent with a soldering iron these kits should be no problem. A full rebuild and sort out service available.***

| | | |
|---|---|---|
| AP30 | Integrated Amplifier | £230.00 |
| AP50 | Integrated Amplifier | £320.00 |
| | Phono Stage Fitted | £70.00 |
| A60 | Stereo Power Amplifier | £300.00 |
| A70 | Mono Power Amplifier | £570.00 Pair |
| A80 | Mono Power Amplifier | £880.00 Pair |
| P50 | 4 Input Pre Amp | £180.00 |
| P90 | 6 Input Pre Amp | £240.00 |
| Phono 1 | MM or MC Phono Unit | £170.00 |
| Phono 2 | MM or MC Phono Unit | £240.00 |
| P.S.U. | Power Supply for Phono 2 | £180.00 |

*EX REVIEW/DEMONSTRATION STOCK BARGAINS, The Emotive Statement (TES) CD Player £1000.00 RRP £2000.00*

**NVA,** *6 Watermill Ind. Est., Aspenden Road, Buntingford, Hertfordshire SG9 9JS*
***Tel: 01763 272707 Fax: 01763 271594***

World Radio History

# KIT NEWS

## LIBERTY TWO

Free demo disks are now available from Marton Music for version 2 of Liberty Audiosuite's LAUD audio analysis software. The full blown version should be available for purchase in July '96.

Significant enhancements over the current version are claimed including a real time analyser, pink noise generator (with both third and sixth octave analysis), automatic adjustment of input sensitivity along with marker positioning, and manufacturing pass/fail procedures.

The system is designed to be user friendly with built in Easy-Script to simplify operation. The complete system including Echo soundcard, calibrated microphone, pre-amp, manuals and all cables and probes will cost a total of £535 + VAT. Customers running the current version can upgrade for £72. For the free demo disk or any further information contact Tony Seaford on the number below.

**Marton Music**
**5 Masterson Avenue,**
**Read,**
**Burnley,**
**Lancs. BB12 7PL**
**Tel: 01282 773198**

## GOODBYE TO WILMSLOW?

After 35 years of supplying loudspeaker kits and components to audiophiles the world over, word is spreading that Wilmslow Audio may soon cease trading. At the moment it's not known if a buyer can be found to take over the business when the current owners emigrate, but it looks as though the name Wilmslow at least will soon vanish from component supplier lists.

## SUMMER AT AUDIOCOM

Welsh component suppliers Audiocom have added several new lines to their latest catalogue. They now stock ultra fast soft-recovery rectifier diodes for use in valve and transistor amplifier power supplies. Also new is a range of DAC chips, including Burr-Brown's PCM69AP, Philips' DAC-7 and Analog Devices' 1862N.

Those with a soft spot for bullion can sate their appetite with a range of uninsulated silver cables, while the slightly less well-to-do can take advantage of a price reduction for five or more of Sanyo's OS-CON electrolytic capacitors.

**Audiocom**
**2 Swallowtree Gardens,**
**Saundersfoot,**
**Dyfed SA69 9DE**
**Tel: 01834 814036**

## AP UPGRADES

Graham Nalty's AP Electronics is offering a range of upgrades for owners of popular amplifiers. These include the likes of the Audiolab 8000A, Naim Nait, A&R A60, and Pioneer A400.

**AP Electronics**
**15 Derwent Business Centre,**
**Clarke Street,**
**Derby DE1 2BU**
**Tel: 01332 674929**

## AUDIO-LINKS SALE

Until the end of July, or until stocks are exhausted, you can save money on some of Audio-Links' components like silver wire, Ansar capacitors, Alps potentiometers and Elna switches.

For lists and prices, send a C5 size SAE to:

**Audio-Links**
**7 Fairmont Crescent,**
**Scunthorpe,**
**N. Lincs. DN16 1EL**
**Tel: 01724 870432**

## BILLINGTON VALVE AMP PARTS

Just to make sure the temperature doesn't drop below sweltering this summer, Billington are announcing stocks of components for budding valve amplifier constructors.

The range of predominantly government surplus oil-filled chokes (prices from about £10 to £35) is complemented by a list of mains transformers. This is made up of C-core oil-filled types as well as more standard shrouded and unshrouded versions.

All bar one of the output transformers available are designed for push-pull use with valves such as the EL34 pentode, with estimated power ratings of between 30 and 100watts.

So you know exactly what's going on inside your valve amp, there's also a range of 'power station' style moving iron meters in state of the art bakelite and brass cases. Quantities are limited, though, so it's first come, first served.

**Billington Export Ltd.**
**Units E1 & E2,**
**Gillmans Ind. Est.,**
**Billingshurst,**
**W. Sussex RH14 9EZ**
**Tel: 01403 784961**

## NVA BUDGET DACON

NVA have developed a low cost version of their DACon digital to analogue convertor. The new Junior DACon uses a smaller in-built power supply instead of the 300VA external version of the original, although it can be upgraded to the level of its senior counterpart.

Built, the new version is available at £300 and as a kit for £180. The DACon senior will also now be available in kit form for £320 plus £180 for each PSU.

**NVA**
**6 Watermill Ind. Est.**
**Aspenden Road,**
**Buntingford,**
**Hertfordshire SG9 9JS**
**Tel: 01763 272707**

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*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 hifi system. This kit is your way to get £K 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*

| | |
|---|---|
| K1100B Complete STANDARD Amplifier Kit, | **£395.21** |
| A1100B Factory Assembled | **£499.21** |
| **K1100SC** Complete SLAVE Amplifier Kit, £ | **£333.62:** |
| A1100SC Factory Assembled | **£422.62** |
| **K1100M** Complete MONOBLOC Amplifier Kit, | **£261.20** |
| A1100M Factory Assembled | **£329.20** |
| RLH10 Reprints of latest Amplifier articles | **£4.50** |
| K1100CM Construction Manual with full parts lists | **£5.50** |

**K1400 AUDIOPHILE PREAMPLIFIER.** *A versatile ultra high quality preamp with no less than seven inputs, all switched by sealed high quality relays. Separate tape output selection. Class "A" headphone output for two 'phones Lo-Z long line drive facility.*

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

**"CHIARA" SINGLE ENDED CLASS "A" HEADPHONE AMPLIFIER.**
*First Module to appear in our new "2000 Range" of kits This unit provides a high quality 'phone output for those many amplifiers that do not have one Easily installed with special link-through facility the unit draws its power from our new Andante Ultra High Quality linear toroidal 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 Pre-terminated interconnecting leads and PCB mounted sockets prevent supply polarity reversal and on-board diagnostics provide visual indication of supply line integrity. Volume and balance controls are Alps "Blue Velvet" components Very easily built, even by beginners, since all components fit directly on the single printed circuit board and there is no conventional wiring whatsoever. The kit has very detailed instructions, and even comes with a roll of Hart audiograde silver solder. It can also be supplied factory assembled and tested Selling for less than the total cost of all the components, if they were bought separately, this unit represents incredible value for money and makes an attractive and harmonious addition to any hifi system*

| | |
|---|---|
| **K2100** Complete Kit | **£109.50** |
| **K2100SA** Series Audiophile version with selected audiophile components | **£112.46** |
| **A2100SA** Factory Assembled and Tested "Chiara" | **£149.46** |

| | |
|---|---|
| **K3565** "Andante" Audiophile Power Supply Kit to suit | **£85.42** |
| **A3565** Factory Assembled and Tested "Andante" | **£128.42** |
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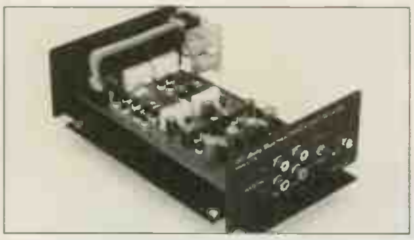

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# KEF's K90 KIT LOUDSPEAKERS

**Our skilled in-house technician, Nick Lucas, gets his hands on KEF's K90s. Did they survive the experience? Read on!**

Wilmslow Audio, the loudspeaker kit people, sent us three of their KEF kits for review, namely the 60s, 80s and 90s. All the kits contain front mouldings, trim rings, sealing gaskets, fixings, instructions and front panel templates.

The crossovers, DN60, DN80 and DN90, are built on good quality printed circuit boards with flying leads attached and are sold separately. KEF do not manufacture flat-pack wood for the cabinets, terminal dishes, internal wadding, damping or ports. Unfortunately, it looks like Wilmslow Audio, KEF's largest UK distributor for their kits, will have ceased trading by the time you read this, but all these items should be available from local carpenters and the suppliers listed in this month's DIY Supplement.

## KEF's Uni-Q Drive Unit

This popular three model constructor series has been around for a couple of years now and is centred on KEF's Q200H Uni-Q drive unit. This is an 8" driver which has its tweeter sitting where the dust cap of the bass/midrange cone would usually be. This coherent source arrangement means that all the sound radiated by the driver is coming from the same point, whereas in a normal two way 'speaker for example it would be coming from two different points. This can provide very clear imaging, which KEF have tried to make the most of by using a low diffraction mounting arrangement for the driver. The plastic front moulding and trim mirror the profile of the cone, helping to reduce diffraction effects. Aesthetically, this also gives a professionally finished look to the loudspeakers.

## The KEF Kit Range

The KEF kit 60 is the smallest of the three. It uses the Q200H driver in a front ported cabinet with a volume of 18.5 litres, and has a claimed sensitivity of 90dB and a power rating of 100watts. The KEF kit 80 is a floorstander that uses the same Q200H along with an 8" acoustic bass radiator (the BD200H ABR) in place of the port. This is basically a drive unit minus the magnet - it's driven only by the air movement of the Q200H - and KEF claim it has the effect of improving and increasing the bass response. Sensitivity-wise, KEF say the kit 80 manages 89dB and can cope with 125watts.

Largest of the three in a ported enclosure of 35 litres is the KEF kit 90. This uses the Q200H, this time with the B200H bass unit which yields a claimed sensitivity of 89dB and a power rating of 150watts. All three kits are bi-wireable.

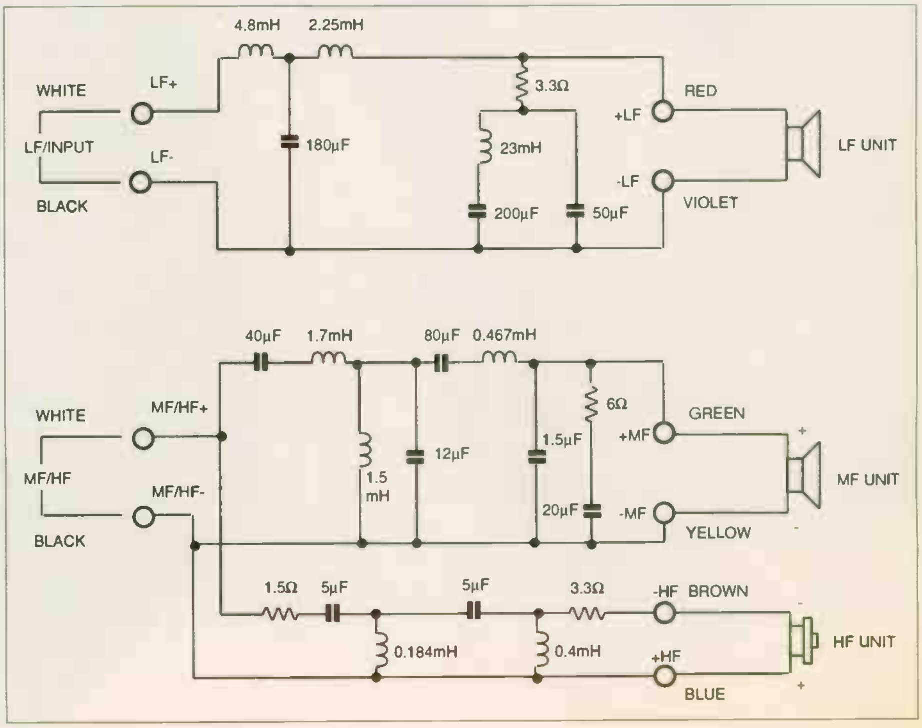
Relaying this information to Dominic I received the response, "Build one". Opting for the top of the range, of course, I chose the KEF kit 90.

**The complete kit laid out ready for assembly. Templates for the driver cut-outs are supplied for those who want to do their own woodwork; ours was supplied in flat-pack form by Wilmslow Audio.**

## The Crossover

Although fairly complex looking and using a large number of components, the crossover for the K90s can be followed fairly easily. Starting in the bass, 4.8mH, 2.25mH and 180µF provide a 3rd order low pass filter. 3.3Ω, 23mH, 200µF and 50µF form a filter that damps resonant peaking in the impedance curve, in this case suppressing the upper of the two peaks characteristic of reflex loaded loudspeakers.

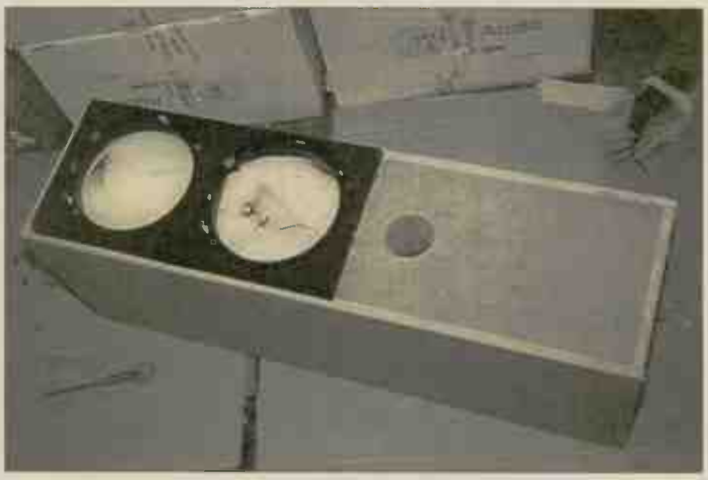
The midrange driver uses a 3rd order high pass filter to roll-off low frequencies and match the bass driver. Rolling off treble is a 4th order filter and impedance compensation is provided by the series combination of 6Ω and 20µF. To match the midrange driver, a 4th order high pass filter is used for the tweeter; the two resistors provide the correct attenuation.



# Building The KEF K90 Loudspeakers

The instructions provided are short and concise, supplying all the information you will need for correct assembly. They contain a 3D finished drawing, components list, cabinet plans, construction tips, assembly notes and technical specification. Note well, read the instructions thoroughly; you may feel information is missing, but if you look carefully it will appear magically in the text.

The DN90 crossovers for the KEF K90s come factory assembled and tested.



Once the baffle is securely in place, the plastic mouldings for the drivers can be fitted and the cabinet filled with wadding.

The flat-pack for the cabinets, supplied by Wilmslow Audio, was made of high quality 15mm medium density fibreboard (MDF) as recommended by KEF. Before cabinet assembly began I found it easier to drill starter holes for the terminal dishes and front mouldings, checking these for correct orientation. I fixed the crossover PCB to the shelf panel after extending the flying leads, realising they were too short to reach the terminal dish. I also fitted the damping material to the inside surface of each top, side and back panel, covering at least half of the inside surface area.

The wood panels came together perfectly using Evostick Resin 'W' wood glue. First of all I laid one side panel flat and then built on this the front, back, top, bottom and shelf and finally the other side. Cabinet maker's clamps would be the ideal aid, but packing tape wrapped around the cabinets sufficed. I left the cabinets to set for 24 hours. It was then a simple matter to stuff the wadding inside the cabinets and fit the front moulding. Following the instructions carefully and keeping to the colour codes for the crossover I wired up the drive units and screwed the terminal dishes into place.

## Finishing Off

The final touch was beautifying the mouldings with their trim rings and Bob's your uncle. I ran a quick DC resistance check, both K90s read 5.5ohms, so I fired them up.

Overall it was a very enjoyable build taking approximately three hours per 'speaker, but it remains to be seen how the finely tuned ears of our editorial department will react to them. . .

Wilmslow's flat-pack cabinet was well machined and fitted together easily and securely. We used strong packing tape to hold the cabinet together and ensure an air tight seal.

Finishing stages: the mouldings are screwed down and the drivers fitted.

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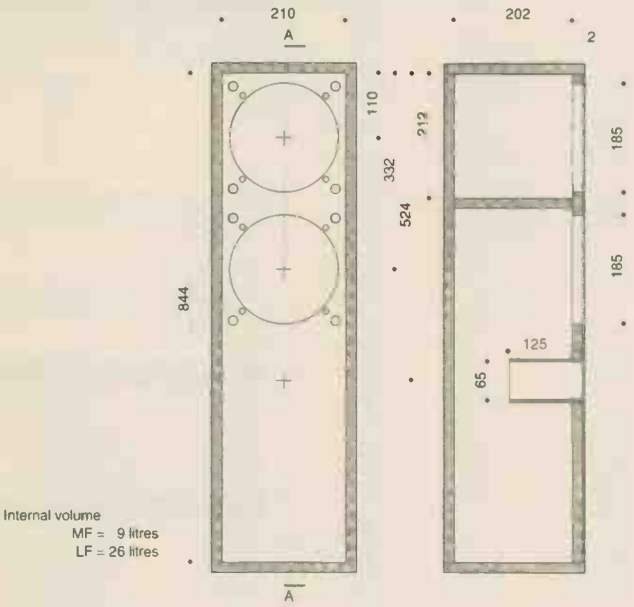
# The Cabinet

| | Internal Port Diameter | Internal Port Length |
|---|---|---|
| KEFkit 90 | 65 mm | 125 mm |

CABINET PLANS FOR KEFkit 90 (All dimensions in millimetres)



The cabinet is a fairly straight-forward affair. Up top, a 9 litre sealed enclosure is used for the Uni-Q midrange and treble driver. The cabinet damping and internal wadding are important here, preventing reflections from the rear of the cabinet coming back through the driver which can produce a clattery sound. The bass chamber is a 26 litre box, reflex loaded to give deep and efficient bass.

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## KEF K90 SOUND QUALITY

Firing up the KEFs with the first few tracks of Boys For Pele revealed well detailed, precise imaging, especially with Tori Amos' vocals. Instruments were clearly located in the left to right spread of the soundstage, although a fairly marked lack of stage depth robbed the music of realism.

Thus far I had no tonal qualms about the K90s, but this started to change with 'Professional Widow' and 'Talula' where vocals showed up some sibilance and harpsichord notes had a sharp edge to them. Muted trumpets on Charles Mingus' Mingus, Mingus. . . album and string instruments on orchestral works also suffered from the same effect.

While Mingus' plucked bass was attractively dynamic, it confirmed an extra richness at the bottom end which was obvious on the saxophones of his album and the drums and Hammond organ of Carlos Santana's Santana CD. The combination of midrange emphasis and full bass meant that the KEF K90 'speakers sounded rather poorly integrated and tended to get confused on busier pieces of music.

The KEF K90s are capable of good dynamics and bass weight, but their rather two-dimensional soundstage and prominent midrange let them down.

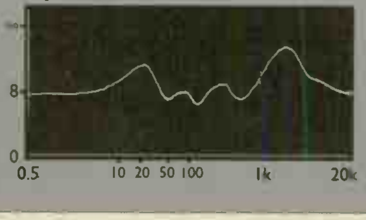
---

## KEF KIT K90

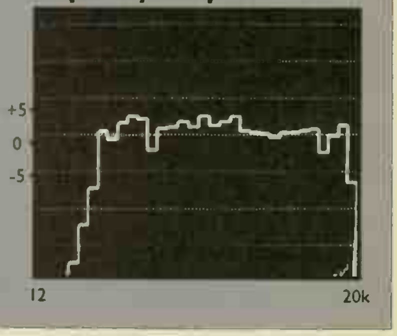
At a glance, the KEF kit K90s look well engineered. The response is flat and smooth in true KEF tradition, but there are some trends which I suspect will be detrimental to their sound. Although essentially flat, there is quite a lot of energy concentrated below 1kHz, lifting lower midrange above treble level. This can result in an over-full or thick sound, especially in conjunction with well extended bass. Pulled well away from walls though, the K90s should sound reasonably balanced.

Although the impedance curve averages out at 7.8Ω and doesn't drop below 4Ω at any point, it isn't the smoothest around. The sharp rises and falls indicate the K90s are a reactive load, which can as it does with KEF's Reference Series, affect amplifier performance quite markedly. Sensitivity was below average too, measuring just 84.5dB, so they'll take some driving. I'd recommend 50watts minimum for best results. **DB**

**Impedance**



**Frequency Response**



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All prices are excluding UK Vat at 17.5% [illegible] the EEC [illegible] after the addition of postage and packing [illegible]

## VACUUM TUBE VALLEY

Now I bet you never heard of this one before, but [illegible] with valves, whether [illegible] or just old and good. [illegible] print and read, each issue focuses on a US brand of [illegible] Issue 2 [illegible] dealt with extensively. There is a long article by Eric Barbour about the EL34, not a [illegible] any longer, but a very popular valve [illegible] and an [illegible] of [illegible] and vintage types. The Audio Test [illegible] looks at tests and equipment for [illegible] amplification building, very practical and useful. [illegible] a great article about how to bias the VV52B and biasing and tube [illegible] in general. [illegible] and much more. It is nice to see a magazine that takes a historical perspective. Well worth a read, available [illegible] at £ 6.50 a copy or directly from VTV 1005 E. Duane Ave. Suite 136 Sunnyvale CA 94[illegible] USA. $ [illegible] subscription.

## POSITIVE FEEDBACK.

This is one type of feedback that we are not [illegible] against. [illegible] with aspirations towards greatness, not unlike the great underground magazines of the 1970s. It is a quarterly publication of [illegible] commentary by in-house writers, members, as well as various industry doyens on the subjects of music, audio, technology and the quest for musical satisfaction. I [illegible] it is an excellent read and provides a good alternative view to most of the established press, which tends to view the world in the context of what new products is available right now, without giving much perspective backwards. We have several back issues available of Positive Feedback and the latest issue is just off the press and all are available at £ 7.00 per issue. Yours truly is a regular contributor to PF, what better reason to subscribe?

## COMPLETE KITS

At the [illegible] the following kits are under development [illegible]

KIT TWO 6550 [illegible] 15 watts Class A [illegible]

Delivery [illegible]

KIT THREE 300B parallel single-ended [illegible] 1[illegible] watts Class A, cost £ 4[illegible]

KIT FOUR [illegible] push pull 1[illegible] watts Class A, stereo chassis, expected cost £ 1[illegible] [illegible] delivery October 1995

KIT FIVE 211 single-ended, 15 watts Class A, mono chassis, expected cost - 2,250.00 [illegible] delivery Dec. 1995. We hope.

KIT SIX 300B single-ended, 7/8 watts Class A, stereo chassis, expected cost £ 400.00 [illegible] valves and Vat, this will be our "entrypoint" or gateway to single-ended triode bliss or rock and roll. If you prefer. Expected [illegible] 1996.

If you are in doubt as to whether a kit project is suitable for you, we suggest you spend £ [illegible] on buying the instructions for the KIT ONE, single 300B amplifier, this will give you a good idea whether a kit project is for you. If you decide to buy a kit then the £ [illegible] will be [illegible] against the cost of the kit. [illegible] their instruction manuals will also be available at £ [illegible] [illegible] and Polish.

## AUDIO NOTE OUTPUT TRANSFORMERS.

We are in the process of building up four separate ranges of Audio Note output transformers, in order to offer the best possible [illegible] at different price points, they will fall into four categories:

A.) Economy range, where the price-quality relationship is carefully calculated to offer the audio quality in a compact package, initially we will only be offering 3 single-ended output transformers in this range, push-pull [illegible] are under development, but do not expect to see any on this side of August 1995.

B.) Mid-price range, which are the output transformers already on offer, [illegible] range since the last list.

C.) High Quality range, this will be a range of double C-core outputs for single-ended circuits [illegible] push-pull outputs will be offered, unless demand requires it. Again 3 offerings initially.

D.) Super High Quality range, pure silver wired outputs of the best possible quality, when I say best possible, I do not mean to say that these silver outputs will be as good as the silver output transformers [illegible] by Audio Note in Japan. They won't, but then again they do not carry the price tag either.

The quality criteria for group A are 20Hz to 20kHz 1 to 1.5dB [illegible] and are supplied with frames and solder tags, which will allow good audio quality at [illegible] the use of a smaller core, specified to the exact power level required, rather than [illegible] or [illegible] as we do on Group B, the winding quality and copper wire is the same.

Group B are typically 20Hz to 40kHz minus 1.5dB [illegible] cored with high quality [illegible] oxygen-free copper wire and [illegible] with either bell-ends or frames always with flying leads.

Group C are typically 12Hz to 70kHz minus 1.5dB [illegible] double C-cores made from the best [illegible] steel [illegible] Permalloy, [illegible] etc.

Specifications

[illegible]

## AUDIO NOTE AUDIO QUALITY OUTPUT TRANSFORMERS.

Group A

Single-ended Outputs

| Recommended Valve Max | Cl. A Power | Prim-S-c. Imp | Size Weight | Max. Current | Price Ex. UK VAT |
|---|---|---|---|---|---|
| [illegible] | 15 watts | 2[illegible] 4/8 Ohms | [illegible] | 9[illegible] A [illegible] | 44 [illegible] |
| [illegible] | 2[illegible] watts | 6[illegible] 4/8 Ohms | | 1[illegible] | [illegible] 50 |
| [illegible] | [illegible] watts | [illegible] | | [illegible] | [illegible] |

Group B

| Recommended Valve Max | Cl. A Power | Prim-S-c. Imp | Size Weight | Max. Current | Price Ex. UK VAT |
|---|---|---|---|---|---|
| [illegible] | 2[illegible] watts | [illegible] 4/8 Ohms | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | 11[illegible] |
| [illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | 11[illegible] |
| [illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |
| 2[illegible] | [illegible] watts | [illegible] 4/8 Ohms | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] watts | [illegible] 4/8 Ohms | [illegible] | [illegible] | [illegible] |
| [illegible] | 5[illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |
| 1[illegible] | 5[illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |
| 211/VT4[illegible] | 7[illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |
| EL[illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] watts | [illegible] 4/8 Ohms | [illegible] | [illegible] | [illegible] |

NEW SE Product

| Recommended Valve Max | Cl. A Power | Prim-S-c. Imp | Size Weight | Max. Current | Price Ex. UK VAT |
|---|---|---|---|---|---|
| [illegible] | 80 watts | [illegible] | | [illegible] | [illegible] |

Group B

Push-Pull Outputs

| Recommended Valve Max | Cl. A Power | Prim-S-c. Imp | Size Weight | Max. Current | Price Ex. UK VAT |
|---|---|---|---|---|---|
| EL[illegible] | [illegible] watts | [illegible] 4/8 Ohms | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] watts | [illegible] 4/8 Ohms | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 5[illegible] watts | [illegible] | [illegible] | [illegible] | 14 [illegible] |
| [illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | 14[illegible] |
| KT[illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |
| KT[illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |

Group C.

Single-ended only

| Recommended Valve Max | Cl. A Power | Prim-S-c. Imp | Size Weight | Max. Current | Price Ex. UK VAT |
|---|---|---|---|---|---|
| 300B/2A3/[illegible] | 25 watts | 2[illegible] | | 9[illegible] A [illegible] | [illegible] |
| 211/[illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | 4[illegible] |
| [illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | [illegible] |

Group D.

Pure Silver Wired Outputs.

| Recommended Valve Max | Cl. A Power | Prim-S-c. Imp | Size Weight | Max. Current | Price Ex. UK VAT |
|---|---|---|---|---|---|
| 300B/2A3/[illegible] | [illegible] watts | [illegible] | [illegible] | [illegible] | 1[illegible] |
| 211/[illegible] | 5[illegible] watts | [illegible] | [illegible] | [illegible] | 1[illegible] |

The AUDIO NOTE silver wired outputs [illegible] ONGAKU, KAGURA [illegible] or the [illegible] as you would expect [illegible] is an ONGAKU [illegible] £ [illegible]

## AUDIO NOTE CHOKES & INDUCTORS.

| Value | Size | Price Ex. UK Vat |
|---|---|---|
| [illegible] | | 18.00 |
| [illegible] | | 14.00 |
| [illegible] | | 24.00 |
| [illegible] | | [illegible] |
| [illegible] | | [illegible] |
| [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] mm | [illegible] |

Other values can be supplied [illegible]

## AUDIO NOTE MAINS TRANSFORMERS.

[illegible]

| Primary Voltages | Secondary HT Windings | Secondary Heater Windings | Price Ex. UK Vat |
|---|---|---|---|
| [illegible] | [illegible] | [illegible] Amp | [illegible] |
| [illegible] | | [illegible] at 4 Amp | |
| [illegible] | 0v [illegible] at 0.4 Amp | 0-12v at 1 A | 41.[illegible] |
| [illegible] | | [illegible] at 4 Amp | |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | 6[illegible] 0v at [illegible] | [illegible] |
| | | | [illegible] |
| [illegible] | 0v [illegible] | [illegible] | [illegible] |
| [illegible] | | 0v [illegible] | |
| [illegible] | [illegible] | [illegible] at 4.5 Amp | 72.[illegible] |
| 0v/[illegible] | [illegible] | 12[illegible] at 1.5 Amp | |
| [illegible] | [illegible] | [illegible] at 4 Amp [illegible] | [illegible] |
| [illegible] | [illegible] at 5[illegible] | [illegible] | |
| [illegible] | [illegible] | [illegible] | [illegible] |
| 0v/[illegible] | [illegible] at 5[illegible] | [illegible] | |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] | [illegible] |
| | | [illegible] | [illegible] |
| | | [illegible] | |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] | |
| | | [illegible] | [illegible] |
| | | [illegible] | |
| [illegible] | [illegible] | [illegible] | 1[illegible] |
| [illegible] | | [illegible] | |
| | | [illegible] | [illegible] |
| | | [illegible] | |
| | | [illegible] | |

[illegible] £ [illegible] per set. [illegible]

[illegible]

## AUDIO NOTE PAPER IN OIL SIGNAL CAPACITORS

[illegible]

| Value | DC Voltage | Size | Price ex. UK Vat |
|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | 5.4[illegible] |
| [illegible] | [illegible] | [illegible] mm | 5.4[illegible] |
| [illegible] | [illegible] | [illegible] mm | 5.4[illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] mm | 5.4[illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] mm | 5.[illegible] |
| [illegible] | [illegible] | | 5.[illegible] |
| [illegible] | [illegible] | [illegible] mm | 6.15 |
| [illegible] | [illegible] | [illegible] mm | 4.[illegible] |
| [illegible] | [illegible] | [illegible] mm | 6.[illegible] |
| [illegible] | [illegible] | [illegible] mm | 4.[illegible] |
| [illegible] | [illegible] | [illegible] | 6.[illegible] |
| [illegible] | [illegible] | [illegible] mm | 5.15 |
| [illegible] | [illegible] | [illegible] mm | 5.[illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] mm | 8.[illegible] |
| [illegible] | [illegible] | | 11.15 |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] mm | 4.[illegible] |
| [illegible] | [illegible] | [illegible] mm | 2.[illegible] |
| [illegible] | [illegible] | [illegible] mm | 2.[illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] mm | 1.45 |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] mm | 5.45 |
| [illegible] | 630 volt | [illegible] | [illegible] |
| [illegible] | 630 volt | [illegible] | [illegible] |
| [illegible] | 630 volt | [illegible] mm | 6.05 |
| [illegible] | 630 volt | [illegible] | 4.[illegible] |
| [illegible] | 630 volt | [illegible] mm | 4.[illegible] |
| [illegible] | 630 volt | [illegible] | 4.[illegible] |
| [illegible] | 630 volt | [illegible] | 4.[illegible] |
| [illegible] | 630 volt | [illegible] | 4.[illegible] |
| [illegible] | 630 volt | [illegible] | 4.[illegible] |
| [illegible] | 630 volt | [illegible] | 4.[illegible] |
| [illegible] | 630 volt | [illegible] | 4.[illegible] |
| [illegible] | 630 volt | [illegible] | 4.35 |
| [illegible] | 630 volt | [illegible] | 4.[illegible] |
| [illegible] | 630 volt | [illegible] | 4.5[illegible] |
| [illegible] | 630 volt | [illegible] | 6.[illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | 630 volt [illegible] | [illegible] mm | 9.[illegible] |
| [illegible] | [illegible] | [illegible] mm | 6.[illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | 630 volt | [illegible] | 7.[illegible] |
| [illegible] | 630 volt [illegible] | [illegible] | [illegible] |
| [illegible] | 630 volt [illegible] | | [illegible] |
| [illegible] | 630 volt [illegible] | | [illegible] |
| [illegible] | [illegible] | [illegible] mm | 4.[illegible] |
| [illegible] | [illegible] | [illegible] mm | 6.[illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| 1.[illegible] | [illegible] | [illegible] mm | 6.75 |
| [illegible] | [illegible] | [illegible] mm | 9.[illegible] |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |

All AUDIO NOTE paper in oil signal [illegible]

AUDIO NOTE PAPER IN OIL COPPER & SILVER FOIL SIGNAL CAPACITORS.

[illegible]

## AUDIO NOTE COPPER FOIL PAPER IN OIL CAPACITORS.

| Value | CC Voltage | Size | Price ex. UK Vat |
|---|---|---|---|
| [illegible] | 630 volt | 23x9 mm | 11.5[illegible] |
| [illegible] | 630 volt | 23x9 mm | 11.55 |
| [illegible] | 630 volt | 27x9 mm | 11.55 |
| [illegible] | 630 volt | 27x9 mm | 12.[illegible] |
| [illegible] | 630 volt | [illegible] mm | [illegible] |
| [illegible] | 630 volt | [illegible] | 15.[illegible] |
| 0.[illegible] | 630 volt | [illegible] | [illegible] |
| [illegible] | 630 volt | [illegible] | [illegible] |
| [illegible] | 630 volt | [illegible] | 22.[illegible] |
| [illegible] | 630 volt | [illegible] | 2[illegible] |
| [illegible] | 630 volt | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |

## AUDIO NOTE SILVER FOIL PAPER IN OIL CAPACITORS.

| Value | DC Voltage | Size | Price ex. UK Vat |
|---|---|---|---|
| [illegible] | 630 volt | [illegible] mm | 41.[illegible] |
| [illegible] | [illegible] | [illegible] mm | 74.[illegible] |
| [illegible] | [illegible] | [illegible] mm | 10[illegible] |
| [illegible] | [illegible] | [illegible] mm | 1[illegible] |
| [illegible] | 630 volt | [illegible] | [illegible] |
| [illegible] | 630 volt | [illegible] | [illegible] |

## AUDIO NOTE SILVER FOIL SIGNAL CAPACITORS.

Best [illegible] Audio Note [illegible] Japan. [illegible]

| Value | DC Voltage | Price ex. UK Vat |
|---|---|---|
| [illegible] | [illegible] | 1[illegible].00 |
| [illegible] | [illegible] | 2[illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | 64[illegible] |
| [illegible] | [illegible] | [illegible] |

## AUDIO NOTE PAPER IN OIL RESERVOIR CAPACITORS.

[illegible]

| Value | DC Voltage | Size | Price Ex. UK Vat. |
|---|---|---|---|
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] | 33.[illegible] |
| [illegible] | [illegible] | [illegible] | 41.[illegible] |
| [illegible] | [illegible] | [illegible] mm | 4[illegible] |
| [illegible] | [illegible] | [illegible] mm | 4[illegible] |
| [illegible] | [illegible] | [illegible] mm | 2[illegible].75 |
| [illegible] | [illegible] | [illegible] mm | [illegible].75 |
| [illegible] | [illegible] | [illegible] mm | [illegible] |
| [illegible] | [illegible] | [illegible] mm | 1[illegible].75 |
| [illegible] | [illegible] | [illegible] mm | [illegible] |

## AUDIO NOTE ACID & CLORIDE FREE SILVER SOLDER.

[illegible]

| Weight/Measure | Price Ex. UK Vat |
|---|---|
| [illegible] | 9.95 |
| [illegible] | [illegible] |

## AUDIO NOTE CABLES & WIRES.

[illegible]

[illegible]

| Gauge | Insulation Material | Price per Meter Ex. UK Vat |
|---|---|---|
| [illegible] | Polyurethane | 18.[illegible] |
| [illegible] | Polyurethane | 22.[illegible] |
| [illegible] | [illegible] | 24.95 |
| [illegible] | [illegible] | 27.85 |
| [illegible] | [illegible] | 3[illegible] |
| 1 mm | [illegible] | [illegible] |

[illegible]

AUDIO NOTE 1[illegible] [illegible] 99.99% Silver Wiring Wire

[illegible]

[illegible] £ 22.[illegible]

## AUDIO NOTE CODEX INTERCONNECT CABLES.

| Type/Colour code | Construction | Price per Stereo Meter Ex. UK Vat. |
|---|---|---|
| AN-A [illegible] | [illegible] copper litz coax | 15.3 |
| AN-[illegible] red | [illegible] copper litz coax | [illegible] |
| AN-[illegible] with silver writing | [illegible] silver litz coax | 84.[illegible] |
| AN-[illegible] | [illegible] 99.99% silver litz coax | 152.3[illegible] |
| [illegible] | [illegible] 99.99% silver litz coax | 302.[illegible] |

## AUDIO NOTE SPEAKER & WIRING CABLES.

| Type/Colour code | Construction | Price per Mono Meter Ex. UK Vat. |
|---|---|---|
| AN-[illegible] | [illegible] | 6.05 |
| AN-[illegible] | [illegible] | 12.[illegible] |
| AN-[illegible] | [illegible] copper [illegible] | 25.11 |
| AN-[illegible] | [illegible] 15 strand 99.99% [illegible] silver [illegible] | 10[illegible] |
| AN-[illegible] | [illegible] 99.99% silver [illegible] | [illegible] |

PTFE Insulated Silver Plated Copper Wires

[illegible] PTFE insulated silver plated copper [illegible] red, green, orange, violet, white and [illegible]

## AUDIO NOTE HIGH QUALITY STEPPED ATTENUATORS & SWITCHES

These [illegible] are manufactured by a friend of Mr. Kondo of AUDIO NOTE and represent [illegible] The attenuator is 46 steps and with [illegible] with an array of [illegible] The switches feature silver [illegible]

| Type | Value | Price Ex. UK Vat. |
|---|---|---|
| [illegible] | 1[illegible] | 221.7[illegible] |
| [illegible] | [illegible] | 221.7[illegible] |
| [illegible] | [illegible] | 23[illegible].7[illegible] |
| 2 [illegible] | 6 [illegible] | 9[illegible].7[illegible] |
| 4 [illegible] | 6 [illegible] | 124.7[illegible] |

## AUDIO NOTE HIGH QUALITY CERAMIC VALVE BASES

[illegible]

| Type | Mounting | Plating | Price Ex. UK Vat. |
|---|---|---|---|
| 4 pin [illegible] A | [illegible] | Gold | 8.25 |
| 4 pin [illegible] A | Chassis | [illegible] | 7.25 |
| 14 pin [illegible] A | Chassis | Silver | 14.75 |
| 4 pin [illegible] | [illegible] | [illegible] | 4[illegible].95 |
| 14 [illegible] | [illegible] | [illegible] | [illegible].95 |
| [illegible] | Chassis | Gold | 9.75 |
| 7 pin [illegible] OA2 | PCB | Silver | 6.15 |
| 7 pin [illegible] OA2 | PCB | Gold | 7.[illegible] |
| [illegible] OA2 | [illegible] | [illegible] | 6.75 |
| [illegible] OA2 | [illegible] | [illegible] | 7.[illegible] |
| 9 pin [illegible] etc. | [illegible] | [illegible] | 5.[illegible] |
| 9 pin [illegible] etc. | Chassis | [illegible] | [illegible] |
| 9 pin [illegible] etc. | PCB | Silver | [illegible] |
| 9 pin [illegible] etc. | PCB | Gold | 5.75 |
| 9 pin [illegible] etc. | Chassis from above | Silver | 4.45 |
| 9 pin [illegible] etc. | Chassis from above | Gold | 6.75 |
| 9 pin [illegible] etc. | Chassis from below | Silver | 4.95 |
| 9 pin [illegible] etc. | Chassis from below | Gold | 7.15 |
| TOPCAPS | | | |
| [illegible] | For [illegible] etc. | [illegible] | 9.75 |

[illegible] and for this purpose we can offer the following "industrial grade" ceramic valve bases.

Industrial Grade Valve Bases

| Type | Mounting | Price Ex. UK Vat. |
|---|---|---|
| [illegible] | [illegible] | 1.45 |
| 9-pin [illegible] | [illegible] | 1.85 |

## AUDIO NOTE CERAMIC STAND-OFFS

In most hardwired valve power amplifiers it is frequently difficult to get the HT and heater rails properly supported and [illegible] safely and neatly from the chassis. This especially applies when building amplifiers using the really high voltage directly heated triodes like 211, VT4C, 845, 849, 304TL, DA100 etc. When planning designs like this, it is important to [illegible] and the AUDIO NOTE stand-offs should be more or less [illegible] a wrap-round tinned "head" on the [illegible]

| Type No. | Number of Tags | Height/Length | Solder Connection | Chassis Fixing | Price Ex. UK Vat. |
|---|---|---|---|---|---|
| AN-[illegible] | 1 | [illegible] mm | [illegible] | Screw-in bolt | 1.41 |
| AN-4[illegible]2 | 1 | 17.4 mm | [illegible] | Screw-in bolt | 1.61 |
| AN-4[illegible] | 1 | 22.[illegible] mm | [illegible] slot | Screw-in | 1.41 |
| AN-[illegible] | 2 | Adjustable [illegible] mm | [illegible] | [illegible] screw-in | 2.4[illegible] |
| AN-[illegible] | 3 | Adjustable [illegible] mm | [illegible] slots | Dual bolt screw-in | 3.[illegible] |
| AN-4[illegible] | 5 | Adjustable [illegible] mm | [illegible] | Dual bolt screw-in | 4.04 |
| AN-58 | 8 | Adjustable [illegible] mm | [illegible] slots | Dual bolt screw-in | 5.7[illegible] |

| | | | | | |
|---|---|---|---|---|---|
| AN-4[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| AN-47[illegible] | [illegible] | [illegible] | [illegible] | Screen [illegible] | 5.[illegible] |
| AN-479 | 9 | [illegible] | [illegible] | Screen [illegible] | [illegible] |

## AUDIO NOTE SELECTED AUDIO VALVES.

Our valves are selected from the best [illegible] in the production of our own amplifiers [illegible] two categories [illegible] Old [illegible] available against a stamped self addressed envelope [illegible] that the valves on this list are NOT cheap [illegible] stock of original GE, RCA [illegible] Mullard GZ34/CV1377 [illegible]

Standard [illegible]

| Type No | Type | Price Ex. UK Vat |
|---|---|---|
| [illegible] 2A[illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| E[illegible] 2A[illegible] | [illegible] VB | 5.[illegible] |
| [illegible] | [illegible] EL83 [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible]95 |
| [illegible] | [illegible] | [illegible] |
| E[illegible] | [illegible] | 5.[illegible] |
| [illegible] | [illegible] UBX [illegible] | 2.[illegible] |
| [illegible] | [illegible] | 5.[illegible] |
| [illegible] | [illegible] | 3.[illegible]5 |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | 8.[illegible] |
| E[illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] power pentode | [illegible] |
| E[illegible]A | [illegible] power pentode | 4.5[illegible] |
| [illegible] | [illegible] power [illegible] | 2.4[illegible] |
| [illegible] | [illegible] power pentode | 2.[illegible] |
| [illegible] | [illegible] power [illegible] | 4.5[illegible] |
| 5[illegible] | medium power [illegible] | 5.[illegible] |
| 6CA7[illegible] | power [illegible] | 8.[illegible] |
| [illegible] | power pentode | 6.[illegible] |
| 300B | power triode. Audio Note branded and tested to our specification | [illegible]45 |
| [illegible] | power triode. Audio Note branded and tested to our specification | [illegible]45 |
| AN[illegible] | power triode. Audio Note [illegible] | [illegible] |
| 8C33 | [illegible] | 14.85 |
| [illegible] | [illegible] | 6.45 |
| 2A3 [illegible] Audio | [illegible] | [illegible] |
| | [illegible] Second Audio amplifier | 17.95 |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| 5Y3GT [illegible] | HT rectifier | 3.[illegible] |
| [illegible] | HT rectifier | 2.[illegible] |
| [illegible] | HT rectifier | 6.[illegible] |
| GZ34/CV1377 Mullard | HT rectifier | 44.[illegible] |
| [illegible]/CV378 [illegible] | HT rectifier, equivalent to [illegible] | 9.[illegible] |
| [illegible] | [illegible] | [illegible] |
| 6X4 | HT rectifier, very good for pre-amplifiers, 7 pin base | [illegible] |
| 6X5 | HT rectifier, for pre-amplifiers & [illegible] | [illegible] |

Please note, our 300B's are manufactured in China by Gold [illegible] but are tested in-house [illegible] stringent than is otherwise done [illegible] good as original WE 300B's or [illegible] following [illegible] original 300B's. It is in most cases far better to [illegible] the better output transformers, better [illegible] components last. A pair of original WE 300B's cost at least £ 1,200.00 on a good day [illegible] price [illegible] you can get [illegible] for the difference in cost between a pair of Chinese 300B's and the original WE's, and in many cases [illegible] AND the [illegible]

[illegible] and 7[illegible] are [illegible] not [illegible] at the moment, so now is the time to try.

**Resistors**

We endeavour to stock the entire E12 range of all the different makes of resistors that we stock, except the very lowest ohmic values, which are extremely costly, as a rule we do not stock values below 10 Ohms or above 3M3. Whilst we always try to have every single E12 value in stock, this cannot be guaranteed, delivery [illegible] Holcos and tantalum film resistors can be very long [illegible] however since most are used in our production of finished products, there will generally be stock available within 4 weeks.

**Beyschlag**

We offer three quality levels of resistor quality, all are 1%, starting with the Beyschlag [illegible] which are slightly magnetic (as are the vast majority of other makes of metal film resistors), but nevertheless very good sounding, it is used in all our UK-made amplifiers, up to and including quality Level 3 [illegible] 300B [illegible] amplifiers.

Beyschlag 1 watt, 1% [illegible] up to 500KOhm £ 0.11, above 500KOhm £ 0.13 each.

**HOLCO.**

Better sound quality can be achieved with the H2 1 watt 1% [illegible] resistors, which are [illegible] as the best "industrial grade" metal film resistors available. They have one small drawback, as they are quite fragile and require careful handling, do not bend the legs too close to the body, they may become noisy.

HOLCO resistors type H2 50PPM cost £ 3.06 each from 1R0 to [illegible] £ 0.[illegible] each from [illegible] to [illegible] £ [illegible] each from 2[illegible]Ohm to 2[illegible]KOhm, £ 0.4[illegible] each from 2[illegible] to 1[illegible] £ [illegible] each from 1M1 to 2M[illegible] £ 1.[illegible] each from 2M[illegible] to 4M[illegible] and £ 2.21 each from 4M[illegible] to 5M[illegible]

**SHINKOH Tantalum Film Resistors.**

This is definitely the best sounding resistors available, forget the VISHAY, which may be ok in high feedback transistor amplifiers, but in our opinion quite uncomplementary to the qualities of [illegible] Audio Amplification [illegible] heated triode amplifiers [illegible] feedback free in single-ended Class A, this is where you will need the [illegible] resistor for the best results.

The 1/2 watt [illegible] tantalum resistors [illegible] non-magnetic and [illegible] £ 2.2[illegible] each.

Some values are available in 1 watt from [illegible] at £ 4.80 each. List of [illegible]

## AUDIO NOTE 1/2 WATT TANTALUM RESISTORS.

With our in-house usage of tantalum resistors increasing all the time, and Shinkoh becoming less and less able to supply, we have found it necessary to second-source the 1/2 watt values in addition to the 1 watt already offered. [illegible] are non-magnetic and share all other aspects of the Shinkoh, except the colour. They will be available by the time you read this in the following values: [illegible] 12R 1[illegible] 2[illegible] 27R 33[illegible] 47R [illegible] 51R 1[illegible] 1[illegible]R 150R [illegible] 1K1 1K2 1K[illegible] 1K33 [illegible] 2K[illegible] 3K3 3K[illegible] 4K7 [illegible] 9K1 [illegible] 62K [illegible] 75K 82K 9[illegible] 1[illegible] 120K 150K 17[illegible] 1[illegible] [illegible] 820K

The 1/2 watt Audio Note tantalum resistors cost £ 1.99 each.

## AUDIO NOTE 1 WATT TANTALUM RESISTORS.

Up to now the tantalum film resistors have been extremely difficult to get [illegible] against a minimum quantity guarantee from Audio Note U.K. the manufacturers [illegible] to [illegible] the range of 1/2 watt and reintroduce the 1 watt range which becomes an exclusive range for AUDIO NOTE, we consider this to be [illegible] breakthrough since without a reasonable range of values at the 1 watt rating it is pretty difficult to get the very best out of the best circuits. The 1 watt Audio Note tantalum film resistors are available in the same values as the 1/2 watt, with the addition of the 1 MO.

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

We shall now be working on getting 2 and 3 Watt tantalum resistors made available as well, and who knows perhaps we will be able to build amplifiers in a year's time that have all tantalum resistors in all parts of the circuit.

## AUDIO NOTE PRECISION CARBON FILM RESISTORS.

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

They cost for the 1/2 watt £ 3.30 each, 1 watt £ 4.85 each, 2 watt £ 6.80 each.

**ALLEN BRADLEY 1 Watt 5% Carbon Film Resistors.**

Due to popular demand, and a general lack of other sources, we have started stocking a range of Allen Bradley carbon film resistors, many experienced DIYers, like my friend Herb Reichert, consider these the very best sounding for many applications.

Available in the E12 range of values, the 1 watt cost £ 1.43 each.

## HIGH WATTAGE WIRE WOUND RESISTORS.

As a new item we shall be offering a range of [illegible] wire wound resistors [illegible] range and expanding [illegible] at the moment the following is available, all these resistors [illegible] and [illegible]

| Wattage | Value | Tolerance | Price excl. Vat |
|---|---|---|---|
| 6 watt | 47[illegible] | 5% | [illegible] |
| [illegible] watt | [illegible] | 5% | [illegible] |
| 6 watt | 47[illegible] | 5% | [illegible] |
| 6 watt | [illegible] | [illegible] | [illegible] |
| 6 watt | [illegible] | 5% | [illegible] |
| [illegible] watt | [illegible] | [illegible] | 1.[illegible] |
| 8 watt | [illegible] | [illegible] | 1.[illegible] |
| 9 watt | [illegible] | [illegible] | 1.[illegible] |
| [illegible] watt | [illegible] | [illegible] | 1.[illegible]4 |
| [illegible] watt | [illegible] | 5% | 1.[illegible]1 |

[illegible] will be added over the next 6 months, [illegible]

**BLACK GATE ELECTRON TRANSFER High Performance Graphite foil capacitors**

[illegible]

## IMPORTANT NOTICE!

PLEASE NOTE, THE PRICE LIST FOR BLACK GATE CAPACITORS IS A GUIDELINE ONLY. DUE TO THE CONTINUOUS STRENGTHENING OF THE JAPANESE YEN IT IS IMPOSSIBLE TO PRINT UP-TO-DATE PRICES MONTHLY, SO ASK FOR PRICE WHEN YOU ORDER.

| Value | Voltage | BG-Type | Suggested Use | Price Ex. UK Vat |
|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | 1.6[illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | 1.75 |
| 3.[illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 2.2[illegible] | [illegible] | [illegible] | [illegible] | 1.23 |
| 3.[illegible] | [illegible] | [illegible] | [illegible] | 1.38 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | 5[illegible] | [illegible] | as above | [illegible] |
| [illegible] | 5[illegible] | [illegible] | as above | [illegible] |
| 4[illegible] | [illegible] | [illegible] | as above | [illegible] |
| [illegible]47[illegible] | [illegible] | [illegible] Type | [illegible] | [illegible] |
| [illegible] | 6.3[illegible] | [illegible] Type | [illegible] | 11.85 |
| [illegible] | [illegible] | BG N Type | [illegible] | [illegible] |
| 4[illegible] | [illegible] | BG N Type | as above | [illegible] |
| 4[illegible] | [illegible] | BG N Type | as above | 2[illegible]45 |
| [illegible] | [illegible] | BG N Type | as above | [illegible] |
| 4[illegible] | [illegible] | BG N Type | as above | 6.05 |
| [illegible] | [illegible] | BG N Type | as above | [illegible]55 |
| 4[illegible] | [illegible] | BG N Type | as above | [illegible] |
| [illegible] | 50[illegible] | BG N Type | as above | 2[illegible] |
| [illegible] | [illegible] | BG N Type | as above | [illegible]95 |
| [illegible] | [illegible] | BG N Type | as above | 4[illegible] |

[illegible] Black Gate [illegible] we can obtain a range of [illegible] good quality [illegible] you [illegible]

## POTENTIOMETERS

Best [illegible] quality [illegible] made by [illegible] high quality [illegible]

**Volume Controls**

| Impedance | Construction | Price Ex. UK Vat. |
|---|---|---|
| [illegible] Stereo | [illegible] type, PCB mounted | 3.95 |
| [illegible] Stereo | [illegible] type, PCB mounted | [illegible]85 |

A better alternative is the [illegible] volume control [illegible] used in pre-amplifiers like the M7Tube, [illegible] and in a [illegible] are very good sounding pots by any standard.

| Impedance | Construction | |
|---|---|---|
| [illegible] Stereo | [illegible] | [illegible] |
| [illegible] Mono | [illegible] | [illegible] |

| | | |
|---|---|---|
| [illegible] | [illegible] | [illegible] |
| Advanced Controls | | |
| [illegible] | [illegible] type, PCB mounted | 4.45 |
| [illegible] | [illegible] type, PCB mounted | 1[illegible] |

[illegible]

## STANDARD TYPE SWITCHES

[illegible] UK [illegible]
[illegible] 6 way 2 [illegible] each

## STANDARD ELECTROLYTIC CAPACITORS

[illegible]

| Value | Voltage | Size | Price Ex. UK Vat |
|---|---|---|---|
| [illegible] | [illegible] | [illegible] 11x[illegible] | [illegible]23 |
| [illegible] | [illegible] | [illegible] | 1.[illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | 1.42 |
| [illegible] | [illegible] | [illegible] | [illegible] |
| 47[illegible] | [illegible] | [illegible] | 4.[illegible] |
| [illegible] | [illegible] | [illegible] 41x[illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | 4[illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | 2.63 |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | 4.45 |
| 2[illegible] | 4[illegible] | 4[illegible] mm radial can | 5.55 |
| 2[illegible] | [illegible] | [illegible] | 2.[illegible] |
| [illegible] | [illegible] | [illegible] mm radial can | 4.[illegible] |

RCA, BNC, [illegible] PLUGS, RCA SOCKETS, SPEAKER & [illegible] TERMINALS, LOUDSPEAKER SPADES

## RCA PLUGS.

| | |
|---|---|
| [illegible] | [illegible]5 |
| [illegible] | 3.85 |
| [illegible] AUDIO NOTE [illegible] | 8.5[illegible] |
| [illegible] AUDIO NOTE [illegible] | [illegible]53 |

## RCA SOCKETS.

| Type | Mounting | Price Ex. UK Vat. |
|---|---|---|
| [illegible] | Chassis mounted | [illegible] |
| [illegible] | Chassis mounted | [illegible] |
| [illegible] AUDIO NOTE [illegible] | Chassis mounted | [illegible] |

## BNC PLUGS & SOCKET.

| Type | Price ex. UK Vat. |
|---|---|
| [illegible] BNC plug | [illegible] |
| [illegible] chassis mounted | 2.[illegible] |

**[illegible] Plugs, Loudspeaker Cable Spades, Chassis Loudspeaker Terminals**

| Type | Price Ex. UK Vat |
|---|---|
| AUDIO NOTE [illegible] | 2.4[illegible] |
| AUDIO NOTE [illegible] | 4.65 |
| AUDIO NOTE [illegible] | 1.[illegible] |
| AUDIO NOTE [illegible] | 2.[illegible] |
| AUDIO NOTE [illegible] | 4.[illegible] |
| [illegible] | 1.45 |

[illegible]

## FERRITE RINGS.

[illegible]

A [illegible] £ 0.5[illegible]

**AUDIO NOTE [illegible] Transformers**

[illegible]

| Type | Colour Code | Primary/Secondary Impedances - Main Use | Price [illegible] UK Vat |
|---|---|---|---|
| [illegible] | [illegible] | 3 & [illegible] | £ 5[illegible] |
| TT[illegible] | Red | 15 & [illegible] | 51.[illegible] |
| [illegible] | [illegible] | [illegible] | £ 5[illegible] |
| TT[illegible] | [illegible] | 3 & [illegible] | 78.2[illegible] |
| [illegible] | [illegible] | [illegible] | 78.[illegible] |
| TT[illegible] | Blue | 130 & [illegible]Ohm, 2[illegible] & 1[illegible]Ohm, copper wired high quality [illegible] | 78.2[illegible] |
| TT[illegible] | [illegible] | [illegible] | 78.[illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |
| TT[illegible] | [illegible] | 3 & 1[illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] |

[illegible]

## AUDIO NOTE CHASSIS SETS.

[illegible]

| Type | Size | Price Excel UK Vat |
|---|---|---|
| [illegible] | [illegible] | 84.5[illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible] |
| [illegible] | [illegible] | [illegible]00 |
| KIT [illegible] | [illegible] | [illegible]90 |
| KIT [illegible] | [illegible] | [illegible] |

[illegible] pre-amplifier [illegible] add £ [illegible]75 to the cost of the chassis [illegible]

[illegible]

## AUDIO NOTE COMPLETE KITS.

As mentioned earlier, we are developing a range of complete kits, to give those of you who have the ability, but do not have the time to develop a project from the ground up [illegible] to be able to offer the best possible quality [illegible] will be [illegible] power supplies and components [illegible] volume control [illegible] CD [illegible]

**KIT ONE**

Based around the [illegible] we [illegible] Single-Ended, No-Feedback, Class A, Directly Heated Triode [illegible]

Kit One [illegible] 300B per channel [illegible] 420 [illegible] The power supply [illegible] AUDIO NOTE [illegible] Beyschlag 1 watt 1% metal film [illegible]

Price £ [illegible] 10 [illegible] 2 x 300B [illegible] £ 900.[illegible] The Kit One is available now.

**KIT TWO**

Kit Two features a [illegible] giving some 17 watts of pure Class A, valve rectified HT [illegible] 5814/ECC82 [illegible] £ [illegible]00 [illegible] Price [illegible] extra at £ 90.00 [illegible] £ [illegible]

**KIT THREE**

Kit Three features 2 x [illegible] per channel [illegible] 7 [illegible] pure Class A [illegible] rectified HT supplies, no [illegible] feedback. It uses a [illegible] The KIT THREE [illegible]

The KIT THREE costs £ 1,[illegible] is available now. [illegible] at £ 90.00 extra per channel (£ 180.00 for two). [illegible] £ [illegible] extra. [illegible] Kit Three as well, ask for details.

**KIT FOUR**

The KIT FOUR is [illegible] power supply mounted on one single printed circuit board with two OTP type [illegible] in a small P1SE type chassis [illegible] The circuit consists of two 6L6GT [illegible] Push-Pull Class A [illegible] driven by a [illegible] and a ECC83 input stage. Easy to build [illegible]

The KIT FOUR costs £ [illegible] and is available now.

## PRE-AMPLIFIER KIT.

A [illegible] based on the AUDIO NOTE M7 tube pre-amplifier [illegible] It will be offered in three/four versions [illegible] cost £ [illegible]00 [illegible] Vat, etc. More details available later. Watch.

AUDIO NOTE (UK) Ltd. Unit C, Peacock Industrial Estate, Lyon Close, 125-127, Davigdor Road, Hove BN3 1SG, East Sussex, England Telephone 01273 220511(6 lines), fax 01273 731498
RUSSIAN Federation, contact ESOTERICA Ltd. Tel. 095 917 4305 Fax 095 917 8762
HUNGARY please contact: Martin Audio, 54 [illegible] Raday krt. 2 H-1092 Budapest, HUNGARY, Tel/Fax 01 215-2612
HOLLAND please contact de Jong Componenten, 2 Roggestraat, NL-5704 MT Helmond, Tel. 04920 14061 Fax 14773
USA please contact: Angela Instruments, 10830 Guilford Road, Suite 309, Annapolis Junction, MD 20701. Tel. 301 725 0451 Fax 301 725 8823
FRANCE please contact: MIEXCO, Paris, Tel/Fax 1 4539 4967 PQ 01 18 1 985

We accept VISA, Mastercard, Access, [illegible] and Amex to pay for [illegible] we will need your address, card no. with start and expiry dates, you can also pay by bankers draft, Eurocheque or cheques drawn on a UK bank account. [illegible] 14 [illegible] up to 60 days [illegible]

[illegible] Audio Design [illegible] of £ [illegible] design or theory.

[illegible] a number of old [illegible] to experiment with, so if you have any PX4's PX25's, DA30's, ADI's, or any of the old triodes, I will be happy to buy or swap at a good price. [illegible] where to find old studio tape recorders, STUDER, TELEFUNKEN or AMPEREX or the [illegible] record cutting, plating, processing or pressing equipment, or have books or information about building microphones, recording technique, LP-manufacture, then it will be gratefully received. AUDIO NOTE has the intention over the next 2 - 3 years to set up recording and record manufacture and whilst we already have quite a lot of information, much more is needed.

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Since nothing really exists which gives a reasonable background to the subject of valve amplifier circuit design, Guy Adams and I have written and assembled a number of articles and extracts from old books which give some background to the subject, do not expect to become an instant expert, but it will serve as a useful reference, for the beginner as well as the more advanced, we have expanded the info-pack to include even more useful information, so [illegible] just send £ 2.00 or US$ 5.00. For the full pack a small charge is required, this is £ 7.[illegible] in small denomination stamps with a stamped self addressed envelope, or outside the UK, please send US$ 25.00.

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AUDIO NOTE

# Upgrading Your Loudspeakers the DIY Way

**Want to upgrade your loudspeakers without shelling out for a new pair? Dominic Baker offers some words of advice.**

The early stage of the DIY hi-fi bug normally begins with loudspeaker tweaking. Whether it's splitting a crossover for bi-wiring or building an existing 'speaker into cabinets you designed yourself, loudspeakers seem to have a strong appeal. I suppose it's because from the outside they appear simpler. There are relatively few components compared to an amplifier for example, and the drivers move as you play music, giving you a 'feel' for the way they work.

One area we consistently get asked about is upgrading the components in a loudspeaker's crossover. Commercial constraints normally mean that your £500 loudspeakers will come with cheap reversible electrolytic capacitors and ferrite core inductors with spindly wire soldered to a circuit board. Just hard wiring the existing components and upgrading the internal wiring to a good quality 'speaker cable will bring a discernible difference. But while you're there it's tempting to replace the components themselves.

Remember though, especially in more up-market designs, that the components in a crossover will have been carefully chosen and balanced. Putting a higher grade capacitor in may unbalance the sound because its electrical characteristics or sonic signature are different. I'd recommend to anyone wishing to experiment that they hard wire the upgraded crossover using high quality wire and silver solder and then listen to the difference between the standard and the upgraded version. If it's worse, then you still have a route back.

## INDUCTORS

Inductors can be replaced fairly easily. Air core inductors are superior to the ferrite cored ones normally supplied. Ferrite cores can saturate if they are not large enough, causing a fall in impedance which may overload your amplifier. Some exhibit hysteresis and the core itself can vibrate causing signal distortion. For large values of inductor like those in the bass crossover section of a three way design where an air core is impractical due to its size and the amount of wire needed, use a laminated core inductor around 0.5-1" thick. Everywhere else an air core type should be used.

When you replace the inductors in a loudspeaker's crossover, there are two important figures you need to know; inductance and resistance. The inductance will be expressed in milliHenries (typically between 0.1mH and 10mH), and is the part that determines the crossover frequency. The resistance in ohms (typically 0.1Ω to 3Ω), is also very important. If the upgraded inductor has a different resistance (DCR) it will exhibit a different insertion loss and, especially, different resonant Q, unbalancing the crossover. Air core inductors have a higher resistance for a given wire gauge because more turns of wire are needed to achieve a specific inductance. Thicker wire will reduce the resistance.

## CAPACITORS

Capacitors are a little more difficult. I've swapped a 4µF Alcap reversible electrolytic for a 4µF Solen polypropylene and watched the crossover point and signal level change considerably on our FFT Spectrum Analyser. Without this kind of test equipment you are shooting in the dark.

I assembled a group of capacitors for listening, spanning 1-12µF, typically used in midrange/treble sections where the differences are most noticeable. When you design a loudspeaker, the effect of the capacitor's electrical and sonic character can be designed in. But to keep things simple here, I decided to use them purely as upgrades to existing designs.

One of the problems with this is that the better capacitors have a lower Equivalent Series Resistance (ESR) and so allow more signal to pass. Putting a lower ESR capacitor in the treble section of a crossover will make the loudspeaker brighter. To keep this effect to a minimum during comparison, the capacitors were used in the midrange and treble sections of a three way design, so both sections should stay aligned.

The loudspeaker was a prototype design using a Focal Audiom 7K midrange driver and Focal T120K tweeter on an open baffle. These are very good quality drivers with a high sensitivity of 97dB and a very detailed, transparent sound. They also share the same cone material so tonal variations are minimised. They highlighted the differences between capacitors quite strongly and proved an ideal tool for this test. Using silver soldered gold-plated croc. clips, I was able to swap capacitors over quickly and listen to the results. All are film type capacitors apart from the Alcap, which is a reversible electrolytic, and they were all left for an hour or two running a pink noise test signal to bed them in.

### ALCAP ELECTROLYTIC

It would be easy to label electrolytic capacitors 'bad' and film types 'good', but that would be to misrepresent their qualities. The Alcaps actually sounded very good - they were soft and musical in a very inoffensive manner. I've heard cheap non-audio grade polyesters and polyprops sound gritty and harsh, so the Alcaps certainly show them a thing or two.

Ultimately they don't have the fine detail or transient attack of the others in this test, but alongside the Solens are top for value. If you're finding the treble in your 'speakers a bit relentless, and they're using a film capacitor, it could well be worth changing to an Alcap to temper the sharpness and produce a more listenable balance.

### SOLEN

Although the cheapest film capacitor I auditioned, the Solen polypropylenes have a very good sound indeed. With a slightly more forward balance than the Supersound capacitors, they could become a little hard in some applications, but they are certainly detailed and very clean sounding.

If you are worried about the hardness but like their price tag, a good idea is to parallel them with an Alcap to get the value you want. This seems to work very well, the softness of the Alcap balancing the forward nature of the Solen without seeming to lose any detail in the process.

### ANSAR SUPERSOUND

The 'Supersound' capacitors are made by Ansar and can be bought from various suppliers who put their own name on them. These came from RATA, but Cricklewood Electronics, Audiokits and a few others all have their own versions.

Their sound is, in essence, very similar to the Solens. A forward balance coupled to a clean and detailed delivery makes for an impressively dynamic sound with fast attack on transients. They weren't quite as hard as the Solens can be and were better damped in the treble, giving slightly better focus.

### KIMBERCAP

The Kimbercaps were hardest to place in this group. Some aspects of their sound were very good indeed; a pleasant richness compared to the dryer and more analytical Supersounds for example. But with it there is a slightly duller tonal quality. This makes them a good match for sharp sounding metal dome tweeters, which can have a brighter tone than is strictly accurate. Here they will soften the sharpness without compromising detail.

Kimber mark the inner and outer foils of their capacitors, so make sure you get them the right way around. Although there was only a slight difference, they did sound a little more open when used the way Kimber recommend.

### HOVLAND MUSICAP

Most expensive in this test, the Hovlands are also the biggest, a good sign. A reliable rule of thumb to follow is the bigger the can size for a given value, the better they seem to sound. Where the Kimbercaps were only a small jump up from the Solen and Supersound capacitors, the Hovland Musicaps took a clear step forwards.

Like the Solens they can sound a little forward, probably a result of their very low ESR. But the extra ambience combined with a very clean treble delivery that seemed far less prone to ringing or sibilance than the other types does make them really quite special. You don't half pay for it though ●

### PRICE COMPARISON TABLE (£)

| | 1µF | 2µF | 4µF | 6µF | 8µF | 10µF | 12µF |
|---|---|---|---|---|---|---|---|
| Alcap 50V | n/a | 0.35 | 0.39 | 0.42 | 0.46 | 0.49 | 0.51 |
| Solen | 1.40 | 1.47 | 1.69 | 1.99 | 2.45 | 2.65 | 2.95 |
| RATA Supersound | 2.08 | 2.46 | 3.00 | 3.63 | 5.65 | 5.29 | 5.57 |
| Kimbercap 200V | 6.76 | 7.94 | 11.27 | 14.83 | 19.13 | 30.29 | n/a |
| Hovland Musicap | 13.93 | 18.93 | 25.50 | 32.20 | 36.89 | 39.74 | n/a |

Prices are for the closest value available in the range to those shown (e.g. there is no 2µF RATA Supersound, only a 2.2µF). The Alcap 100V range costs roughly twice the price of the 50V types.

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| 1.8 | 100 | £17.03 | £14 47 |
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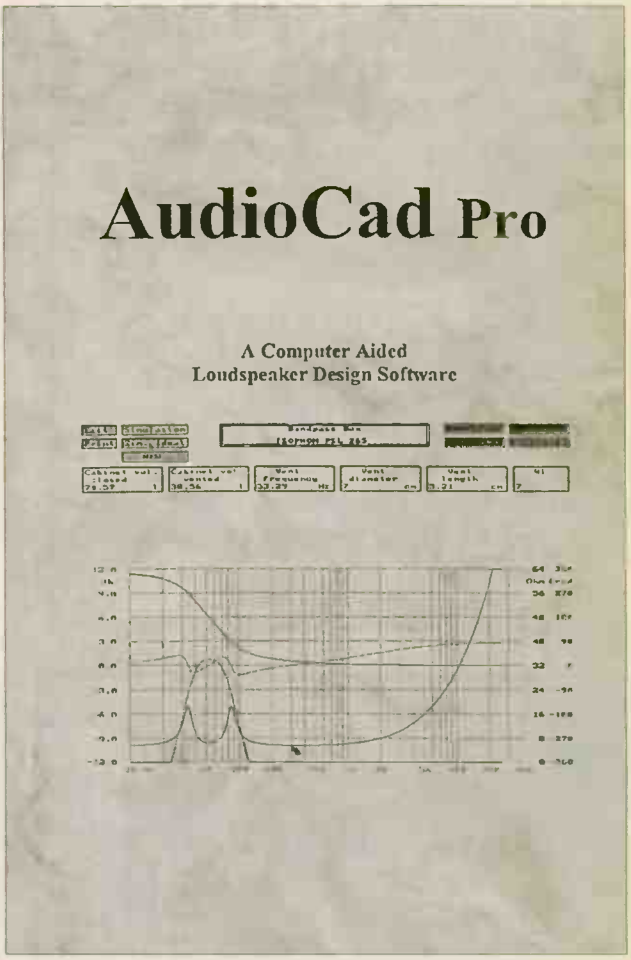
# AUDIOCAD PRO PART 2

**Dominic Baker continues his look at AudioCad Pro, an advanced loudspeaker modelling package for IBM PC compatibles suitable for professionals and enthusiasts.**



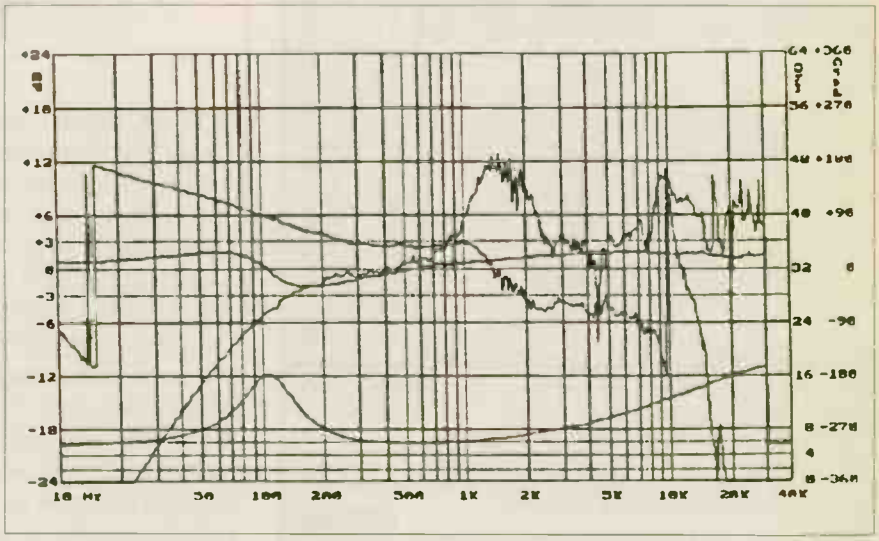
In the last supplement I gave a general overview of AudioCad Pro and its features. It is an extremely comprehensive package, offering a wide range of features to the budding designer. Now, Part 2 will show you AudioCad Pro in action, giving examples of some of the simulations it can perform and how you can use them to help you with your designs.

If you are using AudioCad Pro in conjunction with a computer based measurement package, such as IMP or MLSSA, it will use the measured data you input to perform the simulations. Here, AudioCad is at its most powerful, using real figures to generate the results. If you do not have access to measuring equipment, AudioCad will simulate the loudspeaker from basic Thiele-Small parameters. However, this is no different from any other simulation package, so we'll concentrate here on its use with a measurement system.

Using the Import command, the frequency response, phase and impedance data can be fed into the package. It is best to give the files the same name, with a different suffix for each measurement, eg. HM210Z0.AMP, HM210Z0.IMP, HM210Z0.PHA etc so that they can all be imported at the same time. Once the data is loaded use Calculate Parameters to check whether the Thiele-Small parameters are plausible.

Next, you can use AudioCad to calculate Le, the voice coil inductance, for use later on in the crossover design. Click the mouse on the point in the impedance curve where you intend to place the crossover point. Also from the impedance curve, Calculate Q will instruct AudioCad to calculate fs (resonant frequency), Qms, Qes and Qts (mechanical, electrical and total Q factors for the driver).

Already you can



Electrical and acoustic phase, frequency response and impedance plots supplied by a computer based measurement package can be imported and used by AudioCad for accurate simulation.

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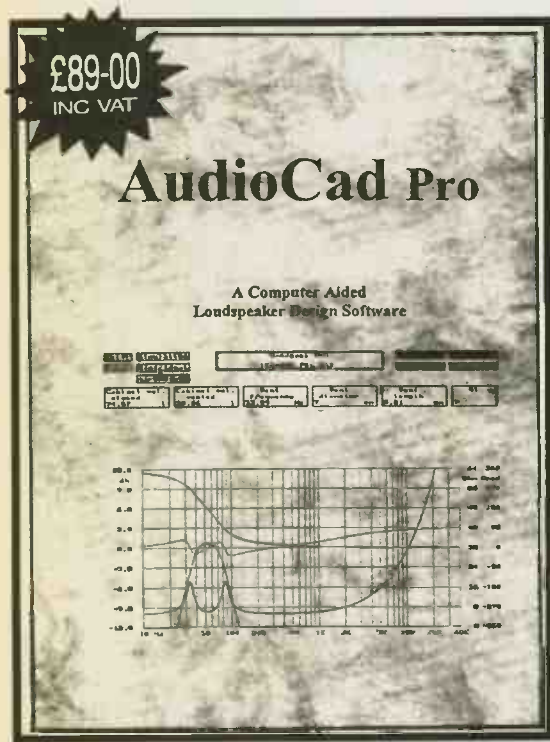

The AudioCad Pro advanced loudspeaker simulation package for PC featured in this supplement is available to *Hi-Fi World* readers at a 10% discount.
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start to see the power of AudioCad. All of the data you will use later to optimise and simulate a design is generated from real measurements on the actual driver you will be using. There will often be notable differences between the manufacturer's supplied data and what you actually measure yourself. Loudspeaker parameters can vary from batch to batch, and there is a tolerance range within each batch too. So the supplied data is often a best case situation, not a real one.

Simulating the enclosure is now as straight forward as with any other computer based package, except that it should be far more accurate because you are using real measured data.

Next you can start to design the crossover. After selecting the cut-off frequency, roll-off rate and network characteristic (Butterworth, Bessel, etc) the author recommends equalising the impedance curve. If you are using AudioCad Pro in conjunction with a measurement system, I'd recommend optimising the crossover using the latter. Often there is no need for impedance compensation - with careful choice of crossover slope and roll-off point you can achieve a smooth enough impedance curve in most cases.

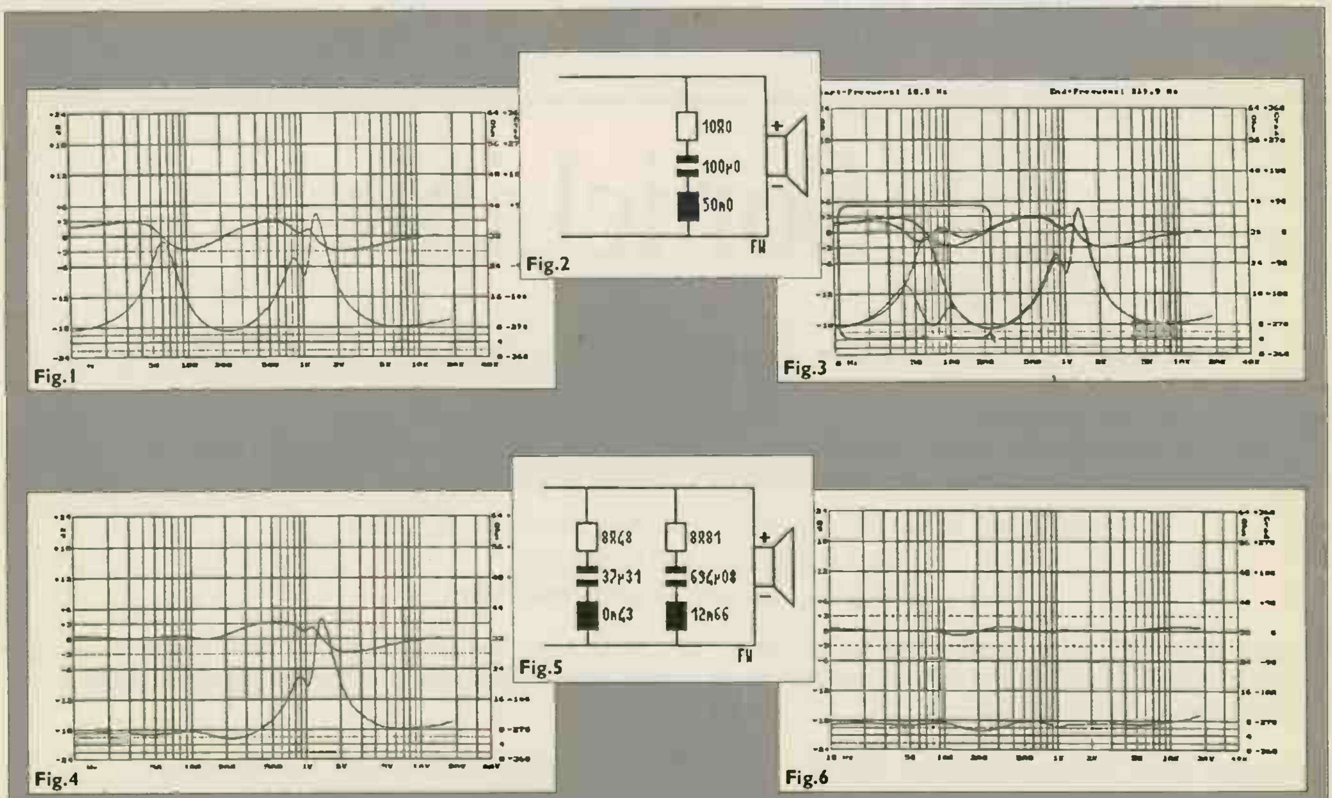
The compensation will give a very flat impedance curve though, allowing you to view the driver as an 8Ω resistor rather than a reactive device which makes crossover calculations easier. This is basically how AudioCad Pro's crossover designer works; the impedance is first equalised to make calculation simpler and more accurate.

Attenuation can also be specified in dB, for when you want to match a tweeter with a less sensitive woofer. AudioCad Pro will calculate appropriate values for an L-pad attenuator that won't affect impedance.

Once all of the decisions have been made, you can begin the optimisation process. AudioCad Pro will optimise the impedance for an individual driver or a complete system, and likewise with the amplitude response. It is fast and easy to use, but does require some knowledge of crossover electronics and how they work so that you fully understand the process and can make sensible decisions. Netcalc is an ideal package for gaining this experience without having to build numerous designs. It is affordable and very user friendly, enabling even novice constructors to get a firm grasp on crossover design within a few days.

AudioCad Pro really is one of the most complete packages I've come across. From one disc it does what you would normally need two or three less comprehensive packages to achieve, making it fine value in my opinion too. For professionals and enthusiasts alike, it's a very valuable design tool indeed.

**AudioCad Pro is available from Old Colony Sound Lab., USA. Tel: (603) 924 9464**



**If you have access to measurement equipment, it is possible to optimise the impedance of a complete loudspeaker. First measure the impedance and electrical phase (Fig.1) of the loudspeaker so that the data can be entered into AudioCad. To start with, approximate values are inserted into the RCL network (Fig.2) which compensates for impedance rise. A target value, say 8Ω, is then specified and the first portion of the impedance curve to be equalised is marked with a box using the mouse (Fig.3). AudioCad will now re-scale the initial approximate values in the RCL network to flatten the impedance curve in the area selected (Fig.4). Now the impedance rise in the bass has been flattened, you can select the midrange rise and optimise this in exactly the same way; select starting values for a second RCL network, set target impedance, then optimise. Fig.5 and Fig.6 show a two-section RCL network and the equalised response. There is still a slight lift above 10kHz, which you can adjust for using the same process.**

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Technical specification: dual mono construction, 40W/channel, 12Hz to 25kHz power bandwidth, distortion <0.1%, five line level inputs, tape output, 230/240V mains input.

Stereo amplifier circuit board : board only £49.50; component pack (including valve bases), add £63; populated board £125; full valve set, add £45. Power supply board : board only £20.50; component pack, add £44; populated board £66. Input board : board only £15.50; component pack, add £16; populated board £33.

The output transformers are configured for the McIntosh connection and have excellent low frequency response and a primary reflected impedance of 3800Ω. Full connection instructions provided. Price £70. The mains transformer is wound for dual mono construction, as this gives superior isolation between channels which sharpens imaging and eliminates inter-channel ground loops in the amplifier. Primary 0-230-240V. Secondaries 2x295V@0.25A (0.4A int.), 2x70V@30mA, 2x6.3V@5A. Price £60. Other primary voltages can be supplied to special order. Data sheets giving connection diagrams, specifications, as well as circuits for using each transformer, £2.50 each.

The chassis, comprising main chassis and transformer cover, is hand polished, welded 1/16" stainless steel - NC machine tooled for a perfect fit and clean finish. Each kit also includes a mesh valve cover and baseplate, finished in semi matt black. Price £310. Also available in mild steel finished in black, £195. For those who wish to use one of these high quality chassis for their own projects, details of the chassis are given in the 4040 reference manual, £6.50.

Connector kit: twelve gold plated phono connectors, two sets of loudspeaker terminals, an IEC mains socket with integral fuse and switch, and an IEC mains lead with fitted 13A plug. £51.50. Cable kit: all cables required for the 4040, £6.

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Technical specification: 47kΩ input impedance, 1kΩ impedance output for driving long interconnects.

Stereo circuit board: board only £25; component pack, add £37.50; populated board £70; full valve set £20.

The mains transformer is wound for dual mono construction and is toroidal for low leakage flux. Primary 0-230-240V. Secondaries 2x295V@20mA, 2x6.3V@0.45A, 16V@1A. Price £30. Other primary voltages can be supplied to special order. These transformers are also suitable for power supplies in preamplifiers and other line level valve circuits - see data sheet for details, £ 2.50.

The chassis (main chassis and transformer cover) is made from mild steel. Each kit comes complete with a mesh valve cover and baseplate, finished in black. Price £110. For those who wish to use a high quality chassis for their own projects, details of the chassis are given in the P2 manual, £6.50.

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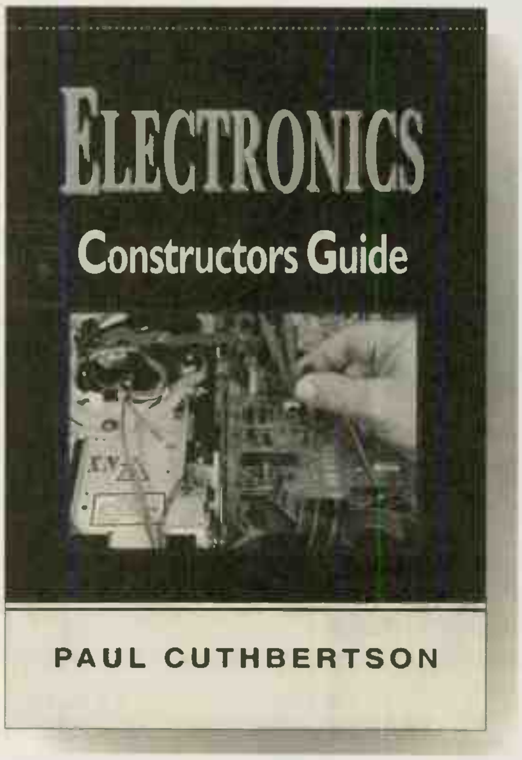
# ELECTRONICS CONSTRUCTORS GUIDE

## by Paul Cuthbertson

**Haider Bahrani gets organised with Paul Cuthbertson's Electronics Constructors Guide.**



The Electronics Constructors Guide is a book for the amateur and professional alike. The first three chapters dedicate themselves to the organisation and documentation of the design and construction process. Whether it's a home DIY project or a manufacturer's prototype, the principles are the same.

The emphasis here is on the preparation necessary before diving into the construction phase of any electronics project, turning the whole escapade into one that is planned as strategically as a Napoleonic battle. Documentation is also encouraged throughout both (or either) the design and construction processes, with more than one or two tips given on how to go about it.

Some will consider this a guide on how to suck eggs. In essence this is true, but many of these procedures are all too often neglected by the pros, and not encouraged in amateur fields. In fact, I would recommend this book for the first three chapters alone. The author is clearly speaking (or writing) with the mind of an engineer rather than a technician, encouraging methodical and modular construction patterns with a balance between effective and efficient design. The book appears to be pouring scorn over anyone who considers diving for the soldering iron and strip board as the first step on any project.

The following two chapters give a run through the necessary, or in certain cases not so necessary, tools with some design ideas thrown in for good measure. I say some, but Paul Cuthbertson has really spilled his thoughts out onto a banquet serving dish here. For someone who needs to learn a lot of basics quickly, or who has forgotten for that matter, there's a lot of detail covered in these pages. Anyone scared of a bit of maths should fear not, because what little maths there is, is presented clearly and thoughtfully.

Chapter six is where things really do start to get interesting, particularly for someone taking their first step into the electronics mine field. This chapter delves into the world of components. By these I mean resistors, capacitors, transistors, etc. Steering well away from the ideal world, the book tries to give an insight into how both passive and active components work, again without blinding the reader with mathematics.

The follow up chapter is a thorough going over of some design examples. The first and the simplest of these is an LED driving circuit. Despite its simplicity, it is perhaps one of the best introductions to electronic circuitry I've read. The author really cuts down to the bone on this one, explaining all the nitty gritties. The examples increase in complexity, culminating in a power supply design, the description of which I'm sure most will feel quite comfortable following.

The warning lights are bright red in chapter eight. Problems in electronic circuitry, more often than not, are associated with the power supply, earthing or noise injection into the circuit. Earth loops are a typical pain in the electronics constructor's neck, as are noisy supply lines and spaghetti wiring. Reading this chapter won't make all these problems go away, but it will at least give you some idea as to what they are when they rear their ugly heads.

Chapter nine changes the tack of the book, aiming now more at the prospective manufacturer than the hobbyist. Build quality and ease of assembly should both be concerns for the amateur constructor, but the coverage in this chapter goes far beyond. This and the next three sections focus on product construction and prototyping on a serious level. Just skimming over these chapters gives a very good insight into how product development should be done. There's even a chapter (No. 13) called 'Going Into Production,' which is the finalé and goes as far as financing.

The Electronics Constructors Guide, despite its more professional inclinations, is one book I would definitely recommend to the hobbyist. It should also be a must for all students. Essential reading ●

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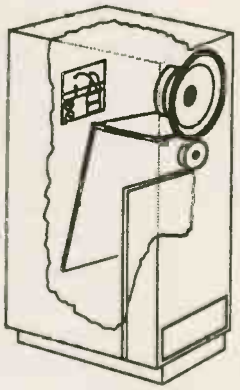

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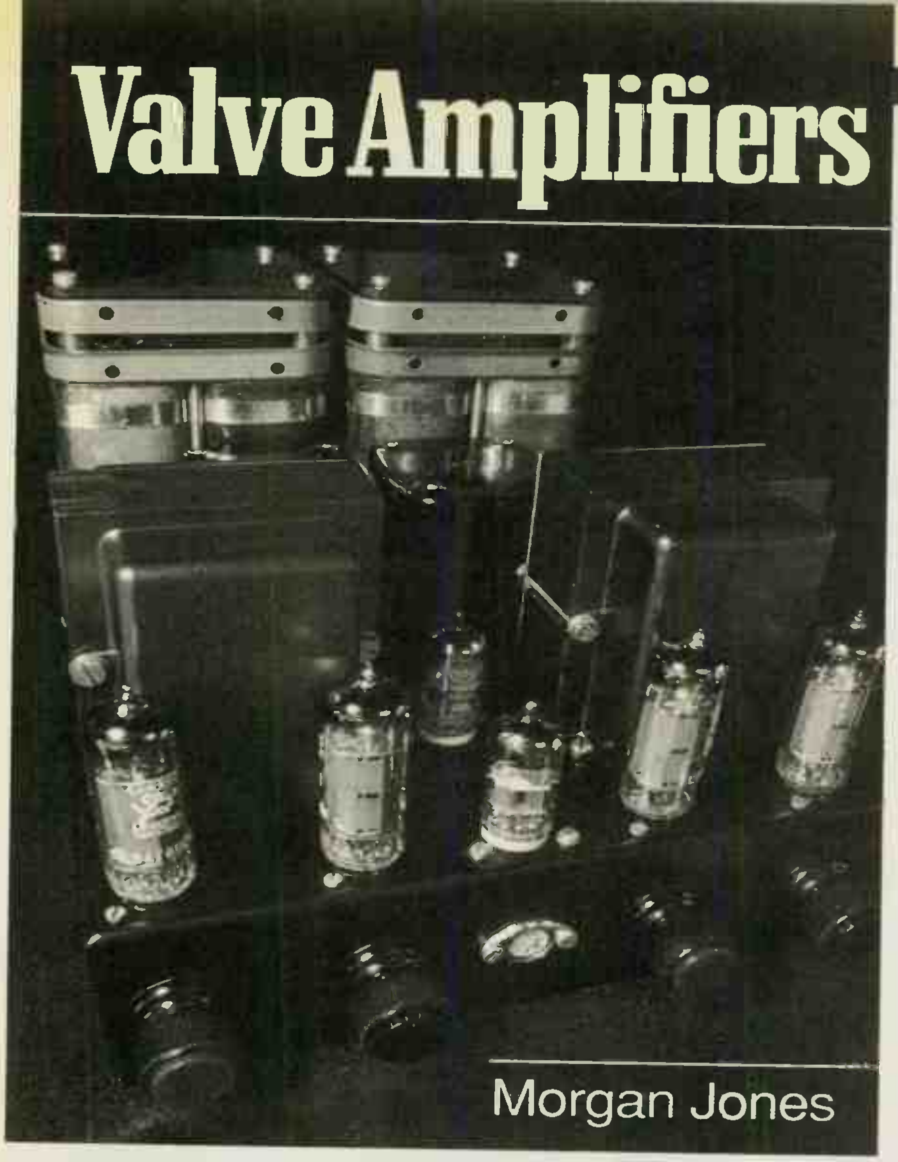

# VALVE AMPLIFIERS

by Morgan Jones

**A comprehensive introduction, reviewed by Andy Grove**

Valve Amplifiers by Morgan Jones is a comprehensive introduction to valve audio electronics. The opening chapter covers the essential electrical and electronic principles, beginning with the electron and rapidly progressing to the concept of charge and thence to current, voltage and so on. There is also an introduction to equivalent circuits, Thevenin's theorem and Kirchoff's laws and even feedback and the operational amplifier. Surprisingly this chapter also introduces the transistor and uses it to demonstrate transconductance and amplification.

Simple valve stages and their mechanics are explained in Chapter Two, with load lines and theoretical analyses; here we meet the triode, the pentode, the cathode follower and most of the other valve building blocks. Some of the more exotic stages, such as the mu-follower and White cathode follower, will be new to those used to the Mullard 5-20. The valve's characteristics as a real world device are clearly shown: for example the distortion caused by nonlinearity can be seen in the example load lines.

Chapter Three is all about passive components, real life components, the capacitors, resistors, inductors, and of course transformers, which make up most of an amp's guts. Component choice is important for sound quality and here is a rational explanation of some of the physical problems inherent in today's bits. Capacitor losses and microphony together with the problems inherent in practical inductors are explained.

Power supplies are covered in Chapter Four, starting with rectification and progressing to choke input filters and on to solid state and valve regulators. There are good tips on the use of IC regulators and some example circuits for HT and LT supplies using them. The importance of good PSU design for sound quality is always emphasised.

Next, the power amplifier and the problems to be overcome are introduced. The different classes and modes of operation from the Class A single-ended stage through to the various push-pull topologies are discussed. The logical procedures for choosing the output valves and transformer, driver stage and so on are covered both separately and in the form of classic amp circuits such as the 5-20 and Quad II. Possible pitfalls like amplifier stability are looked at from a practical, rule of thumb viewpoint, and the author also makes some interesting observations on commonly used building blocks and suggests improvements.

Pre-amplifiers are covered in the following chapter, which takes the reader from the line stage and on into the depths of RIAA equalisation. Signal switching and volume controls are dealt with in some detail, with a listing for a program which works out the resistor values for stepped attenuators. Noise and hum are considered as is the effect of stray capacitances on the EQ network - again a BASIC listing is given to aid calculation.

The final chapter gives very useful advice on constructing amplifiers, the tools necessary, chassis layout and so on. There is also some safety advice on avoiding nasty accidents while experimenting.

This is the first edition of the book, so it would be prudent to double check the information contained against other references such as the Radio Designer's Handbook.

Overall this book is an excellent introduction to valve amp design. It gives an insight into how they work and educates the reader. The writing style is practical and easy to follow. ●

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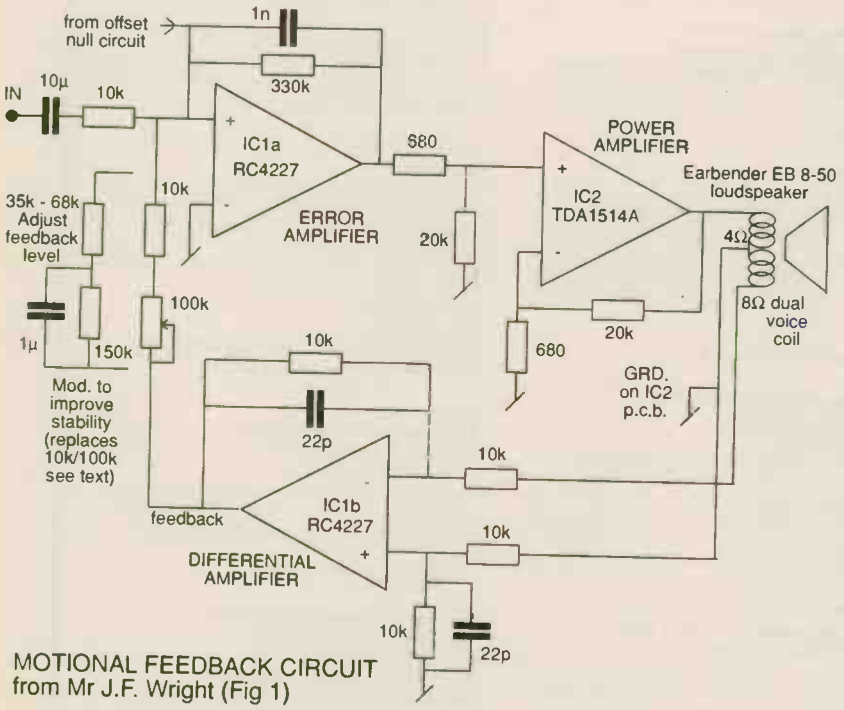
# Motional Feedback

**Noel Keywood takes a look at a technique that promises to bring us the perfect loudspeaker. So why hasn't it done so?**



MOTIONAL FEEDBACK CIRCUIT from Mr J.F. Wright (Fig 1)

I first heard Motional Feedback back in the early 1970s, at a Philips launch seminar held in Eindhoven, Holland, their home town. I was overwhelmed by the quality of bass it produced. Yet I never heard Motional Feedback working again.

Why did the idea die? A few years ago, I decided to lash up a system to see for myself. Lacking any information, a basic system operating on the principle of negative feedback was up and running in one Saturday morning and delivered great bass for a few minutes - then it went bang. This was a good enough omen: Motional Feedback conceals a whole slew of difficulties for the unwary and most of them, if not comprehensively tackled, tend to end up in one result - self destruction.

The problems were too great for me to tackle in the limited time I had available. However, reading about this in our June 1994 issue, Mr J.F. Wright - an electrical engineer - decided otherwise. He built a system, identified its core characteristics and problems and made it work. Hi-Fi World readers have tenacity.

Here, in reasonably understandable terms, are the wonders and difficulties behind Motional Feedback. My thanks to Tannoy and Andy Grove for their contributions. As Mr J.F. Wright has shown, with a bit of determination, Motional Feedback can be made to work. Good luck! **N.K.**

## A READER'S SYSTEM by J.F. Wright

In this letter I hope to provide useful information for anyone interested enough in Motional Feedback to repeat my experiments. Since stability seems to be a big problem, I will start my explanation here.

When negative feedback is used to control a system, it must be truly negative at all frequencies. If one reactive element is introduced into the feedback loop, it produces a 90degree (maximum) phase shift at some frequency. This adds to the 180degree phase inversion of negative feedback to produce a 270degree phase shift.

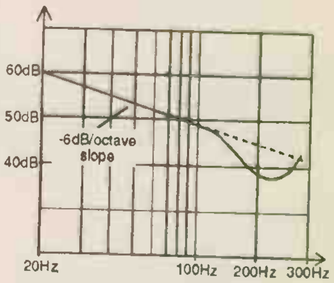
The loudspeaker in this system is a reactive element; the induced e.m.f. in the feedback coil is proportional to the rate of change of flux i.e. cone velocity. The system is therefore a differentiator, so introducing a coupling capacitor - another differentiator - into the feedback loop produces another 90 degree phase shift at some frequency. If the loop gain exceeds unity then we have a ringing or continuous oscillation at that frequency, a potential problem experimenters need to be aware of.

An approach to achieving a useable system is to reduce the amount of feedback used until stability is achieved. Using just enough feedback to control the Q of the driver to fit a particular alignment still gives a worthwhile reduction in distortion. However, I was going for total control.

In my system there was a region of high frequency instability, probably caused by mutual inductance between the two loudspeaker coils (like leakage inductance in an output transformer). This is why I band limited the gain of the error amplifier to 480Hz. I didn't explore this further.

The circuit diagram is given in Fig.1. The feedback signal is proportional to

The feedback signal is proportional to



FREQUENCY RESPONSE (Fig 2)
(velocity feedback)

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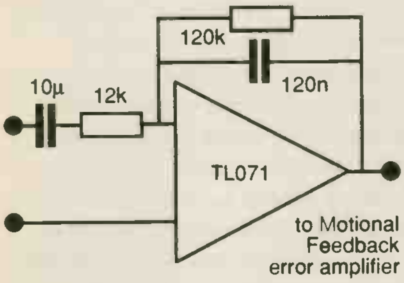
the cone velocity. The only reactive element in the feedback loop is the loudspeaker itself, to ensure stability.

The TDA1514 circuit is a Maplin kit with two alterations: a) shorting out the input capacitor b) increasing the value of the bootstrap capacitor to 470µF. These mods. have no effect on stability, serving only to increase the drive voltage to the output stage. It was fed by a 16v-0-16v power transformer and bridge rectifier.

The op-amp RC4227 is also available from Maplin. The circuit was built on Veroboard and separately powered at +/-15v. Decoupling capacitors of 22µF were included close to the I.C.s.



EQUALISATION AMPLIFIER (Fig3)

The differential amplifier will not be needed if a loudspeaker with isolated coils is used (Ed note: see Audax twin isolated coil drivers at end of article). I used it to reject any voltage drop across the power amp's ground return. The gain of each stage was fixed at about 30, giving 60dB open loop gain, which I felt was a good compromise. Power amp distortion increases with higher gain, and op-amp bias current generates offset errors with higher resistances, which is temperature dependent (although the OP27 has a bias cancellation input circuit and is better than most in this respect). Using the offset adjustment pins on an op-amp degrades temperature stability.

I had problems with 3V of offset voltage, for the following reasons I believe. As the power amp. warms up, the output voltage, caused by offsets, changes. This is coupled via the loudspeaker to the feedback circuit, which increases the output voltage, causing it to heat up, further increasing the output voltage (i.e. the condition is regenerative). This produced a region of instability at a fraction of a Hz. The voltage increases until it saturates.

This is a strange difficulty; there must be a phase inversion somewhere in the chip. The modification shown in Fig.1 reduces the feedback (and increases signal gain) at very low frequencies, the turnover frequency being about 1Hz, in order to minimise this problem.

The phase margin is reduced but this is limited (damped), and it is a very low frequency. This means all direct-coupled power amp I.Cs are not a good choice, because the feedback works down to very low frequencies, which introduces other problems. Unless offsets are independent of temperature, there's little point in providing adjustment to remove them. If you do provide an adjustment, disconnect the feedback temporarily or you'll be adjusting forever!

A properly (custom) designed amplifier should enable higher levels of both gain and feedback (i.e. loop gain), giving greater control. Gain errors caused by a network in the feedback loop can be cancelled exactly by including an identical network in the signal path.

The drive unit I used was the Earbender EB8-50 from B.K. Electronics.

The system's frequency response is shown in Fig. 2. The dip in the curve at about 250Hz confused me at first - I thought reflections were to blame, but it corresponds to the minimum impedance of the drive unit. The phase shift is zero at about 250Hz (i.e. it's a resistive load) and the feedback voltage is very low. Exactly why this is so I don't know; is velocity also a minimum? Is voice coil inductance/mutual inductance significant at this frequency? Perhaps others can come up with suggestions. Rather than equalise it out, I chose to ignore it. I used a 4th order Linkwitz-Riley crossover network (active of course) and the peak in the response is inaudible when so filtered.

Large drive units have a lower minimum impedance frequency - 120Hz for 12" drivers - so unless a cure can be found (like increasing loop gain) small drivers will be best. The bass resonant frequency has been eliminated.

Equalisation can be achieved with a simple integrator circuit, such as shown in Fig.3, the complementary function to a differentiator.

To test the power handling capacity of the system, using the closed box loading, I increased the power until the output sounded distorted. This turned out to be 20W into 4ohms, so there is no point in providing more than, say, 25W for each drive unit.

This brings us to what to look for in a drive unit. Very low Q and low Fs don't seem that important. A smooth midrange from Hi Tech diaphragm materials aren't important, if the driver is to reproduce bass frequencies only. Large excursion and high minimum impedance frequency are.

I strongly recommend a high pass filter to eliminate unwanted low frequency noise. I used one to cut off below 20Hz, since without it even turning up a volume control produced large excursions.

With regard to sound quality, I think the results are remarkable. It is well extended and clean sounding i.e. no boominess. As it stands the system is small, simple, cheap and effective; with refinement, the design should be capable of excellent results. The loudness is of course limited.

I hope you have found this letter informative and that it will inspire others.

**J.F. Wright**
**Chorlton,**
**Manchester.**

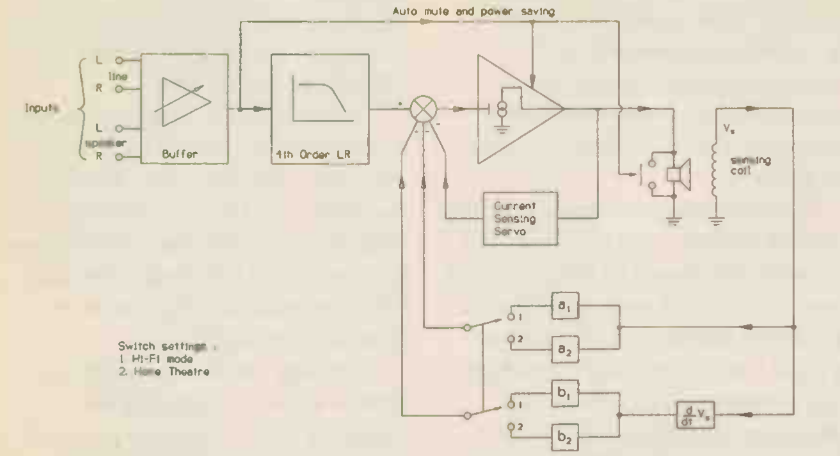
**REFERENCES**

1. Horowitz P and Hill W - The Art of Electronics 1st Ed, Cambridge University Press 1980 pp 136-139

2. Clayton G.B. - Operational Amplifiers 2nd Ed, Butterworth 1979 pp 26-62

## Tannoy reply

Mr Wright's observations on motional feedback very much concur with our own. The Tannoy method is similar in that two voice coils are used, but we were able to use very fine wire for the sense coil, to avoid reducing the efficiency of the driver. We also used a power amplifier with a very high output impedance (current drive), to eliminate voice coil heating effects, known as compression, from the system. The Q is then set by the amount of velocity feedback applied. Differentiating the feedback signal gives us acceleration feedback, so by means of a second feedback loop, it is possible to place the



A block diagram of Tannoy's prototype motional feedback system.

LF roll-off of the system anywhere you want.

In terms of stability, I agree that having the same BL profiles for the two coils provides a safe solution under overload conditions, but not the ultimate linearity. That's the solution we adopted on the 625 ALF. In terms of the amplifier, you need quite a wide bandwidth, say 5kHz or more for a subwoofer. The system is then made stable by a filter in the feedback loop. 2nd order at 250Hz worked fine in our case. We also found it was wise to use a d.c. servo on the power amplifier to avoid drift.

To get the best from such a system, it is our belief that the loudspeaker should operate under current drive, to give further improvements in linearity. The information here is from a lecture on the subject I recently presented at Essex University, as part of a short course in Audio Systems Engineering. It represents a distillation of much of the work I have done in the field.

**Dr Paul Mills**
**Chief Engineer,**
**Tannoy Ltd.**

## THEORY & PRACTICE
## by Noel Keywood and Andy Grove.

With Motional Feedback we are attempting to force the loudspeaker cone to follow the input signal to the system. This can, potentially, eliminate a wide range of loudspeaker evils, making it a very attractive prospect. The considerable distortions of cone/box loudspeakers can be suppressed, box resonance effects can be suppressed, box size and Thiele-Small parameters can be lessened in impact and importance and time-domain effects, like overhang, can be eliminated.

In effect we are forcing the speaker cone to follow the signal applied, giving perfect bass reproduction (M.F. can be full range, but this adds extra complication). But when you force a system to act beyond its "natural" parameters, it becomes highly stressed. This is another reason why M.F. tends to self-destruct. It demands use of a strong drive unit, driven by power amplifiers incapable of destroying it, all guarded by protection circuits. The low frequency limit is best kept sane (20Hz-30Hz) to curb excessive cone excursion.

The easiest way of deriving a feedback signal is to wind a sensing coil on the drive coil former, which will produce an output from movement in the magnetic field. This is what I did, but by putting the coil at the end of the former it moved out of the field while the drive coil remained in it, reducing feedback as signal increased, making for an innately unstable system (i.e. one that goes bang). The feedback coil must be close to the drive coil so that drive and feedback weaken simultaneously. Audax make two drive units with twin drive coils that are closely spaced. They are electrically isolated from each other too.

Output from a feedback coil can swing from +90degrees to -90degrees around resonance, so whilst the system remains stable, the amount of feedback that can be applied is limited by this behaviour. For this reason it is common to employ an all-direct coupled power amplifier, plus d.c. servo feedback to set its low frequency limit and maintain d.c. stability.

Sound pressure level is related to cone acceleration, so a flat response loudspeaker is a "constant acceleration" device. However, feedback taken directly from a sensing coil is velocity related, producing a constant velocity characteristic where bass rolls off at -6dB/octave. To restore conditions, feedback related to acceleration must be applied (alone or simultaneously), which in practical terms means feedback must be reduced at -6dB/octave with decreasing frequency. However, this too will introduce a 90degree phase shift, again limiting feedback and influencing stability. To maintain the stability margin, velocity feedback and pre-equalisation can be used, a scheme Mr Wright adopts.

Finally, Dr Paul Mills, Chief Engineer at Tannoy, suggests that a current drive (transconductance) amplifier possessing high output impedance is preferable to a conventional voltage drive amplifier with low output impedance, when Motional Feedback can be used to suppress low frequency resonance. Either will work, however, so this discussion is a little outside the brief of our look at the unique problems raised by applying Motional Feedback.

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| HM130Z4 | 5in | HDA | 50W |
| HT170G8 | 6.5in | Paper | 50W |

# D.I.Y. Letters

## LOUDSPEAKER GAMBLE

Thank you, Noel and Dominic for the valuable advice you offered at the Scottish Hi-Fi Show last year. I have been very unsatisfied with budget offerings on the market and, as a result, I have built a pair of speakers based on KLS-1.

The open baffled midrange/closed box bass 3-way speaker is a very appealing design approach. To suit, I chose the Scanspeak D2010B tweeter, kept the MW114-S with labyrinth and RCF L10P10-1 bass unit for a smaller enclosure. Unfortunately, the gamble I was banking on, that is stumbling on a suitable crossover through months of relentless tweaking, hasn't quite paid off.

The bass unit does not seem half as sensitive as the specifications led me to believe, I've had to attenuate the midrange to match the bass (Tannoy 607mk II as reference). There also is an uncomfortable difference in bass weight from track to track, due to an almost non-existent upper bass. Playing around with positioning does not do much but changing to the sealed midrange enclosure helps. This may be partly due to the porous dustcap of the bass unit which is recommended for use only in sealed enclosures, by the supplier. Crossovers are also not as smooth as they could be. Could you recommend changes to solve these problems?

**James Kebuchi**
**Loughborough,**
**Leicestershire.**

*Even though you have supplied a lot of details about your design, we can still only offer guidance rather than definitive advice. As a starting point I'd use the crossover we designed for the MW114-S, so at least one part of your loudspeaker is producing a known result. This should give you a flat response from 200Hz-6kHz or so. Try listening just to this driver on its own; it should give an even and balanced sound.*

*Next, work on the tweeter. A basic check suggests that you have set the crossover point far too low, around 2.5kHz I suspect. The Scanspeak tweeter measures 6Ω at 6kHz, around the -3dB point you want to aim for. Using this in a basic 2nd order equation give values of 3μF for the series capacitor and 0.2mH for the parallel inductor. You also need to increase the 10Ω resistor to 20Ω if you are going to use the 5.5Ω series resistor, the value is too low making the tweeter appear to be a 5Ω load. This should at least get you back on the right track.*

*For the bass end it looks as though you've set the crossover point too high. Try increasing the inductor to 9mH and reduce the capacitor to 70μF; this should set the crossover closer to the desired 200Hz. Your box alignment of 30litres or so looks about right, giving a predicted lift of around 2dB at 100Hz and rolling off at -3dB at 50Hz. This should give quite strong bass, so I suspect that you are being fooled by the effects of the crossover.*

*The information I have given you can only be used as a rough guideline. You really do need to get hold of some measuring equipment, like Liberty's IMP for example. DB*

## NOISY 300B?

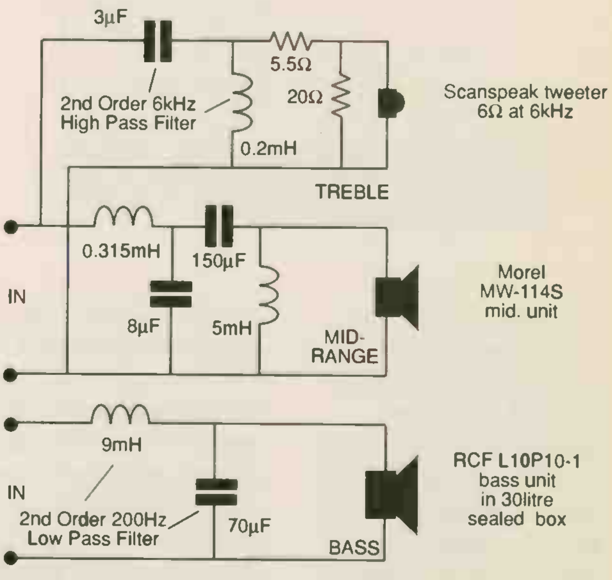
I am interested in your 300B amplifier design, but I have a few questions about the performance data. You say the hum level is -72dB and I find this rather high. Are the heaters of the 300Bs fed with AC? If so why can't they have stabilised 5 volt heaters as this can easily be done with modern ICs.

You mention a rather limited treble response of 18kHz. I see no obvious reason why this cannot be changed to at least 25kHz as you state yourself that very expensive output transformers are used in this design.

Do you know about the Dutch Vanderveen toroid output transformers? I have heard they are amazing everyone with their incredible band response from 1Hz to over 100kHz at very low distortion and no phase shift. The prices are very reasonable. It seems the whole concept is very special, maybe you could make an article over these.

**De Schamphelaere JM.**
**Ghent,**
**Belgium.**

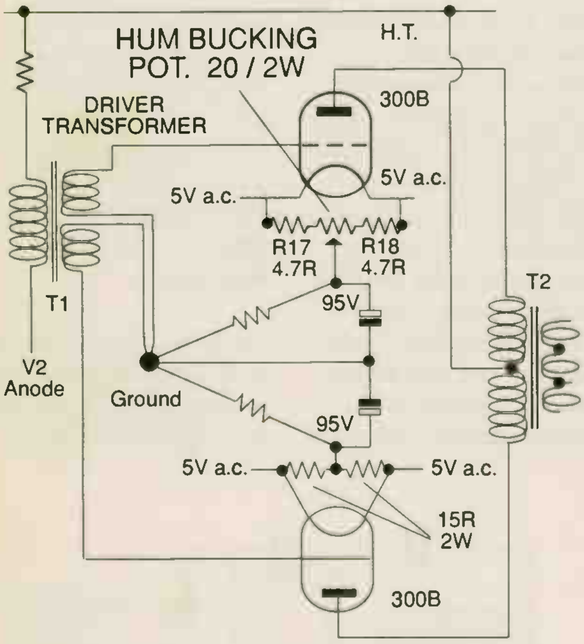
*Stabilising A.C. heater volts will not affect hum. If you are suggesting we use D.C., it can be done, but then*



SUGGESTED COMPONENT VALUES FOR MODIFIED KLS-1 *heater life is shortened, due to migration from the positive end of the filament. It's not an issue with low cost valves, but it can be for anyone who wants to use, say, original 300Bs, which may cost £200-£300 each.*

*Alternatives are to use D.C. and switch polarity regularly, or use high frequency A.C. (i.e. above 20kHz), but both are complex. Since 300B heaters consume 1.2A, 5A total is required for four valves, which limits options. We use hum bucking and this results in adequately low hum; it isn't an issue.*

*No audio output transformer usefully works from 1Hz to 100kHz. It may pass a signal at these extremes, but it will not pass power (>5W) or have a flat response. That such a claim is made strikes me as frivolous.*



Hum Bucking with directly heated valves. The signal is fed to the heater of one valve through a fixed potential divider, and through a pot. to the other. The pot. is adjusted for minimum hum.

*The bandwidth of our 300B is determined by the driver/phase splitter transformer, not the output transformer. It is one of the unique features of the amplifier and a very difficult item to design without resorting to corrective feedback. NK*

*The World Audio Design 300B circuit gives a good measured performance without using any feedback, and using a minimum of components. It is an elegant and effective circuit. Making something ever more complex adds to expense and can subtract from sound quality.*

*The toroidal vs laminated transformer chestnut (donut!) again? Because the toroidal transformer is like a long winding with it's ends joined it should be possible to achieve a very low leakage inductance. As toroids are available in better materials such as M5 and M4, better low frequency performance should also be possible.*

*But, because of the shape of the toroid (like a ring donut) it cannot posses both a short magnetic path length (travelling around at the centre of the donut's cross section) and a large cross sectional area. You just can't bend a really thick chunk of iron into a tight circle - there would be nowhere to put the wire!*

*So there is the problem. You only get a teensy bit of iron in your toroidal transformer unless you make it super big, then the physical size affects HF performanc. This is a Catch 22, just like that suffered by a laminated transformer.*

*Also, with a toroid the weeny core cross section won't stand for any DC offset current caused by valve imbalances.*

*Probably the best solution is a C core transformer with its dimensions specified to suit a particular application. Also, an air gap would control permeability and then we might end up with something better. It would also be expensive. AG*

## MEASURING IMPEDANCE

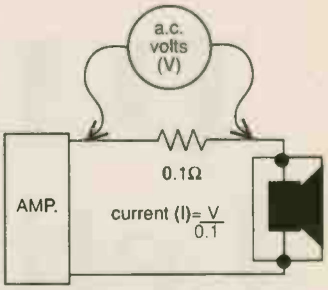
I have made a loudspeaker and wish to do an impedance curve for it. I have an audio frequency generator and a multimeter. Could you please tell me what I need and give me the circuit to carry this out.

**Stephen Dudley**
**London.**

*It may be possible to measure impedance with the equipment you have, but it will depend on the specifications of your meter. You will need to be able to measure AC current and RMS voltage level accurately.*

*First you will need to connect your audio generator to a power amplifier, preferably something with quite high feedback and good current delivery so that it is not affected by the load. I'd make measurements at the following points: 10Hz, 20Hz, 50Hz, 100Hz, 200Hz, 500Hz, 1kHz, 2kHz, 5kHz, 10kHz, 20kHz and plot the results on log graph paper drawing a smooth line between them. This will be similar to the way we print loudspeaker impedance in the measured performance section of the magazine, so you will be able to make comparisons.*

*Set your audio generator to the first frequency and adjust the output so the power amplifier is supplying about 3Vrms to the loudspeaker. Measure this across the terminals of the connected loudspeaker. Once the level has been set at 3V, you can connect your multimeter in series between the +ve loudspeaker cable and the +ve terminal on the loudspeaker. With the meter set to read AC current, expect to see around 200-500mA. Divide voltage by current to find the impedance at that particular frequency and mark the point on your graph. Repeat this procedure for every point above.*



a.c. current can be calculated by measuring a.c. volts across a low value resistor

*If your meter is accurate, you should get a very reasonable result. The other option would be to invest in a system like Liberty's IMP. This is a software/hardware system for the PC that will enable you to measure frequency response, impedance, sensitivity and a whole lot more. It is very accurate and much faster than plotting the results by hand. Contact Marton Music on Tel: 01282 773198 for further information. DB*

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