Hi-Fi WORLD SUPPLEMENT

No. 13 FEBRUARY 1995

BOOK REVIEW - QUICK & EASY TRANSMISSION LINE LOUDSPEAKER DESIGN

LETTERS AND Q&A

BUILD THIS PARALLEL SINGLE-ENDED VALVE AMPLIFIER

WE BUILD AND REVIEW AN AFFORDABLE LOUDSPEAKER MEASUREMENT SYSTEM

FREE D.I.Y. SUPPLEMENT No. 13

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phone Oswestry (0691) 652894

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

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

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

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

K1100S *Complete SLAVE Amplifier Kit, as above but without passive input stage.*
SPECIAL DISCOUNT PRICE FOR COMPLETE KIT IS ONLY **£333.62**
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A1100M *Factory Assembled* **£329.20**

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780-911 Super Low-Noise Signal Cable. Single core double screened Audiophile signal cable. Features Linear crystal oxygen free high purity copper construction with foamed polyethylene insulation. Screening is by a close lapped screen with conductive thermoplastic sheathing. Overall covered with blue soft matt finish PVC. Dia. 6mm. Core to screen Capacitance 110pf/m.
Per Metre **£8.98**

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845-008 100g. Reel Special Valve Grade, 20swg. **£12.90**
845-009 100g. Precision PCB Grade, 22swg. **£14.75**
845-110 100g Reel Superfine 24swg for ultra precise control and easy working. **£21.45**

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SPECIAL OFFER. *With each book purchased you may request a* ***FREE*** *extended index, written by the Author, exclusively from HART.*
0-7806-0868-4. **£16.95**

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

"THE LOUDSPEAKER DESIGN COOKBOOK" *Vance Dickason. (4th Edn.)*
All the information you need to build the loudspeaker system you have always wanted but could not afford. Easy ways to pick the exact box size, the ideal drivers, and the correct way to feed the music to your new super loudspeaker system. Over 140 pages packed with important design data.

1991. 152 Pages.
0-9624-191-7-6 **£19.97**

"THE ART OF SOLDERING"
R. Brewster.
Absolutely essential reading for anyone who ever picks up a soldering iron. Written from knowledge gained in a lifetime in the field, this is the first book ever solely devoted to this essential and neglected skill for all electronic enthusiasts. Covers everything from the correct choice of soldering iron and solder to the correct procedures to follow with many illustrations and practical exercises.
0-85935-324-3. **£3.95**

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In April 1947, Williamson's power amplifier, using excellent-quality push/pull output valves, a special output transformer, and a highly filtered power supply, became an overnight success. The author takes the reader deep into his design considerations, offering practical advise on how to build the units plus concise instructions on setting up the new amp. A cult classic.

1947, Reprinted 1990. 40 Pages.
0-9624-1918-4 **£4.95**

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

1949 Reprinted 1990. 88 Pages.
0-9624-1913-3 **£6.95**

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D.I.Y. Supplement

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TECHNICAL & GENERAL

Some Necessities - From the Original Classic Turntable Specialists

			P&P
Connoisseur			
	BD1/2 Drive Belt	9.85	1.85
	BD1/2 Motor Suspension kit	13.75	2.25
	SAU.2 Headshell	16.75	2.55
	SAU.2 Connecting lead	15.95	3.55
Garrard	Standard Models		
	Wired arm tubes	from 12.75	2.55
	Cartridge carriers (sliders)	9.25	1.85
	Idler Wheels	9.85	2.25
	301/401 Transcription Models		
	Original Thrust pad assembly	9.80	2.25
	Original Idler tension spring	2.95	1.85
	Original Speed control disc - 401	13.75	2.20
	Xeroxcopy Owners Manual 301 incl. full size mounting template	7.35	1.85
	Xeroxcopy Owners Manual 401 incl. full size mounting template	5.20	1.85
	Replacement Intermediate drive wheel	19.95	2.85
	Replacement 301 control knobs On-Off/Speed select	pair 20.25	2.55
	Replacement 301 suppressor unit	5.65	2.25
	Replacement 301 motor pulley (-2%), (-1%), (Std), (+1%)	each 12.65	2.25
	Replacement 301 Chrome plated mounting bolts	set 3.70	1.85
	Recommended Lubrication set - early 301 or 301/401 (specify)	5.20	1.85
Goldring/Lenco			
	Idler wheel (lock-nut or clip fixing)	19.95	2.85
	Arm Pivot bearings with instructions	7.85	1.85
	Spindle/Main bearing assembly complete	22.85	3.85
	Headshells	from 21.95	2.55
	Instruction books	from 4.20	1.85
Thorens			
	TD.124 series		
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	Drive belt	9.85	1.85
	Chassis spring suspension (replaces 'mushrooms')	13.85	2.55
	150/160 series		
	Drive belt	9.85	1.85
	Suspension springs (-1%), (Std),(+1%)	set 10.85	2.55
	Suspension bushes	set 12.50	2.25
	Armboards for most models	from 16.90	2.55

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MODEL NO.	WATTS	P.IMP	FREQ. RESPONSE	APPLICATION	PRICE
X-10S SE	40W	10K	20Hz - 55KHz -2dB	211,845, VT4C	713.00
X-2.7S SE	40W	2.7K	15Hz - 80KHz -2dB	300B, 2A3	678.00
XE60-2.5 SE	30W	2.5K	20Hz - 100KHz -3dB	300B, 2A3	455.00
X3.5P PP	120W	3.5K	4Hz - 100KHz -1dB	300B, KT88	678.00
XE 60-5 PP	60W	5K	4Hz - 80KHz -1dB	6L6GC, KT88	480.00
XE 60 3.5 PP	60W	3.5K	4Hz - 100KHz -1dB	EL34, 6550A	455.00

OTHER TYPES AVAILABLE ON REQUEST

BLACKGATE CAPACITORS

VALUE	SERIES	APPLICATION	PRICE
220uF 35V	FK	PSU TOTAL DISTORTION -150dB OR	33.60
10000uF 63V	FK	LESS. COMPARABLE WITH HIGH	137.00
10000uF 100V	K	PERFORMANCE FILM CAPS	180.20
47uF x2 500V	SKZ	VALVE PSU	52.50
100uF x2 500V	SKZ	VALVE PSU	82.00
2200uf 100V	BG N	VERY LOW ESR, NON POLARISED USE IN	230.00
4700uF 35V	BG N	PAIRS IN L-CANCEL PAIR CONFIGURATION	110.00
1000uF 25V	BG NX	FOR VERY LOW NOISE	22.50
68uF 35V	BG NX	POWER SUPPLIES	24.50

TUBES *(NOS, O. Boxes)*

(RING FOR AVAILABILITY)

TYPE	MAKE	PRICE
GZ34	MULLARD	40.00
KL34	MULLARD	50.00
E80CC	MULLARD G/PIN	35.00
E80F	MULLARD G/PIN	15.00
ECC83	BRIMAR	4.00
ECC88	BRIMAR	4.00
VV30B	VAIC NEW 300B	264.00

MISCELLANEOUS

VALUE	INFO	PRICE
10000uf 40V	PHILIPS LOW ESR HIGH	6.35
4700uF 40V	RIPPLE CURRENT CAPS	9.90
10000uF 63V	PHILIPS COMPUTER	17.25
33000uF 63V	GRAOE CAPACTORS	27.85
NEUTRIK XLR PANEL PLUG 3-WAY G/PLATED PINS		2.75
NEUTRIK XLR PANEL SKT 3-WAY G/PLATED PINS		4.20
NEUTRIK FREE PLUG 3-WAY G/PLATED PINS		3.50
NEUTRIK FREE SOCKET 3-WAY G/PLATED PINS		4.00

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ADD £2.50 DELIVERY AND THEN VAT TO ORDERS

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Wilmslow Audio

As any discerning sound engineer will tell you, the ATC SCM50 and 100 are the ultimate in accurate low distortion professional monitoring. But what they may not know is that self assembly versions based on these classic monitors are now available from the UK's leading speaker kit supplier, Wilmslow Audio, at a fraction of the ready built price. ATC and Wilmslow Audio have worked very closely on the cabinet and crossover design to ensure that the completed kit lives up to the very high standards associated with the ATC name. As with all Wilmslow products, the ATCK50 and K100 kits come complete with precision machined cabinet panels, crossovers, and all necessary hardware, including factory matched ATC drivers. Cabinet parts are machined from high grade MDF for easy assembly and consistent acoustic performance. ATC's MK I Tri-Amp Pack systems are available as an option if required.

The Result . . .

- *Stunning accuracy and clarity*
- *Clean well damped bass*
- *Smooth detailed treble*
- *Totally transparent mid range*
- *No overdraft!!!*

If you aspire to the unrivalled quality of ATC monitoring, but are working to a tight budget, contact Stephen Leigh who will be pleased to tell you exactly how economical these kits are. ATCK50s and 100s are on demonstration by appointment.

Wilmslow Audio Limited, Wellington Close, Parkgate Trading Estate, Knutsford, Cheshire, WA16 8DX, England. Tel: (0565) 650605 Fax: (0565) 650080

KIT *NEWS*

TITANIUM 300B

Hot on the trail of the ultimate 300B valve, we've been listening to P.M. Components' new titanium-anode versions, known as 4.300B Super. Since the standard valve gives ,in essence, a beautifully neutral, smooth and sweet sound - and perfect reliability I might add! - any improvement was sure to capture our interest. We beseeched P.M. Components to send review samples, which at £500 for two matched pairs took some talking. Yes, that's what a top, new 300B costs! The price has to be compared with a famed original from Western Electric, price around £300 each we understand.

If you're wondering what all this is about just let me explain that the 300B valve is one of the world's last audio amplifying devices designed (in 1928) specifically to be fundamentally linear (distortion free). After this date, use of feedback demanded other features be maximised, mainly gain - hence the emergence of the pentode and, in the end, the transistor. For music amplification both need to be used with feedback; the 300B does not.

So forget the fact that 300B is yesteryear - this is a great device for amplifying music. That's why new designs are being cooked up; these days people are able and prepared to pay for a really exceptional sound.

After running-in our review samples over a weekend, during which time sound quality changed little, amounting only to a slight smoothing, these 300Bs showed they offer richer, denser and more three-dimensionally focused images - walk around images in fact - than the normal versions. In fact, they really moved our 300B push-pull amplifier to rival (good) single-ended working.

These new valves bring tremendous timbre and body to instruments, altering overall tonal balance to give greater warmth and less brightness. They impart a richer, lusher sound; P.M.'s new titanium 4.300B Supers usefully capitalise on the glory of the 300B. I'd say - and I've heard most output valves - that sonically they're probably amongst the most deeply satisfying amplifying devices available in the world today. **NK**

P.M. Components Ltd.,
Selectron House,
Springhead Enterprise Park,
Springhead Road,
Gravesend,
KENT DA11 8HD.
Tel: 0474-560521

AUDAX LOUDSPEAKER KITS

Harman Audio, desperate for storage space, have informed us that they are offering 'special' deals on Audax kit loudspeakers. These kits contain drive units and crossover components, etc., but no flat-pack cabinet, so potential customers will have to build their own. The kits are being offered at heavily discounted prices as follows: Pro317 £210 (list 359), Pro218 £173 (list 285), Pro120 £187.44 (list 289), Pro21 £129.71 (list 209), ADX40 £65 (list139), ADX30 £61.36, ADX20 £40. These are special clearance prices and only apply whilst stocks last. For further details please contact:

Harman Audio
Unit 2, Borehamwood Ind Pk,
Rowley Lane,
Borehamwood,
Herts. WD6 5PZ
Tel: 081 207 5050

KEF'S CONSTRUCTOR SERIES IS AVAILABLE

KEF's Constructor Series has recently been re-launched with three new models based around their own Uni-Q driver.

KEF have put together three kits for the home constructor, each comprising drive units and tested and built crossover. Wilmslow Audio will be supplying flat-pack cabinets, making these ideal for the first time kit builder. The KEFkit 60s (£263 per pair) use a single Uni-Q driver in an 18 litre stand mounting, reflex-loaded cabinet. The £345 KEFkit 80 is designed to be a floorstander using a Uni-Q driver loaded by a passive radiator (ABR), giving them deep and powerful bass.

Top of the Constructor series range is the KEFkit90. This is a three-way design, using a Uni-Q driver for midband and treble, and a separate 8" bass driver. This is housed in its own bass chamber and reflex loaded. The KEFkit 90s are priced at £457.

For those constructors more experienced in 'speaker design, the Uni-Q, ABR and 8" bass units are available separately for use in your own designs. A pair of Uni-Q units will be available for £199, ABRs for £74 and 8" bass units £139/pair.

KEF Audio Ltd
Eccleston Road,
Tovil,
Maidstone,
Kent.
ME15 6QP
Tel: 0622 672261

SECOND HAND RECORDS

Lockwood Audio, as well as carrying out repair and restoration work on vintage loudspeakers, are now stocking second hand vinyl too. They have already built up a stock of 2-3000 records comprising mainly classical and jazz. Lockwood say that they are priced fairly, starting at around £3-4.

Because of the nature of their business, Lockwood Audio advise anyone wishing to visit them to telephone first and book an appointment to ensure that there will be someone there who can help you.

Lockwood Audio
Imperial Studios,
Maxwell Road,
Borehamwood,
Herts.
WD6 1WE
Tel: 081 207 4472

K5881 PSE PARALLEL SINGLE-ENDED VALVE AMPLIFIER

Here's an affordable, but high quality 17watt parallel single-ended valve amplifier design based on the reliable 5881 beam tetrode. Dominic Baker and Andy Grove brew up another thermionic delight.

Our first DIY Supplement of the year has something special that will appeal to all of the audiophile enthusiasts amongst you eager to build their own hi-fis. We knew from the start that an all-new valve amplifier design would get your soldering irons excited. We wanted to design something which would combine outstanding sound quality, ease of build and affordability all in one. The result, after a lot of discussion, was this, the K5881 17watt parallel single-ended valve amplifier.

At the moment there is a strong trend towards single-ended designs. Not surprisingly either, since they offer fabulous detail and atmosphere, allowing a performance to really come alive. Our 4watt single-ended amplifier has proved extremely popular for this reason, but with just 4watts on offer its use is limited to those of you lucky enough to have sensitive loudspeakers.

This time around, we wanted to create a single-ended amplifier that had enough power to drive the majority of loudspeakers, but didn't cost an arm and leg. With average loudspeaker sensitivity hovering around 86dB, but rising all the time, a good 15watts or more was needed. We thought about keeping the design a little simpler and aiming for 10watts, but this really isn't that much more than 4watts - and not enough to make for compatibility with a wide enough range of loudspeakers. So, we decided on a single-ended design capable of producing around 15watts.

There were other factors to take into consideration though: reliability, low running costs (affordable valves) and most importantly, fine sound quality.

For reliability, we wanted to use valves we already had experience of, ones that would last for a long period and were easily available. The combination settled upon were the 7025/ECC83 double-triode input valve, 6922 double-triode driver valve and 5881 beam-tetrode output valve. All are made by Sovtek in Russia, are military

specification valves and we use them in our extremely popular valve line-level pre-amplifier and K5881 push-pull amplifier. They perform well in the field and give reliable use over many years.

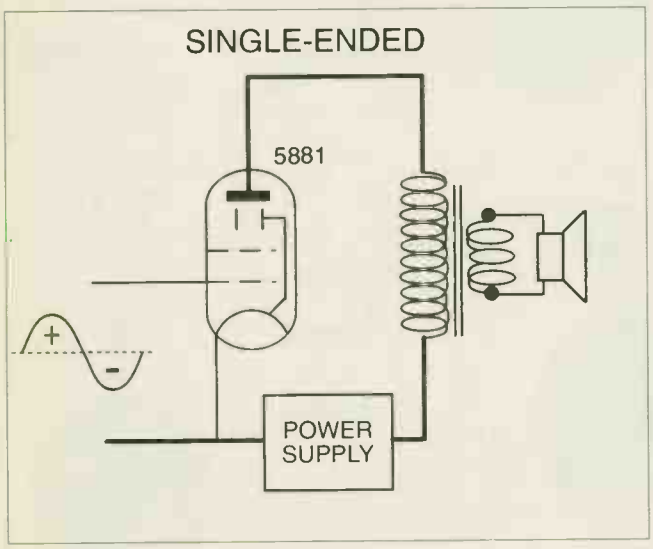
They are affordable too, even the output tubes can be bought for less than £10 each. The Sovtek valves all have a wonderfully clear and open sound, so working in single-ended operation the results are fantastic. We design our own transformers in-house and they're perfectly optimised for the circuit, valves and operating voltages. They are wound using high purity copper wire. Fine silicon steel, grain orientated laminations give superb high frequency performance.

After deciding to go for such open sounding valves in a single-ended circuit, with our own in-house designed transformers we didn't want to skimp on components. In our kit version of this amplifier the components supplied are of high quality: Solen polypropylene signal capacitors, special Panasonic low impedance electrolytics for cathode bypassing and smooth sounding carbon film resistors. The signal wiring is silver plated copper and all input and output sockets are gold plated.

So here's a special 15watt parallel single-ended amplifier using extremely high quality transformers, reliable and open sounding valves, high quality passive components - all in a rugged and affordable package. **DB**

Why Single-ended?

Single-ended working is the simplest way to amplify a signal. In the early days of radio this was how it was done, before they discovered the more efficient push-pull method. But because it is the simplest form of amplification, it seems to give the purest sound for audio use.



In a single-ended amplifier one valve controls the supply of current from the power supply, modulating it through the output transformer as the signal on its grid is modulated. Because a transformer will only 'pass' an a.c. signal, the d.c. current that flows through the primary of the transformer isn't transferred to the output and to the loudspeaker. Only the alternating a.c. audio signal current passes through to the loudspeaker.

The way single-ended works is simple in its own right, but it does have its own set of drawbacks. The large d.c. current flowing through the primary of the output transformer will magnetise the core and take it close to saturation (magnetic overload). This reduces the transformer's ability to accommodate the whole audio signal. So for single-ended working the transformer core must be large enough to withstand this large d.c. standing current and allow enough headroom for the full audio signal, without coming close to saturation or increasing distortion.

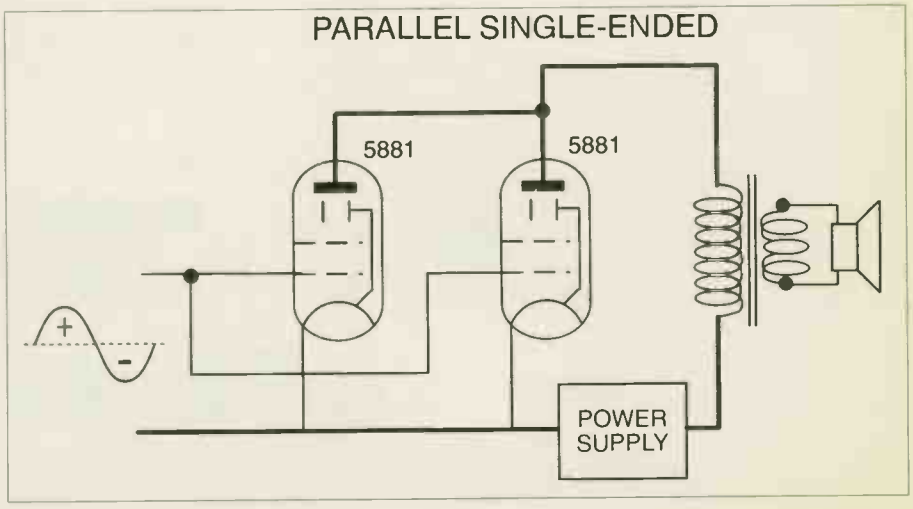
Also, by nature single-ended working is pure Class A and is therefore extremely inefficient, just 35% in fact. So a lot of power is dissipated in the form of heat, which the chassis and components must be able to withstand.

In sonic terms, single-ended amplifiers normally sound richer, incredibly smooth and more atmospheric, with more of the detail around a performance being conveyed. We suspect that a lot of the ambient information you hear from a single-ended amplifier may be cancelled out by the push-pull topology of most amplifiers; single-ended working really does seem to resolve more of the music. And as if that wasn't enough, there can, by definition. be no crossover distortion either. So S.E. working has some radical advantages, even if it is inefficient and, technically, difficult to get working well.

Parallel Single-Ended

Parallel single-ended working is a clever way of increasing output power from a single-ended. Two valves are connected in parallel so that they both pull current through the output transformer together, doubling power output. The load impedance for two valves connected in parallel is halved, reducing the number of turns on the primary of the transformer, making it more efficient. The only disadvantage is that the output transformers need to be made significantly larger to cope with the extra audio power, as well as the increased d.c. current they draw.

Although two valves are used, they are still working in pure single-ended mode. So, parallel single-ended gives you twice the power of a single valve, but retains all of the sonic advantages of the single-ended circuit. By significantly reducing the turns on the transformer primary though, it gives better sound quality. **DB**



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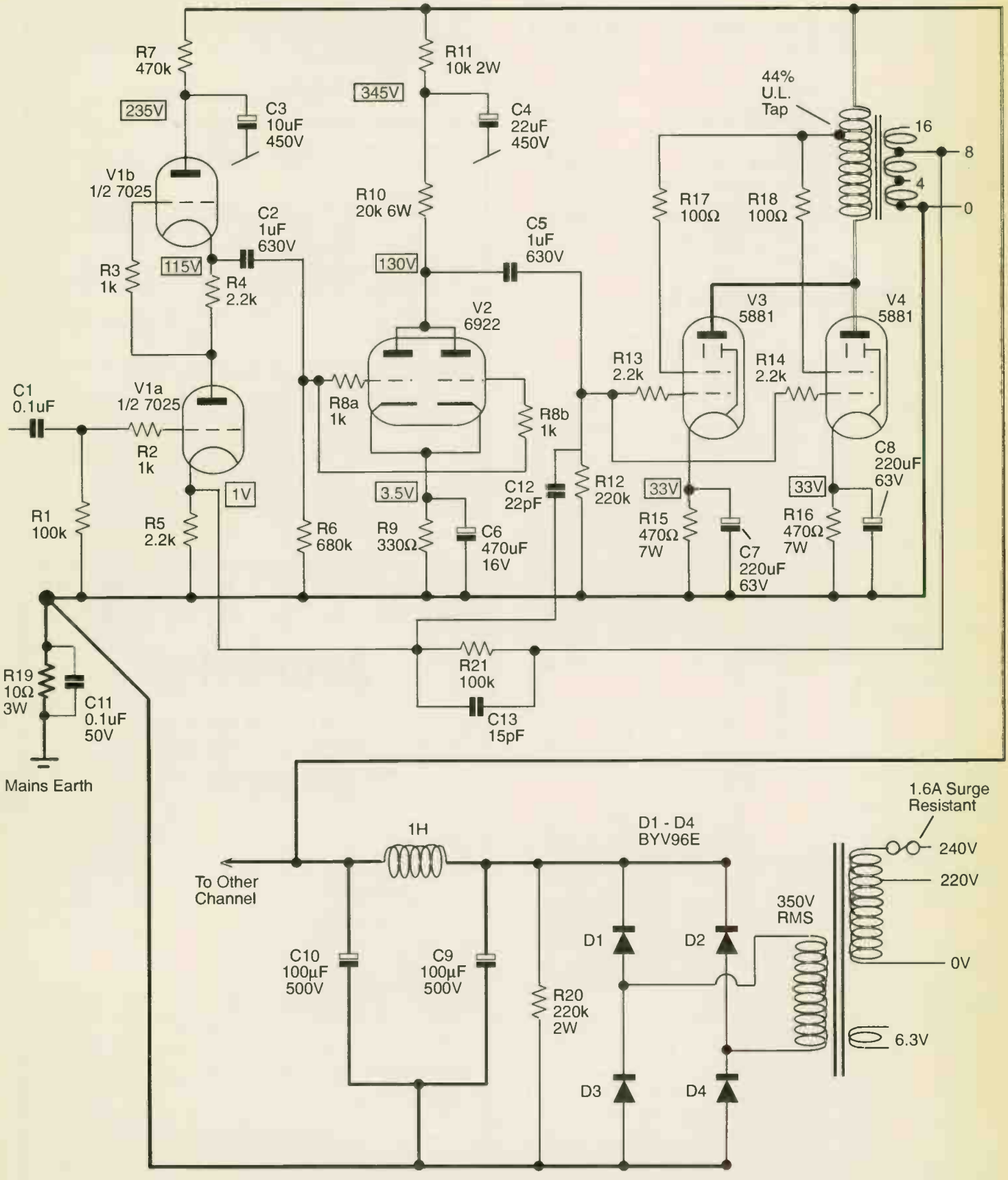
K5881 PSE CIRCUIT



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type	a to a Z	max dc	max P	suggested valve type	price (Inc)
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All the above can be supplied fully shrouded, open frame or drop through as required. Please enquire about any requirements not listed here. A large range of mains transformers and power supply chokes is also available. Full "sets" for amplifiers can be supplied:

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220pF	400V	.50	10nF	63V	.75
330pF	400V	.50	22nF	160V	.85
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1.5nF	.50	100nF	.75
2.2nF	.50	150nF	.75
3.3nF	.50	220nF	.85
4.7nF	.65	330nF	1.00
10nF	.65	470nF	1.00
15nF	.65	680nF	1.25
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33nF	.65	1.5nF	2.00
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* Note that the chassis wire is excellent for loudspeakers internal wiring or to replace the jumper connectors used when Bi-wire speakers are used in single wire mode. When using the wire to carry signals of less that 100hz a double run should be used. High quality preamps should be wired with 16T.

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HOW THE K5881 PSE WORKS

by designer Andy Grove

The K5881 PSE circuit is quite straightforward, having two gain stages and an output stage. All valves used are Russian Military specification and are in current production with world-wide availability.

The first stage is a 7025 (high performance ECC83) connected in Shunt Regulated Push-Pull (SRPP) configuration. The two halves of the double-triode are used, one as the actual amplifying element (V1a), the other as an active load (V1b). The active load part presents a high impedance, equal to ra+Rk+gmRk(Rk+ra) or approximately μRk+ra (around 300k in this case) to the amplifying valve ensuring good linearity at low signal levels.

For small signal amplitudes SRPP works very well if set up correctly, but whereas a simple single-ended stage generates predominantly 2nd harmonic distortion, the SRPP configuration can generate high order harmonics due to the modulation of the load valve's characteristics under large signal amplitude conditions, these harmonics often show up as "false detail" in the treble. In this amplifier though the SRPP stage is used at the input stage and therefore only has to cope with small voltage swings.

As the signal output is taken from the cathode of V1b rather than the anode of V1a the output impedance is lowered due to the local feedback around V1b. This low output impedance is needed to drive the following stage correctly at high frequencies giving almost twice the uncompensated open loop bandwidth. The second stage is a 6922 (similar to ECC88 but mil. spec.) double-triode with both sections in parallel.

The 6922 is usefully linear allowing a large undistorted voltage swing for the output valves and parallel connection increases drive capability but grid stoppers R8a and R8b are needed to stop parasitic oscillation.

The output valves are two 5881 beam-tetrodes with their screen grids connected via 100Ω grid stoppers to a 44% tap on the output transformer in what is termed Ultra Linear operation. A proportion of the anode signal is fed into the screen grids and the valves work part way between triode and pentode operation. This gives a good share of a triode's plus points: low output impedance and low, mainly second harmonic, distortion. If the valves were operated purely as triodes though, by connecting the anode and screen together, the power obtainable would be low at around 10watts total output, this could be a modification for the builder to experiment with if the lower power is acceptable. The operating conditions for UL operation have been calculated to cause no loss of power over pure pentode operation.

Feedback is taken from the output transformer secondary and fed to the cathode of V1a in the usual manner via R21. Around 25dB of overall feedback is used to lower distortion and output impedance, giving it the ability to drive most loudspeakers. There are two compensation networks, C12 and C13. C12 gives frequency dependant feedback from the output of the driver stage, setting the "open loop" bandwidth. C13 gives frequency dependant feedback from the secondary, the two networks together set the HF roll-off point and stability margin.

The power supply is of standard design, comprising a bridge rectifier and a Pi filter for smoothing which gives 450V when running. Slightly increased capacity was needed due to the lack of cancellation inherent in single-ended output stages, so the power supply capacitors, at 100μF, are twice the size of those in the K5881 push-pull design.

AG

K5881PSE Parts List

Resistors

R1	100k/0.5W
R2	1k/0.5W*
R3	1k/0.5W
R4	2.2k/0.5W
R5	2.2k/0.5W
R6	680k/0.5W
R7	470k/0.5W
R8a	1k/0.5W*
R8b	1k/0.5W*
R9	330/0.5W
R10	20k/6W
R11	10k/2W
R12	220k/0.5W
R13	2.2k/0.5W
R14	2.2k/0.5W
R15	470/7W
R16	470/7W
R17	100/0.5W
R18	100/0.5W
R19	10/3W
R20	220k/2W
R21	100k/0.5W

*Solder the grid stopper resistors R2, R8a and R8b hard up against the valve base pins.

Capacitors

C1	0.1μF*
C2	1μ/630V
C3	10μF/450V
C4	22μF/450V
C5	1μF/630V
C6	470μF/16V
C7	220μF/63V
C8	220μF/63V
C9	100μF/500V
C10	100μF/500V
C11	0.1μF/50V
C12	22p/polystyrene
C13	15pF/polystyrene

C1 rolls off low bass at the input to prevent transformer saturation. it is soldered to the input phono socket.

Diodes
D1-4 BYV96E (4)

VALVES + BASES
5881 (4)
6922 (2)
7025 (2)
Octal (4)
B9A (4)

TRANSFORMERS
K5881PSE Mains
K5881PSE Choke
K5881PSE Output (2)

BUILDING

The amplifier is built up on tag boards, making construction easy for the DIYer and allowing experimentation with different brands of component at a later date. This also makes for extremely good contact between components, a thick silver plated copper wire takes the place of a thin printed circuit board track.

The tag board layout shown below is for guidance only. To be able to successfully build this amplifier you will need to have a good understanding of electronics and components e.g. which way around a diode or electrolytic capacitor should go, and be able to read a circuit diagram.

SKILL LEVEL

To build this amplifier you must be able to:

a) solder

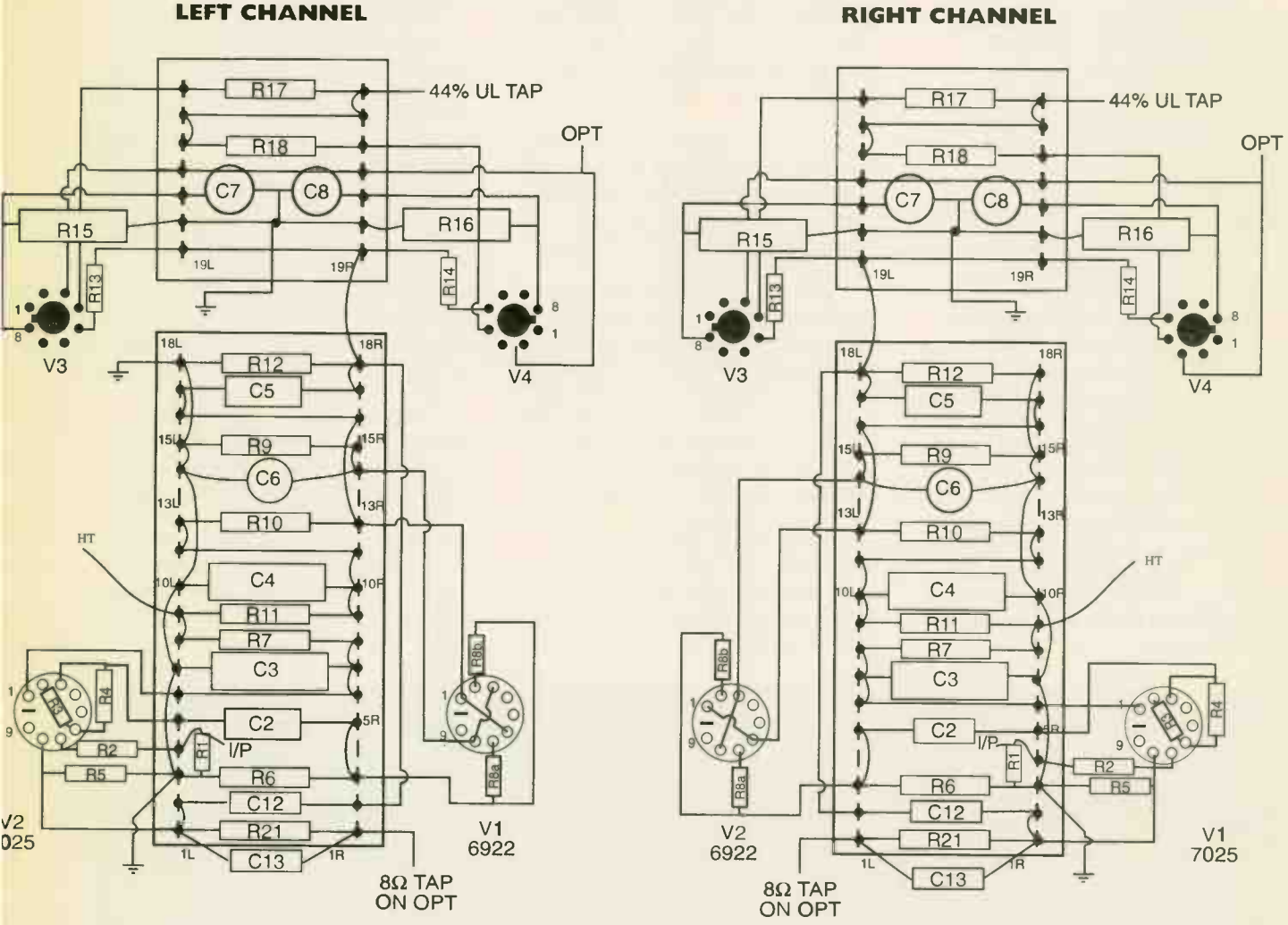
b) understand a circuit diagram (the component layout diagram does not show all connections).

c) possess a rudimentary understanding of electricity and electronics

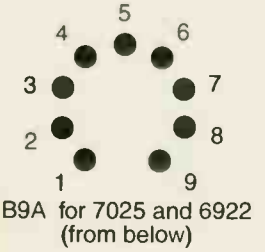
d) have a multimeter and be able to use it for checks and fault finding

e) know the necessary precautions to avoid electric shocks from the mains and power lines.

Tag board layout



NOTES
1) Not to scale: representations only
2) OPT = output transformer; UL TAP =Ultra Linear tap on OPT, HT = high voltage
3) R1,R2 very hum sensitive; keep leads short
4) R15,16 run hot; keep away from chassis and components
5) R10 goes under the board to make space
6) Wire gnd stoppers, R2, R8a, R8b hard up against holder pins



B9A for 7025 and 6922 (from below)

	7025	6922
1	A"	A"
2	G"	G"
3	K"	K"
4	H	H
5	H	H
6	A'	A'
7	G'	G'
8	K'	K'
9	Hct.	Screen

Octal for 5881 (from below)

	5881
1	i.c.
2	H
3	A
4	G2
5	G1
6	no pin
7	H
8	K

SOUND QUALITY

By David Price

The first thing that struck me when listening to K5881 PSE was its classic single-ended smoothness. I started my listening with one of the sweetest analogue recordings ever committed to vinyl, Cafe Reggio's by Isaac Hayes, an early seventies pressing on the legendary Stax label. As the stylus hit the groove, out came a sweet and clear sound, conveying horns with an earthy, raw timbre.

As the bass kicked in it became clear that the K5881 PSE was a very grippy little amp, reproducing the envelope of the note and the texture of the sound with equal clarity. As the song got into its groove, the amp sounded unfailingly smooth and clear, cymbals had a silken sheen yet were so finely etched you could almost feel them. The space and air around the drum kit was a revelation, as was the loose, effusive way that the drums were hit by the Stax session drummer. It displayed wonderful control on a song that had been recorded in a very loosely syncopated way, keeping all the instruments and rhythms together with great authority. Lesser amps can't do this and descend into rhythmic disarray.

Moving onto dance music, and Inner City's Good Life was the next disc to go on the turntable. Singer Paris Grey's solo vocal came across with a clarity few other amplifiers can match - her voice just hung above the KEFs with an eery presence. As the electronics kicked in, I found myself comparing the K5881 PSE to the 300B. The latter is one of the best valve amplifiers I've heard to date, with an expansive soundstage and outrageous bass slam and extension. It was instantly apparent that K5881 PSE just didn't have this, majoring instead on control and transparency. Bass was lighter, faster and more percussive, but ultimately the 300B won the day on this track through sheer muscle.

Although K5881 PSE lacked the dynamic weight to capture drum patterns, it still endeared itself in other ways. The classic 808 hi-hat sound had unprecedented clarity and every strand of the mix seemed to work together with one another.

Moving on to ABC's classic Lexicon of Love album, and my feelings on the K5881 PSE crystallised. It displayed incredible separation of instruments in the mix, separating the voice out from the fray and projecting it with superlative clarity. The percussive bass playing at the top of the fretboard was caught as never before, making Date Stamp positively bounce along. Synth textures were superbly conveyed and lead and rhythm guitars were tightly located. The amplifier proved detailed and poised at the same time, managing to sound fast and incisive but never harsh. Whereas many lithe transistor amps get their speed from the brightness their added switching distortion creates, the K5881 PSE made it through sheer grip.

All in all, it's a very charming amplifier. Modest power means you need reasonably efficient loudspeakers or a small room. But in the right system it can be breathtaking, pulling you into the music like very few amps at any price can do. Many will find it a real charmer.

HOW TO ORDER

K5881 PSE is available now! For further information and ordering details, please see page 82 in the main issue.

SAFETY

Lethal voltages exist in this amplifier. We do not suggest you attempt to build it unless you are conversant with valve circuits and safety precautions. You should possess a voltmeter capable of reading up to 1000volts.

An approved BUILT version is available for those without electronic knowledge or experience - see page 82 in the main issue.

MEASURED PERFORMANCE

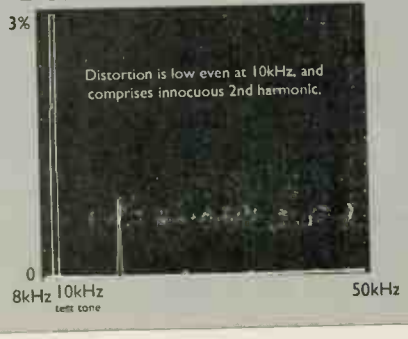
The K5881 PSE amplifier discloses its single ended nature in its measured performance. At 1W/1kHz distortion measured 0.16% of nearly pure second harmonic, typical of a well designed single-ended amplifier. Higher order harmonics only appeared when clipping was reached.

An interesting experiment was to disconnect the UL tap and run the output valves as pure pentodes. The distortion characteristic was dramatically different, with second harmonic dropping to be replaced by third and higher order components, but with no power increase. This demonstrates the effectiveness of this design feature.

Power was measured at a distortion limit of 1%, at which point output was slightly over 17W/channel with both channels just below visual clip. This is enough to drive reasonably sensitive 'speakers to surprisingly good levels, after all a 60W/channel amp will only play 6dB louder on the same speaker.

Bandwidth is deliberately set at 30Hz-25kHz (-1dB). The output transformers will allow full output at 30Hz, but maximum power starts to drop as the frequency is lowered even though there is a substantial mass of iron in the cores. This prevents the cores saturating when subjected to subsonics such as those from LP.

Distortion



Hum and noise will not be a problem at 1.5mV and -90dB respectively. In practice this will be inaudible at the listening position, except maybe with horn loudspeakers of 100dB sensitivity or more.

Sensitivity is 280mV for full output, which is enough to be used with most vintage and modern equipment including passive preamps. Very low output equipment, such as the Leak Troughline however, will need some preamplification. **AG**

AMPLIFIER TEST RESULTS

Power		17watts
Frequency response		30Hz-25kHz
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TEST YOUR OWN LOUDSPEAKER DESIGNS

Liberty Instruments' IMP/MLS is an affordable audio analyser capable of accurately measuring loudspeaker frequency response, impedance and phase. Complete with microphone and designed to run on an IBM PC compatible, Dominic Baker finds IMP/MLS a powerful system.

The world of DIY loudspeakers is fast expanding these days. State of the art drive units are becoming more commonly available to the DIY'er, at reasonable cost. Most people can knock up their own box, and crossovers are relatively simple to construct in comparison to other, more arduous projects such as valve amplifiers and CD convertors.

But if you want to design your own loudspeaker system the major problem of bringing it up to a reasonable state of accuracy as a transducer will face you. Many people do engineer by ear and, with great experience and a good reference 'speaker, response flatness to within a few dB can be obtained. However, few people will ever achieve this, lacking the background. Loudspeakers are seductive and engineering them by whim, without any guidance from measurement, often results in strong imbalance. By this I mean you can, for example, engineer a speaker to give a wonderfully smooth easy sound, only to find in later comparison against, say, a friend's, that quite a lot of information is missing and that what seemed like smoothness now sounds like murkiness. You've failed to marry up midrange to treble in the crossover, a common failure even in commercial loudspeakers. Without frequency response measurement, you won't know in the first place and, once having found out, will have difficulty in finding a remedy.

To develop a loudspeaker properly the ability to measure frequency response accurately is crucially important. It doesn't mean you have to engineer for a flat response, it simply means that educated decisions can be made about its performance. Want a soft yet adequately revealing sound? Make sure the tweeter rolls off gently to around -2dB down or so at 20kHz. Want super vocal intelligibility and projection? Put in 1dB or so of upper midrange lift. There are affordable computer packages that can help you design the box, and those more mathematically minded can use the Thiele-Small equations these rely upon, fine tuning in the bass being carried out by ear. But when it comes to crossover design, for good results frequency response needs to be known, as well as driver impedances and much more.

Most bass/midrange units have a

response that rises with frequency, needing a series inductor to compensate. Crossovers calculated from simple theoretical equations are usually unsatisfactory in practice. I use a package called Netcalc to model crossovers accurately. But, for perfect results, precise fine tuning still requires response and impedance measurements of the actual system you are working on.

Up until now this has demanded heavy duty equipment, our Hewlett-Packard FFT spectrum analyser and Brüel & Kjær microphone would set you back around £15,000. The complicated part of our FFT analyser is the bit which performs the maths that turns what the microphone 'hears' into a graph on the screen. With an IBM PC, all that's needed is something to convert this signal from the microphone into something that the PC can understand, and some clever software.

The IMP system reviewed here does just that. The IMP box converts the analogue signal from the microphone into a digital code for the PC, and the computer software displays it in the form of a graph which is easily interpreted. For a fraction of the price, it carry out the essential tasks of a dedicated FFT.

IMP allows the DIYer to measure frequency response, impedance and phase. So, now not only can the enthusiast get their hands on state-of-the-art drivers and crossover components, but with the aid of IMP they can produce a design as well engineered as almost any manufacturer.

You're probably asking "at what price though?" The basic IMP system comes complete with a microphone, the hardware and software, for just $304.95 (equivalent to around £190.59) in kit form. Fully built and tested it is still only $460 (equivalent to around £287.50). If you already own a PC, this makes it one of the most affordable FFT measuring systems available. But is it any good? To find out, read on.

IMP - HOW IT WORKS

The IMP audio analyser is a Fast Fourier Transform spectrum analyser capable of making frequency response, impedance and phase measurements. It takes an analogue signal from a microphone or one of its probe inputs and converts the signal into a stream of digital data which can be fed into an IBM PC compatible. Once the analogue signal has been converted into digital data, the IMP software loaded on the computer can manipulate the data to display it in the frequency response, impedance curve and phase plots we are more familiar with. For those of you who are not so technical, this is about all you need to know to get an idea of how the IMP system works.

In more detail, this is how it goes. The IMP system sends an impulse with broadband energy, amplified by your existing hi-fi amplifier, to the item being measured. In the case of a loudspeaker, the pulse will be captured by a microphone and sent back to the IMP hardware.

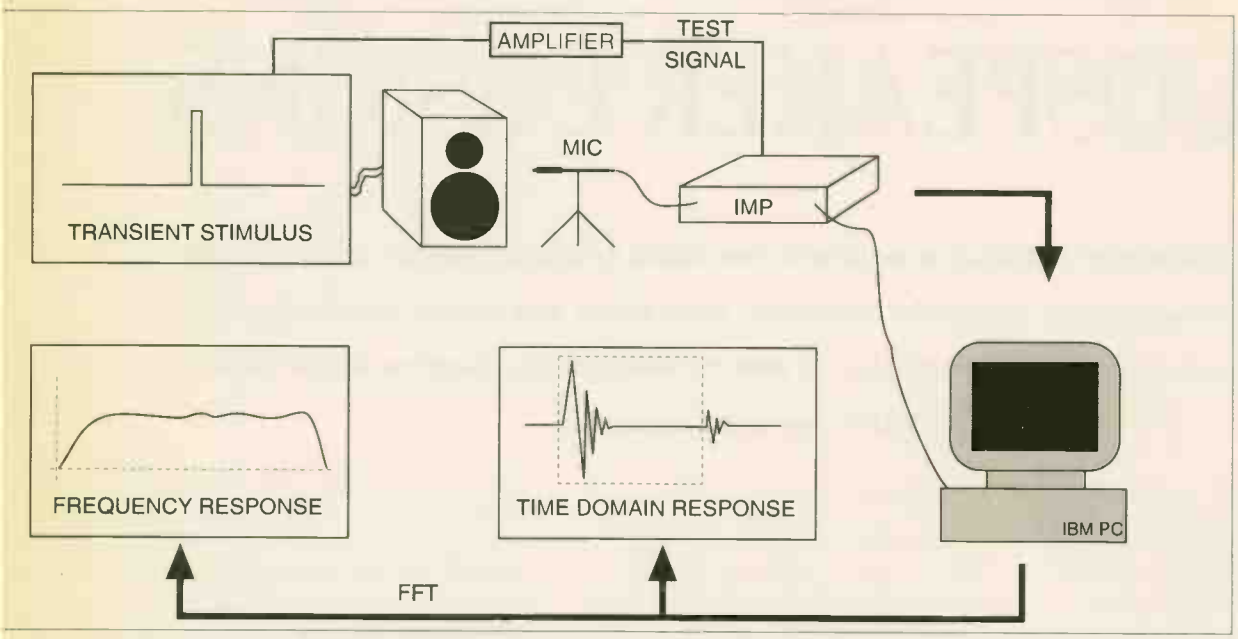
This pulse is converted by the analogue-to-digital convertor in the IMP hardware and displayed on the computer screen as shown below. A portion of this time domain response can be selected and transformed into a frequency domain response using a mathematical equation called the Fourier Transform. In fact a variation of the Fourier Transform is used which is especially well suited to computers, the Fast Fourier Transform (FFT).

The time domain response will show a sharp peak as the impulse is read by the microphone or probe input, and then a series of ripples as the pulse decays back into a flat line. Further along you will see a second ripple, smaller than the initial impulse, which is the first reflection. The portion of this that contains the information we need, is the portion between the beginning of the initial pulse up to just before the first reflection.

This portion of the time domain response contains all the information needed for the computer to mathematically transform (FFT) it into either a phase, frequency response or even a 3D waterfall plot. You can adjust scales and settings to get maximum detail where you want it, say around the crossover region, perform smoothing operations - octave, half octave, third octave up to 12th, and so on.

Obviously it is extremely important to get an accurate time domain response in the first place, as this is the reference from which all the other data is extracted. For greater accuracy, especially at low frequencies, multiple measurements can be made, each doubling in the number of tests resulting in a 3dB improvement in noise.

An upgrade to the standard IMP system (which our review kit came supplied with) is the MLS hardware and software package. MLS mathematically squeezes around 4000 test and average sequences into one, greatly improving noise immunity. If even greater immunity is needed, the MLS pulse itself can be averaged.

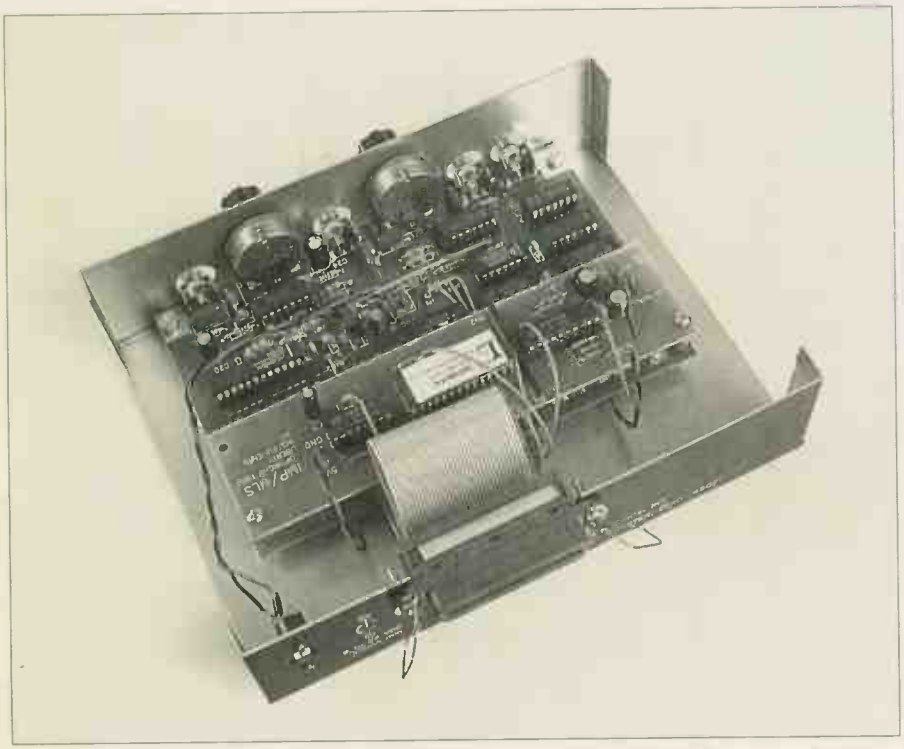


A broadband pulse is sent to the loudspeaker under test and converted by the IMP Audio Analyser into a digital signal. The PC displays this as a time domain response, a portion of which can then be converted into more meaningful response plots.

BUILDING THE IMP AUDIO ANALYSER

Our IMP/MLS audio analyser came as a kit, as requested. I wanted to find out how difficult, or perhaps easy, it would be to build for the constructor and how much work was involved.

Before I go any further, one warning to potential purchasers of IMP. Some of the integrated circuits (ICs) supplied are static sensitive. If you touch the bare pins with your hands, it will destroy them.



The MLS board sits 'piggy back' on top of the main IMP circuit board.

You either need an extremely steady pair of hands or, better, a wrist strap which earths any static build up on your hands (Maplin Code FE29G, price £8.99).

IMP is built up on a small, professionally made, printed circuit board. A lot of the soldering work involves fitting the sockets for the ICs. These range from 14-pins to 24-pins and there are a fair number of them too. I use a needle point soldering iron for ICs; the sharp point is far better suited to making a neat job with the tiny pins of the socket and the pads of the circuit board.

The instructions are not the most comprehensive I've ever come across, but the build sequence is described in detail, step by step. Quite a lot of work is involved, what with hundreds of IC socket pins, resistor network, a handful of capacitors and wire links etc. But it is all fairly straight-forward stuff, taking me around 3 hours to complete.

Updates to the board do require three modifications to be made by the user, where tracks have to be cut on the underside of the board and small capacitors soldered between them. This is by far the trickiest part, because the tracks are so fine and closely spaced. I was a little worried that enthusiastic builders could get this far, slip whilst cutting a track, cause damage to other tracks or parts and be faced with a non-working device and a great deal of extra work. I think Liberty Instruments need to produce an updated board that doesn't require such delicate and precise modifications, since we know from our own experience that poor soldering and errors in soldering are one of the commonest causes of failure in a kit.

The MLS board is much the same, but being considerably smaller and only using a couple of ICs, is far faster to build. Once completed, this board sits 'piggy back' on top of the main IMP board and has to be hard wired using short connecting wires.

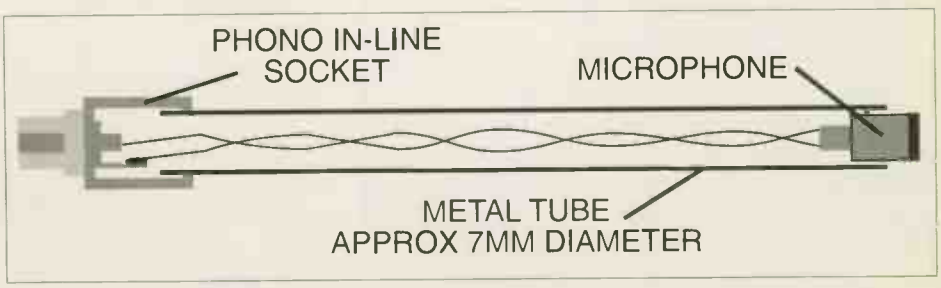
Again, because MLS is an add-on board, the wires that come from it have to be carefully soldered to the thin tracks on the underside of the main IMP board. This is extremely tricky, so the MLS addition renders the kit suitable only for highly experienced builders, preferably those who are familiar with PCB repair work. The wires have to be soldered onto tracks which are barely wider than the wire itself, and the next track along sits dangerously close for those with a tendency to overdo the solder.

Check, and then double check that you have made all the right connections between IMP and MLS. Each is detailed in the instructions which should prevent any misconnections being made.

Once the two boards are built and fitted together, they can be mounted into the case. It's a lightweight and flimsy affair, but adequate for the job and well finished all the same. This is the easy part, and anyone who's made it thus far should cope with ease. The only bit of effort required is breaking off the positioning pin on the potentiometers - it would have been easier to have these punched into the chassis, but it does add to the 'kit' feel.

Assembly should take the experienced builder around 6 hours to complete in all, but it's not over when the boards are finished, for IMP is supplied complete with a microphone capsule. The only thing is, you have to make a 'wand' (body) for it yourself. The capsule is slotted into one end of a 300mm long tube (use tape to give it a firm fit) and an in-line metal phono socket fitted to the other. You may have to do some drilling here. Once slotted inside, it can be held firmly with Araldite or solder.

My system worked first time The only problem I encountered was that a 110V mains supply had been provided instead of 240V for the UK. A trip to Maplin solved this though. Be sure to specify clearly what mains supply you will be using IMP on when you order.



The microphone housing has to be made by the constructor, but it is a relatively straightforward task for the practically minded.

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USING IMP

In use IMP is relatively straightforward, the "Quick intro" tutorial describing most of the basic measurement techniques. Good, clear diagrams of exactly how to set up the equipment for frequency response and impedance allow you to get working very quickly; I had the system up and running with an accurate response curve displayed within an hour.

CAL

One feature of the IMP/MLS audio analyser I haven't described so far is the CAL process. By just sending the MLS signal to a loudspeaker under test you are leaving a lot to chance. The microphone may not have a perfectly flat response, nor the amplifier you are using to amplify the test signal. So straight away there are two possible causes of inaccuracy. Less obviously, the MLS test pulse will not have a completely even energy content and further errors will be introduced as the IMP converts the analogue signal from the microphone into digital code for the PC.

Fortunately, one of the great advantages of using a computer based test system like this, is that errors such as these can be quickly and easily corrected for. With a computer it doesn't matter how lumpy the response of the microphone is, as long as you have an accurate response plot for it. This can be programmed into the computer software which will then correct its response to give a perfectly flat result. When you order the IMP test system ask for a calibration file with the microphone. This costs $25 extra, but is well worth it, taking care of this problem.

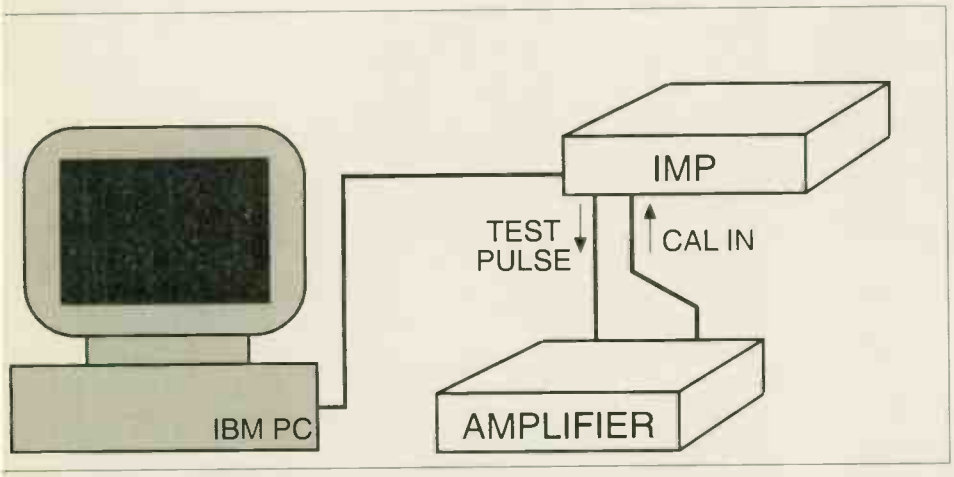
The other errors within the test system can be corrected using the CAL process. Put simply, a probe is connected to the output of the test amplifier so that IMP can 'see' exactly what is being fed to the loudspeaker as a test stimulus. Once this is known, any errors in the test signal can be divided out by the computer. By connecting the test signal output from my amplifier into the input CAL probe of IMP, it will measure its own response. The curve it displayed had strong treble roll-off above 10kHz. This was quickly programmed in and used as a correction curve for future measurements, which proved extremely accurate. CAL should always be used for accurate measurements with IMP.

CYCLING

One great advantage of computer based test systems is that they store their results for convenient display and manipulation. IMP is the same. You press 'Acquire' to trigger the test sequence, sending the pulse to the loudspeaker and creating a measurement which is stored in the computer's memory.

IMP has a useful feature called Cycling. This repeats the sequence, sending a pulse, receiving it on the computer screen and transforming it into a response plot over and over again.

On my reasonably fast 486dx33 PC, this contiguous updating was fast enough to give close to 'real time' measurements, allowing the microphone position to be adjusted or a crossover component changed, whilst the results were viewed almost simultaneously on screen, much like our Hewlett-Packard 3561A. This makes crossover design and port tuning fast, efficient and accurate, showing the power of a good test system.



The CAL Process calculates any errors introduced in the measurement system which can then be divided out in the computer software.

CONCLUSION

IMP is a remarkable system for the Do-It-Yourself loudspeaker designer, allowing fast and accurate measurements to be made at an affordable price. It is capable of measuring frequency response, impedance, phase and, with a calibrated microphone, sensitivity too.

Using a system such as this, the DIYer can truly rival some of the most advanced and complex commercial loudspeaker designs around. The only point to bear in mind is that whilst IMP provides the information, the user has to act upon it, needing knowledge and experience. However, IMP offers a powerful starting point. It's a remarkable tool for any DIY loudspeaker engineer ●

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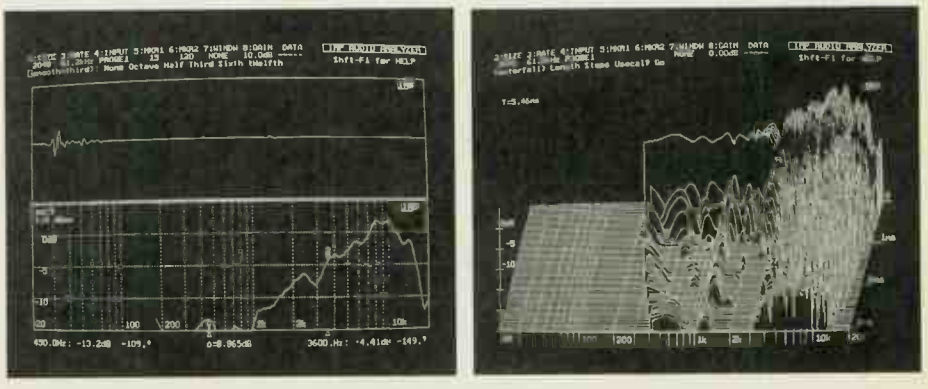

Once the time domain response has been measured, IMP can quickly manipulate it into frequency response, impedance, phase or even a waterfall plot.

Audio Note

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We do accept a UK cheque or bankers draft in Pound Sterling for the above charges as well, just convert the US$ amounts to Sterling at $1.60 to the Pound, and then round up to nearest $5.00.

NEW DIRECT HEATED TRIODE!

It is not every day that you can announce the arrival of a new triode, this courageous endeavour is [illegible] the VV30B is [illegible] the 300B [illegible] 50% higher power! [illegible] can be expected the VV30B will not be cheap, [illegible] £300.00 [illegible]. Life expectancy is minimum 10 hours at maximum power, guaranteed for 2 hours or 1 year. Full specifications available on request, please enclose a stamped addressed envelope.

SOUND PRACTICE

If you are seriously interested in the subject of valve amplifier design without the usual [illegible] "good" amplifier design and technology [illegible] then SOUND PRACTICES is the magazine to read. Here you will find articles about [illegible] DIY articles for amplifiers and speakers, reviews of new and old, in other words [illegible] advertising [illegible]. You can buy SOUND PRACTICES [illegible] 5 issues [illegible] by subscription from SOUND PRACTICES, P.O. Box 180562, Austin, TX 78718, USA. A regular modern world bargain, and there are practically [illegible] SOUND PRACTICES [illegible] So get a [illegible]!

By the time you read this SOUND PRACTICES issue 6 should be HERE [illegible] the street for the next [illegible] £5.00 + postage [illegible] the UK [illegible] articles: Orleo 211 [illegible] PP 2A3 by Diego Nardi, [illegible] Single-Ended [illegible] affordable SE [illegible] the AES SE 1 [illegible] 2A3 [illegible] Shunt Regulator by John Camille, the 71A [illegible] A tube Output Stage for the DAC in the Box by Mike van Evera and last by [illegible] Law by Cathode Ray! And with luck Vinny Gallo [illegible] to the EMT 927 [illegible] to be a classic! [illegible] £5.00 + an A4 [illegible] US$ [illegible].

POSITIVE FEEDBACK

[illegible] Positive Feedback [illegible] greatness, not unlike the great underground magazines of the 1970's. It is a quarterly publication of [illegible] controversial commentary by [illegible] as well as [illegible] on the subjects of music, audio [illegible]. For one, think it is an excellent read and [illegible] which tends to view the world in [illegible] now without giving much perspective [illegible]. Positive Feedback's latest issue is just off the press and is available at $6.00 per issue.

COMPLETE KITS

At the [illegible] should be available during 1994. The sequence of introduction may be different from the number, we have the KIT THREE [illegible].

KIT TWO [illegible] single-ended, 15 watts Class A, [illegible] chassis, expected cost £ 599.00 incl Vat. Delivery Oct. 1994.
KIT THREE 300B [illegible] single-ended [illegible] chassis, 16/17 watts Class A, cost £1 450.00 incl Vat.
KIT FOUR [illegible] push-pull, [illegible] watts Class A, stereo chassis, expected cost £179.00 incl. Vat, delivery Dec 1994.
KIT FIVE 211 mono-ended, 15 watts Class A, mono chassis, expected cost £2 250.00 incl. Vat, delivery [illegible] 1995. We hope!
KIT SIX [illegible] single-ended, 7 [illegible] watts Class A, [illegible] £499.00 [illegible] "[illegible]" or "[illegible]" [illegible] rock and roll, if you prefer. Available November/December 1994.

If you [illegible] whether a kit project is suitable for you, we suggest you spend £10.00 on buying the instructions for the KIT ONE single 300B amplifier. This will give you a good idea whether a kit project is for you, if you decide to buy a kit then the £10.00 will be refunded against [illegible]. As the other kits become available their instruction manuals will also be available at £10.00 each. We have the Kit One instructions available in English and [illegible].

AUDIO NOTE OUTPUT TRANSFORMERS.

We are in the process of building up our [illegible] in order to offer the best possible outputs at different price points, they will fall into four categories:

A) Economy range, where the price/quality relationship is carefully calculated to ensure audio quality in a compact package. Initially we will only be offering 3 single ended output transformers in the [illegible] development, but [illegible] of Christmas.
B) Mid-price range, which are the output transformers already on offer, we have made a couple of additions to this range since the [illegible].
C) High Quality range, [illegible] will be offered, unless demand requires it. Again 3 offerings [illegible].
D) Super High Quality range, [illegible] possible. I do not [illegible] will be as good as the [illegible] transformers [illegible] by Audio Note in Japan, they won't, but then again they do not carry the price tag either!

The [illegible] group A are [illegible] 1 to 1.5dB, [illegible] termination and are supplied with [illegible] good audio quality at the cost. The main cost saving being the use of a smaller core, specified to the exact power level required, rather than overspecifying by 50 or 100%, as we do in Group B. The winding quality and [illegible] the same.

Group B are typically 20Hz to 45kHz [illegible] 1.5dB, [illegible] cored with high quality [illegible] with either half-ends or frames [illegible].

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

Group D [illegible] Audio Note silver wire, need I say more??

SPECIFICATIONS

PP = Push-Pull, PPP = Parallel Push Pull, SE = Single-ended, PSE = Single-ended Parallel, UL [illegible] we do not consider the use of UL [illegible], as we [illegible] ** [illegible].

All primary impedances are calculated for Class A operation, with [illegible] consideration given to [illegible].

All our single ended output transformers are air gapped, and the maximum standing current allowed [illegible] 5.

All our output transformers are [illegible] minimum 3 [illegible], all 211/845 outputs are insulated to 5kV flash, every transformer is tested to this level of insulation.

We [illegible] our transformers by 50% power in Push-Pull [illegible] that a transformer [illegible] as 25 watts will deliver about 35-38 watt peaks, our single-ended outputs are generally over specified by 100%, which means that they will [illegible] peaks of double the given maximum power [illegible].

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

In addition to the output transformers offered below, we offer a design service, where we can [illegible] for wideband transformers, whether for microphones, moving coil [illegible] phase splitter, interstages, driver or power output, we design and manufacture prototypes in-house, the cost for the paper design is £200.00, prototype cost is calculated on a per case [illegible]. We can also produce production quantities.

Sizes are given as Width/Height/Depth, where [illegible] is the depth of the coil stool and width is the length of the core.

AUDIO NOTE CHOKES & INDUCTORS

Value	Size	Price Ex. UK Vat
0.5H/40[illegible]A		18.00
3H/100mA		14.00
[illegible]H/25[illegible]A [illegible]		24.00
5H/150mA		21.00
[illegible]A		31.00
10H/125mA	63x74x76mm	26.00
[illegible]A	[illegible]	33.00
[illegible]A	[illegible]	[illegible]4.00

[illegible]

AUDIO NOTE PAPER IN OIL COPPER & SILVER FOIL SIGNAL CAPACITORS

[illegible] paper in oil capacitors where instead of using aluminium foil as in the above caps, in the first range we use oxygen free copper foil with 99.99% pure solid silver lead out wires these copper foil paper signal capacitors are considerably better than the [illegible]. Surprisingly [illegible] the price/quality gap between the [illegible] capacitors, we will be offering [illegible] 99.99% pure silver foil signal capacitors, which are pretty staggering in quality, even if [illegible] the silver foil caps [illegible] of each available.

AUDIO NOTE COPPER FOIL PAPER IN OIL CAPACITORS.

Value	DC Voltage	Size	Price ex UK Vat
0.047mF	630 volt	28x16mm	12.35
0.1mF	630 volt	33x22mm	14.[illegible]
0.15mF	[illegible] volt	35x22mm	16.45
0.22mF	630 volt	56x25mm	19.75
0.47mF	630 volt	[illegible]	27.45
1mF	630 volt	[illegible]x44mm	45.85

AUDIO NOTE SILVER FOIL PAPER IN OIL CAPACITORS.

Value	DC Voltage	Size	Price ex UK Vat
0.047mF	630 volt	14x46mm	41.00
0.1mF	630 volt	[illegible]x46mm	74.00
0.15mF	630 volt	22x[illegible]mm	101.00
0.22mF	630 volts	19x[illegible]	135.00
0.47mF	630 volt	[illegible]	196.00
1mF	630 volt	[illegible]	486.00

AUDIO NOTE CERAMIC STAND-OFFS

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

AUDIO NOTE CERAMIC STAND-OFFS.

Type No	Number of Tags	Height/Length	Solder Connection	Chassis Fixing	Price Ex UK VAT
AN-451	1	25.5mm	Wrap-round	Screw-in bolt	1.41
AN-45[illegible]	1	17.4mm	Wrap-round	Screw-in bolt	1.41
AN-45[illegible]	1	22.0mm	Solder [illegible]	Screw-in	1.41
AN-452	2	Adjustable 17mm	Solder slots	Double bolt screw-in	2.42
AN-453	3	Adjustable 24mm	Solder slots	Dual bolt Screw-in	3.05
AN-455	5	Adjustable 32mm	Solder slots	Dual bolt screw-in	4.04
AN-458	8	Adjustable 58mm	Solder slots	Dual bolt screw-in	5.75
AN-460	10	Adjustable 72mm	Solder slots	Dual bolt screw-in	7.31
AN-4[illegible]	6	26mm/45mm	Solder slots	Screw-in bolt	5.[illegible]
AN-4[illegible]	9	25mm/[illegible]mm	Solder slots	Screw-in bolt	7.5[illegible]

AUDIO NOTE AUDIO QUALITY OUTPUT TRANSFORMERS

Group A
Single-ended Outputs

Suggested Valve	Max Cl. A Power	Prim-Sec Imp	Size/Weight	Max Current	Price Ex. UK VAT
300B/2A3/6B4G	15 watts	2K5 - 4/8 Ohms	80X67X[illegible]	90mA SE	44.50
811A/VT4C/845	20 watts	8K - 4/8 Ohms		[illegible]mA SE	73.5[illegible]
300B/2A3/6B4G	20 watts	1K25 - 4/8 Ohms		150mA PSE	84.50

Single-ended Circuits
Group B

Suggested Valve	Max Cl. A Power	Prim-Sec Imp	Size/Weight	Max Current	Price Ex. UK VAT
EL[illegible]	20 watts	2K6 - 4/8 Ohms	117x[illegible]	[illegible]mA PSE	87.00
300B/2A3/6B4G	25 watts	2K5 - 4/8 Ohms	117x[illegible]	90mA SE	
[illegible]CA7	30 watts	1K5 - 4/8 Ohms	15[illegible]	1[illegible]mA PSE	113.[illegible]0
[illegible]	30 watts	1K25 - 4/8 Ohms	[illegible]	[illegible]mA PSE	97.00
5[illegible]/KT66	30 watts	2K1 - 4/8 Ohms	115x[illegible]	14[illegible]mA PSE	[illegible]0.00
211/VT4C	30 watts	2k1 - 4/8 Ohms	117x[illegible]	150mA SE	114.00
211/VT4C/845	50 watts	10K - 4/8 Ohms	1[illegible]2x134x1[illegible]	[illegible]mA SE	124.00
300B	50 watts	1K25 - 4/8 Ohms	1[illegible]x115x1[illegible]	18[illegible]mA PSE	151.0[illegible]
845	50 watts	2K5 4/8 Ohms	137x114x1[illegible]	180mA PSE	172.00
211/VT4C	75 watts	5K - 4/8 Ohms	137x115x145mm	240mA PSE	237.00
EL[illegible]/KT88	20 watts	3K - 4/8 Ohms	117x[illegible]	1[illegible]mA SE	1[illegible]4.00
300B/2A3[illegible]	25 watts	2K5 - 4/8/16 Ohms	11[illegible]	[illegible]mA SE	1[illegible]5[illegible]
[illegible]	30 watts	3K - 4/8 Ohms	115x[illegible]	140mA SE	107.00
NEW SE PRODUCT					
[illegible]/KT88	60 watts	2K3 - 4/8 Ohms		11[illegible]mA PSE	123.00

Group B
Push-Pull Circuits

Suggested Valve	Max Cl. A Power	Prim-Sec Imp	Size/Weight	Max Current	Price Ex. UK VAT
EL84/ECL86	15 watts	8K - 4/8 Ohms	80x67x[illegible]	PP	42.00
EL[illegible]	25 watts	6K - 4/8 Ohms	[illegible]	PP	5[illegible].00
2A3[illegible]	30 watts	5K - 4/8 Ohms	88x[illegible]	PP	63.00
KT88/6550	50 watts	6K6 - 4/8 Ohms	108x91x[illegible]	PP	73.00
EL34/KT66/5881/845	50 watts	3K - 4/8 Ohms	[illegible]	PPP	74.00
KT88/6550	60 watts	4K3 - 4/8/16 Ohms	1[illegible]x11[illegible]	[illegible]PP	11[illegible].00
KT88/6550	100 watts	2K2 - 4/8 Ohms	150x147x11[illegible]	[illegible]LPPP	134.00

Group C
Single-ended only

Suggested Valve	Max Cl. A Power	Prim-Sec Imp	Size/Weight	Max Current	Price Ex. UK VAT
300B/2A3/6B4G	25 watts	2K5 - 4/8/16 Ohms		9[illegible]mA SE	[illegible]0.00
211/VT4-C/845	50 watts	10K - 4/8/16 Ohms	165x148x14[illegible]mm	150mA SE	410.00
300B	50 watts	1K25 - 4/8/16 OHMS	1[illegible]MM	[illegible]mA PSE	[illegible]6.00

Group D
Pure Silver Wired Outputs

Suggested Valve	Max Cl. A Power	Prim-Sec Imp	Size/Weight	Max Current	Price Ex. UK VAT
300B/2A3/6B4G	25 watts	2K5 - 4/8 Ohms	117x[illegible]	9[illegible]mA SE	1 645.0[illegible]
211/VT4-C/845	50 watts	10K - 4/8 Ohms	112x134x15[illegible]	150mA SE	1 9[illegible]5.00

The Audio Note silver wired outputs listed here are designed and made in the UK, we can supply the AUDIO NOTE Japan manufactured outputs for the ONGAKU or the KEGON, but they are [illegible] as you would expect [illegible] take upwards from 100 hours each to make, for example an output transformer for an ONGAKU costs £16 500.00.

AUDIO NOTE MAINS TRANSFORMERS.

This range relates to our finished products, mains transformers are notoriously difficult items to offer as the number of permutations of HT and Heater voltages are almost endless. We have added mains transformers for [illegible] of the KASSAI and ONGAKU, as there has been considerable call for these. [illegible] we are preparing mains transformers for the WE91 described in Sound PrActices Issue 1, we shall continue to expand the range as opportunities and our experience with your requirements improve.

Primary Voltages	Secondary HT Windings	Secondary Heater Windings	Price EX UK VAT
0v-100v-110v-120v	0v - 2[illegible]v at 250mA	0v - 12.6v at 1 AMP	34.00
0v-[illegible]		3.15v-0-3.15v at 4 Amp	
[illegible]	0v - 2[illegible]v at 0.4 Amp	0v - 12[illegible] at 1 A	41.00
0v-100v-110v-120v		3.15v - 3.15v at 4 Amp	
12[illegible]	380v - 0v - 380v at 60mA	12.[illegible] - 0v at 1.5A	[illegible]
130[illegible]		6.3v - 0v at 600mA for M7 Tube Pre-amp	
with 5[illegible]			
0v-100v-110v-120v	0v - 290v at 40mA	12.6-0v at 1.5A	26.00
0v-100v-110v-120v		0v - 6.[illegible] at [illegible]mA	
0v-[illegible]	3[illegible]v - 244v-0-244v-3[illegible]v at 3.15 at 4.5 Amp	72.5[illegible]	
0v-100v-110v-120v	3[illegible]mA	12.6v at 1.5Amp	
120v/110v/100v/0v	0v-920v at 160mA	0 - 10v at 4Amp, 0v-6.3v at	98.00
0v-100v-110v-120v	150v - 150v at 50mA	1.5A, 0v - 5v at 2.5A	
12[illegible]/11[illegible]/0	380v-0-380v at 200m a	3.15-11.2 amp, 7 amp	86.[illegible]
0v-100v-110v-120v	170v at [illegible]mA	at 3A, 7v at 3A, 5v at 2A	
120v/110v/100v/0v	425 v-0v-425 at 220mA	3.15v-0v-3.15v at 2.5A	95.60
1[illegible]v-110v-120v		7[illegible]-0v at 2A 7.0v-0v at 2A	[illegible] KIT ONE & KIT
		5.0v-0v at [illegible]A	THREE MONO [illegible]
		3.15v-0-3.15v at 750mA	
120v/110v/100v/0v	390v-0v-390v at 200mA	170-0v at 50mA, 7.0v - 0v at	107.00
100v-110v-120v		3A, 7.0 - 0v at 3A, 5v - 0v at	
		2A	For KASSAI [illegible]
		3.15v-0v-3.15v at 1.2A	
120v/110v/100v/0v	380v - 0v 380v at 200mA	150v-0v at 150mA, 10v-0v	137.00
100v-110v-120v		3.25A, 1[illegible]-0v at [illegible]5A	
		5v - 0v at 3A, 5v - 0v at 3A	For ONGAKU [illegible]
		5v - 0v at 3A, 5v - 0v at 3A	
		6.3v - 0 6.3v at 1.25A	

We [illegible] for the WE91 power amplifier [illegible] in Sound Practices [illegible] single ended output transformers with 3K Ohm primary impedance [illegible] the copies of the [illegible] £420.40 per set.

We [illegible] to make any mains transformer to your specification [illegible] minimum 2 pcs, they can be supplied [illegible] bell-ends. Ask for a quote.

On a more general note it is important to understand the specialised nature of the design and manufacture of transformers for audio equipment, in most industrial applications the main criteria are cost, weight or longevity, an audio mains transformer also have to have good regulation under load, must run cool, and generate no mechanical noise or vibration, produce no excessive stray magnetic fields etc. etc., a pretty tall order, when one considers that the cost also has to be reasonable. So no matter where you order your mains transformer remember that it should conform to the above criteria [illegible]. As a general rule we do not recommend potted transformers, as tests have shown these to sound less clear than unpotted equivalents.

AUDIO NOTE SILVER FOIL SIGNAL CAPACITORS

Best signal capacitors available, quality really speaks for itself, used in amplifiers like ONGAKU, KEGON, CAKU-ON and M7 Tube Silver, hand-made in very limited quantities at Audio Note's facility in a Tokyo [illegible]. These capacitors use a fine [illegible] dielectric and are manufactured using considerable tension on the foil and dielectric to give the best possible contact and the least scope for internal resonance.

Value	DC Voltage	Price ex UK Vat
0.[illegible]mF	500 volt	177.00
0.[illegible]mF	500 volt	211.75
0.05mF	500 volt	346.75
0.1mF	500 volt	645.75
0.[illegible]mF	500 volt	995.75

AUDIO NOTE PAPER IN OIL RESERVOIR CAPACITORS

Mainly for use in inductor power supplies, but have other uses.

Value	DC Voltage	Size	Price Ex UK Vat
2mF	400 volt	[illegible]mm	25.75
2mF	630 volt	[illegible]	33.65
2mF	1000 volt	43x[illegible]x72mm	41.75
2mF	1600 volt	5[illegible]	45.95
4mF	[illegible]00 volt	[illegible]	[illegible].95
4mF	2[illegible]00 volt	[illegible]	205.75
10mF	1000 volt	70x[illegible]x10[illegible]	96.75
12mF	1000 volt	[illegible]	100.95
12mF	1600 volt	[illegible]x100x1[illegible]	185.75
12mF	2000 volt	100x100x220mm	153.75

AUDIO NOTE PRECISION CARBON/FILM RESISTORS

In addition to the non-magnetic resistor equations we are going to divide a range of precision gold plated carbon film resistors. In every case the value that appears is embedded if you are building an amplifier based on the circuit. We've arranged for VF351 or another brand of a similar wattage. We shall be removing lower wattages in products like the Model 1+1.2 and 1 each values. Small resistors are made particularly for us by a major manufacturer.

They cost on the 1/2 £3.00 each 1 watt £4.80 each 2 watt £6.00 each

AUDIO NOTE PAPER IN OIL SIGNAL CAPACITORS

These hand made signal capacitors are specially assembled by one of the plastic or other paper types we have come across. It is the most experienced the difference that a well grind essential capacitor can make to a valve amplifier. Here are made around by our specially made paper oil caps has a fifty colour dot of hand-made and overseen in Europe, delivered across the frequency range, which is guaranteed in whether or not your own. Recommended as replacements in old and new amplifiers when used even in the very sensitive amplifiers, and essential for DIY projects. In line with environmental standards, all AUDIO NOTE paper in oil capacitors contain non-toxic, biodegradable vegetable oil. The paper is a specially treated and impregnated by a method that enhances longevity and sound quality, to ensure optimum performance all round. As you will see, require utterly astonishing, over 99.9% pure silver electrodes as the range of paper in oil capacitors as well. In common with copper and silver foil types. These are available now values available, including the 2.2mF/50 volt, also made for speaker crossovers and the 1.56mF/1000 volt available for solid state amps.

Value	DC Voltage	Size	Price ex UK Vat
2.2mF	50 volt	21x9mm	11.65
0.56mF	250 volt	25x20mm	4.95
0.1mF	630 volt	27x9mm	2.85
0.22mF	400volt axial leaded wired	25x11mm	4.45
0.047mF	400 volt	29x11mm	4.10
0.082mF	440 volt	33x14mm	4.25
0.1mF	440 volt	41x14mm	4.75
0.15mF	400 volt axial leaded wire	34x16mm	4.65
0.18mF	400 volt	32x16mm	5.15
0.22mF	400 volt	35x18mm	5.85
0.33mF	400 volt	40x18mm	6.75
0.14mF	400 volt	32x24mm	14.95
0.0015mF	630 volt	17x9mm	2.85
0.022mF	630 volt axial leaded wire	23x18mm	4.45
0.033mF	630 volt	28x11mm	3.75
0.056mF	630 volt	41x11mm	4.25
0.056mF	630 volt	31x14mm	4.25
0.068mF	630 volt	31x14mm	4.25
0.082mF	630 volt	28x14mm	4.25
0.068mF	630 volt	31x14mm	4.25
0.071mF	630 volt	36x16mm	4.35
0.075mF	630 volt	31x16mm	4.35
0.075mF	630 volt	31x16mm	4.75
0.075mF	630 volt	31x16mm	4.85
0.082mF	630 volt	31x16mm	4.55
0.1mF	630 volt	34x16mm	6.65
0.1mF	630 volt	47x16mm	5.45
0.22mF	630 volt axial leaded wire	50x16mm	7.25
0.27mF	630 volt	41x21mm	6.15
0.33mF	630 volt	50x21mm	7.25
0.39mF	630 volt	46x25mm	7.45
0.39mF	630 volt	50x25mm	7.95
0.47mF	630 volt axial leaded wire	50x28mm	9.85
0.22mF	1000 volt	56x28mm	6.95
0.39mF	1000 volt	61x28mm	11.65
1.2mF	1000 volt	61x39mm	16.75
0.22mF	1600 volt	60x28mm	9.05
0.22mF	2000 volt	74x28mm	11.55

All AUDIO NOTE paper in oil signal capacitors are axial type. We are producing a range of very small production value paper in oil capacitors at the moment in addition to this range. The issue of AUDIO NOTE paper in oil signal capacitors is steadily expanding, so ask for whom that you do not see

AUDIO NOTE ACID & CHLORIDE FREE SILVER SOLDER

The best solder we have been able to find, were not contaminate the conductor, which may lead to increased junction resistance. Used in all our amplifiers from OTO to the GAKU DR.

Weight/Diameter	Price Ex UK Vat
50 gramme or close to each 1mm diameter	19.95
1 this roll of 1mm diameter	210.65

AUDIO NOTE CABLES & WIRES.

We are proud to offer the AUDIO NOTE range of high fidelity copper and silver/silver, speaker and wiring cables which, depending on the overall price of the product, will be supplied as standard, upgrade or good.

SOLID 99.99% PURE AUDIO NOTE SILVER WIRE

Gauge	Insulation Material	Price per Meter Ex. UK Vat
1.63mm	polyurethane	16.75
1.21mm	Polyurethane	22.75
0.28mm	Nil	24.95
0.6mm	Nil	27.85
0.8mm	Nil	31.75
1mm	Nil	36.75

This wire is gold silver wire use suitable for rewiring, for speaker crossovers, both vertical soldering or for internal wiring in loudspeakers, amplifiers etc.

AUDIO NOTE COAX INTERCONNECT CABLES.

Trim/Colour code	Construction	Price per Stereo Meter Ex UK Vat
AN-A yellow	conventional 99 copper/Si coax	15.00
AN-C red	conventional OFHC copper/Si coax	29.70
AN-S think grey with yellow stripe	conventional 99.99% silver/Si coax	84.25
AN-X black grey with yellow stripe	conventional	240.00

It is recommended to use the internal wire of grey which is the AUDIO NOTE coax cables as internal wiring parts, this is what we do in completing the DN GAKU, MF Tuner etc.

AUDIO NOTE SPEAKER & WIRING CABLES.

Type/Colour code	Construction	Price per Mono Meter Ex UK Vat
AN-O silver	single core 99.99% copper speaker wiring	6.85
AN-B blue cross whitney	double strand, screened 99.99% copper wire	12.34
AN-L blue black wiring	double strand, screened 6N 99.9 copper speaker wire	25.11
AN-SP silver	single core 15 strand 99.99% 6N silver speaker wire	106.38
AN-SPX silver	single core 26 strand 99.99% 6N silver speaker wire	309.98

PTFE INSULATED SILVERPLATED COPPER WIRES.

We can also provide less expensive wiring suited for hand wiring circuits. These PTFE insulated silver plated copper wires are 19 strand of 0.15mm wire and come in 5mm, 10mm, 15mm, and 20mm insulation styles, white and red/white. Only cost £1.60 per metre in any colour.

AUDIO NOTE HIGH QUALITY STEPPED ATTENUATORS & SWITCHES

These hand made attenuators and switches are manufactured by a friend of my friend of AUDIO NOTE and designed by him, including volume controls and potentials you can use in your pre-amplifier. The attenuator is 48 steps and with silver / rhodium plated contacts and has made with an eye of isolation the resistors. The controls feature silver plated contacts and gold detailing switch.

Type	Value	Price Ex UK Vat
Stereo Potentiometer Attenuator	50K Ohms	196.75
Stereo Potentiometer Attenuator	10K Ohms	257.75
2 Channel attnu	6 way selectable	78.75
4 Channel switch	6 way selectable	101.75

AUDIO NOTE SELECTED AUDIO VALVES.

Our valves are selected from the best available sources and are tested to the same stringent standards that we apply in production of our own amplifiers. Also we are now designing stronger production valves and can, hopefully, NOS (Nuvo Old Stock) valves which are no longer in production. We have provided a comparison of NOS items, which is available on request, however, the whole list may be are out of date.

Standard stock items

Type No.	Type	Price Ex. UK Vat
E[illegible]	double triode	2.95
E[illegible]	double triode	3.95
E[illegible]	pentode	2.45
E[illegible]	double triode, mil spec	5.15
6N1/6J7	double triode, 1/8W base	1.75
6SL7GT	double triode, 1/8W base	2.65
6SJ7	pentode	1.75
6SN7GTA	double triode very powerful	4.55
6AV6/6A	double triode	4.15
EL84/6BQ5	small power pentode	1.55
EL86/6CW5/PCL86/6GW8A	small power pentode, mid input version	4.51
6V6GT	small power pentode	2.45
KT66	medium power pentode	2.75
5881/6550/KT88/KT90	medium power tetrode	4.51
6CA7/EL34 Fat Soft	power tetrode	8.85
EL34/	power pentode	6.45
6550/KT88	large power tetrode	12.45
6C33	powerful regulator, industrial heated triode	24.65
6AS7/6080	strong regulator, industrial heated triode	9.45
2A3 4.0A	directly heated small power triode	17.85
300B	directly heated power triode	57.95
VALVE VV30B	directly heated power triode	800.01
5U4G	HT rectifier	3.25
5Y3GT	HT rectifier	2.25
5U4GT	HT rectifier	2.25
GZ34/5AR4	HT rectifier	8.75
6N4	HT rectifier, very good for low amplifiers, 7 pin base	2.65
6A5	HT rectifier, for pre-amplifiers & amplifier front ends, 9K1 base	2.65

Please note, our 300Bs are manufactured in China by Gold Dragon Shopping, but we tested in house under real working conditions to guarantee unmatched more stringent than commercial tests. No, they do not sound quite as good as original WE 300Bs or STC 4A/300s, but do they carry the same premium price, please consider the following: power tube manufacturer, power transformer, amplifier chassis on your side, do not compare the original 300Bs, it is in most cases far better to invest the money in one manufacturer features of the amplifier project, like better output transformers, better signal caps or soldering or the like, spend way out better quality passive components first. A pair of original WE 300B cost at least £3,200 in original day, then in terms of an overall price compromise, you can get some fabulous sounding products for the difference in cost between a pair of Chinese 300Bs and the original WEs and in many cases the improvement in sound quality is greater than the WE 300Bs will contribute, and the contribution is considerable permanent, consider that when you plan your project

RESISTORS

We are pleased to stock the whole E12 ranges of either different values or resistors that we stock, except very low/very high ohmic values, which are extremely costly, as a rule we do only stock below 10 Ohms or above 2MΩ. Whilst we already try to keep every single E12 value in stock, this cannot be guaranteed, however, especially as the values and tolerance the resistors can be very long indeed, however, since some are used in our production or limited products, these will generally be stock available within 4 weeks.

Bayoching.

We offer three levels of bayoch quality, at an 1%, sorting with mounting wires the whole are slightly magnetic, as are the non-magnetic of other makes at mixed low resistors, but inconsistent, very good sounding, as used in all our DA mixed amplifiers, as is also including audio Lens 3 (by BB/SHU K1P4, 3038 we evaluate these) amplifiers.

Bayoching 1 watt 1% resistors up to 500 Ohm £0.11 above 500K/Ohm £0.13 each

Holco.

Better vacuum quality can be received with the HC, type, 1% non-magnetic resistors, which are regard as the best industrial grade metal film resistors available. They have very good thermals, as they are quite flexible, and require careful handling, do not bend the legs too close to the body, they may become broken.

HRLCO resistors type HC SERIES mid. £3.65 each from 1R0 to 1R0 £1.39 each from 5R1 to 10R, £1.35 each from 22 Ohm to 220R Ohm, £1.45 each from 221R Ohm to 1K0 Ohm, £1.10 each from 1M1 to 10M0, £1.24 each from 2M1 to 4M0 and £2.21 each from 4M1 to 6M0.

AUDIO NOTE HIGH QUALITY CERAMIC VALVE BASES.

All of our valve bases are of the highest possible quality, made from polycarbonate using the best metal parts from which even their quality is taken, some of the valve pin or shaft. They recommended as upgrades for most valve amplifiers and should be an essential part of any DIY project.

Type	Mounting	Plating	Price ex UK Vat
4-pin UX4 for 300B/2A3/801A	Chassis	Gold	8.25
4-pin UX4 for 300B/2A3/801A	chassis	Nickel	7.25
4-pin UX4 WE type for 300B/2A3/801A	Chassis	Silver	14.75
4-pin UX4 WE type with keyway mounting	Chassis	Silver	48.95
4-pin Jumbo 4 in 211/VT-4/C/845	Chassis with Shield	silver/chrome	159.95
5-pin UY1 for 80	Chassis	Gold	9.75
7-pin B7G for KT4, 0A2	PCB	Silver	6.15
7-pin B7G for KT4, 0A2	PCB	Gold	7.85
7-pin B7G for KT4/0A2	Chassis non shield	Silver	6.75
7-pin B7G for KT4, 0A2	Chassis non shield	Gold	7.950
8-pin B8A for EC86, EL84, GZ34, 6L6G etc	Chassis	Silver	5.65
8-pin B8A for EC86, EL84, GZ34, 6L6G etc	Chassis	Gold	8.65
9-pin B9A for ECC88, 6922, 6N6P, 6350 etc	PCB	Silver	3.85
9-pin B9A for ECC88, 6922, 6N6P, 6350 etc	PCB	Gold	5.75
9-pin B9A for ECC88, 6922, 6N6P, 6350 etc	Chassis non shield	Silver	4.45
9-pin B9A for ECC88, 6922, 6N6P, 6350 etc	Chassis non shield	Gold	6.75
9-pin B9A for ECC88, 6922, 6N6P, 6350 etc	Chassis with shield	Silver	4.95
9-pin B9A for ECC88, 6922, 6N6P, 6350 etc	Chassis with shield	Gold	7.15
Top cap	For 807 particularly etc.	Nickel	0.75

You may want to start your project with an even small cost, and for this purpose we've offer the following industrial 'grade' ceramic valve bases.

Type	Mounting	Price Ex. UK Vat.
8-pin for EL34, 6550, KT66, 6RG	Chassis with shield	1.45
9-pin for ECC83, ECC88, 5687, 6SG	Chassis with shield	1.85

BLACK GATE ELECTRON TRANSFER HIGH PERFORMANCE GRAPHITE ELECTROLYTIC CAPACITORS

There are many low quality electrolytic capacitors on the market which, basically, are ok for most applications, but there is what the BLACK GATE capacitors achieve, an Electrolytic which electrolytic capacitor is nowhere in the circuit of an amplifier or in the crossover of a speaker will generally improve sound greatly. We are working on some collaboration as to which, how and where bigger or Black Gate to use in different circuits, the first such traditional guidance is available now and is called 'Improving your CD Player' and can be improved by removing a damaged electrolytic or unique circuit converting the filter. All AUDIO NOTE Level 2 Signature products use Black Gate Electrolytic Transfer in critical sonic/dynamic locations. It is very important to note that all BLACK GATE capacitors need time to charge up or stabilize when first put in circuit, depending on the type and application this 'maturing' time can be between 100 and 300 hours. Black Gate call this the 'aging process' as explained by an 'invisible valve'. We 'not' however, that this process takes longer than that.

We are about to unveil the entire range of values on the enclosed list, so a separate price list is available in the list of Black Gate graphite products. Also we please say that as it is a 'buying up' circumstance, there may be a price increase in list. Again, as always we appreciate a confirmed self addressed envelope

Value	Voltage	BG-Type	Suggested Use	Price ex UK Vat
47nF	25volt	PK	Anywhere	1.60
33nF	35volt	PK	Anywhere	1.75
0.47mF	50volt	PK	Anywhere	1.90
1mF	50volt	PK	Anywhere	1.12
2.2mF	50volt	PK	Anywhere	1.20
3.3mF	50volt	PK	Anywhere	1.60
4.7mF	50volt	PK	Anywhere	1.80
10mF	50volt	PK	Anywhere	1.85
22mF	50volt	PK	Anywhere	3.60
100mF	50volt	Standard	Anywhere	5.47
150mF	50volt	Standard	Anywhere	7.75
1000mF	16volt	Standard	Anywhere	8.00
1000mF	50volt	Standard	Anywhere	14.65
220mF	16volt	Standard	Anywhere	4.95
470mF	16volt	Standard	Anywhere	6.30
2200	16volt	Standard	Anywhere	12.45
10,000mF	25volt	Standard	PSU Smoothing	23.65
4700mF	16volt	Standard	Anywhere	14.95
47mF	500volt 56dia range	Mix Type	PSU filter capacitor	85.95
100mF+100mF	500volt 56dia range	Mix Type	PSU filter capacitor	191.95
150mF	500volt 56dia range	Mix Type	PSU filter capacitor	212.15
220mF+220mF	500volt 48dia range	SK2 Type	PSU filter capacitor	402.65
100mF+100mF	500volt 48dia range	SK2 Type	PSU filter capacitor	375.00
22mF	350volt	FK Type	Mix Type Decoupling or filter capacitor	18.65
150mF	350volt	Mix Type	Filter capacitor	67.85
220mF	16volt	FK Type	Ultra low ESR version recommended in film caps	9.65
100mF	50volt	FK Type	As above use anywhere	40.95
220mF	25volt	FK Type	As above use anywhere	58.55
2200mF	63volt	FK Type	As above use anywhere	98.85
2.2mF	50volt	C Type	For use with DC potential difference	2.97
4.7mF	50volt	C Type	For use with DC potential difference	3.95
1mF	63volt	K Type	K type for use in capacitor feedback circuits etc	4.65
4.7mF	50volt	N Series	as above	5.75
10mF	50volt	N Series	as above	6.95
47mF	50volt	N Series	as above	10.75
150mF	50volt	N Series	as above	16.85
6.8mF	50volt	R type	For loudspeaker crossover networks	8.95
10mF	50volt	R type	as above	10.95
22mF	50volt	R type	as above	17.45
47mF	50volt	R type	as above	27.95
0.47mF	50volt	BG-NX Type	for PSU decoupling	12.00
220mF	6.3volt	BG-NX Type	For super low noise PSU	11.85
1000mF	16volt	BG-N Type	For super low noise PSU	14.65
470mF	16volt	BG-N Type	as above	9.45
470mF	25volt	BG-N Type	as above	10.45
4.7mF	50volt	BG-N Type	as above	6.95
100mF	50volt	BG-N Type	as above	10.45
2200mF	100volt	BG-N Type	as above	423.95

It is recommended that you set from a starting of all available 80cm, both values, together with their value, best respected.

Lastly we can supply a range of more modestly priced components, still good quality, conductive plastic fi.

SHINKOH TANTALUM FILM RESISTORS

This is definitely the best surrounding resistors available, forget the TANSHAY which may be OK in high feedback transistor, amplifiers and it can produce good accompaniments to the particle of low Audio Amplification, I, a friend to tested these excellent tuning feedback that in single ended Class A, this is where you will need the purpose film resistor to the best result.

The 1/2 watt Shinkoh tantalum especially are non-magnetic and cost £1.20 each

Some values are available in 1 watt from Chesham at £4.65 each (list of stocks available)

AUDIO NOTE 1 WATT TANTALUM RESISTORS

Up time the tantalum film resistors have been available it difficult to get, however, after much persuasion and up time a minimum quantity available from Audio Note UK, the manufacturers have agreed to when the range of 1/2 watt and re-introduce the 1 watt range which become an outstanding range for AUDIO NOTE like complete this to be a major breakthrough, you're allowed to use metal range of values at the 1 watt rating it is quite difficult to get the very best out of the best metals. As with most hand made replacement items, which covers lead of the cost, delivery may be quite long on some values, so be prepared to wait at the time, not in stock.

The AUDIO NOTE 1 watt 1% tantalum resistors are £1.70 each

We shall now be stocking on getting 2 and 3 Watt tantalum resistors, made available as well, and you know perhaps we will be able to build specifically in a piece from that of many of tantalum resistors in a quote of the short.

HIGH WATTAGE WIREWOUND RESISTORS

As a new item we have short offering a range of 2 15 watt wirewound resistors, we shall be stocking well small range and especially 4 capacity, 4 in single rating, all the members are following a standard all these resistors are 5% tolerance and grade.

Wattage	Value	Tolerance	Price ex Vat
5 watt	47R	5%	0.85
5 watt	100R	5%	0.85
5 watt	470R	5%	0.85
5 watt	1K0	5%	0.85
5 watt	2K2	5%	0.85
5 watt	15K	5%	1.32
5 watt	22K	5%	1.32
5 watt	33R	5%	1.24
5 watt	1K5	5%	1.24
5 watt	1K8	5%	1.24

Many values will be added over the next 6 months, together with some non-industrial specification

VOLUME CONTROLS

Impedance	Construction	Price Ex Uk Vat
100K Ohm Stereo	Frame type PCB mounted	3.45
100K Ohm Stereo	Encapsulated type PCB mounting	12.85

A better alternative audio KO-OH mounted volume stereo any case in pre-amplifier like the M77 Line, M7 Line and line 1 mono version can be used in the Reg-Mic, Mic-Mic, KRIMS and GAKU-OH. These are very good switching type 10-way stereo.

Impedance	Construction	Price Ex UK Vat
100K Ohm Stereo	Encapsulated	12.25
100K Ohm Stereo	Large encapsulated	19.65
100K Ohm Stereo	Large, encapsulated, high quality	29.45

BALANCE CONTROLS.

100K Ohm	Frame type, PCB mounted	3.95
100K Ohm	Encapsulated type, PCB mounting	14.15

HQ-OH also makes a very good quality 100K Ohm balance control, similar to the encapsulated 100K pot this is from £32.25

STANDARD TYPE SWITCHES

The switch is available in 2-6 way, it has gold plated contacts and a stainless steel shaft for best possible connection protection and contact, price ex UK VAT £3.30

Again, HQ-OH offers a very high quality rotary switch, 6-way, 2 channel at £32.65 each

STANDARD ELECTROLYTIC CAPACITORS

Good quality standard industrial type.

Value	Voltage	Size	Price Ex UK Vat.
10mF	10volt	16x8mm axial 11x7mm radial	0.23
100mF	16volt	16x8mm axial	0.35
220mF	16volt	11x8mm radial	0.51
220mF	40volt	13x10mm radial	0.45
100mF	63volt	12x10mm radial	0.47
470mF	16volt	26x10mm radial	0.55
330mF	63volt	26x10mm axial, 41x10mm axial	0.55
10mF	63volt	16x10mm radial	0.90
22mF	350volt	21x10mm radial	1.25
10mF	450volt	21x10mm axial	1.00
47mF	25volt	13x21mm radial	1.15
68mF	400volt	18x22mm radial	2.00
68mF	400volt	18x22mm radial	2.00
100mF	63volt	18x22mm radial	2.20
220mF	25volt	21x22mm radial can	4.45
220mF	450volt	40x30 radial can	5.85
220mF	550volt	112x76mm radial screw terminal	27.65

RCA, CMC BANANA PLUGS, RCA SOCKETS, SPEAKER&GROUND TERMINALS & LOUDSPEAKER SPADES.

RCA PLUGS.

Stainless Gold plug	1.00
Ah-C Gold Plug	3.85
AN-GP AUDIO NOTE gold plug	8.51
AN-P AUDIO NOTE Silver plug, teflon insulated, non magnetic	35.50

RCA Sockets.

Type	Mounting	Price ex UK Vat
RCA panel mount board	Chassis mounted	0.41
RCA socket gold plated	Chassis mounted	2.85
AN-GS AUDIO NOTE non-magnetic teflon insulated socket gold plated	Chassis mounted	3.65

BNC Plugs and Sockets

Type	Price ex UK Vat
Stainless BNC plug	3.45
BNC Silver plated special chassis	7.50

Banana Plugs, Loudspeaker Cable Spades, Chassis Loudspeaker Terminals.

Type	Price Ex UK Vat
AUDIO NOTE Banana plug, gold plated spring loaded version	2.45
AUDIO NOTE Loudspeaker Cable spade, silver plated, non-magnetic	4.85
AUDIO NOTE AN-ST Speaker Terminal, chassis mounted, nickel plated, red or black	1.85
AUDIO NOTE AN-ST/G Speaker Terminal, chassis mounted, gold plated, non-magnetic	2.75
AUDIO NOTE AN-STR Speaker Terminal, chassis mounted, gold plated, non-magnetic, red or black	4.75
Ground Terminal, chassis mounted and nickel plated	1.45

Our range of components is constantly expanding, as we find new or better suppliers, or supplies found by reading our advertisements in Hi-Fi World and Hi-Fi News.

FERRITE RINGS

In many systems, especially new wiring, mains cause amplification. Here is often a problem of incoming RF in long set interface lead, especially from connected CD players. Adopting a ferrite rings around the cable, both near the CD transport and the DAC or the output of the DAC or CD player will help prevent any of these annoying results.

A pair of two ferrite rings costs £9.95

AUDIO NOTE COMPLETE KITS

As mentioned earlier, we are developing a range of complete kits, to give to those of you who have the ability, but do not have the time, to assemble a product from the ground, scratch. In order to be able to offer the best possible quality, value and economy, by not any other kit will be ground level, chassis, with top fully populated and components, all kits have equal attention central to those one of a single owner, like TO pay or direct it.

KIT ONE

Based around the Sully Series 300B direct heated triode, we say this kit suffer manufacture as well. Audio manufacturer, as it power the improved quality of design necessary. Single Ended, Pre-Power Class A Directly Heated Triode, to become a member of the exclusive club of excellence.

Kit One for one 300B per channel running at 40 watt each. Some purpose giving 9/10 watt of the maximum power you will ever hear. The input stage consists of a ECC82 with a 6922 double triode driver stage amongst them. The power supply is a capacitor choke capacitor with a small HT rectifier, the heaters are AC fed but Centre-point quality is similar to our Level 2 Reference products. AUDIO NOTE silver in all signal capacitors. Everything, from the transformers, quality components, wires, to Kevlar Gaffer cord a simple, attractive power cleaner is also particularly. Protecting cover is extra.

Price £795.00 inc. VAT which includes all valves and, due the 2 X 30+8 mounting. Not as postage/packing which is UK mainland is £12.00. Elsewhere at £80.00 extra. No time is available now.

KIT TWO

Kit Two includes a single ended triode running in Single Ended mode providing some 5+ watts of pure Class A, valve rectifier HT for the entire circuit, mono version, and 6SN7GT input and 5814A/ECC82 SRPP driver stage, complementary and chassis as Kit One

Price £595.00 inc. VAT, includes valves. Actual postage charges, three or more at £80.00 Available in November 1998.

KIT THREE

Kit Three features 2 X 6P3S per channel running in single ended parallel giving 10+ watts of pure Class A, this kit is an ideal mono chassis, with valve rectified HT supplies, an original feedback of 20dB/TGT tetrode driver as input valve and a pair of 5687 double mono triodes running in SRPP as drivers.

KIT THREE is essentially a mono version of the KIT ONE with double the power, the same components chassis and the classic refinement of one.

Kit Three costs £1,495 and is available now.

Write to:

AUDIO NOTE (UK) Ltd, Unit 1, Block C, Mono Business Centre, Fontmell Road, Hove, East Sussex, BN3 6HA England. Telephone +44 (0)273 220511, Fax +44 (0)273 731496. Direct line & sales +44 (0)273 885511*

HUNGARY, please contact Martin Audio 54, U. Radday Ilz 2, H-1092 Budapest, Hungary Tel/Fax 01 215 2612

HOLLAND, please contact Jo van Zeeuwen, 2 Reigerlaan NL-6701 BH Veenendaal, The Netherlands Tel/Fax 14773

USA please contact Allegro International, 10830 Guilford Road Suite 309, Annapolis, American MD 20701, Tel 301 725 0401

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ECH81 MULLARD	3.00	ECC81 - 6201 / GOLD PIN MULLARD	8.50
ECL82 MULLARD	3.50	ECC82 - M8136 / CV4003 MULLARD	6.50
ECL86 MULLARD	3.50	ECC83 - M8137 / CV4004 BRIMAR	6.50
EF86 MULLARD	7.50		
EL84 MULLARD	6.00	**AMERICAN TYPES GE.**	
GZ32 MULLARD	8.50		
GZ34 MULLARD	15.00	6L6GC 12.50	6550A 17.50
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6SN7GT BRIMAR	4.50	6146B 15.00	
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BORBELY AUDIO

is dedicated to supply high quality audio components to the audio amateur community and to OEM customers.

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COMPONENTS:	PREAMPLIFIER KITs:
Low-noise complementary JFETs	Phono preamps
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ROEDERSTEIN/Resista resistors	Buffers
TANTAL resistors	Crossovers for active speakers
Stepped attenuators	Power supplies
ALPS, NOBLE, TKD potentiometers	**POWER AMPLIFIERS KITs:**
ROEDERSTEIN/RIFA Electrolytics	SERVO-50
ROEDERSTEIN/RIFA /WIMA polyprop. caps	DC-50
ELMA Gold plated switches	DC-102
RCA and XLR connectors	DC-200
Cables, Relays	DC protection circuit
Tubes and tube sockets	Output boards for TO-3P MOSFETs

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Please send two International Reply Coupons (available at your post office) for our price list, or DM12 for our complete KIT info package.

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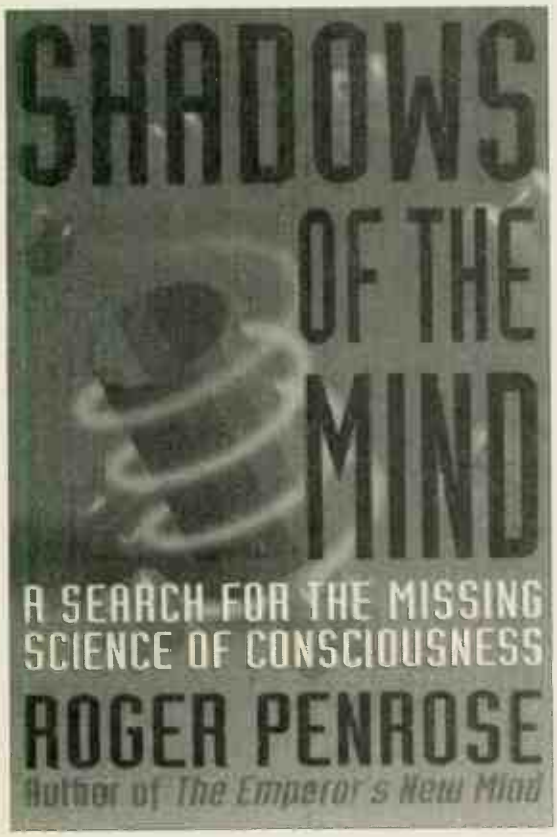
SHADOWS OF THE MIND

- A Search for the Missing Science of Consciousness, by Roger Penrose.
Reviewed by Noel Keywood.



Shadows of the Mind seemingly argues for a crucial element of non-computability in human thought. You might think this will produce some thoroughly interesting (?) arguments about logic, the limitations of machines and such like. It does - and a lot more. In a monumental charge through mathematics, logic, physics and then (phew!) biology, Penrose discusses ideas that I think most of us find fascinating, if a little incomprehensible - putting it mildly!

To start at the end, as he does, which is perhaps necessary because the path is so tortuous it is nice to know where it might lead before embarking on the journey, "I argue that whereas neuron signals may well behave as classically determinate events, the synaptic connections between neurons are controlled at a deeper level, where it is to be expected that there is important physical activity at the quantum-classical borderline'. Or, in other words, that the mysteries and paradoxes of quantum behaviour influence classical physical behaviour and must somehow be inducted into any understanding of how the brain works.

The notion of consciousness being linked to quantum mechanical effects and perhaps the unsettling idea of action at a distance being in the schema seems to hover in the background. Biological imperatives are not given much credence for exerting perhaps 'confusing' influences though, except in passing references to evolution.

Initially, Roger Penrose sets out to explain the implications behind various views of how the brain may work, listing four basic views as starting points, namely (in brief) -

A - All thinking is computation, as is awareness

B - All thinking is computation, but awareness is not a by-product of computation

C - Awareness is a result of thought, but neither can be computed

D - Neither awareness nor thought can be explained in scientific terms

Of these, however, he favours the view that not all physical thought is computation (*C*) and Shadows of the Mind is meant to be his justification for such a view. But it doesn't invoke mysticism - Roger Penrose is a mathematician of considerable interdisciplinary sweep and he certainly isn't about to deny access to understanding, although for most people I suspect - including myself - whether it's there or not is less the point than whether it is personally accessible!

But that's nothing other than to say that Shadows of the Mind is a fairly incredible work that seeks to draw on an impressively wide range of insights made by scholars of 'modern' science, from Geroiamo Cardano (1501-76) onward to Einsten and Maxwell but, interestingly, drawing mostly upon recent views and insights, from around 1980 on, by today's researchers. I got the impression that in drawing from so many different disciplines, Penrose was also helping toward unifying them - perhaps necessary nowadays to begin to explain some of the paradoxes and problems that seem to exist.

For example, Penrose probes consciousness by considering what causes it to be absent" (p.369). He continues, "it is a remarkable fact that general anaesthesia can be induced by a large number of chemical substances that have no chemical relationship with one another - even the chemically inert gas xenon". Single cells like amoeba and "even green slime mould (as was noticed by Claude Bernard as early as 1875) is similarly affected by anaesthetics". For the implications that can be drawn from an apparently prosaic fact like this, read the book!

By jumping to page 369, I've skipped the first section of the book about consciousness and computation, including the important implications, for Penrose's view, afforded by Godel's theorem.

The second section of the book covers classical physics, the quantum world and how well quantum theory currently links with apparent (observed) reality. Penrose discusses some of the puzzles ("Z-mysteries") and paradoxes ("X-mysteries"), believing that the former will become understood, but the latter - like Schodinger's cat - are implausible and will disappear when the theory is complete. After all this - and many times I wondered where it was all going - and what, in heaven's name, was the binary pulsar system PSR1913+16 to do with Argument *C*? - a focusing starts to occur ("there is the possibility of large scale quantum coherence . . . in biological systems") much later on in the book.

It is Penrose's plucking from the histories and disciplines of the sciences that is fascinating, his attempt to patch together a picture that might be useful as an aid for future understanding. I hope I don't blow the gaff by noting that, in the end he concludes that at present we cannot construct a truly intelligent device, which for some might seem tautologically obvious, at least until we have "another breakthrough in theory".

Luckily, the negativity of this conclusion doesn't matter much in contrast to all the other various insights and conclusions he provides. "The arguments of this book are making the point that what is *not* going on is computational activity and what is going on will have no chance of being properly understood until we have a much more profound appreciation of the nature of matter, time, space and the laws that govern them. We shall need also a better knowledge of the detailed physiology of our brains."

As a trip through these subjects, Shadows of the Mind is a great read, an exercise in wonderment even if, being for the initiated, it might burn an intellectual hole through your average coffee table. At around £17 it's a bargain; but is this how today's professors have to earn their living in post-Thatcher's Britain I wonder? What a pity we missed Einstein writing children's stories about time travel! **NK**

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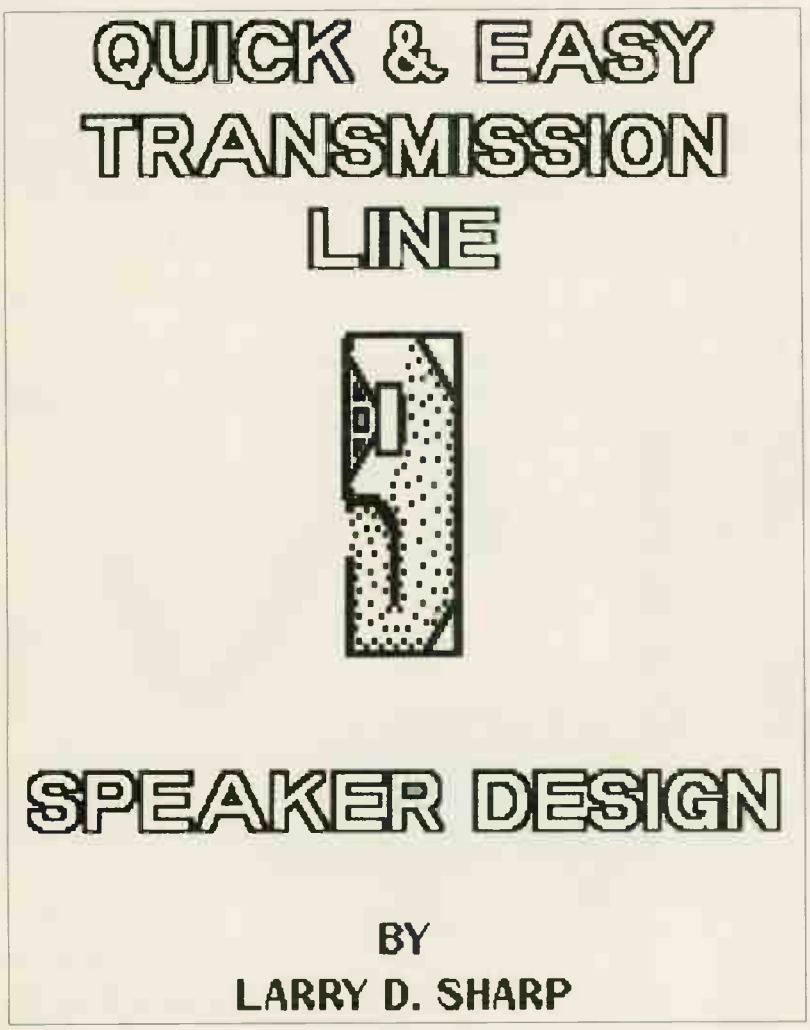
QUICK & EASY TRANSMISSION LINE SPEAKER DESIGN

by Larry D. Sharp.
Reviewed by Dominic Baker.



Transmission line loudspeakers have always seemed to be a bit of a black art. We've tried one in the past, finding that the line length and acoustic damping of the line was more a case of tuning by trial and error than calculation. So, when we spotted Quick and Easy Transmission Line Speaker Design by Larry Sharp, a book published by Mahogany Sound in the States, we jumped at the chance to review it.

The book begins by defining a transmission line in very practical terms. Gone is the infinite pipe which completely absorbs rear radiation (the theoretical model of a transmission line) replaced with a practical view where the end of the pipe vents into the room with only treble and midrange frequencies absorbed. This is how all practical transmission line loudspeakers work, the bass venting into the room to boost low frequency output.

Larry Sharp, like a lot of American writers, has a down to earth and chatty style which makes his explanations easy to follow and understand. He has obviously researched this subject well too, identifying who invented the transmission line, discussing the first commercial transmission line loudspeaker and how they have evolved over the years.

Once the basic principles of the transmission line loudspeaker have been covered, the author gets down to the practicalities of designing your own system. He starts with woofer selection, giving advice on what to look for on a manufacturer's data sheet for best results, e.g. low resonant frequency (Fs), a total Q (Qts) of between 0.25 and 0.6, and good cone excursion. Even a simple test set-up is shown for measuring these parameters yourself, if you have no data sheet.

The next part of the design process is to use this data to calculate the line length. Quick & Easy Transmission Line Speaker Design comes complete with a computer disc which contains a simple program to run under Lotus 123 that makes the maths easier to handle.

Once you have picked a suitable woofer, a few basic parameters such as resonant frequency (Fs), total Q (Qts) and cone area (Sd), which are normally supplied by the driver manufacturer, are all that is needed. The computer quickly works out the line length, stuffing density, box volume, etc, for you.

However, for anyone with access to a scientific calculator the maths isn't that difficult; calculations are set out in a very clear and understandable fashion with each step fully explained. There are even design worksheets which set out the equations, allowing you to fill in the numbers as you go. Whilst computer is faster and parameters can be quickly changed and compared, it is certainly not essential.

As Larry Sharp takes you through the equations he uses an example design, so that you can get a feel for the figures. There is also a second complete design, the Mini Monolith TL, which gives the home constructor a good feel for what's involved and how to decide on certain design criteria. There's even a glossary of terms explaining many of the technical symbols and words used in loudspeaker design.

Quick & Easy Transmission Line Speaker Design comes as a 22 page booklet, complete with a disc which takes care of the maths. Although relatively short, it covers all of the no-nonsense practical aspects of transmission line design, without confusing the issue with theoretical models never seen in practice. For DIYers who are keen to design and construct their own transmission line loudspeakers, it's a must, containing more practical advice than I've seen elsewhere.

QUICK & EASY TRANSMISSION LINE SPEAKER DESIGN by Larry D. Sharp is available through the Hi-Fi World library, price £10.95 inc p&p.

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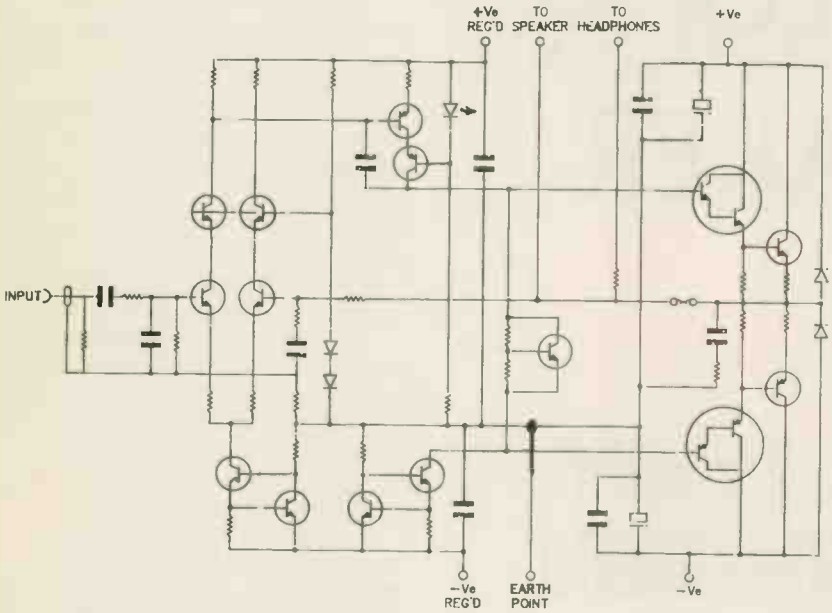

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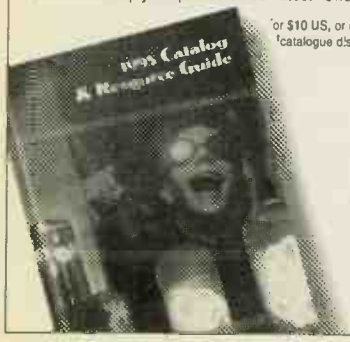

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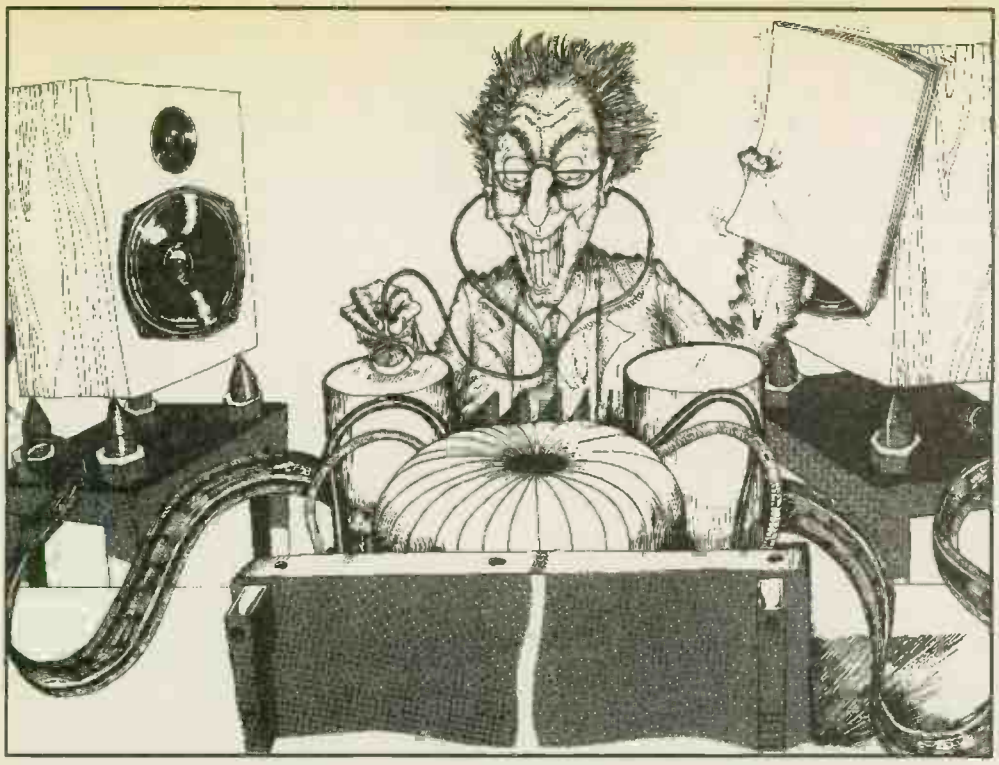

D.I.Y. Letters

UPGRADING YOUR VALVES

In addition to reading your excellent magazine, I also subscribe to Hi-Fi News and Record Review, and was most interested to read in the August issue a letter from Mr T.R. Lyons in which he mentioned that he had replaced the EL34 valves in his Radford STA15 with KT66s to obtain improved sound quality (at the cost of increased distortion, but still 2nd harmonic and relatively innocuous). I have a pair of the 5-20 monoblocks which you marketed briefly some time ago and would be interested in doing this modification to them, but am unsure how to go about it, or who could advise me. Is it a straight swap, EL34 for KT66, or is there more to it, like resistor/capacitor changes?

You also promised, when you first started selling the kits, that there would be articles on tweaking them, but I have yet to see any. Where have they got to?

Although I am being mildly critical, I enjoy reading your magazine more than any other, especially the valve amp articles and the supplements.

I also have an Edison 12 valve power amplifier which I would recommend to anyone, despite its low power. Few people seem to know of it, but those who do rate it highly, used in the right context (i.e. with efficient speakers and suitable input levels - it has a high input sensitivity.) Mine is very quiet and reliable, but I have heard some that are not! I built mine from a kit, so I made sure it was well built and fitted much higher quality input sockets.

Rod Theobold
Rochdale,
Lancs.

The Radford STA15 is a very good amplifier and great care was taken over the design. Just plugging in a pair of KT66s instead of the EL34s intended is likely to make the amplifier worse rather than better and this shows itself in the increase of distortion. The 5-20 kit you have may be modified to use KT66s, but again they will not be properly load matched and an increase in distortion is likely to result. You are very unlikely to be able to source real G.E.C. KT66s so you will in fact be using 6L6s which, unless they are the 6L6-GC type, will not be able to dissipate more than 23W, and you may experience problems with the screen grids being at such a high voltage because of the Ultra Linear connection. If using G.E.C. KT66s or RCA or G.E. etc 6L6-GCs then leave the amplifier unmodified and plug in the new valves. If using any other type of 6L6 or KT66 then change the cathode resistors to 560Ω and wear a bullet proof vest and goggles or preferably a suit of armour when you switch it on.

It is a common misconception that valves can be swapped around easily like this, but unless you know what you are doing it can be dangerous. The very least that could happen is a reduction in performance and at worst you could end up with a pile of ashes where your W.E. 91 used to be! AG

You and others maybe interested to know that PM Components will be producing KT66 and KT88 equvalents soon, based on a modified EL156. Phone 0474 - 560521. NK

HOME BREW TURNTABLE DESIGN

I would like to tell you about my turntable which I built myself. In 1986 I was thinking of buying a top quality turntable to complement my Naim amps/Lowther 'speakers. I found that from an engineering point of view most turntables in the £1000-£3000 price bracket had some rather disappointing features.

So to cut a long story very very short, I decided to build my own.

The general idea was to take advantage of what was already available on the market, that is, investigate several top-flight turntables, pick out their best points and design these into one unit.

These features include three layer chassis system with motor drive on its own suspension, two-belt drive system, oil damped inverted bearing, two layer platter with record clamp, outboard power supply for motor, pick-up arm designed as integral part of the turntable.

The whole project took about three years to complete. It functions rather well and is called 'Encore'.

Derek Hall
Nuthall,
Notts.

A commendable effort, designing your own turntable. It sounds like you had a lot of ▶▶

fun doing it too, and engineered it pretty heavily to have spent three years refining the design. I'm glad you feel that you have something special and something which rivals the best commercial product. Keep up the DIY. DB

TRUE CLASS?

In the DIY supplement No. 9 you had an article written by Richard Brice. The subject of the article is a 'high quality headphone amplifier', a follow-up to a circuit, published in the April edition of your magazine. The original circuit I assumed was an April fool's joke, as it claimed to be a class A headphone amplifier, but the signal-path contains an op-amp. The same description is being applied to the later version of the circuit (published in the DIY supplement No.9), but the signal-path again contains op-amps. The op-amps in question are TL072s which I'm sure you know contain a double-emitter output stage, this is not a class A!

To be fair the output stage of the op-amp is suitably biased so that their will be no cross-over distortion present in the output, but to use an op-amp as the pre-amp in a low level Class A amplifier does seem to be missing the point a little, a simple transistor amplifier stage could have been constructed to replace the op-amp, then the headphone amplifier could truly be called a class A amplifier.

N.J. Crouch
Farnborough,
Hampshire.

TL072 operational amplifiers possess a "complementary emitter-follower" output stage which remains operating as a Class-A amplifier, provided the peak current delivered during the output cycle does not exceed the standing current in the output stage. Individual TL072s do differ but, since the load "seen" by the op-amp (especially in the later version of the headphone amplifier where the output transistor is buffered by an extra PNP emitter-follower) is several kilohms and the peak signal

Letter of

CIRCUIT SOUNDS

Included in your recent design for a solid-state Class A amplifier was a section relating the sound of transistors to valves. If I may, I would like to put forward a few of my own thoughts on the subject for possible publication in the DIY Supplement. I have tried to keep this letter as non-technical as possible, but because of the nature of the subject it is quite involved.

There is much written today about the 'sound' of transistors and valves, but the components used in the circuit may not, in my opinion, be the only factor determining the sound. I believe that the circuit design itself may play a large role in governing the sound of the amplifier (or any other hi-fi component for that matter) and I have not seen anything written about this matter. The basic circuits of valve and transistor amplifiers differ greatly, for several important reasons, so much so that it would be possible to design a valve amp, and a transistor amp, which had no sub-circuits in common! To demonstrate this point I will take a hypothetical amplifier of both types and break them down into their component parts.

Points resulting from this table are:

	TRANSISTOR	VALVE
Input stage	Differential pair	Common cathode
Load	Current mirror	Resistive
Gain	10^4	50
Feedback applied at -	Base 2nd transistor	Cathode
Driver stage	Common emitter with V_{be} multiplier	Phase splitter (various)
Output stage	Complementary transistors (usually emitter follower)	Push-pull with matched valves

1) The ideal differential amplifier produces only odd-order distortion whereas the common-cathode amplifier, in common with all single-ended amplifiers, produces all distortion products.

2) The current mirrors used in the differential amplifier active load result in a very high open-loop gain, so even though the closed-loop gain of the transistor and valve amps are the same, the return difference is not, which affects the phase shifts and stability of the amplifiers.

3) The Vbe multiplier produces two outputs from a single input and allows the use of complementary transistors for the push-pull output stage. However, when the Vbe multiplier has an active load (as in your circuit) the transfer function of the circuit is very complex as the negative load presents a non-linear impedance, as it depends on the very non-linear Vce vs Ic vs Vbe characteristics of the transistors. Of course, when feedback is applied these non-linearites are masked.

So, with all the differences in circuit design between transistor and valve amplifiers we really have no right to expect them to sound the same just because they are Class A. A much better comparison would be between, say, a single-ended valve amplifier and a single-ended transistor amplifier similar to the one included in the DIY Supplement a few issues ago. I am not sating that these would sound the same, but at least it would be the differences between valves and transistors that we would hear, without the effects of the differences in circuit design getting in the way. Could this be the way that certain companies are able to produce both transistor and valve products which can satisfy their designer's ears and have the same company sound?

Best wishes to all the team and keep up the good work. Long may the DIY hi-fi banner fly high.

Andrew Kennerley,
Haworth,
Keighley,
West Yorkshire.

The actual circuit configuration is at least as important as the type of

voltage is only a volt or so, it would be a very inauspicious set of circumstances - combined with very high listening levels - which would cause the op-amp output stage to leave its Class A regime and enter Class B working.

As a general point, I actually see no reason why Class B circuits should not be used in low- level signal stages where the problems of this type of operation (e.g. hole-storage, changing stability-margins etc.) are not a problem as they are in Class B audio output stages. For instance, I have designed many amplifiers which operate in Class B and yet work well to 50MHz and beyond without generating appreciable distortion, provided they are not called upon to drive low-impedance or reactive loads. **RB**

DAILY TESTER

When are you going to offer us a kit for building a valve-tester for modern production valves? Use of such a device has to be better than swapping suspect valves about in equipment which is daily use.
T H Ritchie
Glossop,
Derbyshire

I sympathise with you over trying valves in working equipment, which can be pretty risky when buying valves which haven't been tested before sale. The problem is that the words "simple" and "valve tester" do not go together. Any valve-tester worth its salt requires stable and accurate voltage sources, both DC and AC, for good measurements of the valve's characteristics. Just to wire-up all of the valve bases and switching required would be a nightmare. Vintage Avo testers are fetching high prices on the market today. A very basic operational test could be carried out by building a mock-up circuit for the valve in question and measuring the voltages on the electrodes when running. **AG**

MOSFETS - PROS AND CONS

Regarding your review of John

The Month

components used. Each device needs to be optimally set up with carefully chosen load resistance and bias point etc. When our solid-state amplifier was designed the philosophy was to create a very high quality amplifier using the best devices we could get, and to use them in a carefully designed and optimised circuit, not to try to recreate a "valve sound".

I do feel though that the vast differences between transistors and valves in terms of current density and curvature of characteristics will prevent the two from ever sounding the same. It is often said, for example, that the characteristic curvature of a FET is similar to that of a pentode valve. This is only superficially true. All solid-state devices, especially FETs, suffer from serious trans-conductance droop at high currents, but pentodes do not. In fact, the trans-conductance increases with increasing current right up to Vg=0, the normal overload point.

Is it just coincidence that some of the best sounding solid-state amplifiers use multiple pairs of output devices? This cuts the current density in each of the transistors, reducing or eliminating trans-conductance droop.

In high feedback amplifiers the sound of the components and devices used tends to be obscured (as well as the music?!) and valve and transistor amplifiers using large amounts of feedback do sound more alike than those without.

With regard to your comments on our solid-state amplifier, the current mirror is there mainly to ensure accurately balanced DC currents through the differential pair, maximizing the CMRR. The output impedance of the current mirror stage is so high it can be considered to be working in current drive mode to the voltage amplifier stage, and this is where most of the voltage amplification occurs. For good open loop linearity the load impedance seen by the voltage amplifier must be high, and the following stage must disturb this situation as little as possible. In our circuit these conditions are fulfilled, by the constant current load and by the carefully designed driver/output stage. **AG**

Thanks for your views. Although there are few single-ended transistor amps around at present, listeners have remarked that there are stronger similarities between them and single-ended valve amplifiers than is usually the case between silicon and the beloved vacuum. So perhaps we should be considering this matter, since solid-state SEs are arguably a little more domestically acceptable than thermionic ones.

One point I would like to re-iterate is this: distortion doesn't necessarily sound bad and we are suffering beneath an unecessary constraint in believing so and that, ipso facto, huge amounts of feedback produce the perfect amplifier. It may be better to accept second harmonic or a certain harmonic pattern in reasonable quantity in order to engineer a simpler amplifier (i.e. one with less open loop gain) that may benefit from a greatly reduced component count and a better sound as a direct result. **NK**

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▶▶

Linsley Hood's book "The Art Of Electronics" (DIY Supplement, August), a copy of which I have read, I would like to comment on your remarks on the subject of MOSFETS.

Surely the characteristics of these devices, including their degree of linearity, are matters of verifiable fact and not of opinion. It is also a matter of fact that some very fine sounding amplifiers have been designed making use of MOSFETS in their output stages, including Chord in the commercial field, and of course JLH's own design (P162 in the book) which is available to the DIY enthusiast.

I know that there are, as you suggest, still a number of designers in the commercial field who, for whatever reasons, have not come to terms with use of MOSFETS in their designs. However, I submit that the proof of the (sonic) pudding is in the eating (or should I say listening!) The best designs using MOSFETS need no apologies from me or anyone else.

J.K. Bodley Scott
Axminster,
Devon.

The characteristics of MOSFETS are well known, and they are generally less linear than BJTs. In a typical output stage application MOSFETS will produce in the region of ten to fifty times the distortion of a similar bipolar stage - this is a verifiable fact.

Another fact is that a well designed amplifier with a MOSFET output stage will have a far better HF bandwidth performance than a similar BJT amp, which allows large amounts of feedback to be applied, covering up the distortion from the output stage. MOSFETS also suffer from a rather poor current density/high on resistance which means that to get any sort of efficiency into low impedance loads parallel pairs must be used. At the same time though, this problem - as well as their positive temperature coefficient - renders them immune to thermal runaway and similar heat related problems, which explains their use in professional/disco amps which must run at full power under the most arduous conditions.

On the subject of sound quality, as with valve amps, plain distortion figures do not fully explain the sonic performance of an amplifier, so if you like the sound of FET amps, then so be it. AG

The implication that MOSFETs are fundamentally linear is all I was trying to counter in my review of this book, not whether they are acceptable as audio amplifying devices, which is quite a different argument. We have it in mind to develop a MOSFET amp some time in the future, just to see what the problems are and how a good design compares.

Poor fundamental linearity is likely to make MOSFETs unsuitable for a low or zero-feedback amplifier though, a notion which every hi-fi amplifier designer should have on the agenda, in my view. It took a lot of development effort to make our 300B amplifier sufficiently linear to work without feedback, but it was worth it. To employ single-ended working and/or low feedback techniques we need linear audio amplifying devices, like the 300B valve for example. My only criticism of today's MOSFETs is that they do not fulfil this criterion - but who knows what tomorrow might bring? NK

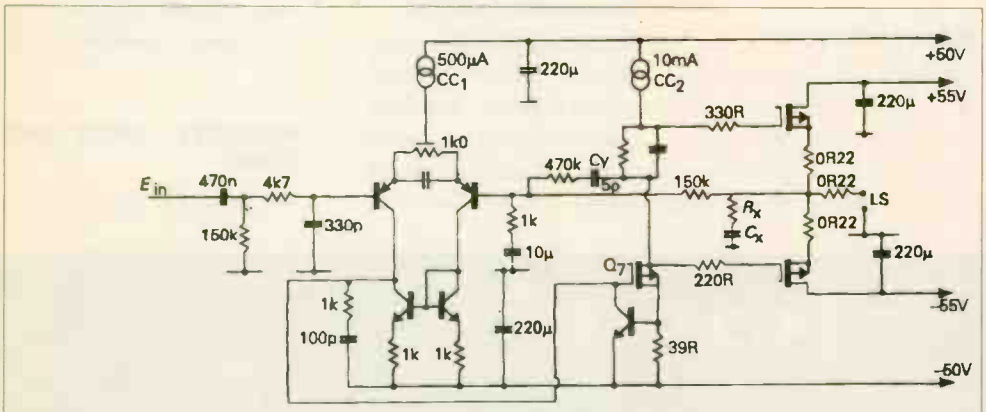

Figure 9.28 *80–100 W power amplifier based on MOSFET devices*

Reproduced from The Art of Linear Electronics by John Linsley Hood, Butterworth-Heinemann ISBN 0 7506 8684.

HOME-GROWN AMP

Although I have had much enjoyment out of my current set-up (NAD 3025 amp; NAD 5420 CD player; Marantz 4240 receiver which I use as a tuner; Monitor Audio MA 14 loudspeakers and Audioquest cables) and have improved it considerably with DIY tweaks (hand-wired 'speakers and amp, Blu-Tak'd CD components, cooker wire on a four-way mains adapter, metal film resistors in amp etc.), I often feel disappointed with the sound; it just doesn't seem real.

As fortunes dictate that I cannot afford to buy an amp that would sound real I endeavour to make my own transistor amp. Could you please produce a Supplement covering this area. I am most interested in simple, single-ended designs and other designs deemed 'good'. I am sure that a great amp could be made for £200-£300.

Could you also point me in the direction of further amplifier designs and other sources of top-quality transistors.

Brent Meredith
Boston,
Lincolnshire.

We have covered one area of solid-state amplification in the October '94 Supplement with our 36W Class A monoblocks. This supplement also has a concise description on the operation of the circuit. Keep your eyes peeled for future projects and circuits in the Supplements, though.

The problem with cheap amplifiers is that you end up with a pay-off between power output and sound quality - there's not much point in either producing a high-powered amplifier which sounds like a cheap wedding reception disco, or a great sounding one which has such low output it needs direct cerebral connection in order to hear it.

For books we recommend The Art of Electronics by Horowitz and Hill. This is a standard university text and is written in a very understandable manner. It is available from us at £40 - a bit pricey, but well worth it if you are serious about electronics.

A more specialist book is the Art of Linear Electronics but you really need a strong background before venturing into this level of audio design. Transistors can be bought from Maplin, Cricklewood, Electromail and other suppliers, many of whom advertise regularly in Hi-Fi World these days. AG

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