FREE GADGETS, GAMES & KITS SUPPLEMENT INSIDE

Hobby Electronics

JUNE '81
ISSN 0142-6192
60p

For A Down-To-Earth Approach To Electronics

Power Amplifier

over 100 watts/channel
- easy to build
- special kit offer

Radio-
its discovery, development and operation

Continuity Checker
- use it for circuit fault finding
- kit under £5

PLUS

Other Projects & CB News Inside

How To Use An Oscilloscope
Special Practical Feature

Hobby Electronics

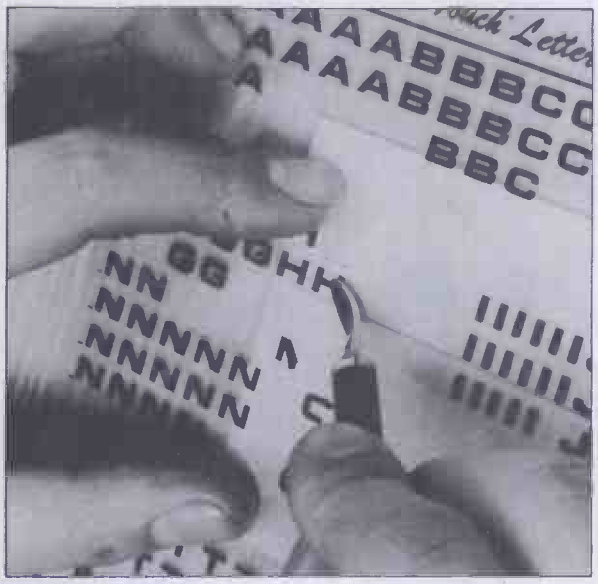
JUNE 1981
Vol 3 No 8

Editor: Hugh Davies **Assistant Editor:** Keith Brindley **Editorial Assistant:** Judith Jacobs
Drawing Office Manager: Paul Edwards **Group Art Editor:** Paul Wilson-Patterson BA
Managing Editor: Ron Harris B Sc

PROJECTS

The radio receivers on this month's cover include three from the Science Museum. Left is a GECoPhone crystal set, which cost £5.50 in 1923. Next to it is a Marconiphone 81, a 'straight-eight' luxury TRF receiver. It used triode valves, and cost £49.50 (plus £5 royalty) in 1925. In front of these is a Murphy A52. This had nine valves, and was a double-superhet. It cost £18.50 when it was introduced in 1938.

In the foreground is the latest AM/FM stereo tuner from Mitsubishi, the DA-F630E. This contains four ICs, 24 discrete transistors and 20 diodes, including six LEDs. It costs around £97.



FEATURES

NEWS & INFO

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Lower Prices In Heathkit Catalogue

Some of the general-purpose test instruments featured in Heathkit's Spring/Summer '81 catalogue have been reduced in price.

Among the test meters, the SM2215 hand-held digital multimeter, which has a liquid-crystal display and a maximum accuracy of 0.03% of full scale, now costs £76 assembled or £63.25 in kit form (original price was £87.40).

Hand-held frequency counter SM2400, which has a range of 50 Hz to 512 MHz and typical input sensitivity of 10 mV RMS, now costs £89 assembled or £85.10 as a kit (original price £102.35).

Function generator SG1271, covering 1 Hz to 1MHz, is now £125 assembled or £121.90 as a kit (original price £143.75).

And among the power supplies, the SP2718 tri-output power supply (5 VDC fixed and 2 x 0 to 20 VDC variable) has been priced at £99 assembled, or £66.70 as a kit (original price £113.85).

Emphasis is placed on digital electronics in this catalogue, with 16 of its 64 pages dedicated to computer hardware, software and programming courses.

HE hopes to review a couple of Heathkit's courses in a future Gadgets, Games & Kits supplement.

The catalogue is available (send 25p in stamps) from: Heath Electronics (UK) Ltd, Bristol Road, Gloucester GL2 6EE or The London Heathkit Centre, 233 Tottenham Court Road, London W1P 9AE.

High-quality Sound . . . All Round The House

SoundLink is a new product from a new company, IMP Electronics of Cambridge. It enables you to relay music from most hi-fi systems to an extension loudspeaker — without trailing cables.

Based on what is described by IMP as the 'established principle of FM mains transmission', the system is supplied as a pair of ready-built circuit board modules.

For the system to operate, it is first necessary to connect the input module to your hi-fi system and to connect the output module to an extention speaker. (Additional output module and speaker combinations can be added as required.) But that's not the complete story — some additional hardware is required, including two mains transformers, two potentiometers, two switches and, of course, the extension speaker.

HE hopes to review the SoundLink system in a future Gadgets, Games & Kits supplement.

SoundLink is available for £45.50 from IMP Electronics, 34 Caraway Road, Fulbourn, Cambridge CB1 5DU (tel 0223 881105).

Sussex Mobile Rally

A second Sussex Mobile Rally is to be held at Brighton Race Course on Sunday 19 July 1981. The event, organised by six amateur radio clubs in the Sussex area, will run from 10.30 am to 6 pm.

Last year nearly 3,000 people attended the rally, with more than 100 stands under cover. This year the rally will be larger (over 20,000 sq ft of display area) with more trade stands dealing with all forms of electronics including amateur radio, microprocessors, components and CB.

This rally will cater for the family, with free trips to the sea front by minibus, restaurant and bar facilities and many attractions.

Entrance charge will be 50p (including draw ticket), with no charge for disabled persons or for children under 14 years.

Parking space for more than 4,000 cars will be available, together with an area for caravan parking.

More details are available from: A.K. Baker (G4GNX), 38 Elphick Road, Newhaven, Sussex (tel 07912 5327 evenings).

HE COMPETITION — Project Design for IYDP

Come on! You're not trying hard enough! The response so far to HE's electronic project design competition for the International Year of Disabled Persons, announced in the April '81 issue, has been disappointing. Or perhaps your project entries will all come in at the last moment!

Just think of a physical or mental handicap, or of a disabled person you know and then think: 'What ingenious device can I come up with to help cope with that handicap or aid that person?'

As stressed in the April issue, no design is too small — and the first prize is big — £200 in cash.

So if you have any difficulties or questions, give Hugh Davies a ring on 01 437 1002 or drop him a line at HE, Modmags Ltd, 145 Charing Cross Road, London WC2H 0EE. Please head your envelopes 'Competition'.

Next month we plan to run a special article on electronic aids for the disabled.

Clean Up Your Video Head

Cleaners in cassette form have been available for some years for audio tape heads: now one has been produced specifically for tape heads in video recorders. Intended for use with tape head systems in BETA-MAX recorders, the Bib Videophile Edition tape head cleaner is claimed to have sufficient tape for 20 cleaning operations, covering 800 hours of playing.

After each 40-hour period of playing, the cassette is inserted in the normal way and run for 15 seconds. No portion of tape, once run through the machine, should be replayed.

Recommended retail price for the cleaner is £8.98, including VAT.

Bib Hi-Fi Accessories, Kelsey House, Wood Lane End, Hemel Hempstead, Herts HP2 4RQ (tel 0442 61291).

PETs On Show

The Second International PET Microcomputer show will be held at the West Centre Hotel, London SW6, from June 18 to 20.

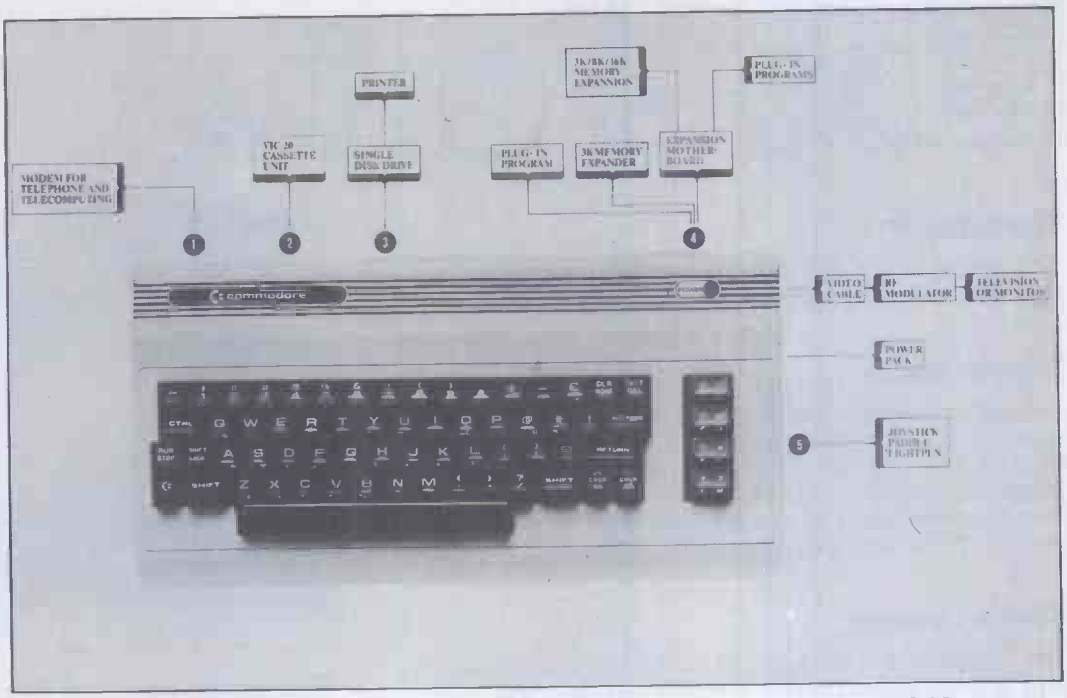
The show, open to the public from 1.00 pm to 7.00 pm on Thursday 18 June, 10.00 am to 7.00 pm on Friday 19 June and 10.00 am to 5.00 pm on Saturday 20 June, will enable visitors to see about 300 PET computers showing off their tricks.

Among the estimated 100 exhibitors will be companies from all over Europe and the US. Also exhibiting will be PET user club groups.

Apart from computer systems and applications for business, medicine, education and engineering, products and programs for the home will be on show.

Of particular interest to HE readers will be the Commodore VIC colour home computer, which can be connected to a TV and is likely to cost under £200.

HE hopes to report on this event in a coming issue.



Commodore VIC 20 computer

Keep A Hold On Your Cells

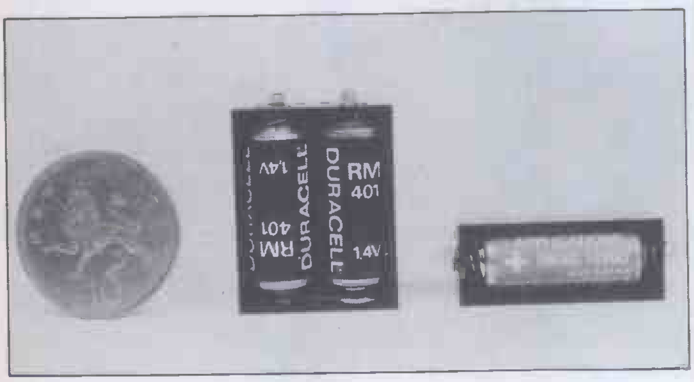
Two new holders are available from Magenta Electronics for RM401 mercury cells. The first, priced at 22p, holds a single 1.4 V cell, while the other, priced at 27p, takes two cells side-by-side.

Despite their small size (about 28 mm long by about 11 mm diameter) RM401 cells have a remarkable capacity — 800 mA/h. Shelf life to 75% of full capacity is *three years*. These cells are available from Magenta at 64p each.

Most cells are difficult items to connect or solder leads to, and are equally difficult to anchor down to a circuit board. The holders are fitted with solder terminals and have pre-drilled holes for mounting.

In common with most other mercury cells, the case of the RM401 is positive (+ve) while the tip is negative (−ve). So the springs in the holders go to the case-ends while the studs go to the tips. Each holder has a small picture of a cell between the terminals as a guide. However, as pointed out by Magenta, because the holders were originally intended for another type of battery having the same case size as the RM401, it is best to ignore the pictures and be guided by the spring and stud connections instead.

Add 40p with each order placed with Magenta Electronics Ltd., 135 Hunter St., Burton-on-Trent, Staffs DE14 2ST (tel. 0283 65435).



Vintage Radio

Readers who have an interest in radio can do two things this month: first, read Radio, the special feature starting on page 24 in this issue; and second, take a subscription to the Antique Wireless Newsheet.

This A5-sized booklet is published by The Vintage Wireless Company in Bristol. The company, run by Tudor Gwilliam-Rees, specialises in vintage radio (or should we say 'wireless') receivers and all the associated hardware and nostalgia.

Gwilliam-Rees told HE that the most sought-after sets are the BBC period models from the early 1920s. These have a type-approval stamp, with the letters BBC in a circle, and with 'type approval by the Post Master General' printed around the circle.

He said that, at present, most collectors are on the look-out for sets from the 1930s. The more unusual they look the better: square-box sets have little value unless they possess some exceptional technical qualities. It appears, however, that even these vintage sets have not escaped the ravages of the recession, because their value has dropped in recent months.

Gwilliam-Rees is at present restoring some receivers for the company which originally made them in the early-to-mid 1930s — Clarke-Atlas.

Subscription to the Newsheet is £2.50 per year (£5.00 for overseas via airmail). It is issued 12 times a year.

The Vintage Wireless Company is based at 64 Broad Street, Staple Hill, Bristol BS16 5NL (tel 0272 565472).


The Vintage Wireless Company

OFFICE & SHOWROOM AT:
64 Broad Street, Staple Hill, Bristol. BS16 5NL. Gt. Britain.
Telephone Bristol (0272) 565472. VAT Reg. No. 139 9018 47.

IMPORT EXPORT
OBSOLETE ELECTRONI[illegible]
RADIO, T.V. & INDUSTRIA[illegible] VALVES
ANTIQUE WIRELESS

"THE ANTIQUE WIRELESS NEWSHEET"

Number 68 March 1981
An X marked on the dotted line if your subscription has expired with this issue......
The newsheet is issued 12 times a year.
Subscriptions:-
U.K.& Eire:- £2.50 per year.
Overseas via airmail:- £5.00 per year.

"What Are The Wild Waves Saying"

The Truth, the whole Truth and nothing but the Truth.

If your set gives you poor quality, it is telling lies about the Broadcast Station. If it fails to transmit the low bass notes, it is concealing part of the truth. You want true reception, you are entitled to it. So is your family. There is a way to get the truth in wireless reception:—

FERRANTI

The following back numbers of The Antique Wireless Newsheet are still available, free upon receipt of a suitable stamped addressed envelope:- No's 67,66,65,62,51,48, 46,44,43,34 until the end of March when the residue will be destroyed.

Buying in old dealers stocks,etc,as we often do,it is always interesting to find the odd"curio"amongst service sheets,valves,etc.Often this can take the form of old letters,bills,etc.Recently,however,we found a real"gem",a pair of cufflinks in chrome, red & blue enamel issued and bearing the title of"Ekco",complete in their presentation

Hobby Electronics

THE JULY ISSUE IS ON SALE JUNE 12th

Roger Jefcoate demonstrating the TCL Lightwriter, an electronic aid for the handicapped

Next month

Here are just a few of the things we have planned for the July issue of Hobby Electronics.

Burglar alarm

A simple-to-build yet very effective thief detector, designed to stop burglars in their tracks. HE Ultrasound Burglar Alarm uses the tried and tested Doppler effect along with ultrasonic sound waves, in a low-cost *battery operated* circuit, which means you won't have to spend all the money you are trying to protect on building it.

Treble booster

The next project in our series of complementary guitar effects is a good-looking, and even better-sounding treble booster. It has two switched boost options — a 'normal' boost, identical to that from other circuits and a 'super' boost for real ear-splitting treble from your guitar. It is housed in the same style case as two previous projects, the Fuzzbox and this month's Envelope Generator.

Electronic aids for the disabled

How many projects have you built that have been fun for a while and then have been either left to gather dust or just be discarded? Hugh Davies spoke to Roger Jefcoate, consultant assessor and lecturer on technical aids for disabled people and was made aware that many electronic projects, some of them very simple, can be of great benefit to the disabled. This article describes some projects in use, looks at computer-controlled aids and opens the way for *your* ideas.

Doorbuzzer

Commercial doorbells and buzzers usually operate along electromagnetic lines. Typically they need a low-voltage transformer too. Our doorbuzzer is different — it's battery operated for a start (a single PP3-sized battery should give around six months' operation) and it features a solid-state design (ie, there are no moving parts to wear out). Total cost of this project should be around a fiver. With those specifications and that price, what more could we offer?

Plus

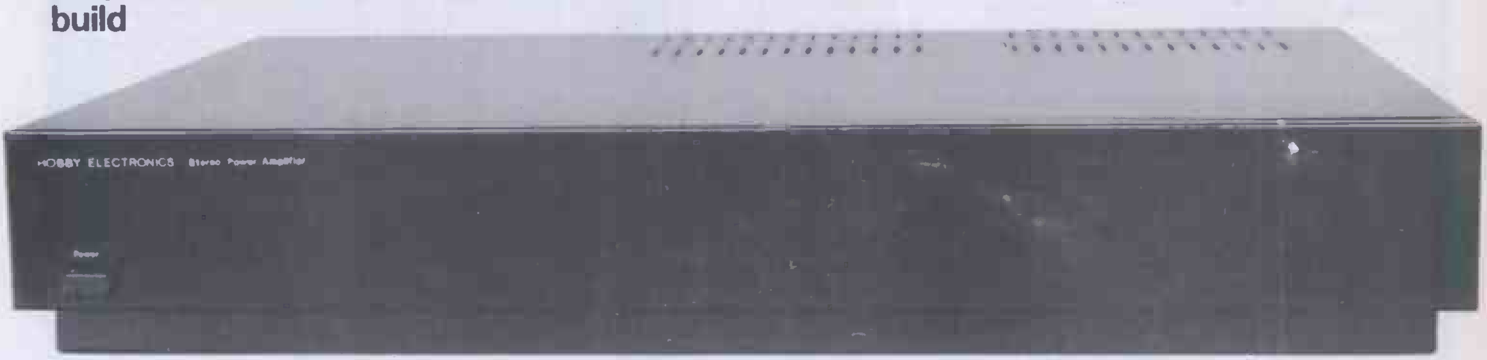
News and information, circuits, projects, regular features, your views — all presented in an understandable and down-to-earth fashion.

Keep up with the rapidly changing world of electronics with Hobby Electronics — the magazine that's written for the electronics enthusiast and hobbyist.

Items mentioned here are those planned, but unforeseen circumstances may affect the actual contents

Power Amplifier

Designed to match the HE Pre-amplifier, this project allows you to choose power output level to suit your own requirements. Modular construction makes it easy-to-build



HAVE YOU EVER heard 300 W of power (ie 150 W per channel into speakers of 4R impedance) at a distance of only 6 ft? It's loud.

Pardon?

I SAID IT'S LOUD! In fact, after we had tested the HE Power Amplifier in our project laboratory it took two hours before our hearing had returned to normal and we could hear anybody knocking on the door to ask what it was.

No, really, joking apart, 150 W per channel *is* loud and for those readers who want a very good quality amplifier system but with not quite that power output, there is an option to lower the output to the more manageable figure of 60 W per channel.

Whatever output power rating you choose, your finished amplifier will be a high quality device. Distortion is very low, meaning that the amplifier will faithfully reproduce at its output an amplified version of whatever signal is applied to the input, without adding any extra bits of its own. Its frequency range limits are well below and above the limits of hearing, so whatever you can hear, the amplifier can amplify with no problem.

Other Uses

The amplifier is suitable not only for home use but, because of its high output power option, is ideal as a high-power disco amplifier, a group instrument amplifier for guitar, organ, etc, or a high quality public address (PA) amplifier for on-stage use in, say, a theatre. In most situations, the amplifier will be limited only by the other equipment, eg pre-amplifier, speakers, etc, used with it.

Stylish Appearance

Apart from extremely good technical specifications the power amplifier is also aesthetically pleasing, being housed in a sleek, low-profile, black plastic-coated steel case.

The modular format of the project means that even those readers who aren't too sure of their capabilities should be able to build it. The case is available ready to use, pre-formed and punched to fit all hardware. The most difficult job is the wiring-up and we'll take you through that stage, step-by-step, next month.

Table 1 is a list of the specifications of the complete amplifier.

Bandwidth	10 Hz to 70 kHz (±3 dB)
Input sensitivity	775 mV (variable by RV1)
Input impedance	10k
Harmonic distortion	<0.06%
Signal-to-noise ratio	100 dB
Damping factor	minimum 100

Table 1.
Power Amplifier electrical specification

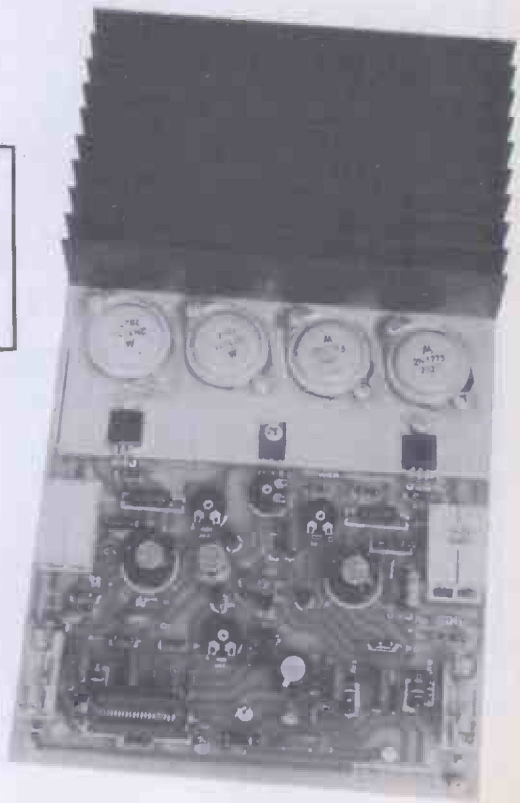
Construction

You have to decide at this point which power rating you want. As supplied, the amplifier printed circuit boards (PCBs) are complete and ready for operation in their higher power option. To derate them to 60 W amplifiers, the following procedure should be adhered to.

Desolder and remove the middle two power transistors on the heatsink. Then desolder and take out R34 and R35. Replace the two resistors with wire links. You now have a 60 W power amplifier PCB.

The remainder of this month's work concerns the case hardware.

First, locate and fit all the rear panel components onto the blank chassis of the case: three fuseholders, two phono sockets, a 5-pin DIN socket, four 4 mm sockets, the power supply cable clamp, and the small false panel. **Figure 1** shows where each part is positioned.



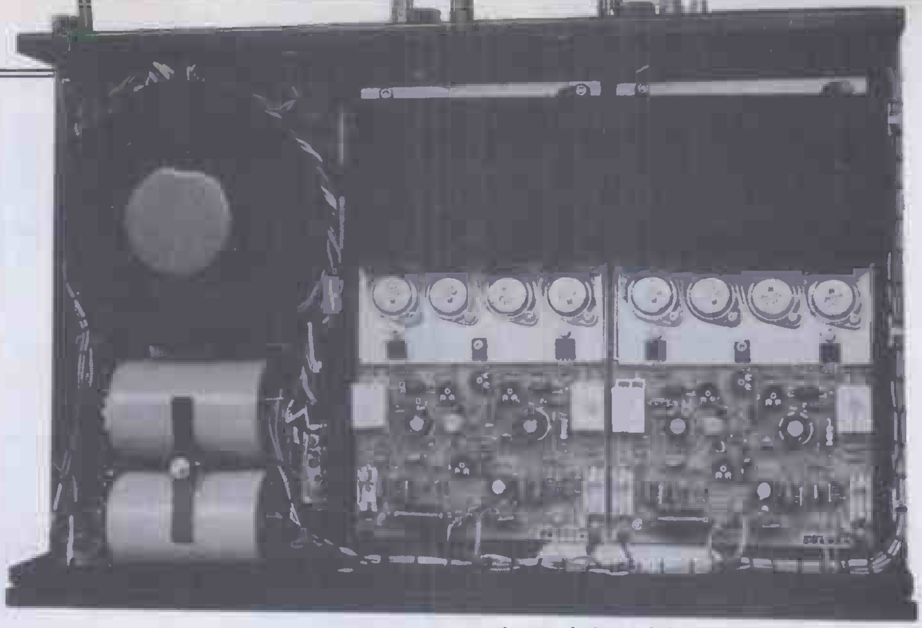
Next fasten the mains on/off switch and neon to the inside front panel. Leave the false front panel aside for the time being, safe from harm.

Locate and fit the inside hardware, as shown in Fig. 2, by bolting from the underside of the chassis.

Two special points to note are:

- the 12-way terminal block is held by two self-tapping screws
- both PCBs are mounted as follows: Fasten eight nuts and bolts (one per corner of each board) to the chassis bottom. Put a nylon washer over the end of each bolt. Insert the two PCBs into the chassis so that the bolts go through the ready-drilled holes in the corners of the boards. Fasten the boards down with a nut on each bolt

Next month we shall describe the wiring-up procedure of the project.



Internal view of the completed project. Below you can see details of the chassis and all parts.

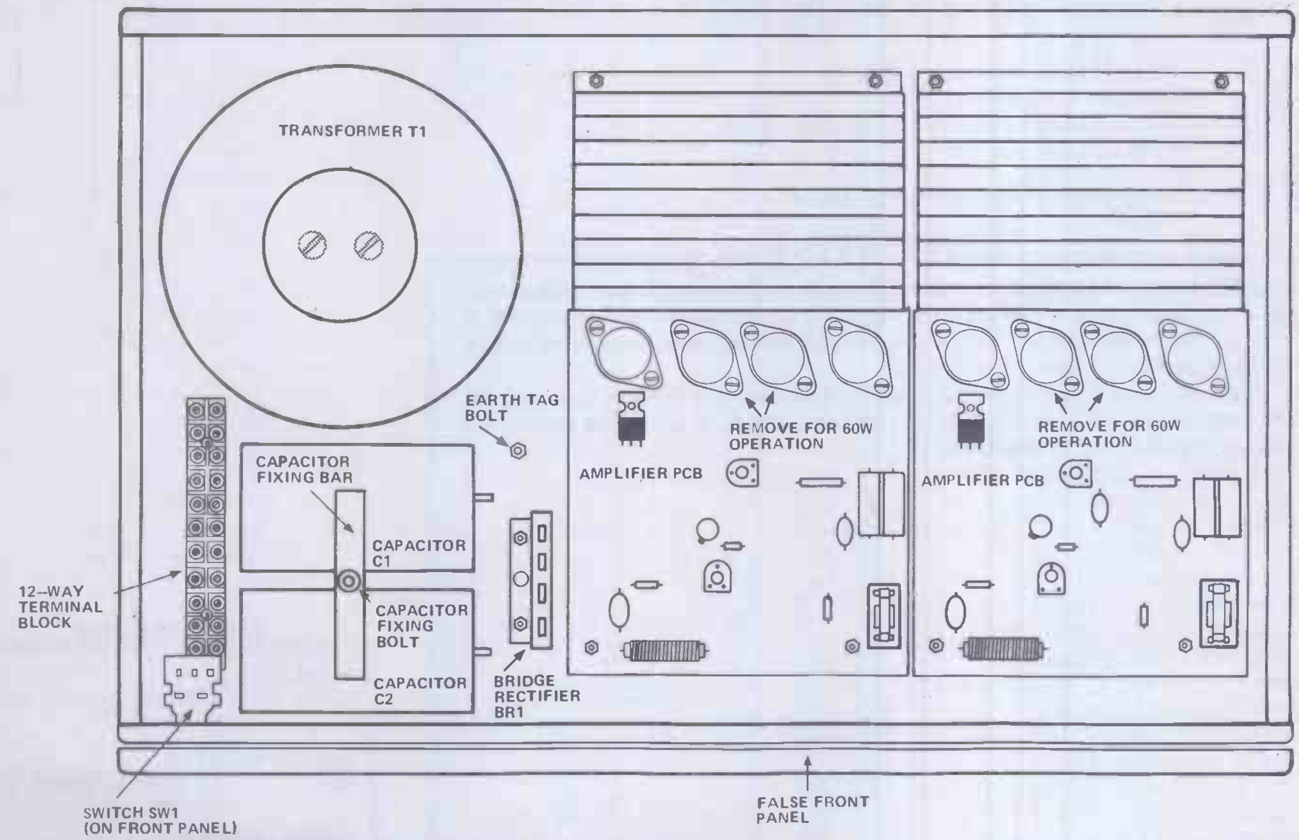


Figure 1. Positioning details of the major parts within the chassis of the HE Power Amplifier

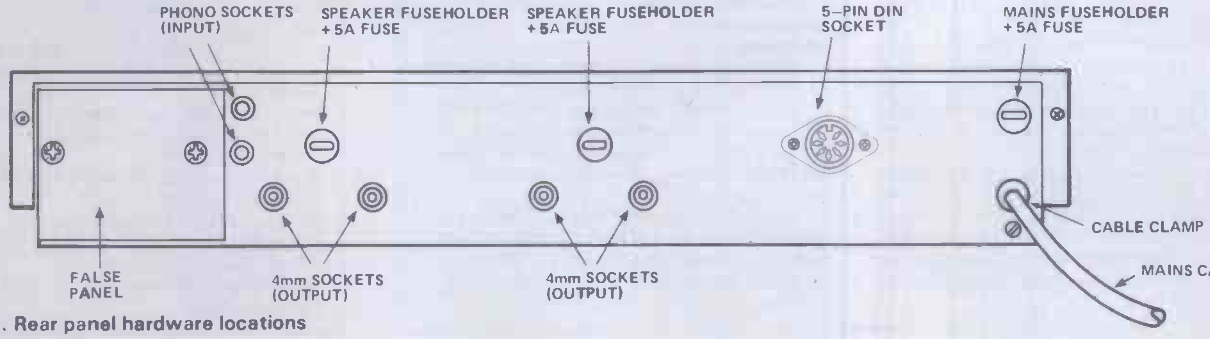


Figure 2. Rear panel hardware locations

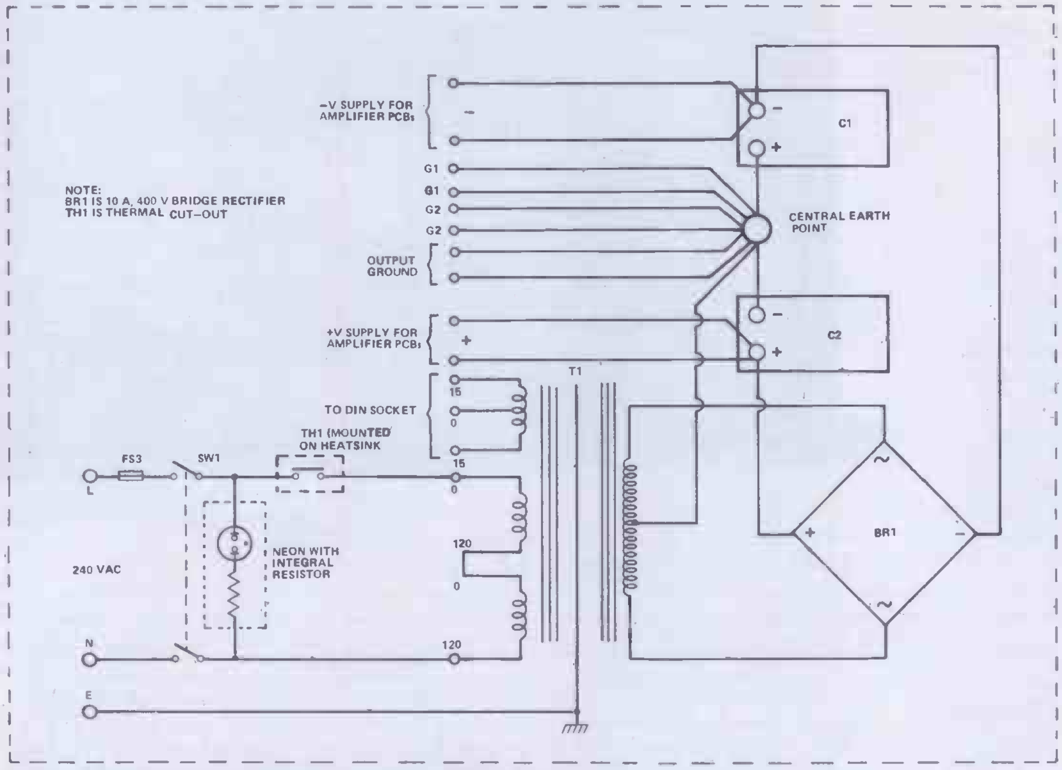
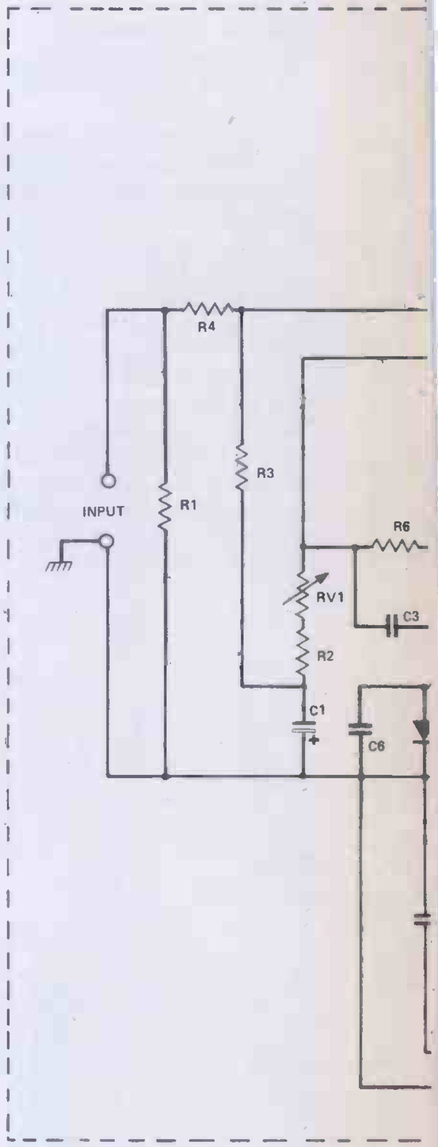


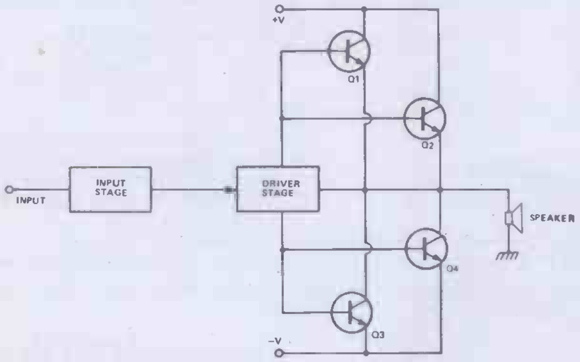
Figure 3. Circuit of the power supply used in this project



How It Works

The HE Power Amplifier consists of three main stages: an input stage which allows simple gain adjustments, a driver stage which provides the power necessary to drive the output stage, and an output stage formed by high-power transistors.

Four output transistors (two pairs in parallel) are used in the 150 W amplifier option. Derating the amplifier to 60 W is a simple matter of removing one pair of transistors.



Integrated circuit IC1 and associated components form the input stage of the power amplifier. The IC presents a fairly high impedance to whatever signal source is used, thus acting as a buffer amplifier. This stage's gain, and in turn the whole amplifier's gain, is set by preset RV1.

One of the purposes of the driver stage is to produce DC standing voltages on the bases of the output stage transistors turning them partially on at all times. The standing voltages are set by the voltage across Q9 and can be varied by RV2.

The AC signal to be amplified is superimposed onto the standing voltages.

Final amplification in this stage is performed by Q6 to Q8, and Q10.

The power stage in the Power Amplifier is formed by transistors Q11 to Q14. By removing Q12 and Q14 the amplifier can only deliver about half of the maximum power.

From the output of the amplifier there is a feedback loop via R6 to the input of the operational amplifier IC1. This is a negative feedback loop and defines the overall gain of the complete amplifier.

Parts List

CAPACITORS

C1, 2	4700u (or greater), 63 V electrolytic

SEMICONDUCTOR

BR1	10 A, 400 V bridge rectifier

MISCELLANEOUS

SW1	double-pole, double-throw push-button switch
T1	120/240 V primary, 50-0-50 + 15-0-15 V secondary transformer

Case to suit
Neon with integral resistor
3 x fuseholder + fuse (all 5 A)
5-pin DIN socket
4 x 4 mm socket (2 red, 2 black)
2 x phono socket
Mains cable + entry clamp
2 x ready-built PCB
12-way terminal block
Mounting hardware
Cable harness

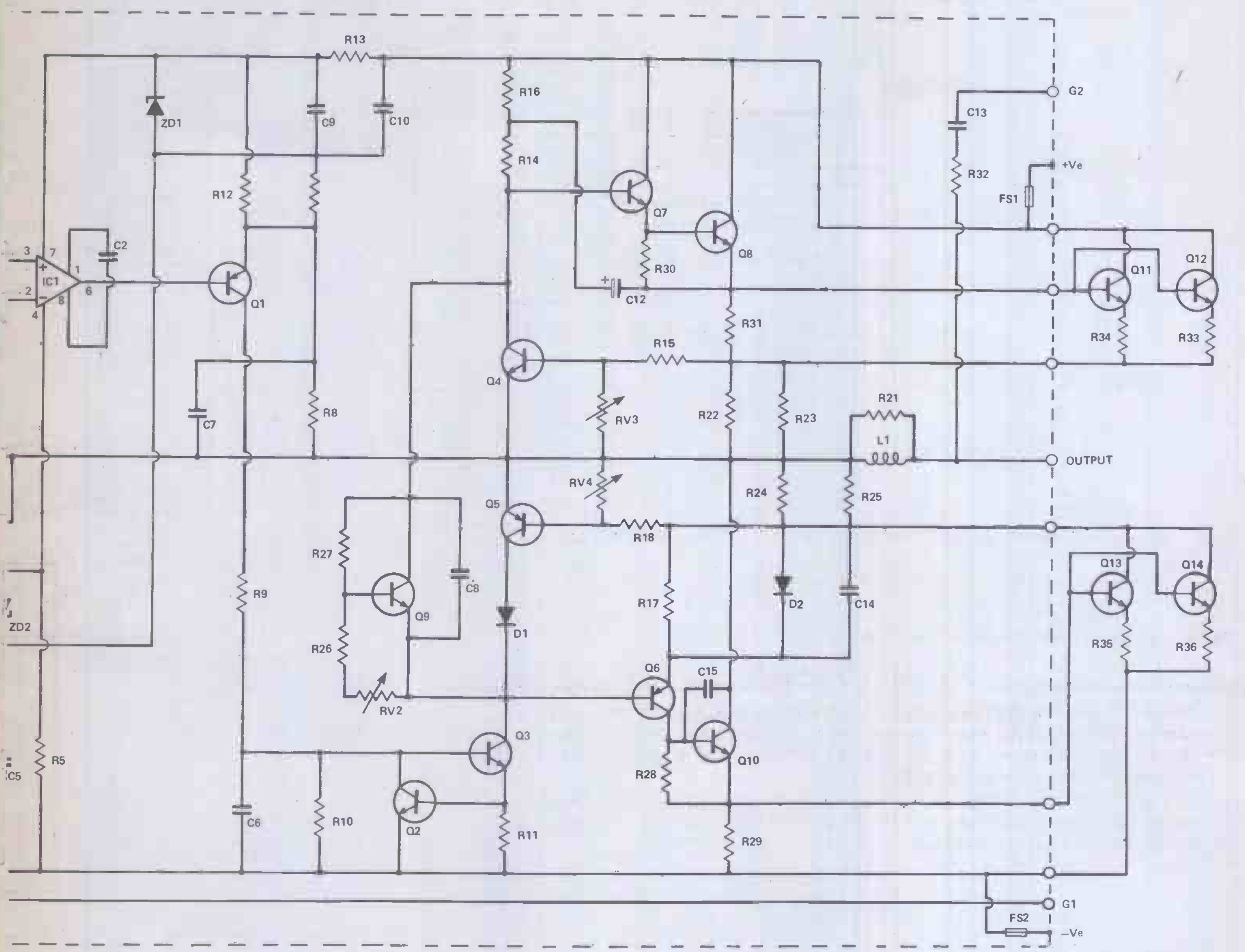
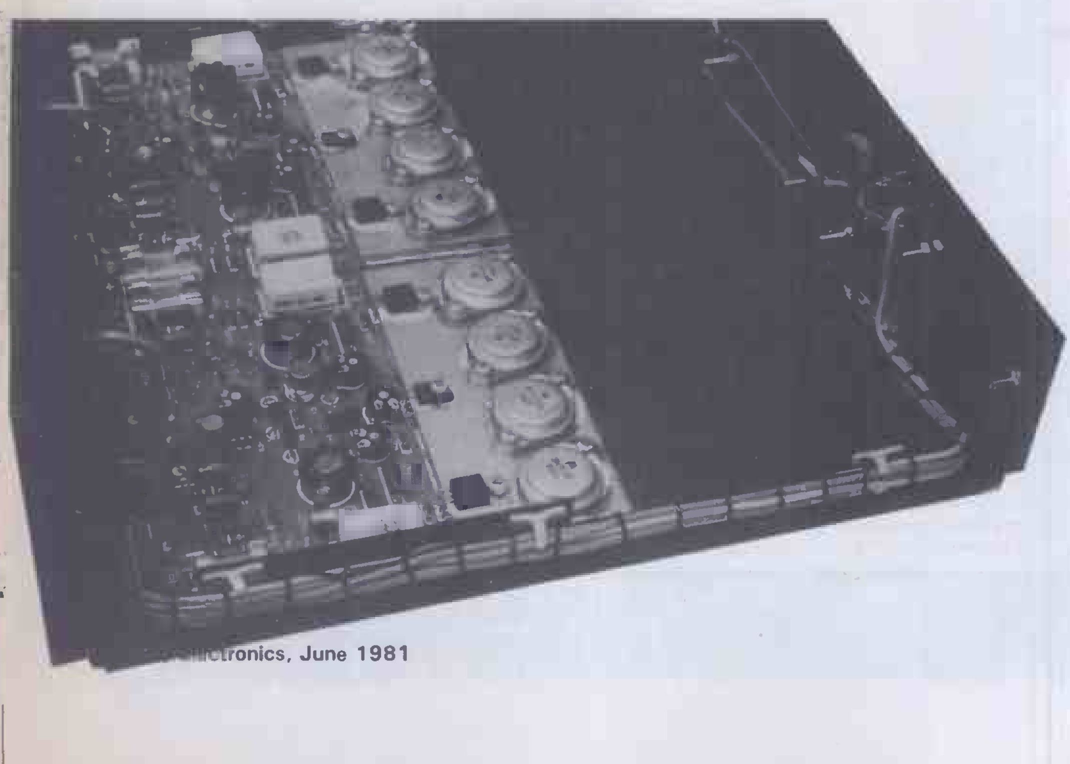


Figure 4 Circuit of the 150 W power amplifier, reproduced by courtesy of Capricorn Electronics. Two identical circuits are used on ready-built PCBs in the HE Power Amplifier



Buylines

A complete kit of parts for the HE Power Amplifier project is available from:

Capricorn Electronics,
281 Balmoral Drive,
Hayes, Middlesex UB4 8HD
(Tel: 01 573 1566)

for £155.

If you prefer to build the amplifier into a case of your own choice, Capricorn can supply all parts (excluding the case) for £125.

Please add £1.50 to your order to cover p&p.

All components and parts are also obtainable individually from Capricorn.

HE

TTLs by TEXAS					
7400	11p	74365	100p	4021	110p
74S00	60p	74366	100p	4022	100p
7401	12p	74368	100p	4023	20p
7402	12p	74390	200p	4024	50p
7403	14p	74393	200p	4026	130p
7404	14p	74490	225p	4027	50p
7405	18p			4028	84p
7406	30p			4029	100p
7407	30p	74LS SERIES		4030	55p
7408	17p	74LS00	14p	4031	200p
7409	19p	74LS02	16p	4034	200p
7410	15p	74LS03	18p	4035	110p
7411	24p	74LS04	16p	4036	295p
7412	20p	74LS05	25p	4039	295p
7413	30p	74LS08	22p	4040	100p
7414	40p	74LS09	21p	4041	80p
74C14	90p	74LS10	20p	4042	80p
7416	27p	74LS11	40p	4043	90p
7417	27p	74LS13	40p	4044	90p
7420	17p	74LS14	50p	4046	110p
7421	40p	74LS20	20p	4047	100p
7422	22p	74LS21	40p	4048	55p
7423	34p	74LS27	38p	4049	45p
7425	30p	74LS30	20p	4050	45p
7426	40p	74LS32	27p	4051	80p
7427	34p	74LS37	30p	4052	80p
7428	36p	74LS38	38p	4053	80p
7430	17p	74LS42	70p	4054	150p
7432	30p	74LS47	60p	4055	125p
7433	40p	74LS51	24p	4056	135p
7437	35p	74LS55	30p	4059	600p
7438	35p	74LS73	50p	4060	115p
7440	17p	74LS74	27p	4063	120p
7441	70p	74LS75	36p	4066	50p
7442A	60p	74LS76	45p	4067	450p
7443	112p	74LS83	70p	4068	27p
7444	112p	74LS85	80p	4069	20p
7445	100p	74LS86	40p	4070	30p
7446A	93p	74LS90	40p	4071	25p
7447A	75p	74LS92	70p	4072	25p
7448	80p	74LS93	50p	4073	25p
7450	17p	74LS96	110p	4075	25p
7451	17p	74LS107	45p	4076	107p
7453	17p	74LS109	80p	4081	27p
7454	17p	74LS112	40p	4082	27p
7460	17p	74LS113	90p	4086	72p
7470	36p	74LS114	45p	4089	150p
7472	30p	74LS122	80p	4093	70p
7473	34p	74LS123	60p	4094	250p
7474	30p	74LS124	180p	4095	95p
7475	38p	74LS125	50p	4096	95p
7476	32p	74LS126	50p	4097	340p
7480	50p	74LS132	60p	4098	120p
7481	100p	74LS133	30p	4099	200p
7482	84p	74LS136	55p	40100	220p
7483A	90p	74LS138	55p	40101	125p
7484	100p	74LS139	55p	40102	180p
7485	110p	74LS145	120p	40103	180p
7486	34p	74LS147	220p	40104	99p
7489	210p	74LS148	175p	40105	120p
7490A	30p	74LS151	80p	40106	75p
7491	80p	74LS153	60p	40107	60p
7492A	46p	74LS154	200p	40108	470p
7493A	36p	74LS155	80p	40109	100p
7494	84p	74LS156	90p	40110	300p
7495A	70p	74LS157	60p	40114	250p
7496	65p	74LS158	60p	4502	120p
7497	180p	74LS160	90p	4503	70p
74100	130p	74LS161	75p	4507	55p
74107	34p	74LS162	140p	4508	290p
74109	55p	74LS163	60p	4510	90p
74116	100p	74LS164	90p	4511	80p
74118	100p	74LS165	140p	4512	80p
74119	120p	74LS166	180p	4514	250p
74120	110p	74LS173	110p	4515	300p
74121	34p	74LS174	100p	4516	110p
74122	48p	74LS175	75p	4518	90p
74123	60p	74LS181	200p	4520	100p
74125	75p	74LS190	80p	4521	250p
74126	60p	74LS191	80p	4526	108p
74128	75p	74LS192	80p	4527	150p
74132	60p	74LS193	80p	4528	100p
74136	60p	74LS195	140p	4532	140p
74137	50p	74LS196	120p	4534	550p
74141	50p	74LS197	90p	4536	375p
74142	200p	74LS221	120p	4538	120p
74145	90p	74LS240	140p	4543	180p
74147	190p	74LS241	120p	4553	320p
74148	150p	74LS242	120p	4556	72p
74150	130p	74LS243	120p	4560	200p
74151A	70p	74LS244	120p	4569	250p
74153	70p	74LS245	150p	4572	40p
74154	120p	74LS247	140p	4583	110p
74155	90p	74LS251	140p	4584	75p
74156	90p	74LS253	90p	4585	150p
74157	70p	74LS257	90p	4724	250p
74159	190p	74LS258	160p	40097	90p
74160	100p	74LS259	160p	14411	700p
74161	90p	74LS266	100p	14412	1100p
74162	100p	74LS273	130p	14433	1100p
74163	100p	74LS279	90p	14500	700p
74164	120p	74LS283	90p	14599	290p
74165	130p	74LS298	160p		
74166	120p	74LS323	400p		
74167	200p	74LS324	200p		
74170	240p	74LS348	200p	INTERFACE ICs	
74172	450p	74LS365	48p		
74173	120p	74LS367	50p	AD536A	£13
74174	90p	74LS368	100p	AD561J	1400p
74175	85p	74LS373	150p	AD7524	600p
74176	90p	74LS374	150p	DM8123	175p
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74178	160p	74LS377	160p	DP8304	450p
74180	93p	74LS378	140p	DS8835	250p
74181	160p	74LS390	90p	DS8836	150p
74182	90p	74LS393	90p	DS8838	225p
74184A	150p	74LS399	200p	MC1488	75p
74185	150p	74LS445	140p	MC1489	75p
74186	500p	74LS670	400p	MC3446	300p
74188	325p			MC3480	850p
74190	120p			25S10	350p
74191	120p			75107	160p
74192	100p	4000 SERIES		75110	200p
74193	100p	4000	15p	75150	175p
74194	120p	4001	22p	75154	175p
74195	95p	4002	20p	75182	230p
74196	95p	4006	95p	75324	375p
74197	80p	4007	20p	75361	300p
74198	150p	4008	80p	75363	400p
74199	150p	4009	40p	75365	200p
74221	160p	4010	50p	75451/2	72p
74251	140p	4011	20p	75491/2	70p
74259	250p	4012	25p	8T26	160p
74278	290p	4013	40p	8T28	160p
74279	110p	4014	84p	8T95	180p
74283	140p	4015	84p	8T97	160p
74284	360p	4016	45p	81LS95	120p
74285	360p	4017	60p	81LS96	140p
74290	150p	4018	89p	81LS97	120p
74293	150p	4019	45p	81LS98	140p
74298	200p	4020	90p	9602	220p

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9302	175p	74S04	60p	74S124	300p
9308	316p	74S05	75p	74S132	160p
9310	275p	74S08	75p	74S133	75p
9311	275p	74S10	60p	74S138	225p
9312	160p	74S20	60p	74S139	225p
9314	165p	74S30	60p	74S157	250p
9316	225p	74S32	90p	74S163	300p
9321	225p	74S37	90p	74S174	250p
9322	150p	74S64	60p	74S175	320p
9334	360p	74S74	90p	74S194	350p
9368	250p	74S85	300p	74S241	450p
9370	300p	74S86	180p	74S260	70p
9374	200p	74S112	120p	74S373	500p
				74S374	500p

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AY1-1320	320p	MC1458	48p
AY1-5050	140p	MC1495L	350p
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AY3-8910	800p	MC3340P	120p
AY3-8912	650p	MK50398	750p
AY5-1224A	240p	ML920	775p
AY5-1315	600p	MM57160	620p
AY5-4007D	520p	NE531	150p
CA3019	80p	NE555	20p
CA3046	70p	NE556	70p
CA3048	225p	NE564	420p
CA3080E	72p	NE565	130p
CA3086	48p	NE566	155p
CA3089E	225p	NE567	140p
CA3090AQ	375p	NE571	425p
CA3130E	90p	NE5534A	250p
CA3140E	50p	RC4136	80p
CA3160E	100p	S566B	270p
CA3161E	140p	SAD1024A	1250p
CA3162E	450p	SFF96364	1100p
CA3189E	300p	SL490	400p
CA3280	160p	SN76477	160p
DAC1408-8	200p	SP8515	750p
FX209	750p	TA7120	120p
HA1388	260p	TA7204	200p
ICL7106	850p	TA7205	250p
ICL8038	300p	TAA621	275p
ICM7555	80p	TBA641B11	300p
LF351	48p	TBA651	200p
LF356P	95p	TBA800	90p
LM10C	425p	TBA810	100p
LM301A	27p	TBA820	90p
LM311	70p	TBA950	300p
LM318	200p	TCA220	350p
LM319	225p	TCA940	175p
LM324	45p	TDA1004	300p
LM339	75p	TDA1008	320p
LM348	95p	TDA1010	225p
LM358P	50p	TDA1022	570p
LM377	175p	TDA1024	120p
LM380	75p	TDA1034B	250p
LM381AN	180p	TDA1170	300p
LM386	95p	TDA2002V	325p
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LM748	35p	UAA170	175p
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LM3302	140p	UPC1156H	300p
LM3900	70p	XR2206	300p
LM3909	70p	ZN414	90p
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VOLTAGE REGULATORS
Fixed Plastic TO-220

1A	+ve		-ve	
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	70p
18V	7818	60p	7918	70p
24V	7824	60p	7924	70p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS			
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LM317T	200p	78HO5KC	550p
LM323K	500p	78MGT2C	135p
LM723	37p	79HGKC	600p
		TL497	300p

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OCP71	90p	ORP61	120p
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MCT26	100p	TIL112	90p
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LEDS			
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TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular LEDs (R, G, Y)	30p
TIL216 Red	18p	NSB5881	570p
		TIL311	600p
DISPLAYS		TIL312/3	110p
3015F	200p	TIL321/2	130p
DL704	140p	TIL330	140p
DL707 Red	140p	7750/60	200p
FND357	120p	**DRIVERS**	
FND500	110p	9368	250p
FND507	110p	9370	300p
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MAN4640	200p	UDN6184	320p

TRANSISTORS									
AC126	25p	BFR40	25p	TIP30A	48p	2N3055	48p	3N140	120p
AC127/8	20p	BFR41	25p	TIP30C	60p	2N3442	140p	3N141	110p
AC176	25p	BFR79	25p	TIP31A	58p	2N3553	240p	3N201	110p
AC187/8	25p	BFR80	25p	TIP31C	62p	2N3565	30p	3N204	120p
AF116	50p	BFR81	25p	TIP32A	68p	2N3584	250p	40290	250p
AD149	70p	BFX29	30p	TIP32C	82p	2N3643/4	48p	40361/2	75p
AD161/2	45p	BFX30	34p	TIP33A	90p	2N3702/3	12p	40408	90p
AU107	200p	BFX84/5	40p	TIP33C	114p	2N3704/5	12p	40409	100p
BC107/8	11p	BFX86/7	30p	TIP34A	115p	2N3706/7	14p	40410	100p
BC109	11p	BFX88	30p	TIP34C	160p	2N3708/9	12p	40411	300p
BC117	20p	BFW10	90p	TIP35A	225p	2N3773	300p	40594	120p
BC147/8	9p	BFY50	30p	TIP35C	290p	2N3819	25p	40595	120p
BC149	10p	BFY51/2	30p	TIP36A	270p	2N3820	50p	40673	75p
BC157/8	10p	BFY56	33p	TIP36C	340p	2N3823	70p	40871/2	100p
BC159	11p	BFY90	90p	TIP41A	65p	2N3866	90p		
BC169C	12p	BRY39	45p	TIP41C	78p	2N3902	700p		
BC172	12p	BSX19/20	20p	TIP42A	70p	2N3903/4	18p		
BC177/8	17p	BU104	225p	TIP42C	82p	2N3905/6	20p		
BC179	18p	BU105	190p	TIP54	160p	2N4037	65p		
BC182/3	10p	BU108	250p	TIP120	120p	2N4058/9	12p		
BC184	11p	BU109	225p	TIP122	130p	2N4060	12p		
BC187	30p	BU126	150p	TIP142	130p	2N4123/4	27p		
BC212/3	11p	BU180A	120p	TIP147	130p	2N4125/6	27p		
BC214	12p	BU205	200p	TIP2955	78p	2N4401/3	27p		
BC237	15p	BU208	200p	TIP4055	70p	2N4427	90p		
BC327	16p	BU406	145p	TIS43	45p	2N4871	60p		
BC337	16p	E300	50p	TIS93	30p	2N5087	27p		
BC338	16p	E308	50p	ZTX108	12p	2N5089	27p		
BC461	36p	E310	50p	ZTX300	13p	2N5172	27p		
BC477/8	30p	MJ2501	225p	ZTX500	15p	2N5179	90p		
BC516/7	40p	MJ2955	90p	ZTX502	18p	2N5191	90p		
BC547B	16p	MJ3001	225p	ZTX504	30p	2N5194	90p		
BC548C	9p	MJE340	50p	2N457A	250p	2N5245	40p		
BC549C	18p	MJE2955	100p	2N696	35p	2N5296	55p		
BC557B	16p	MJE3055	70p	2N697	25p	2N5401	50p		
BC559C	18p	MPF102	45p	2N698	45p	2N5457/8	40p		
BCY70	18p	MPF103/4	40p	2N706A	30p	2N5459	40p		
BCY71/2	22p	MPF105/6	40p	2N708	30p	2N5460	60p		
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BD135/6	54p	MPS6534	50p	2N930	18p	2N5875	250p		
BD139	56p	MPSA06	30p	2N1131/2	36p	2N6027	48p		
BD140	60p	MPSA12	50p	2N1613	25p	2N6041	160p		
BD189	60p	MPSA13	50p	2N1711	25p	2N6044	160p		
BD232	95p	MPSA20	50p	2N2102	70p	2N6052	300p		
BD233	75p	MPSA42	50p	2N2160	350p	2N6059	325p		
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BD242	70p	MPSA70	50p	2N2369A	25p	2N6254	130p		
BDY56	200p	MPSU06	63p	2N2484	30p	2N6290	65p		
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How To Use An Oscilloscope

John Strong describes some simple tests and measurements that can be done with an inexpensive oscilloscope

AN OSCILLOSCOPE is probably the most informative instrument that anyone interested in electronics can possess. Used properly it can give a visual indication of what a circuit is doing, and often it can show what is going wrong quicker than any other instrument.

As with most things, the more money you spend, the better the equipment you can get. However, for the average hobbyist, equipment cost cannot be allowed to get out of proportion with the hobby itself. For this reason it is better to start with a simple and inexpensive 'scope rather than an elaborate and expensive one. As knowledge and finances improve, you can move on to more 'professional' equipment.

Getting Started

It is best to start with a single-channel, single-timebase oscilloscope. Such an instrument has the advantage of being fairly inexpensive (new ones can be bought for around £100) and it will have the minimum of controls.

Regular readers should have some idea of how a 'scope works (see The Oscilloscope, HE February 1981, pp18 to 22) but as a reminder, Fig.1 shows a basic 'scope in block form.

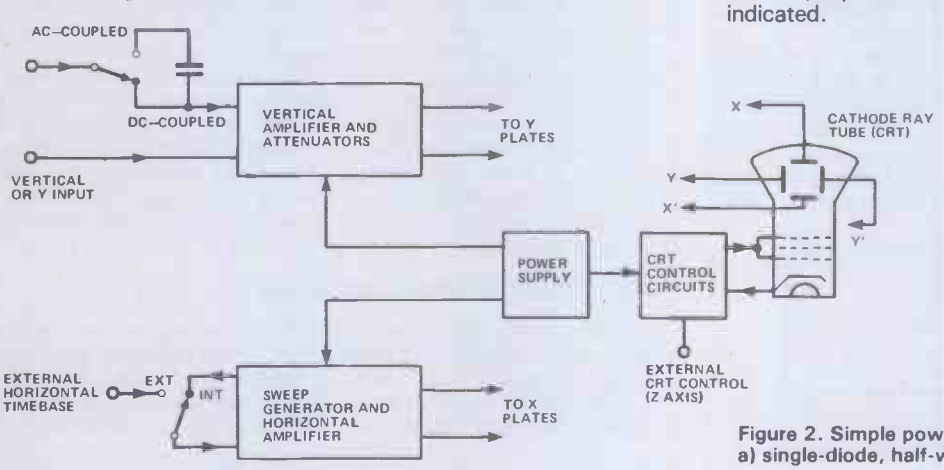


Figure 1. Principal stages of a simple oscilloscope

To make use of your 'scope it is best to follow the same procedure every time. Even those who make regular use of 'scopes can make mistakes by assuming that the controls are set correctly.

The following steps should serve as a guide.

1) Turn the horizontal gain fully up, and make sure that the sweep range control is *not* set to an external input position.

2) With no signal applied to the 'scope, adjust the position controls so that a continuous horizontal line is displayed across the centre of the screen. Check that the intensity and focus controls are correctly set at this stage. If the intensity control is set to high then there is a danger that the life of the CRT (cathode ray tube) will be shortened.

3) Check that the input voltage does not exceed the maximum value specified for the 'scope or of any probe used with the 'scope.

4) Check that the vertical gain (attenuator) control is set to, or above, the voltage of the signal to be measured. If in anyasured. If in any doubt, start with maximum attenuation (highest voltage setting, equivalent to least sensitivity) and work down the range until the correct setting is reached.

5) Check that the vertical input selector is set to the correct mode (that is, DC- or AC-coupled).

6) Check that the timebase and vertical amplifier controls are in their 'calibrated' positions (if these settings are provided). Remember that the CRT is the most expensive single component in a 'scope so keep beam intensity down to the minimum required for a particular test. Take care to 'turn down the glare' on slow sweep speeds or if the 'scope is being used in the external horizontal timebase mode, as described later. When using the 'scope in this mode, avoid displaying a stationary bright 'dot' for any length of time. Once the phosphor coating has been burned from any part of the CRT screen the only remedy is to renew the CRT.

Practical Measurements

Rather than plunge into the depths of complicated circuits, it's best to start with something simple such as some rectifying and smoothing circuits. Figures 2a to 2d show various transformer, rectifier, capacitor and load resistor combinations, with test points indicated.

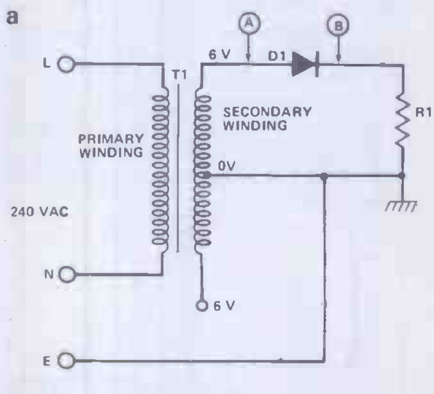
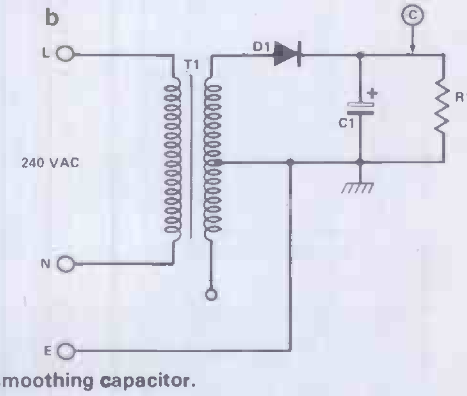


Figure 2. Simple power supplies. Figs. 2c and 2d are shown overleaf a) single-diode, half-wave rectified circuit, with resistive load.



b) as circuit a, with smoothing capacitor.

Nothing is critical about the components used in these circuits: suggested values are given in Table 1. When wiring up the transfomer, take care to insulate the primary winding connections to avoid the chance of any electric shocks from exposed 'live' points. It is also advisable to 'breadboard' the components; that is, to mount the diodes, capacitor and resistor so that they can be easily rearranged for each configuration shown.

Power Supply Components	
Transformer	Low-current type (say 50 mA) with 240 V primary and 6 V/6 V centre-tapped secondary
Diodes D1 and D2	1N4001 or similar
Capacitor C1	1000u, 10 V electrolytic
Resistor R1	1k0, ¼ W

Table 1. Suggested components for circuits shown in Figs. 2a to 2e

It is also worth mentioning that a valuable aid when making oscilloscope measurements is a pair of probes. If you have an inexpensive 'scope then you won't need a deluxe probe set with built-in compensation components, variable gain and a kitchen sink built in. For most measurements, two lengths of ordinary insulated wire are sufficient. However, you will probably like to invest in a set of ordinary test leads, the black or earth lead having a crocodile clip or similar on one end, and the red or signal probe lead with a test prod or probe at its end.

Switch the 'scope to DC-coupled mode and adjust the trace to the centre of the screen before making measurements. Connect the clip of the earth probe to the point on each circuit marked with the earth symbol (ie, ⏚)

With the circuits shown in **Figs. 2**a and **2b** only one half of the secondary winding is used (centre tap and one 6 V tap). Both windings are used in the other two circuits, with the centre tap earthed.

When the probe is applied to point A in the circuit shown in **Fig. 2**a, trace A in **Fig. 3** should be obtained. This represents an AC voltage with a frequency of 50 Hz (mains frequency).

The waveform of trace B at point B in **Fig. 2**a shows the effect of diode D1; that is, only the positive half-cycles are allowed to pass through to the load resistor R. This waveform represents DC in its crudest (unsmoothed) form. This kind of rectification is used, for example, in simple battery charger circuits.

Moving on to the circuit in **Fig. 2b**, capacitor C has been added in parallel across the resistor. The smoothing action at point C is indicated in trace C.

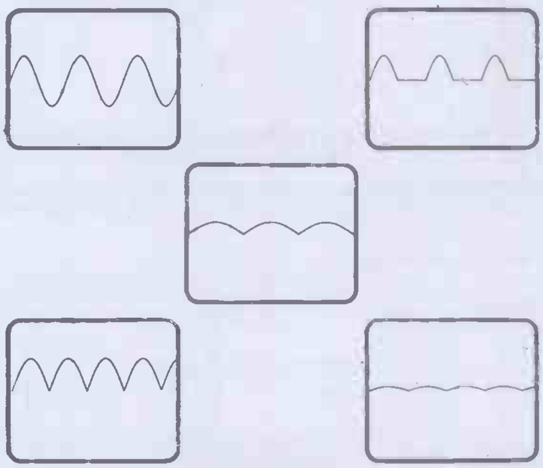
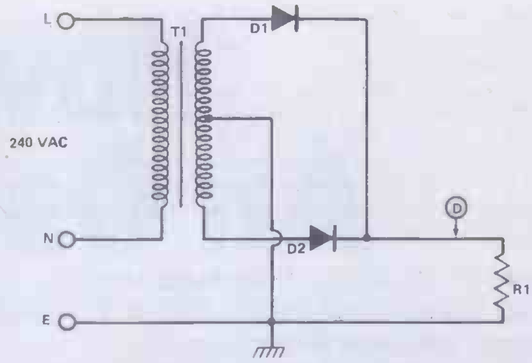


Figure 3. Traces that should be obtained from points A to E in circuits in Fig. 2

Figures 2c and **d** both show a full-wave rectified circuit. Here, two diodes are used to extract both half-cycles, giving the continuous line of 'humps' shown in trace D. With the capacitor in circuit as shown in **Fig. 2d**, a smoother trace is obtained: much smoother than obtained with the single-diode circuit.

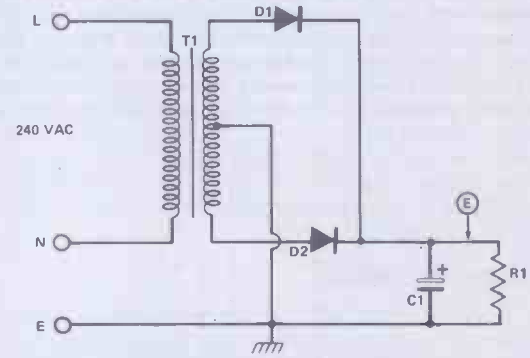
You will notice that even the best smoothed circuit has some ripple (trace E). Pure DC from a battery would, by comparison, give

c



c) two-diode, full-wave rectified circuit, with resistive load.

d



d) as circuit c, with smoothing capacitor.

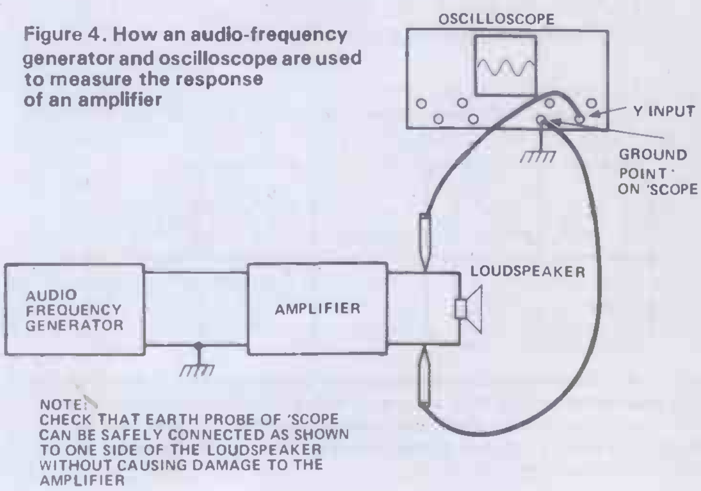
a straight line on the 'scope. In the DC-coupled mode, the displayed line simply moves up the screen in proportion to the DC voltage. Thus the 'scope enables you to 'see' the presence of any ripple, which is the part of the AC voltage which, after rectification by the diodes, escapes smoothing by the capacitor. If the load were increased by reducing the value of R, then the ripple would be worse. If the ripple is observed with the 'scope in the AC-coupled mode, then the sensitivity of the vertical amplifier can be increased to allow the amount of ripple to be measured without the trace shifting out of view. This power supply ripple is an important consideration when designing some circuits and can, for example, produce an unwanted buzzing sound from an audio amplifier when it is run from a supply with a high ripple content.

Amplifier Measurements

To observe the response of an amplifier at various frequencies you will need, in addition to the 'scope, an audio-frequency generator similar to the one described in HE February 1981, pp 36 to 38.

The instruments are connected to the amplifier as shown in **Fig. 4**. Connect the generator, set to its lowest output voltage, to the

Figure 4. How an audio-frequency generator and oscilloscope are used to measure the response of an amplifier



input terminals of the amplifier, and connect the output of the amplifier to the vertical input terminals of the 'scope. Adjust the input attenuator and timebase controls to obtain a display. With the output signal from the generator held constant, try varying the generator frequency over the range of interest while adjusting the timebase controls to display only a few cycles of the waveform. The response of the amplifier at chosen frequencies can be observed, and the probe can be moved from the output of the amplifier back to the input to make comparisons of the shape and size of the signals at these points.

Simple Frequency Measurements

A display of what are called Lissajous figures can be useful for measuring the frequency of signals, particularly where no indication of time or frequency is given on the 'scope. Lissajous figures are obtained by feeding two different signals at the same time into the 'scope, one into the vertical input and the other into the horizontal input. Under these conditions, the timebase is switched off (that is, it is set to external horizontal timebase). The waveforms can be used to measure frequency if one of the signals has a known frequency while the other has an unknown frequency.

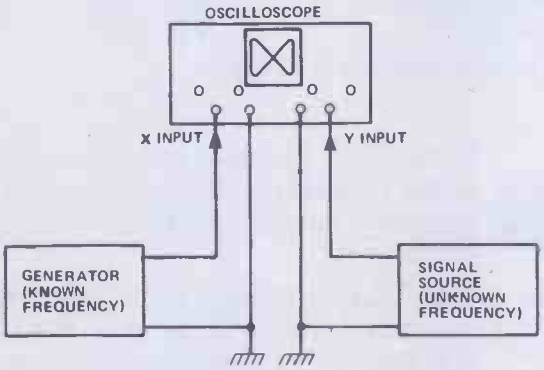


Figure 5. How a signal generator, providing a signal with known frequency and a signal source of unknown frequency, are connected to an oscilloscope to produce Lissajous figures

Connect the 'scope as shown in Fig. 5 and adjust the gain and position controls to centre the trace on the screen. Apply the unknown frequency to the vertical input and adjust the gain control to give a convenient sized display. Then adjust the generator frequency for a stationary display. The unknown frequency can then be calculated as follows:

$$\text{Unknown frequency} = \frac{\text{Number of crossing points over the horizontal scale line}}{\text{Number of crossing points over the vertical scale line}} \times \text{Known frequency from generator}$$

For example, let's assume that the generator frequency is 1 kHz. If the trace in Fig. 6a is obtained, then the unknown frequency will be:

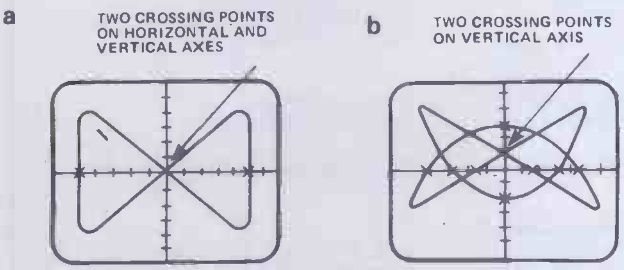


Figure 6. Lissajous figures produced by signals applied to the vertical and horizontal inputs of a 'scope: a) trace crosses horizontal axis at four points (twice at centre of screen) and vertical axis at two points (both at centre of screen), b) six crossing points on horizontal axis and four on vertical axis

$$\frac{4}{2} \times 1000 = 2 \text{ kHz.}$$

If the trace in Fig. 6b is obtained, then the unknown frequency will be:

$$\frac{6}{4} \times 1000 = 1.5 \text{ kHz.}$$

Reading The Scale

All the measurements described so far have been based on observation of the displayed image, and this method is satisfactory for most purposes. Often, the 'scope is used as an 'eye' to see what is going on in a circuit, and with experience much can be gained from correct interpretation of what is displayed. For example, if you are putting a pure sinewave signal into an amplifier and you get a flat-topped waveform from its output, then 'clipping' is taking place in the amplifier as the result of over-driving one of its stages. (See O Level Q & A, HE May '81, page 55 for a description of this effect.)

Sometimes, however, you may need to take measurements of units such as frequency and voltage *direct from the screen*. To do this, you will need to know what each little square on the screen means in terms of time and voltage. An example is given in Fig. 7.

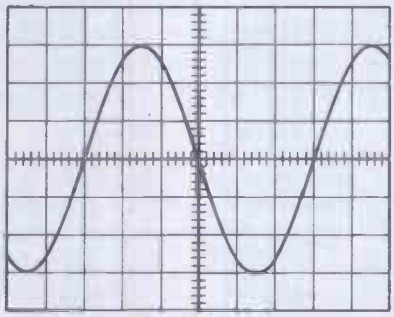


Figure 7. Example of sinewave signal displayed on typical oscilloscope screen. Timebase has been set to 5 ms/cm and vertical attenuator to 1 V/cm

A sinewave signal has been applied to the 'scope's vertical input, with the timebase set to 5 ms/cm and the vertical attenuator set to 1 V/cm. Therefore, the period of the waveform, measured over a full cycle, will be six divisions along the horizontal axis, equivalent to:

$$6 \times 5 \text{ ms}$$

or $6 \times 0.005 \text{ s} = 0.03 \text{ s}$.

OK, you may say, what does 'period' mean? Let's convert it to frequency f (number of full cycles per second), by taking its reciprocal, where

$$f = \frac{1}{\text{Period in seconds.}}$$

Therefore,

$$f = \frac{1}{0.03} = 33 \text{ cycles/second or } 33 \text{ Hz.}$$

What about the voltage? Counting the vertical divisions between the peaks gives:

$$6 \times 1 \text{ V} = 6\text{V.}$$

Thus we have a 6 V peak-to-peak sinewave signal with a frequency of 33 Hz. All this calculation may seem a trifle complicated but you will soon get a 'feel' for it, and you can often do a rough calculation of frequency or voltage in your head.

Remember that the more practice you get in using a 'scope the more useful it will become.

HE

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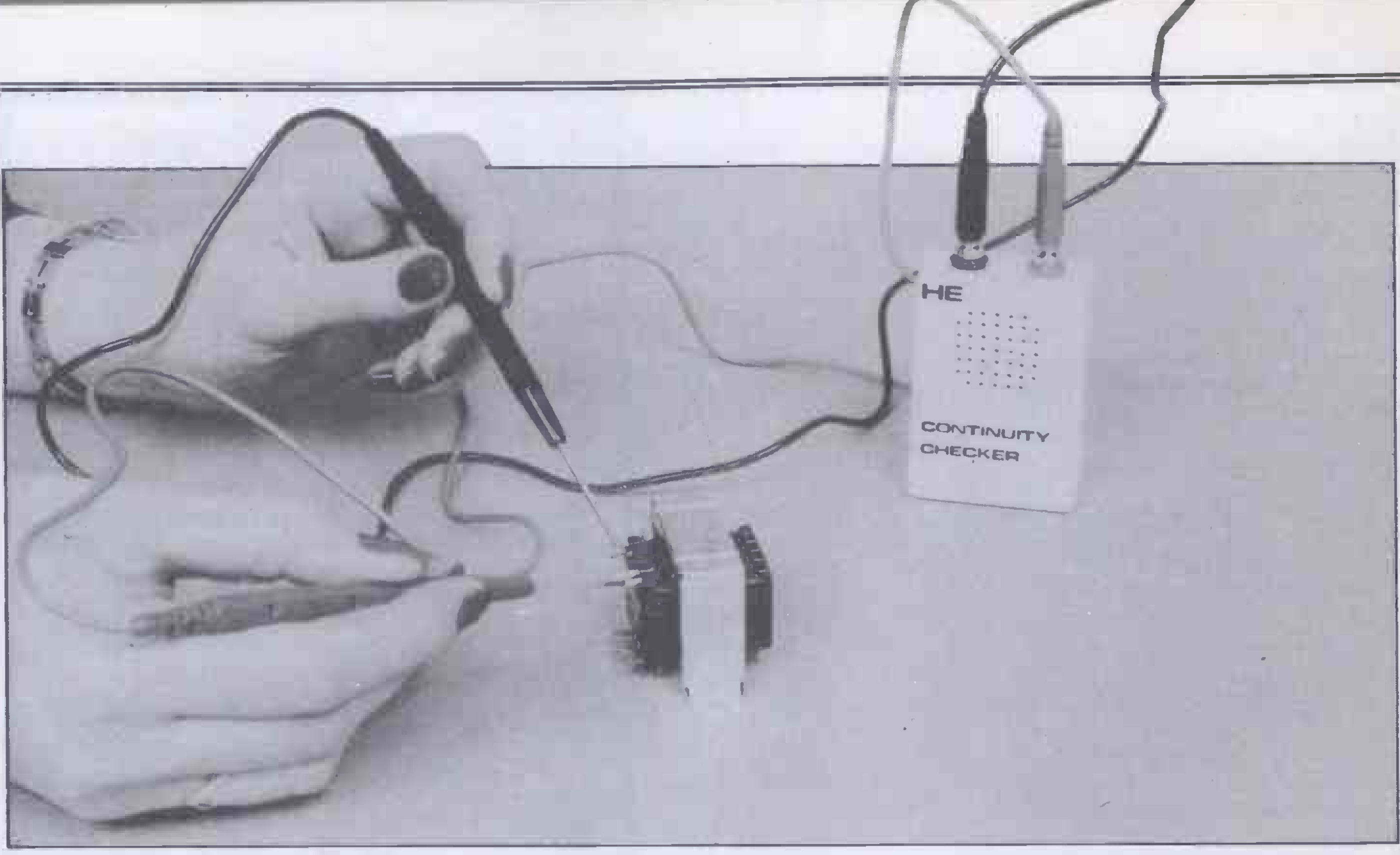
BRIEF SPECIFICATION

Vertical Deflection	
Voltage sensitivity	< 10 mV/division
Bandwidth	AC 2 Hz to 5 MHz DC DC to 5 MHz within −3dB
Input impedance	1M0 ± 5% within 35 pF
Ext. Horizontal Amplifier	
Voltage sensitivity	< 250 mV/division
Input impedance	1M0 10% within 35pF
CRT	75 mm (2.95") round screen, green phosphor
Power Requirements	
Voltage	100, 110, 117, 220, 230, or 240 VAC, 50 to 60 Hz
Wattage	about 10 VA
Dimensions	202 mm wide by 160 mm high by 305 mm deep. (7.9 by 6.3 by 12")

B



Continuity Checker

Here's an ideal project for you to build — it's cheap, simple-to-build and very useful

THERE ARE MANY times in the electronics hobbyist's life when a need arises for a quick and simple test to check fuses, coils, circuit boards etc, for short or open circuits. Normally this means searching for a multimeter (only to find that the internal battery is long dead) or diving into the junkbox to look for a battery, bulb and holder, and suitable wire (and then struggling to hold all connections in place between your knees while trying to position the probes onto whatever you're testing). The HE Continuity Checker is a project to end all of that. In fact, once you have built it you won't know how you ever managed without it. Housed in a small, hand-held case it combines usefulness with good looks. Total cost is around £5 so the project won't burn a large hole in your pocket, and it is very easy to build.

The circuit is formed around a single IC, the LM3909, which directly drives a miniature loudspeaker with an audio frequency tone. The frequency of this tone varies with the resistance between the two probes — the lower the resistance, the higher the frequency. We reckon that, with a bit of practice, the 'experienced' ear should be able to distinguish easily between short circuits, open circuits or rough values of resistance from about 10 to 220R. The audio tone generated also means that you don't need to look away from the object under test (as would be necessary with a meter) while holding the probes in position on that object.

When the Continuity Checker is connected to a loudspeaker, the speaker under test (if it works) will also emit the tone, so giving a good/bad speaker acoustic test.

No on/off switch is necessary because when the probes are disconnected battery drain is *nil* and battery life of the project (using an RM401 battery) should be a matter of *years* with average use. These batteries are specified as having a capacity of *800 mA/hours* and a battery shelf-life, to 75% of full capacity, of *3 years*.

Construction

Start construction by making the four breaks in track, on the underside of the Veroboard beneath IC1, as indicated in **Fig. 2**.

Next, insert and solder the links, followed by an 8-pin IC holder for IC1. Now insert and solder R1 and C1 making sure that you polarise C1 correctly, and then push IC1 into its socket.

Mark and drill the case for the two 4 mm probe lead sockets, also drill a number of holes in the front panel to act as a loudspeaker grille. Glue the speaker into position, being careful not to get glue on its cone, and fasten the two probe sockets into their positions.

Finally, wire together the speaker, battery holder, Veroboard and 4 mm sockets as shown in **Fig. 2** using short lengths of connecting lead, and then fasten the board and the battery holder into the case using double-sided adhesive pads. Insert the battery, seemingly the wrong way round (ie +ve to the spring) into its holder. The construction of these batteries is such that their *outer* case is positive, unlike most batteries of similar size, and consequently they should be inserted into the holder the opposite way round.

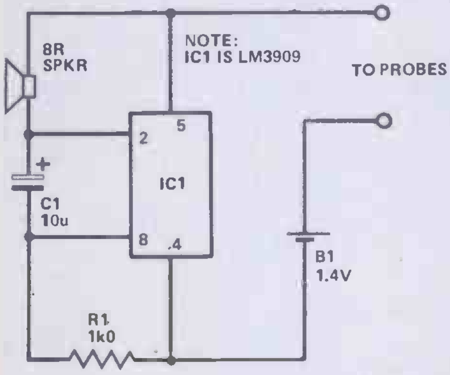
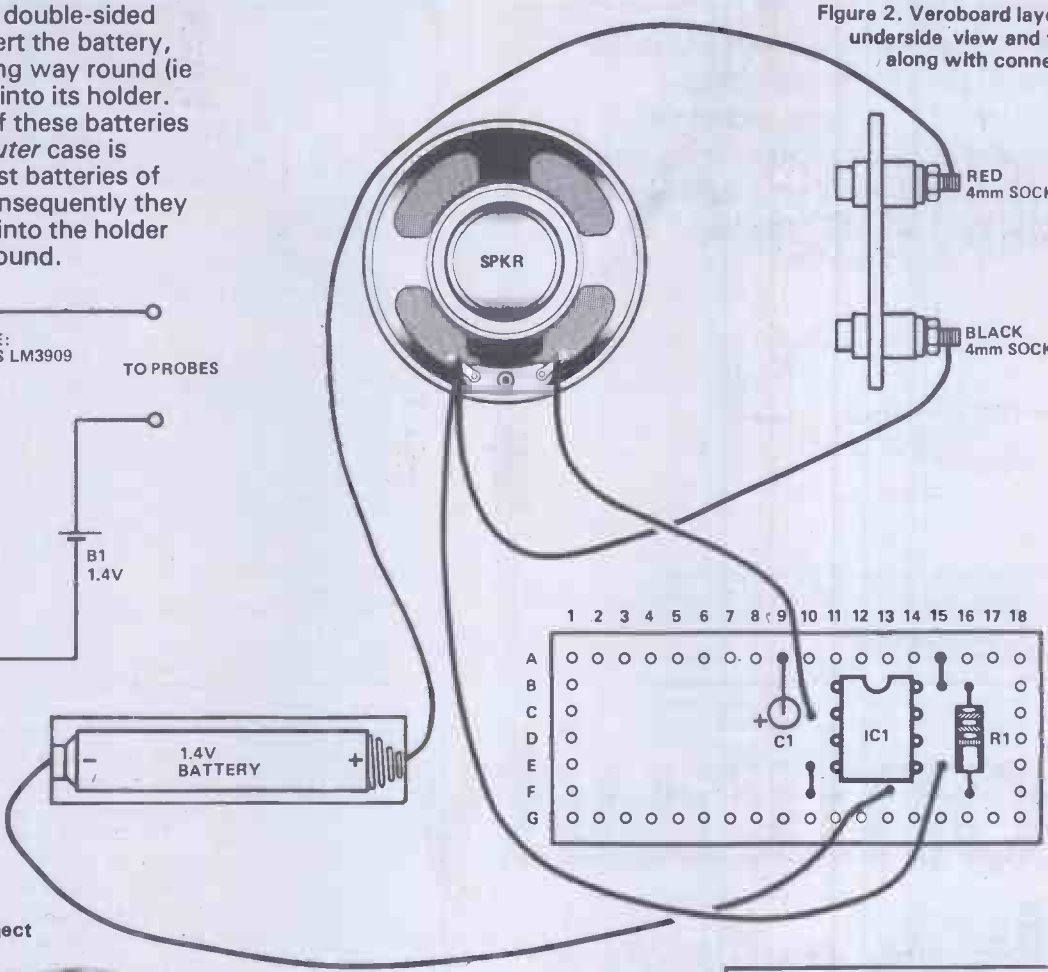
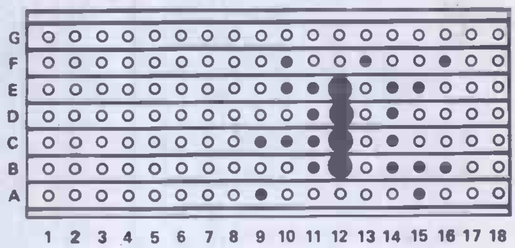


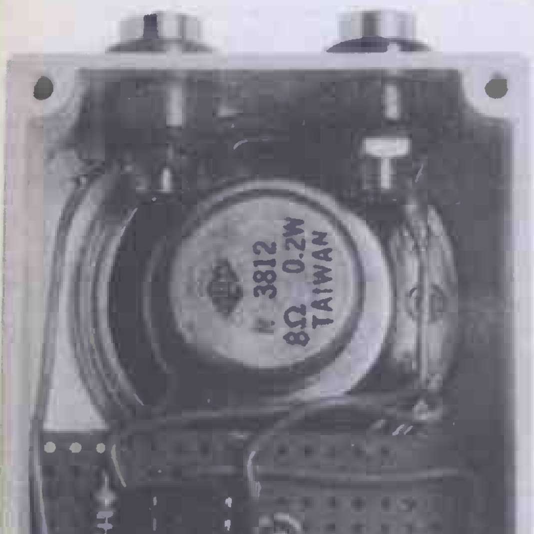
Figure 1. Circuit of the Continuity Checker

Figure 2. Veroboard layout, showing underside view and track breaks, along with connection details





Internal view of the project



Parts List

RESISTOR (¼W, 5%)
R1 1k0

CAPACITOR
C1 10u, 10 V electrolytic

SEMICONDUCTOR
IC1 LM3909 LED flasher/ oscillator

MISCELLANEOUS
Case to suit (Vero type 202-21025K)
RM401 battery + holder
8-pin DIL IC socket
2 x 4 mm probe sockets (red and black)
2 x probes (red and black)
8R speaker
Veroboard, 7 strips x 18 holes, 0.1" matrix

Buylines

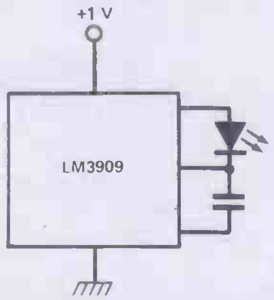
A complete kit of parts for the Continuity Checker is available from Magenta Electronics for £4.86 including VAT, probes and battery.

RM401 batteries are available separately for 64p each, the holders cost 22p each and LM3909s cost 79p each, all from Magenta.

Please add 40p p&p, whatever the total order price.

How It Works

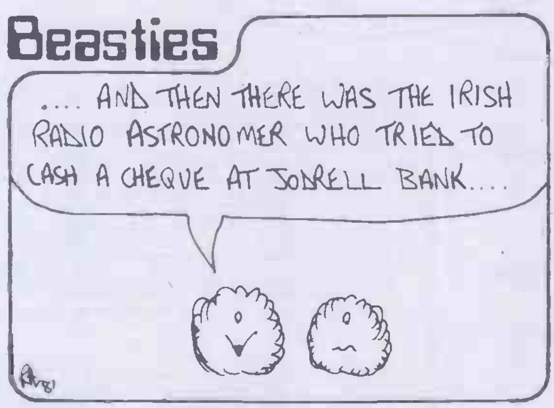
Integrated circuit IC1 is a purpose-designed oscillator requiring a minimum of only one external component, a capacitor, to operate. Its main function is as a low-voltage (as low as 1 V) LED flasher.

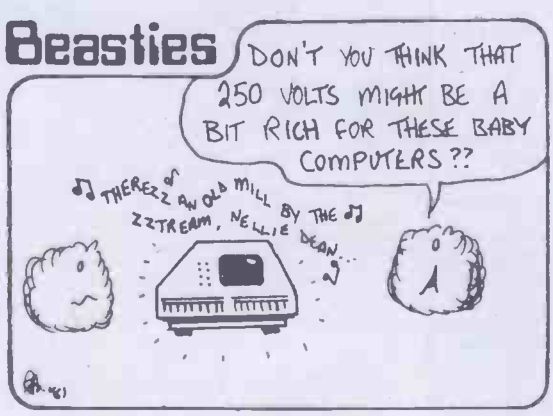


The output stage of the circuit is quite powerful and a small 8R loudspeaker can be driven directly, replacing the LED in the above circuit.

Oscillator frequency is dependent on supply voltage, so if the probe leads are made part of the supply line then whatever resistance is in between the probes will determine the voltage across the IC and hence the oscillator frequency.

HE





Radio

Even in this age of microelectronics, radio still has its appeal. Ian Sinclair traces its development and describes wave propagation, reception and simple receivers

"THERE WAS A TIME" quavered the old man, his stick trembling slightly, "when every recruit to the ranks of electronics as a hobby would have started by making his own radio receiver."

It would have been, of course, a simple receiver, not the sort of miracle-box which automatically tunes Radio Tokyo for you at 7.25 each morning, but a receiver which at least you had built with your own fair hands. In those days, too, we could take it for granted that everyone who started that way knew a fair bit about radio, because there wasn't much else to electronics in the early days.

Things have changed a lot. Radio is just one tiny part of the whole electronics scene, although one which looks as if it might make quite a comeback as an amateur activity when legal CB comes into operation later this year. Many people nowadays join this hobby of ours without ever coming into contact with radio, and that's a pity. Perhaps this article will help put some of that right.

Early Discoveries

The best place to start is always the beginning, and the beginning was, as so often happens, a bit of a false start. In 1864, James Clark Maxwell, a physicist of considerable distinction, put forward the idea, backed by theory, that light was an electrical wave. (See Famous Names, pp 63 to 64 in last month's HE.) He also said that it should be possible to generate similar but invisible electrical waves which would travel through space with the speed of light and which, unlike the telegraph or telephone, would need no wires to connect the transmitter with the receiver. His ideas were met with polite disbelief, his calculations were thought to be unrealistic, and because no-one had succeeded in producing any detectable waves by electrical methods, Maxwell's Electromagnetic Theory, as it was called, remained just a theory. Like all true research, however, it was not wasted. In 1888, some nine years after Maxwell had died, a researcher called Heinrich Hertz succeeded in producing the waves that Maxwell had predicted — and that's why we use the word hertz today for the unit of frequency. A brief look at Hertz's achievements is given in this month's Famous Names, on page 56.

Why had it been so difficult to produce radio waves? To answer that, we must know something of what was needed (as Maxwell knew) and also why it could not be achieved easily. What was needed was an alternating voltage which alternated at a high frequency. Alternating voltages had, of course, been around for several years (even in the 1860s), because an alternating voltage is what you get when you spin a coil of wire between the poles of a magnet. The voltage between the ends of the wire is alternately positive, zero, negative, zero and positive again in each revolution of the coil. The frequency of the alternating voltage is the number of times per second that it goes through this complete cycle of changes. When the alternating voltage is generated by a coil rotating between the poles of a magnet, the frequency of alternation is easily found — it's the same as the rate of turning in revolutions per second. In the 1860s, it was reasonably straightforward to build generators which could rotate at around 3,000 revolutions per minute. That's 50 revolutions per second, giving a frequency of 50 Hz, the frequency we still use for mains supplies today.

Now it wasn't at all obvious from Maxwell's equations that the frequency of an alternating voltage should be an important factor in deciding whether or not it could be used for radio. Nevertheless, the information was there and several researchers found it and drew the correct conclusions — that the amount of radio wave which could be radiated from a piece of wire would be immensely greater if the frequency of the AC voltage on the wire was higher, much higher than 50 Hz. As it happens, the frequency of a radio wave is very closely related to another quantity called wavelength. The wavelength is, as the name suggests, the distance between two neighbouring wave peaks (Fig. 1), when the wave is travelling through space. Wavelength multiplied by frequency of a wave gives wave speed, and for all electrical waves — and that includes light — the speed is constant at around 300 million metres per second. By comparison, Concorde at full speed manages to cover just 630 metres per second. Because the speed of all types of radio waves is constant and of known value (in space), we can find the wavelength for any frequency by dividing the speed by the frequency.

For a 50 Hz wave, for example, the wavelength is

$$\frac{300 \text{ million}}{50}$$

which is a wavelength of 60 million metres, a distance equal to 15 times around the earth.

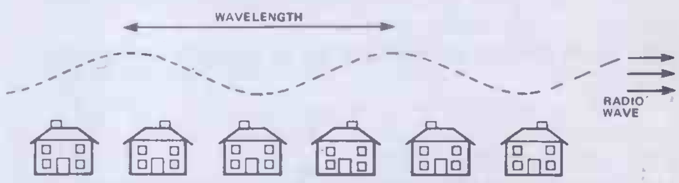


Figure 1. Wavelength. As the radio wave travels through space, there is a measurable distance between wavepeaks. This distance is the wavelength

Now Hertz and several others reckoned that an alternating voltage on a wire would cause a radio wave to be launched only if the wire was long compared with the wavelength — and no-one was likely to come up with a wire long enough to launch a 50 Hz wave. Hertz therefore concentrated on trying to generate much shorter wavelengths, which meant much higher frequencies. That, in turn, meant forgetting about rotating machines, because no alternator could stay in one piece at the frequencies Hertz was trying to generate; that is, frequencies of several thousands of millions of hertz. He solved the problem by using spark-gaps to generate high-frequency signals (see Fig. 1 on page 56), and radio was born at last.

Shift To Thermionic Valves

Radio has changed a lot since that momentous discovery by Hertz, and the work of Marconi, Tesla, Popov and many others who developed Hertz's laboratory experiments into a workable method of communication. Radio at the start of this century was still primitive — an induction coil to develop a high voltage, a spark-gap to cause high-frequency oscillations, and an aerial. The only control that was possible was to switch the induction coil on and off, using a telegraph key so that Morse code could be transmitted. To distinguish this from the 'normal' method of telegraphy, transmitted along wires, it was christened 'wireless telegraphy', and that's where the word 'wireless' comes from.

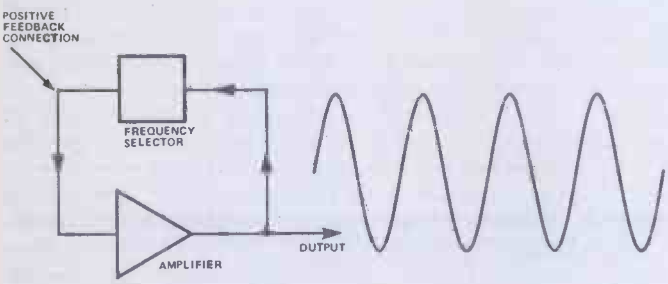


Figure 2. Block diagram of an oscillator

As a way of communicating short or emergency messages spark-gap transmitters were effective, and they were carried as emergency transmitters on ships right up to the '50s. But radio broadcasting needed something much more electronic in nature, and that came when thermionic valves were developed during the early years of this century. The thermionic valve was the device that dominated electronics for half a century. It could rectify (convert AC into current in one direction only), amplify (create a large-scale copy of an alternating voltage) and, most important of all, oscillate. Oscillation means creating an alternating voltage, and the important difference between a valve oscillator and a rotating generator is that the valve, like the transistor, has no mechanical moving parts. That in turn means that higher frequencies were at last simple to generate (as long as they were not *too* high!). It also meant that transmitters could operate at last on set frequencies.

That last remark needs some explaining. An oscillator, whether it uses a valve or a transistor, consists of three parts: an amplifier, a frequency selector and a positive feedback circuit (see **Fig. 2**). The amplifier has an input terminal and an output terminal, and produces at its output a large-scale copy of the alternating voltage — the signal — at its input. A frequency selector is a circuit which, as its name suggests, picks out one frequency of signals and rejects all others. A positive feedback circuit connects the output of an amplifier back to its input so that the amplifier provides its own input signal and doesn't need any other signals. Put these three components together and you have the kind of oscillator that is useful for radio. Because of the frequency selector, though, the signal from such an oscillator is a sinewave which has a single frequency, a frequency which can be changed only by altering the frequency selector circuit.

The old spark-gap transmitters lacked such refinements, and in the early days of radio no-one needed them anyway. As more and more transmitters were built, however, it became important to prevent them from interfering with each other (as they did because the spark-gap created signals which comprised a huge mixture of frequencies). Valve oscillators allowed different transmitters to operate on different frequencies, not interfering with each other. They also permitted something else — modulation.

Controlling The Waves

Modulation means 'control', and in radio it means the control of the high-frequency oscillations of the radio wave or carrier wave. Morse code is a simple type of modulation, on or off, a digital signal long before its time. Why would we want to modulate a carrier wave? In the early days the most important reason was the ability to carry speech rather than Morse code. The human voice (yes, I include even DJ's) produces sound waves in air. Microphones can then convert these into electrical waves which have the same frequency and waveshape (**Fig. 3**) as the sound waves, so that we can amplify the electrical waves, something we can't do with sound waves. We cannot, however, transmit these electrical waves through space because their frequencies are too low — most voice signals are in the range of 300 Hz to 2000 Hz. The solution that was found simultaneously by several pioneers of radio was to make the high-frequency signals produced by an oscillator carry these low-frequency signals — the audio frequency signals, as they were later called. To do this it was necessary for the audio signals to *control* some feature of the high-frequency radio signals. In other words, the audio signals were used to *modulate* the radio signals.

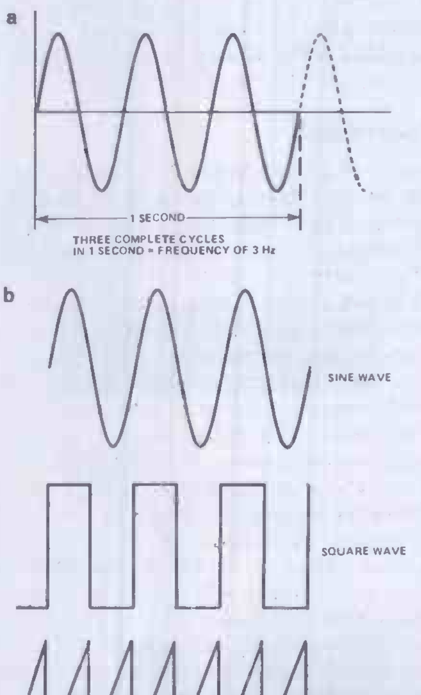


Figure 3. Frequency and waveshape. Frequency (a) is the whole number of complete cycles of a wave which happen each second. The waveshape is the shape of the graph of the wave plotted against time. For a sound wave, the quantity that is plotted is air pressure, and for an electrical wave, voltage is plotted

The idea had been around for a long time. In 1903, Valdemar Poulsen (who invented tape recording) patented a way of modulating the output of a spark-gap transmitter. It was called the 'singing arc' and it was necessary to speak directly into the spark. There were no volunteers for DJ duties — not surprising, when the spark was a foot long and generated by nearly 100,000 V!

The use of valves as oscillators made possible a comparatively simple method of modulation, known as amplitude modulation. The amplitude of an oscillation is the voltage of the signal measured from one peak of the wave to the opposite one (Fig. 4): strictly speaking, this is peak-to-peak amplitude, because there are other ways of measuring amplitude. The idea of amplitude modulation is to use the audio signal to control the amplitude of the carrier wave, so that the carrier wave has its normal amplitude only when the audio wave voltage is zero.

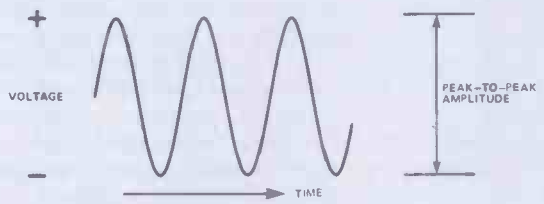


Figure 4. Peak-to-peak amplitude for a wave

When the audio wave is at its negative peak the carrier wave amplitude is reduced, and when the audio wave is at its positive peak the amplitude of the carrier wave is greater than normal. In this way (Fig 5), the outlines of the carrier wave are a copy of the waveshape of the audio wave — the carrier has been modulated. The carrier wave is still a radio frequency wave, so that it can be transmitted easily. At the same time it carries the information of the audio wave with it.

Band On The Side

A curious thing happens when a carrier wave is modulated. Before modulation, a carrier which is a sinewave consists of one frequency only. When it is modulated other frequencies are present, equal to carrier frequency plus audio frequency and carrier frequency minus audio frequency. For example, if the carrier frequency were 100 kHz, then before modulation only a frequency of 100 kHz would be present. When this same carrier is modulated with, for example, a 5 kHz sinewave, then four frequencies are present. One is the carrier frequency of 100 kHz, another is the audio frequency of 5 kHz. In addition, however, there are frequencies of 105 kHz (carrier + audio) and 95 kHz (carrier - audio) present, and these are called sidebands. The reason for the name? If we draw a graph of signal amplitude plotted against frequency, these two new frequencies lie on each side of the line that represents the carrier frequency (Fig. 6).

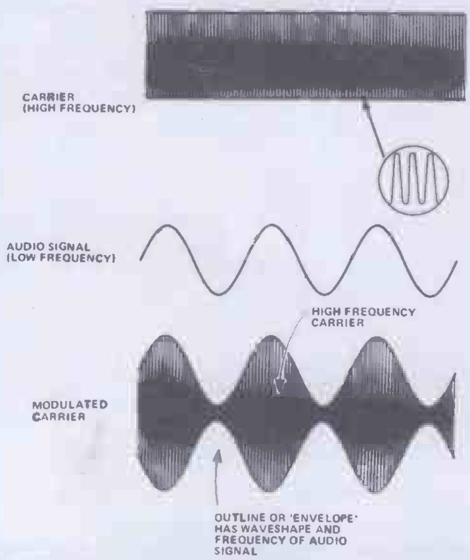


Figure 5. Modulating a radio-frequency carrier so that it carries an audio frequency wave. The frequency of the carrier must be much higher than the frequency of the audio wave

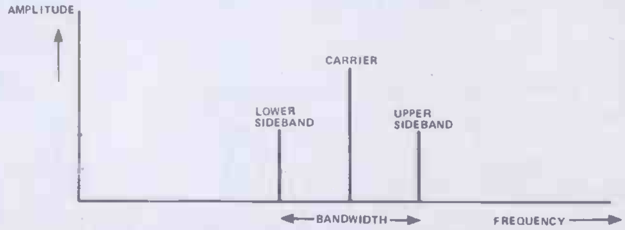


Figure 6. Sidebands. A carrier alone has a single value of frequency. When it is modulated by a low-frequency signal, the result is two new frequencies, the upper and lower sidebands

Why should this be important? For one thing, it limits the range of frequencies that we can use for radio transmitters. We can't, for example, have one transmitter operating at 100 kHz and another at 105 kHz if they are both being modulated with audio frequencies up to 5 kHz. If we did, then any receiver which was tuned to receive the complete signal (carrier plus sidebands) from one transmitter would also receive some of the sidebands of the other transmitter (see Fig. 7). This overlap causes interference, so that clear reception of either transmitter is not possible.

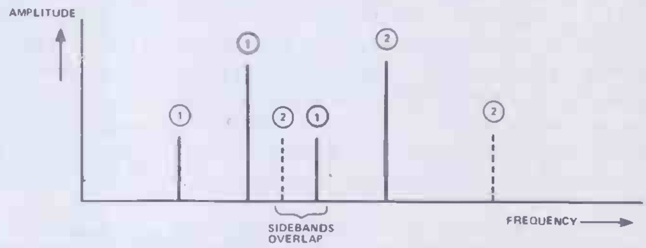


Figure 7. Interference is caused when the sidebands of two transmitters overlap, even though the carriers are separated

The sidebands have another effect. We have assumed so far that the radio transmission has been at a single frequency, the carrier frequency, so that a receiver which could receive only that frequency would suffice. Because a modulated carrier contains sidebands, however, a receiver for a modulated signal must be able to pick up and amplify the full range of frequencies from the lower sideband frequency to the upper one: this is the range of frequencies that we call the bandwidth.

Capturing Signals With A Ferrite Rod

Receiving a radio wave starts with catching a chunk of the modulated radio wave which has been sent out from the transmitter. The traditional way of doing this was to use a long piece of wire (Fig. 8), the aerial, slung between insulators and well clear of buildings. The radio wave is both an electric and magnetic wave, and the electric part of the wave will produce an alternating voltage between the ends of any wire in its path. The voltage is greatest if the length of the wire is equal to a quarter of the wavelength of the wave, and that is the principle that we use for TV (operating at ultra high frequencies) and FM radio (operating at very high frequencies). For transmissions at medium wave, where the wavelength is several hundred metres, a quarter-wavelength aerial is usually impractical.

Figure 8. The traditional aerial, a long piece of wire insulated from its supports

The alternative to a long-wire aerial is to detect the magnetic part of the wave, using a coil. This method has been used for many years (it was called a frame aerial in the early days of radio) but was given a tremendous boost in the late '50s by the use of ferrite rods. Ferrite is a non-metallic magnetic material which, like all magnetic materials, has the ability to concentrate magnetism (see **Fig. 9**). By winding a coil round a ferrite rod, the magnetic portion of the transmitted wave can be made to provide an alternating signal between the ends of the coil, and because of the concentrating effect of the ferrite this signal can be as large as would be obtained from quite a long aerial wire. In addition, the ferrite rod is *directional*, because it is the magnetic waves approaching the *ends* of the ferrite rod that are most concentrated by the rod. Other magnetic materials, incidentally, are useless for this purpose because they are conductors, and the signal current flows within the material rather than in the coil — we had to wait for non-conducting ferrite before this method became really useful.

Now that we have a radio signal between the ends of a coil, what do we do with it? There are two important requirements. One is to select the signal we want from the thousands which are sent out from transmitters all over the world. The other is to amplify the signals, and extract the modulating audio signals from them.

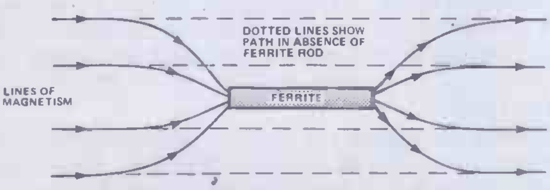


Figure 9. How ferrite concentrates magnetism. The dotted lines show what the tracks of the magnetic lines would be if no ferrite were present

Sorting Out The Signals

Selection is not quite so difficult as it sounds. Of all these thousands of signals, many are so faint that we can forget about them, and the stronger ones, providing they are all on different carrier frequencies, can be separated by using resonant circuits. A resonant circuit in its most familiar form consists of a coil (inductor) and a capacitor (**Fig. 10a**). The most usual form of this circuit in amplitude-modulated radios is the parallel one, and that's the one we will look at.

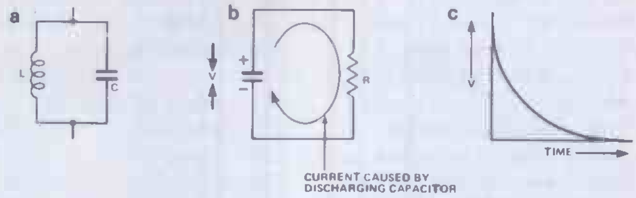


Figure 10. The resonant (tuned) circuit (a). This is a parallel type. If the capacitor were charged and connected to a resistor (b), then the capacitor would rapidly discharge through the resistor (c)

Imagine, to start with, a charged capacitor. If we connect this capacitor to a coil, the charge will flow from the positively charged plate of the capacitor through the coil to the negatively charged plate: this movement of charge is a current. If we had simply connected a resistor to the charged capacitor the current through the resistor (**Fig. 10b**) would heat up the material of the resistor, the heat would be lost to the air around, and once the capacitor was discharged that would be the end of the process. In other words, the energy of the charged capacitor has been changed to heat energy and lost. When the capacitor is connected to a coil which has a very low resistance, however, things are very different. The action of a coil, an inductor, is to keep current flowing, because the energy of the current goes into creating magnetism rather than heat, and magnetism does not flow away. Even when the voltage that has caused the current to flow is at zero the current does not stop, because the magnetism converts back into current, pouring charge back into the capacitor, this time charging it up in the opposite direction (**Fig. 11**). It can't stop there as the coil is still connected to the capacitor, so that the capacitor discharges again, sending current through the coil in the opposite direction this time. Once again the coil keeps the current flowing so that the capacitor ends up charged again, almost as it was in the beginning, and will then start to discharge again. This see-saw action keeps going at a rate which is set by the value of the capacitor and the inductance of the coil, but it can't go on forever because the coil has resistance which causes some of the electrical energy to be converted into heat and lost.

We have to leave the story of Radio at this point, but next month we'll continue the saga starting with the waveform obtained from a circuit such as that in Fig. 11.

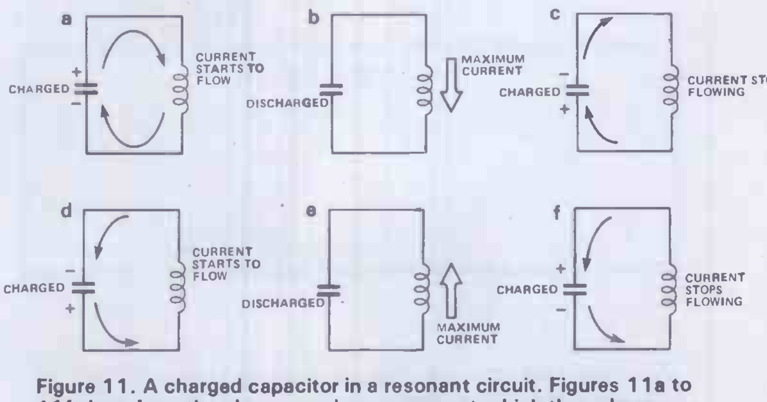


Figure 11. A charged capacitor in a resonant circuit. Figures 11a to 11f show how the charge produces a current which then charges the capacitor in the opposite direction, reversing the current until the charge is almost at its original value

HE

Your Letters

A selection of your letters to the Editor

IT IS ALWAYS frustrating to have reached the final stages of project construction . . . and to be stuck for one vital component. This was certainly the experience of David White in our first letter.

Dear Sir,

From your October 1980 HE issue, in my schools Electronics Club, I have built the "Intruder Alarm". But, I am unable to complete it because two ICs used in the circuit I cannot obtain. So could you tell me where I can get it and how much they cost or an equivalent as the project has already cost me £9.

The IC's number is JCL 7611. Maplin and Watford do not stock it.

David White
Hornchurch, Essex

True, the ICL 7611 is not a widely-stocked device. However, a quick check by 'phone revealed that it is available directly from Magenta Electronics, 98 Calais Road, Burton-on-Trent, Staffs for £1.31 plus 40p postage and packing.

The next two letters relate to circuit boards.

Dear Sir,

I am wondering if you could explain the Hobby Prints and also generally how P.B.C. is constructed.

R.G. Bannocks
Leytonstone

The Your Letters page is the wrong place to answer your two queries in sufficient depth. I would suggest that you read Building Site in the November '80 issue of HE, on pages 46 and 47. A good description is given of how to use Hobbyprints and of the different stages in the production of a PCB. (I assume it was *PCB* that you were referring to.)

Dear Sir,

I am very interested in H.E. projects. I found it difficult to follow mounting of components on P.C.B. given for the 'Watchdog' Alarm (H.E. October 1980).

Since I am a beginner and keen on H.E. projects, would you please help me to mount components on Veroboard layout, which I find much easier to follow. In most of your projects you do give Veroboard layouts but on this occasion you gave it on P.C.B.

D.L. Rao
London N18

When I looked at the component overlay in **Fig. 3**, page 61 of the October '80 Issue, I could appreciate your problem. We try, wherever possible, to show a faint pattern of the copper track — appearing as if the board were translucent (see Light Dimmer, Fig. 4, on page 35 of the same issue). Around that time we were experimenting to see if the overlay could be shown without the pattern. One problem associated with including the pattern is that, when the board contains many components and connection points, inclusion of an outline of the track on the overlay can make the overall picture confusing. Most designs published since October '80 have, however, included the pattern.

Some projects are more suited to PCB layout while others are better suited to Veroboard. A few readers have told us that they have tried to use Veroboard in place of our PCB patterns but have become confused in the process, because of the cross-linking required. We will continue to use both methods: Veroboard for the simpler projects and PCBs for the complicated ones (or where space-saving is important).

Finally, a call for some information on electronic components.

Dear Sir,

I am a pupil at Tunbridge Wells Technical High School. I am undertaking an English Study on Electronics.

I would be very pleased if you could send me some information on how components are made and work. It is a beginners study so I need information on resistors, capacitors, diodes and transistors etc.

Ian Scholey
Edenbridge, Kent

We plan to take a careful look at the fundamental components of electronic circuits in a few issues' time. Meanwhile, you might like to refer to Into Electronics Plus, a booklet which gives broad coverage of electronic components. It is available, price £1.30 (including post and packing) from the Hobby Electronics Book Service, Modmags Ltd, 145 Charing Cross Road, London WC2H OEE. **HE**

GADGETS GAMES & KITS

Here is the second free GG&K supplement to HE. Last month we reviewed the Tantel adaptor for connecting you and your TV to Prestel. This month we look at the Radofin TAD110 adaptor, which enables your TV to display CEEFAX and ORACLE teletext transmissions. We also review three hand-held games, install a car radio/cassette combination and try our hand at a portable electronic chess game

Time For Teletext

We had a look at Tantel, Tangerine Computer Systems' Prestel adaptor, last month. The other sort of TV information service is teletext — but again, you need an adaptor. This month we look at one available from Silica Shop.

There isn't the amount of information available on teletext (about 700 pages) that there is on Prestel (nearly 200,000 pages at present) and the speed of page recall is much slower. One point in teletext's favour, however, is that any information received is completely free. All the on-screen data which you can read is already there (on the received TV signal) and you only need an adaptor to decode it into a readable form. The cost of using Prestel, on the other hand, can be quite high, because you are billed (on your telephone bill) for telephone time and also for certain (not all) pages of information. You pays your money....

The Radofin TAD110 Teletext Adaptor comes complete with the necessary leads and instructions. All *you* need to supply is a plug, a TV and a good aerial signal. You take out the aerial plug, which goes to the back of your TV, and put it in the back of the adaptor, where it says 'To aerial'. Next, you plug the lead from the adaptor's 'To TV' socket into your TV. Last, you switch on and go.

Selecting Pages

Your TV needs to be tuned to channel 36 and the adaptor must be tuned to your usual received TV stations. This procedure is a bit tricky, but the instruction booklet tells you how to do it step-by-step.

You now have three complete magazines under your remote control (at the end of a long lead). The two Beeb stations — 1 and 2 — have a 100-page magazine each, under the name CEEFAX, while the ITV version is called ORACLE and has about 500 pages.

When you first switch on, the adaptor automatically looks for and displays page 100 — the index page (except for BBC2, which has it on page 200). After this, requesting any particular page is a simple matter of entering the number of the page onto the keypad. After a few seconds' delay, due to the fact that the pages are broadcast in sequence, your requested page will appear on the screen. And so it goes on.

You can choose between teletext or television via your hand controller, or have a mix of the two on the screen, at any one time. An 'alarm clock' facility, using the highly accurate clocks transmitted by the broadcasting companies in the TV signal, can produce a chosen page or signal onto the screen at a preset time, if you want. You can also use one of the clocks as (would you believe) a digital clock to tell the time by.

Useful Machine?

We found the adaptor very simple to operate, and extremely useful in obtaining news headlines or sport updates, looking for what's on at theatres, cinemas, and of course TV programmes. It's ideal if, like us, you're a gadget-lover, button-pusher or gimmick-freak. If you are, then you'll have hours of fun, entertainment and interest with one of these.

Radofin TAD110 Teletext Adaptor is available for £199 including VAT from Silica Shop Ltd, 1-4 The Mews, Hatherley Road, Sidcup, Kent.

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Three In Hand

Here we have three neat little hand-held games from Computer Games Ltd: Galaxy Invader 1000, Grand Prix and Jet Fighters. All of them are battery-operated and so are great for carrying with you on the long journeys which seem to be an inevitable part of the family summer holiday. To cut down the cost of batteries, mains adaptors are available as an optional extra at £4.95 for Galaxy Invader 1000 and Jet Fighters. It is not possible to use a mains adaptor with Grand Prix: it uses only three AA-size batteries, and Computer Games considers that the game is unlikely to be played for long periods.

Galaxy Invader 1000

If you like space attacker games, then Galaxy Invader 1000 should appeal to you. It is housed in a particularly attractive yellow and black casing shaped like a missile, with an equally eye-catching three-column LED (light emitting diode) display in green and red. The graphics are neat and easily definable, consisting of standard space attacker-type figures of monsters (in green) and UFOs (in red). The invaders appear at random on the display, moving sideways and down towards your missile base. The UFOs appear only on the top row of the screen and disappear again if you don't manage to hit them. A maximum of two invaders and one UFO appear on the screen at any time.

You are given three missile launchers for each game and shooting down a UFO will gain you 10 points on the accumulating scoreboard on the top of the display. Shooting down an invader will give you between one and five points depending on how far down the screen it gets before you blast it into infinity. When you have accumulated 700 points on the scoreboard you will automatically gain an extra missile launcher and 50 missiles. The game is over when either you have reached 1,000 on the scoreboard and repelled the invasion, or if all your missile launchers are destroyed, or if the invaders capture your missile pad. It also comes to an end if you have fired the maximum of 250 missiles.

There are sound effects with this machine which simulate the firing of your missiles or the demise of your enemy.

The controls of the game are simple: on the left of the case is a rudder for lateral movement across the display, on the right is the 'fire' button and in the middle is the on/off/reset switch and a skill control which can be set to three different levels, depending on how good you get.

In all, this is a very attractive game, well thought out and straightforward to use. It can stretch the abilities of the most skilled invaders player with its three skill levels and is as authentic as you can get for such a small machine. The case is sturdy enough to stand the wear and tear it is likely to get. At £22.95 including VAT it should prove to be a very popular game — particularly as with this version you can *actually beat them!*

Grand Prix

The second CGL offering is a game called Grand Prix. It is a car racing simulation game and this game's case is cunningly shaped like a Formula 1 racing car, made of good solid material.

The display of this game differs from that of the other two in that it is an LCD (liquid crystal display), the type preferred in most new digital watches. The black and grey display shows the three lanes of the race track and indicators for speed, time and lap. On the left of the case is the accelerator lever and on the right the steering key for changing between the lanes.

When playing the game, your car does not in fact move; it is the other cars which whizz past as you dodge them. The speed at which they pass you is determined by your use of the accelerator. There are sound effects to simulate the sound of your exhaust — and the sound of your car crashing! When the inevitable crashes occur your car will disappear for two seconds for repairs.

There are two modes which you can play in: 'lap' mode and 'time' mode. Playing in 'lap' mode will tell you how many laps you have completed in the fixed time of 140 seconds. In 'time' mode, you are told how many seconds it takes you to drive the distance of 800 kilometres.

This is an absorbing game: although you can't actually win, you can improve your reflexes. The display is a little unusual being an LCD, which seems to cause a few problems. LCD displays are notorious for being slow to change, unlike LEDs which are simply on or ▷

off. This means that it is sometimes difficult to judge exactly where your opponent's car is when you are travelling at very high speeds, so you crash, thinking the car is somewhere else. This game needs quite a lot of skill to play, and is great fun, and a number of people can compete for the best times. This game is the most expensive of the three at £26.95, including VAT.

Jet Fighters

Game number three is Jet Fighters, and it looks like the controls of a missile launcher. The relevance of this will become clear as you read on. The game itself is based on the same concept as Galaxy Invaders. The difference is that the enemy takes the form of jet fighters and warships, and you have a missile launcher to beat off their attack. Unlike Galaxy Invaders, this game is played sideways-on with your launcher on the right and the enemy coming at you from the left. The principle of the game is to shoot down the jet fighters before they shoot you down or land on your base. The warships appear only momentarily, and then disappear if you don't hit them. Like the Galaxy Invader 1000 game, you gain points which are accumulated on the scoreboard. You score three, two or one points for exterminating a jet fighter, depending on its position on the screen, and 10 points for a warship, up to a maximum of 199 points. There are sound effects built in to simulate explosions etc, and a little tune to signify your destruction or your victory. There is a choice of skill levels and you can be a Private, Captain or General, which you choose depending on how good you are.

Comparatively speaking, this game did not seem as impressive as the other two. The case is not so well finished and the controls didn't seem terribly accurate. The display flickers rather a lot as well (very straining on the eyes), and although it is very similar to Galaxy Invaders it is not quite so addictive. When your launcher is hit you disappear from the screen for a couple of seconds, so when you reappear you are frequently just in the right place to be hit by another missile! Jet Fighters costs £21.95 and could really do with a few improvements to bring it up to the very high standard of the other two games.

Computer Games Ltd., 214-220 Maybank Rd., Woodford, London E18 1EX (tel 01-504 2255).

Car Radio Do-it-yourself Kit From Blaupunkt

As mentioned in Monitor in the May issue, Blaupunkt (Robert Bosch in the UK) was poised to launch four of its car radio and radio/cassette combinations in do-it-yourself installation packs. The four models, supplied along with loudspeakers, wiring, fitting kits and instructions are the Hamburg, Tempelhof CR, Hamburg CR and Mannheim CR. It was the Mannheim CR that HE had an opportunity to review.

After the contents of the yellow take-away box were emptied out on the carpet (radio, two speakers, leads, plastic facia panels, packets of screws and knobs and instruction leaflets), we were ready to go.

The car chosen for the installation was a Ford Escort (1600 Sport), which already had a radio installed.

Instructions

It is worth commenting on the main instruction booklet supplied with the kit. This eight-page booklet contains most of the information you are likely to need for the installation, together with some general information. It starts with details of the tools you will need, lists the contents of the box and follows with a teach-in on radio waves, reception and the automatic suppression unit (ASU) included in all Blaupunkt radios and radio/cassette combinations. The next four pages or so deal with the installation, including 28 illustrations. Radio interference and its suppression is dealt with in the final part of the booklet and diagrams showing how to connect an extra pair of speakers are given on the back page.

Installation

As mentioned earlier, the Escort Sport 1600 comes with a radio fitted (not a particularly good one was fitted to our test vehicle). This made the job easier, because the supply cables, aerial and its cable and the suppression components were already in place.

We could bend the rear retaining lug on the existing metal carrier to allow for the slightly longer case of the Mannheim CR. The components supplied with the kit would have made mounting possible had this 'modification' not been possible.

Once mounted in place on the 1600's plastic dash extension, the various connections were made to the back of the Mannheim CR, including the earth lead supplied with the kit.

With the mounting and wiring completed, the speakers were laid on the floor of the car and the radio was tested on all functions.

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Loudspeaker Mounting

Under Loudspeaker Fitting in the instructions, the opening paragraph begins: 'Great care must be taken in fitting the loudspeakers'. The choice was in the rear parcel shelf, in the kick pads in the driver and passenger footwell areas or in the doors. The instructions then say: 'If the door assembly can accommodate the depth of the speaker then this is a particularly good place to site them since the door area acts as a sound chamber'.

Fine, we thought, the doors are where they shall be fitted. Investigation showed the depth to be right, so the panel was removed, marked out and a hole was cut using the paper template supplied with each speaker as a guide. A convenient hole was found in the door (made by the undersealers) for the cable and everything went like a dream — until we came to fit the window-winding handle. We discovered what many a motorist has discovered too late; that is, when the speaker cover was snapped into place, it was too proud to miss being caught by the inside edge of the handle as it was rotated. The choice was simple: either leave the handle off, or remove the speaker. We took the second choice and were left with a hole in the door.

On Test

With a couple of box-mounted speakers, the Mannheim CR performed well. Apart from the fact that it does not have push-button station selection, the sound quality was very pleasant and of adequate volume. Pressing the Db noise limiter button helps to cut down noise from cassettes.

Problem Solving

HE spoke to Robert Bosch about the speaker problem. Surely flush-mounting speakers could have been supplied with the kit? Ron Sherwood, UK product manager of Robert Bosch, said that flush-mounting speakers from the Quick Fit range had been considered, but they were more expensive. Quick Fit model 723 speakers cost £9.55 plus VAT each, compared with £6.15 plus VAT for each of the model 555 speakers supplied with the kit.

So, if you want to fit door-mounted speakers, beware: check that you have sufficient clearance between the window-winding handle and your speaker. Alternatively, you *could* buy the Quick Fit 723s at extra cost and, as Ron Sherwood suggested, use the speakers supplied with the kit to make up a four-speaker system.

The 723s, by the way, are only available through specialist outlets for Blaupunkt. We'll try and report on a pair in the next GG&K supplement.

Blaupunkt Kits

A rough guide to the radios in the four kits is given below.

Hamburg
An AM car radio. The Hamburg has five push-buttons for station selection, one for long wave and four for medium wave. Power output is 7 W and it has a variable tone control. Kit cost is around £53.50 plus VAT.

Tempelhof CR
An AM car radio with stereo cassette player. The Tempelhof CR has manual tuning of medium and long wave. Power output is 9 W/channel and it has a variable tone control. The cassette player has electronic speed control, lock-on fast forward wind and rewind and cassette ejection. It switches to radio when the tape ends. Kit cost is around £88.60 plus VAT.

Hamburg CR
An AM car radio with stereo cassette player. The Hamburg CR has push-button selection of five medium wave stations and one long wave station. Output power is 9 W/ channel and it has a variable tone control. Cassette player functions are as the Tempelhof CR but the cassette player has a luminescent aperture outline for easier access in darkness. Kit price is around £113.60 plus VAT.

Mannheim CR
An AM/FM car stereo radio and stereo cassette combination. The Mannheim CR has manual station tuning on long, medium and VHF wavebands. Output power is 9 W/channel and it has a variable tone control. Cassette functions are as the Tempelhof CR and Hamburg CR. It features a push-button Db Noise Limiter system for use on cassette playback. Kit price is around £122.70 plus VAT.

Robert Bosch Ltd., PO Box 166, Rhodes Way, Watford WD2 4LB (tel 92 44 233).

Moves On The Move

With many people contemplating summer holidays at the moment, the Chess Traveler has appeared on the market at just the right time. This is a machine to while away the long hours of your journey to the sun!

It is a small hand-held chess computer, and as its name suggests is suitable for playing more or less anywhere. It runs for 9 to 10 hours on alkaline batteries, or a mains adaptor is available as an optional extra. The price is £39.95 plus a further £4.95 for the adaptor.

This machine has all the functions you would expect to find on many of the larger machines, including eight skill levels, castling, pawn promotion, and en passant. It accepts special board positions and solves mate-in-two problems, as well as having a multi-move key for specific openings and simple position verification.

The pieces are of the peg variety, fitting into holes on the chessboard with extra holes for the captured pieces in a game. Positions and moves are entered using the multi-function keyboard and the whole thing is protected with a tinted plastic cover which clips onto the base during play.

In use, the Chess Traveler is simple and straightforward as far as keying in the moves is concerned. Unfortunately the pieces themselves are quite small and awkward to move — they fit rather snugly in the holes, which, although of obvious advantage in a portable chess machine, means that you tend to knock the surrounding pieces off the board when you make a move! The pieces are also not very easy to identify. For example, the bishops and the pawns are very similar.

In all, this would be quite a nice machine for a beginner to learn on as it is straightforward to use, but it's also capable of playing a mean game of chess at its higher levels. Despite any reservations about the pieces it is probably the best sort of design for balancing on your knee as you're whizzing through the verdant countryside on an Inter-City 125!

Chess Traveler is available from Silica Shop (address on page 31).

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Building Site

This month, Keith Brindley proves how easy it is to give your projects a professional appearance. Front panel lettering is easy when you know how

A FINISHED PROJECT is only as good as it looks. It doesn't matter how well it works, how undistorted a thingummy is or how many flashing LEDs an electronic wotsit has got, if it doesn't look good. I mean you can't show it off to the neighbours or to friends if it looks as though it has been dragged through an electrified barbed wire fence backwards, can you? It's the finishing touches which make or break the appearance of your project.

One of the best ways to 'professionalise' your project is to label it, showing the functions of all switches, pots etc, and to give it an individual title. Take a look at some of the projects in HE this month and imagine them without labelling — see what I mean?

How Do We Do It?

We label all our projects by making use of dry transfer lettering systems. A variety of types can be seen in **Fig.1**. Letraset, Chartpak, Mecanorma and Blick are just a few of the trade names you will find associated with dry transfer systems. Many readers will know what they consist of — semi-opaque or transparent film sheets, with dry ink letters on the underside. The idea is to lay the sheet on the surface to be lettered and then to rub down the required letter, transferring it from the sheet onto the surface. That's all there is to it really.

You should be able to buy at least one variety of dry transfers at any graphics or drawing office supplier. A lot of booksellers also sell them, so you probably won't have to go far to get what you want.

There are literally hundreds of different typefaces (styles of letters) to choose from. The most popular ones are duplicated on all manufacturers' systems. The typefaces *we* use most on our projects are Eurostyle Bold and Eurostyle Bold Extended. But *you* don't have to use the same type. In fact you can 'personalise' your project by using a typeface of your own choice.

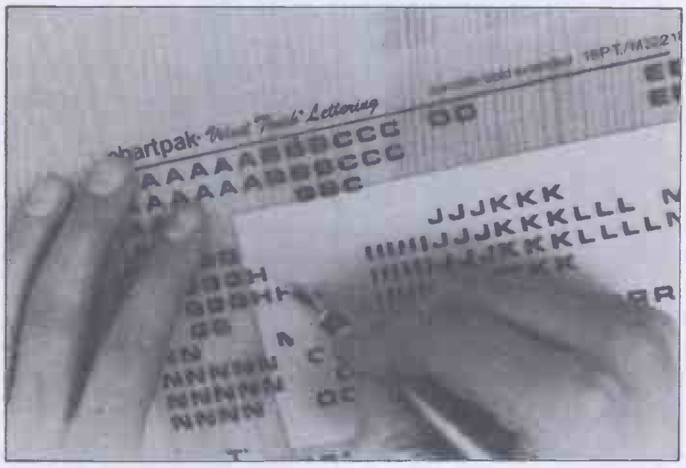
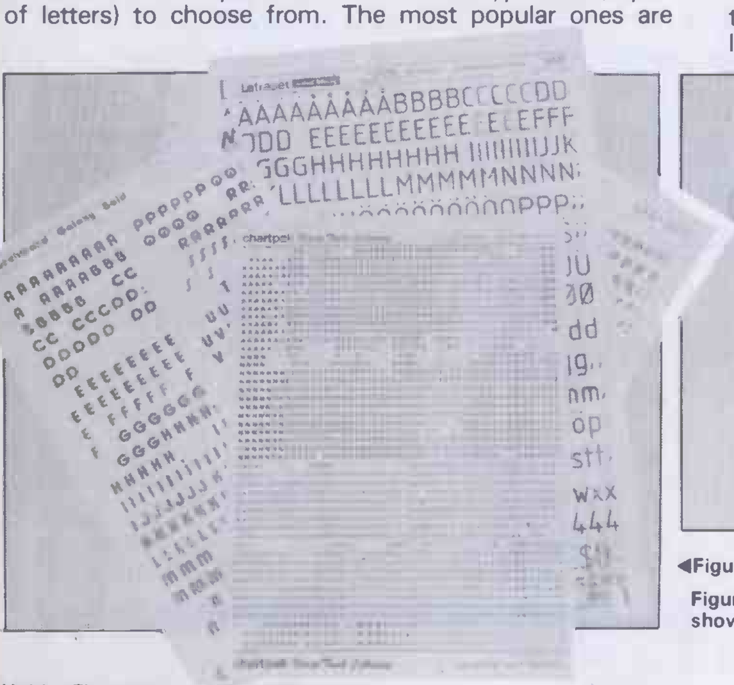


Figure 2. Transferring characters from the sheet to the front panel. Here a burnisher is shown in use

You can also choose the size of the letters which suits you best. The letters are measured by what is known as their point size (for example, 12pt and 20pt). As a general guide, the larger the point size, the larger the letter. We normally use 10pt for labelling around switches and knobs, and 18pt for titles, etc. A single sheet of each size will provide sufficient letters and numbers for quite a few projects.



◄Figure 1. Examples of sheets of lettering suitable for your projects

Figure 3. To keep the character in a straight line, draw guidelines as shown to line up with the top and bottom of each character

How Do You Do It?

After you have reached the completion stages on any metalwork on the panel, such as drilling or filing, make sure the panel is grease-free — a quick wipe with a rag dampened with methylated spirits will ensure this.

Now you simply lay the sheet over the panel and position the letter you require over the correct place. By rubbing lightly with a soft pencil or, better still, a tool called a burnisher, the letter can be transferred onto the panel, as **Fig.2** shows.

If you find it difficult to line up the letters, a good tip is to use a guideline. With a ruler and a sharp soft pencil simply draw lines across the panel, as in **Fig.3**, at every necessary height where letters are planned. Lining up is easy after this as you just position each letter slightly above the pencil line before rubbing down.

Don't worry if you make a mistake and put a letter in the wrong place, or mis-spell a word, because you can remove the boo-boo by covering it with a small piece of Sellotape and then sharply pulling the tape off. The letters will stick to the adhesive backing of the tape leaving a clear panel again.

When transferring long words, or words positioned above or below switches and knobs, it's a good idea to start with the middle letter of the word and then work backwards and forwards until the word is complete. This makes sure that the word is central and looks correct.

After you have finished labelling the panel you carefully remove the pencil lines with a good clean rubber, as in **Fig.4**. Make sure you don't catch any of the letters with the rubber, or you'll have to start again!

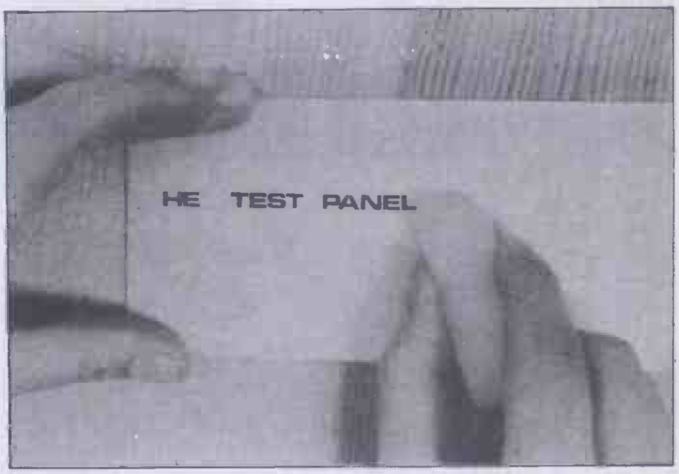


Figure 4. Great care is needed when erasing your guidelines to avoid damaging the lettering. Make sure that your rubber is soft, clean and has a sharp edge

Finally, to protect the letters and also the panel from accidental damage from scratching, spray it with an aerosol fixing spray. You'll find a suitable variety to choose from at the supply shop where you got your transfer sheets.

Now you can stand back and admire your project. See you next month. **HE**

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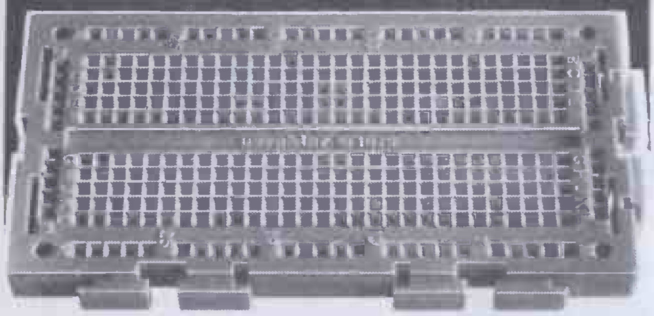

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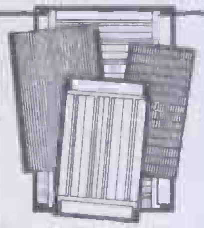

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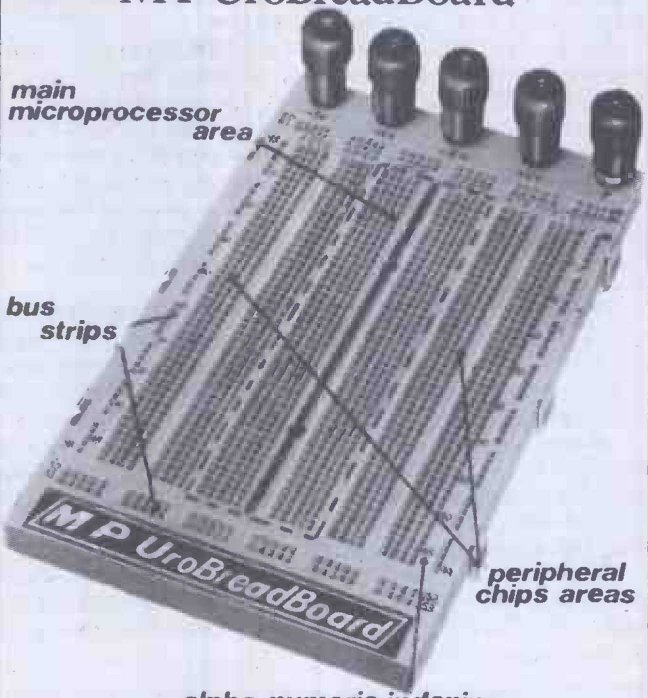

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Electronic Organ-2

Here is the second part of our organ project, which gives details of how to make your own keyboard contacts at a small fraction of the cost of commercially-available types

IF YOU'RE UP-TO-DATE with your project so far, you will have a baseboard with all hardware attached, including the keyboard, control panels and PCBs. You will also have built and tested Board 1 which contains the project's power supply, pre-amplifier and power amplifier, and filter and stops circuitry.

There are two jobs to do this month: build and wire up Board 2 (the master tone generator PCB), and make and fit all the key contacts to the keyboard.

Construction

Construction of the PCB is straightforward. Insert and solder all printed circuit board pins and the link first. Then do likewise to the 16-pin IC holder.

Following the overlay details in **Fig. 2** insert and solder all resistors and capacitors, then semiconductors, and lastly the coil. Make sure all polarised components are correctly inserted.

Fit IC1 to its socket, checking that it is the right way round. The board can now be screwed into position on the PCB guiderails.

Using thin multi-strand wire, make all connections from Board 2 to the three potentiometer controls of vibrato depth, vibrato speed and pitch. Finally connect three power supply leads, +12 V, 0 V and −12 V, from the board to Board 1. **Figure 3** shows the edge of Board 1 where power connections should be made, and also shows the positions of points 1, 2 and 3 which were accidentally not shown (oops) last month.

Now, with the aid of Board 1, you can test Board 2. Connect a loudspeaker to the speaker output jack socket of the organ and turn the organ on. Attach one end of a length of wire to one of the filter inputs at the right-hand side of Board 1 (it doesn't matter which, but make sure you don't connect it to the point at the top edge, beside capacitor C10 — this is a power supply point).

Using the other end of the wire touch each of the 12 outputs from IC1 of Board 2 in turn. These outputs encircle the IC at a distance of about ½".

If all is working you will hear one note from the top octave at each point, 12 notes making the complete octave.

Useful Contacts

The contacts are made using small strips (about 1½" by 3/16") of precut phosphor-bronze. **Figure 4** shows details of one pair of contacts and from this you can see that they are all mounted onto lengths of copper laminate PCB, which are in turn mounted onto a wooden batten. Each pair of contacts is made from one straight piece of phosphor-bronze and one shaped piece.

First, glue the lengths of PCB onto the wooden batten using good quality contact adhesive. The lengths of PCB (two or more) with continuous areas of copper should all go along one edge, and similarly the lengths with broken areas of copper should go along the other edge. Both types of PCB lengths should be glued copper side up.

When the glue is thoroughly dry, link the lengths of continuous copper strips where they meet by soldering short pieces of tinned copper wire across the breaks.

Next glue the whole wooden batten, complete with PCBs, onto the underneath of the keyboard, parallel to and 1" away from, the key actuator tips. Allow the glue to dry.

Now comes the monotonous bit! Position one length of phosphor-bronze strip onto the left-hand edge of the continuous strip PCBs so that it rests on the key actuator plastic tip, then solder it carefully in place as shown in **Fig. 4.** Repeat this for the other 59 straight key contacts.

The shaped key contacts are formed with the use of (ideally) a pair of flat-nosed pliers. The contact shape is not critical as, even after soldering into position, minor adjustments can be made by hand where necessary. Make and solder each shaped contact into place, individually.

Finally, adjust the contacts so that there is approximately 1/16" gap between each shaped and straight key contact.

This whole process of making the contacts is quite time-consuming (it will probably take you about four hours) but provides a cheap yet reliable method of keyboard switching.

That's all for this month (you can breathe a sigh of relief!). Next month we'll move on to Boards 3 and 4.

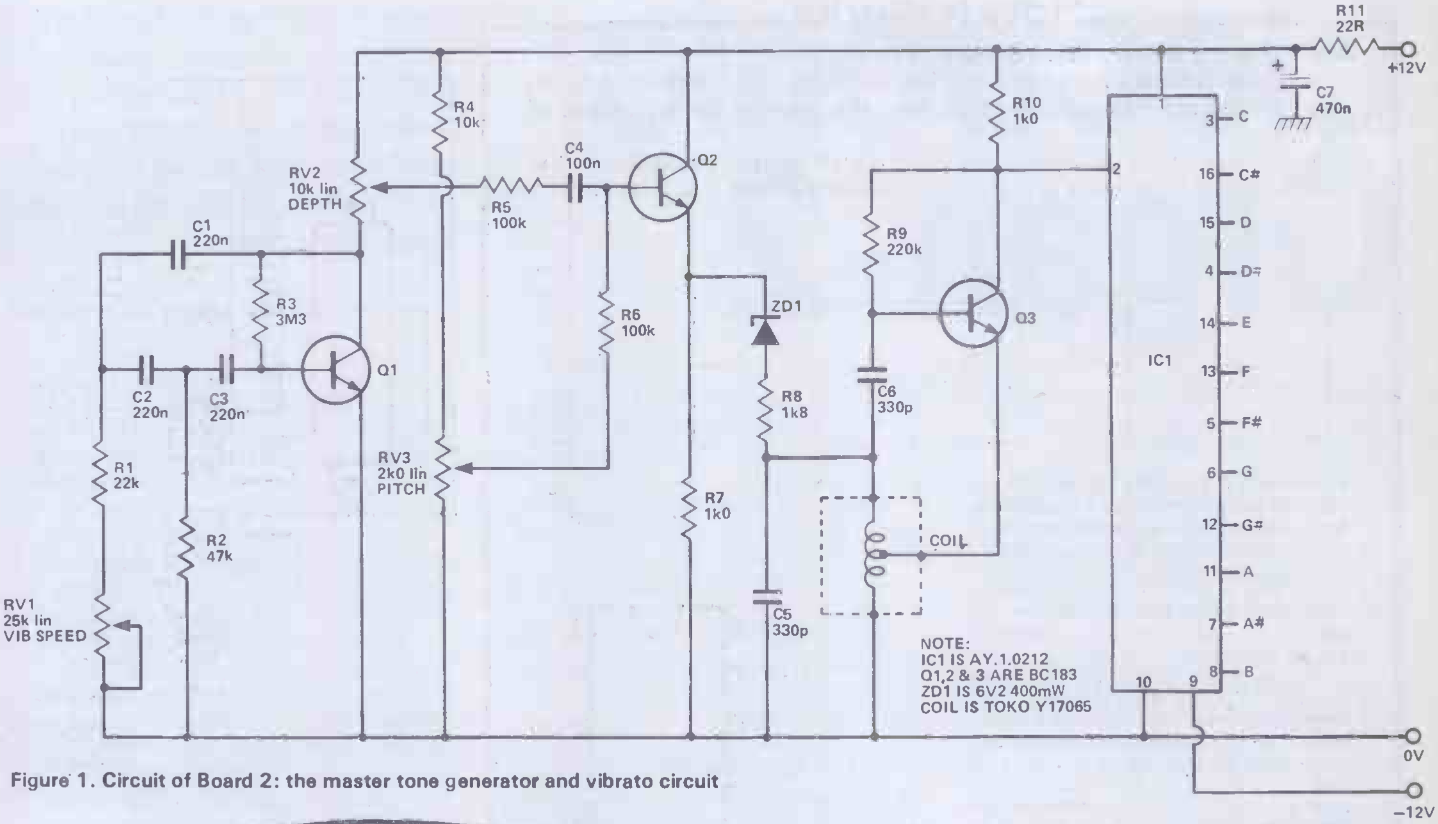


Figure 1. Circuit of Board 2: the master tone generator and vibrato circuit

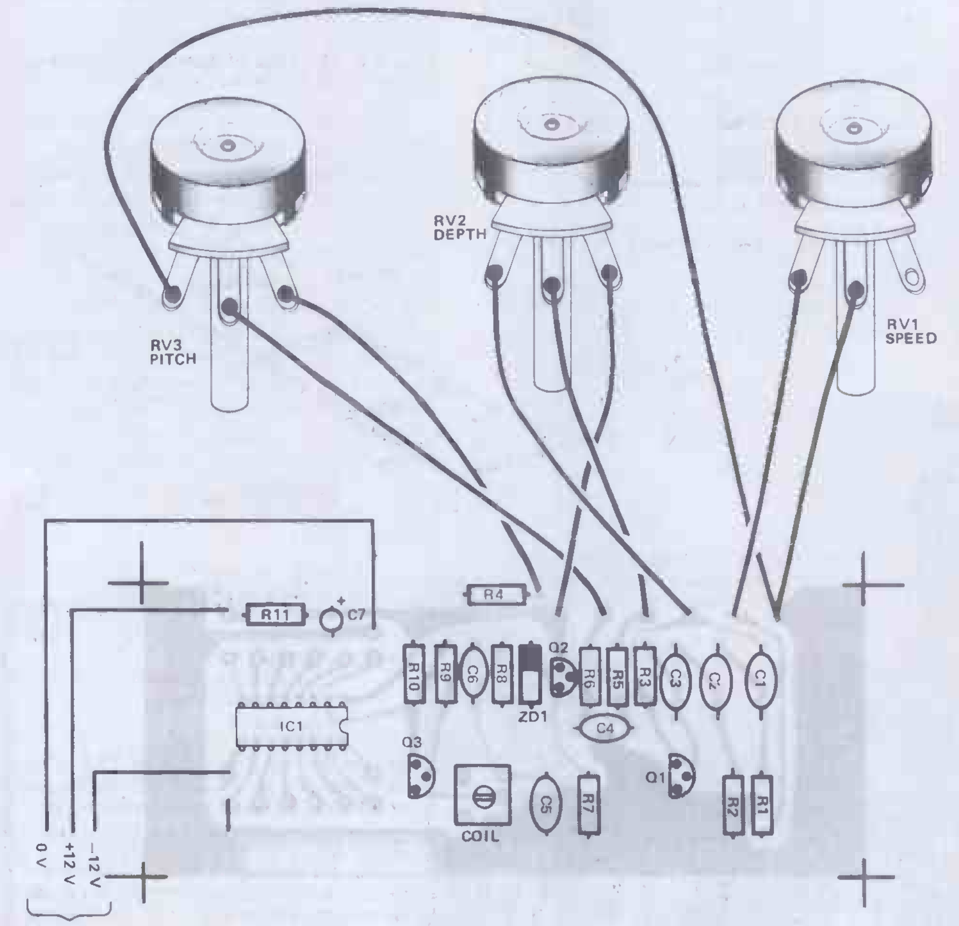


Figure 2. Overlay of Board 2 and connection details

Parts List

The list below consists of the parts needed for this month's constructional part of the project.

RESISTORS

R1	22k
R2	47k
R3	3M3
R4	10k
R5,6	100k
R7,10	1k0
R8	1k8
R9	220k
R11	22R

POTENTIOMETERS

RV1	25k linear potentiometer
RV2	10k linear potentiometer
RV3	2k0 linear potentiometer

CAPACITORS

C1,2,3	220n polyester
C4	100n polyester
C5,6	330p silver mica or polystyrene
C7	470n, 16 V tantalum

SEMICONDUCTORS

IC1	AY-1-0212 top-octave generator
Q1,2,3	BC183 NPN transistor
ZD1	6V2, 400 mW zener diode

MISCELLANEOUS

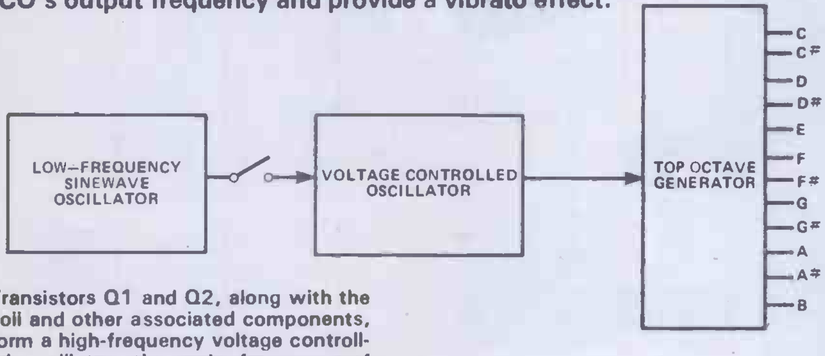
Coil TOKO Y17065
120 phosphor-bronze strips (approx size 1½" by 3/16")
Strips of copper laminate (plain and etched to suit)
Wooden batten

How It Works

Board 2 is the Master Tone Generator Board.

The output from a voltage controlled oscillator (VCO) is divided down into 12 separate frequencies which form the notes of the top octave of the organ.

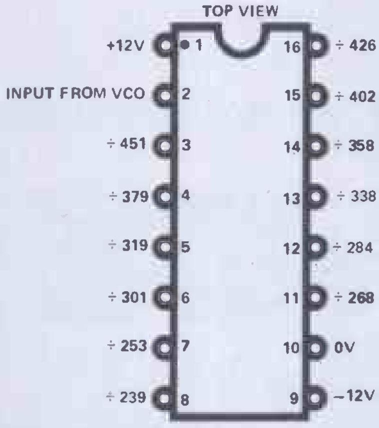
A low-frequency sinewave also can be switched in, to modulate the VCO's output frequency and provide a vibrato effect.



Transistors Q1 and Q2, along with the coil and other associated components, form a high-frequency voltage controlled oscillator, the main frequency of which is adjustable by the position of the ferrite slug in the coil. Other control inputs come from pitch control RV3 and the low-frequency sinewave oscillator output from RV2.

Integrated circuit IC1 is a top-octave generator. Its job is to take the high-frequency signal from the VCO and produce from it 12 subdivided signals corresponding to the 12 semitones of a musical octave. The IC consists of 12 divider circuits, each of which divides the input signal by an exact integer to produce the scale of the top octave of the organ. Thus the pitch of the *whole* octave is defined by the one oscillation frequency.

A low-frequency (about 2 to 8 Hz) sinewave oscillator is formed around transistor Q1 and its frequency can be adjusted by pot RV1. The amplitude of the output signal can be varied by RV2.



Integrated circuit IC1

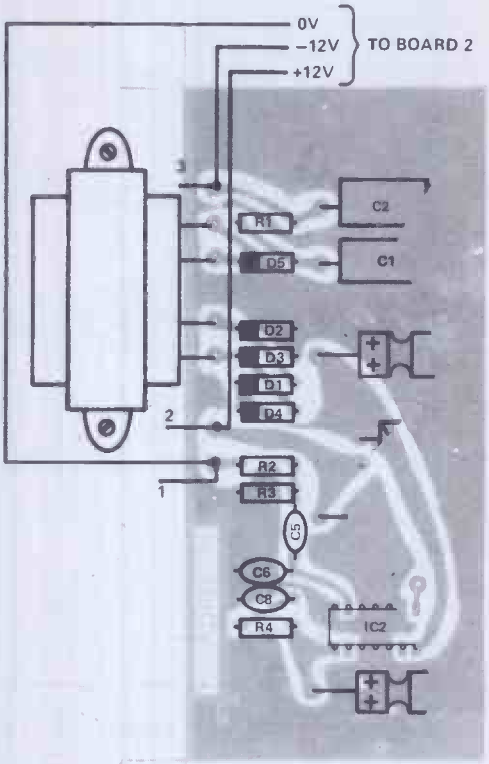
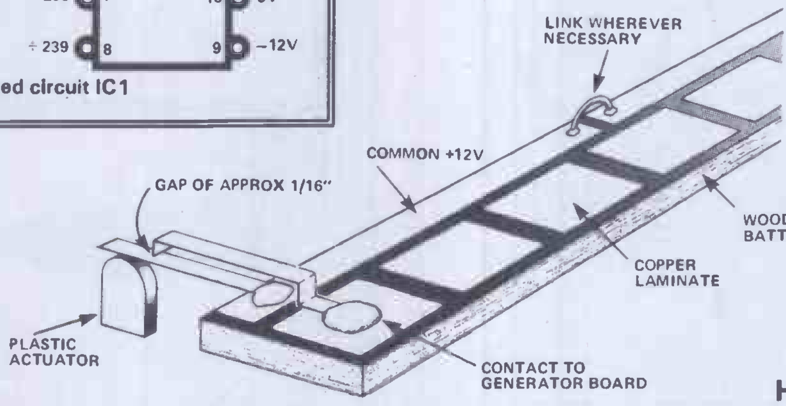


Figure 3. The edge of Board 1 where power connections are taken to Board 2



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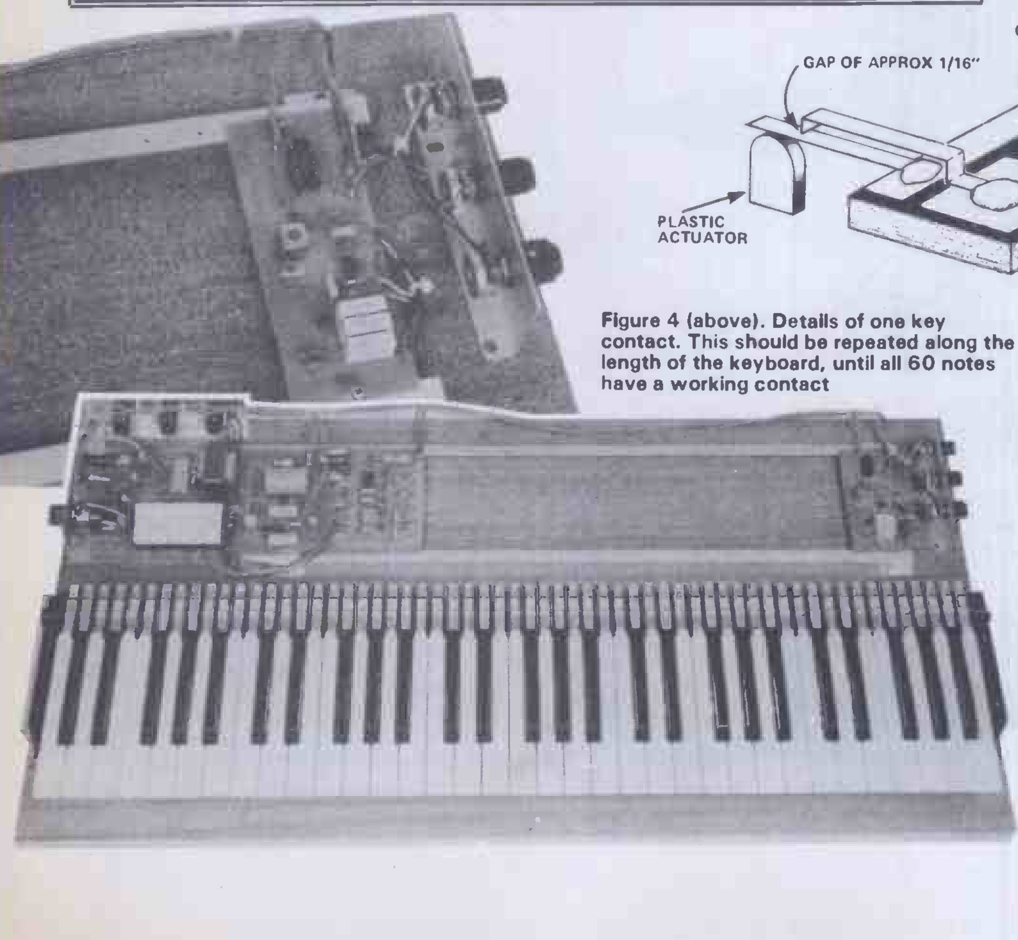

Figure 4 (above). Details of one key contact. This should be repeated along the length of the keyboard, until all 60 notes have a working contact

Buylines

A limited number of kits for the HE Organ can be obtained from:

Mr A. T. Hawkins
23 Blenheim Road
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Herts AL1 4NS

for the all-inclusive price of £95. The kits contain all metalwork, hardware and PCBs, as well as the keyboard and components. You only need to supply your own baseboard and case.

For those readers who would prefer to buy the components themselves, Mr Hawkins will supply the keyboards separately. None of the other items should be difficult to find.

O Level Q & A

As we near the end of the syllabus, Nick Walton covers two main topics this month: Op Amps and Systems

LAST MONTH WE looked at amplifiers, especially the type you might find in a radio or hi-fi — though in practice these would have much more sophistication. There is, however, another type of amplifier called the operational amplifier, or op amp for short, which we will consider this month, along with the way we can come to terms with difficult circuits by what is known as a 'systems approach'. This will bring together what we have seen in previous articles, and enable us to look at how more complicated systems might be put together.

Understanding Op Amps

So let's start with the op amp and see why it is such a useful and versatile little beast. Actually, the operative word is little because these days about the most common form of operational amplifier is the 741 integrated circuit package, which as you can see from **Fig. 1** does not need a crane to lift it, in spite of the fact that a typical circuit for the 741 contains 20 to 25 transistors and 10 to 15 resistors. It has eight legs often in a dual-in-line (DIL) configuration; that is, in two rows of four, as opposed to the pins going round in a circle. When you think that back in the old days an operational amplifier would contain several valves, and now you could fit several 741s into the volume occupied by one valve, you really do see how things have shrunk. Indeed, all the circuitry lies in an area 1 or 2 mm square, so much of what **Fig. 1** shows is merely encapsulation.

Figure 1. Comparison in size between a 741 operational amplifier and a 2p coin

However, enough of the lyrical 'small is beautiful' bit: let's try to answer the question 'What does it do?' One of its fundamental uses is to perform mathematical operations like add, subtract, multiply and divide, differentiate and integrate in analogue computers. 'What is an analogue computer?' did you say? Well, computers can be divided into two classes: digital and analogue. The first of these uses electronic logic and strings of binary digits 0 and 1, and bases all its working on the possible logic gates (NOT, AND, OR, NOR and NAND, so well expounded by Ian Sinclair's series). The other class uses some quantity, most commonly voltage values to stand for numbers; that is, voltage value being analogous to number, or the analogue of it. Thus, for example, 1 V might represent the number one, 2 V the number two and so on. Perhaps the neatest illustration of the difference between analogue and digital devices lies in contrasting the electronic calculator (a digital computer at heart) with what people used before calculators became widespread — the slide rule. This uses the length of the slide to be analogous to number, so it is a simple form of analogue computer.

To understand the function of an op amp properly we must take a look at what it does, and throw in a little theory for good measure. The ideal op amp will have four properties. First, it will have an infinitely high gain when there is no feedback (from the output back round to the input). The no-feedback gain is properly called the 'open loop gain', and this is very high — for the 741, it is typically about 10,000 or 100,000. We shall see in a moment that the gain *with* feedback can be set entirely by the feedback resistor and the input resistor. The second property is that it needs to have an infinitely high input impedance so that the signal is not reduced by the amplifier drinking up everything that is being offered. In other words it must not *load* the input signal. Third, it needs to have a low output impedance: theoretically it should be zero but in practice it will be about 100R. This really comes back to something we met in an earlier article where if your voltage source, a battery at simplest, has an internal resistance then the more current you take from it the more voltage you lose across the internal resistance, and the less appears actually across the output terminals. The fourth property is that ideally it will amplify all frequencies by the same amount, from zero (DC) to very high frequencies (a few megahertz).

The circuit representation of an amplifier is a triangle and **Fig. 2** is the usual way of representing an op amp. Something you notice immediately is that it has one output but two inputs, called the inverting input and the non-inverting input. You might remember from last month's O Level Q&A that the non-inverting amplifier will give an increase in output voltage for an increase in input, while the inverting input does the opposite: the output goes *up* if the input comes down (like umbrellas and rain!).

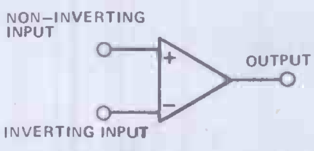


Figure 2. Circuit representation of an op amp

Virtual Earth

Whichever input you happen to be using, the actual input point where it enters the amplifier is known as a 'virtual earth' and it is not difficult to see how this comes about when one considers the high gain aspect of the amplifier. (Strictly speaking, what is being amplified is the difference in voltage between the two input terminals, though quite often one of these will be earthed.) Consider an op amp with an open-loop gain of 100,000 and suppose also that the positive supply rail is + 10 V, which will then of course also be the maximum positive voltage to which the output can swing. Now ask yourself what change of input voltage will cause a swing to + 10 V (given this gain of 100,000). Since gain A_v is equal to

$$A_v = \frac{V\,(out)}{V\,(in)},$$

V (in) becomes one ten-thousandth of a volt, or 0.1 mV, which is really nothing at all between friends, hence the name virtual earth.

In practice you can easily pick up a stray tenth of a millivolt without wanting to, and thus get a spurious value for the output voltage. It is in these circumstances that the 'offset null' pin can be used to compensate for such a stray voltage.

It is now fairly easy to see how the gain of the op amp can be fixed by means of the resistances round it. Consider **Fig. 3**. Resistor R(in) is what we call the input resistor and Rf is called the feedback resistor. The input voltage V(in) will be applied as shown in **Fig. 3**, and the output voltage V(out) will appear as shown. Focusing on R(in), the voltage at the amplifier end is earth (virtually!) and at the other end it is V(in). Thus the voltage across it is V(in) and the current through it (by courtesy of Georg Simon Ohm yet again) is derived from V(in)/R(in).

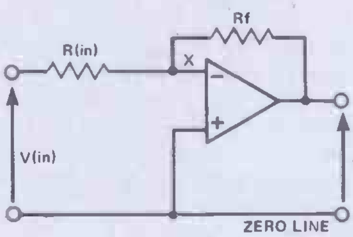


Figure 3. Circuit arrangement to show that voltage A_v is equivalent to Rf/R(in)

Similarly for Rf, one end is at virtual earth and the other is at V(out), giving a voltage across it of V(out) and a current of V(out)/Rf or strictly minus V(out)/Rf.

Assuming these currents as being equal we get:

$$\frac{V(in)}{R(in)} = -\frac{V(out)}{Rf},$$

and this gives the gain

$$\frac{V(out)}{V(in)} = -\frac{Rf}{R(in)}$$

as the ratio of the feedback resistor to the input resistor. Notice that to get this result we had to use two of the basic properties of the op amp mentioned earlier, namely that it had an infinitely high gain (to justify saying X was virtually at earth potential) and that it had infinitely high input impedance (so that no current was actually siphoned off into the amplifier itself — it all went through R(in) and Rf).

The same two vital properties are used when thinking of the op amp as an adding amplifier, as a thoughtful look at **Fig. 4** will show. Since X is a virtual earth, then each of the currents i1, i2, and i3 (also equal to V1/R, V2/R and V3/R respectively) must flow through Rf. In other words:

$$i1 + i2 + i3 = \text{current in Rf} = i$$

so

$$\frac{V1}{R} + \frac{V2}{R} + \frac{V3}{R} = \frac{-V(out)}{Rf},$$

making the output voltage depend on the sum of the input voltages.

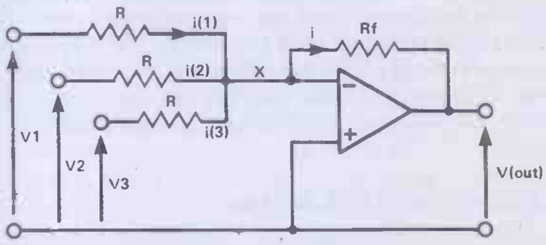


Figure 4. Op amp used as a summing amplifier

If we were to put a capacitor into the feedback position as in **Fig. 5** we get a circuit which produces a steadily rising output voltage for an input consisting of a step. If you are familiar with integration you will see that the output can be regarded as the integral of the input and such an arrangement is called an integrator.

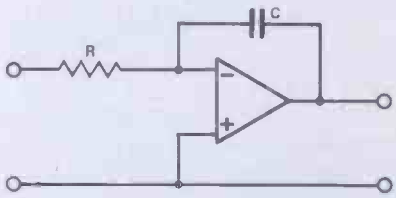


Figure 5. Op amp used as an integrator

We will take as our final brief example the set-up in **Fig. 6**. Before you read on you might like to try to see why we can regard this as the op amp in a non-inverting mode, and an example of a negative-feedback amplifier. You may remember from the previous article that the use of negative feedback stabilises an amplifier. Here, the effect is to stabilise the output at 10 V. If we imagine an initial condition with the input at 5 V and the output at 10 V, then the voltage at Y between the two equal resistors will be 5 V which is fed back to the inverting input. So, if for any reason the output voltage drifts above 10 V, the voltage at Y will go up and because it is fed into the *inverting* input, will pull the output down again. The overall picture is that the output is stabilised at 10 V. There's a lot of fun to be had with op amps and much more to them than this brief survey can express.

Systems

I don't suppose there is a single person with an interest in electronics who at some time or another has not taken one

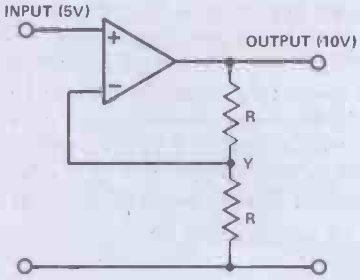


Figure 6. Op amp in non-inverting mode as a negative-feedback amplifier

look at a complicated circuit diagram and thought: "How will I ever understand what is happening in all that maze?"

Even the circuit of a not-very-complicated radio can induce this effect and if you still frequently feel bemused then this part of the article is for you. Help lies in one simple word: *systems*. In fact, it is rapidly coming into everyday use. We would not, for example, be surprised to hear that a friend had been saving up and was now going out to buy a hi-fi system. What is meant is that this friend will go and buy several different boxes, all of which must be connected together correctly. One box might contain the turntable and pickup. The pickup will be connected first to a pre-amplifier, the function of which is to amplify the minute signals coming in from the pickup (a few millivolts) up to a voltage that could be fed to the power amplifier input. This voltage could be around 1 V. When the signals come out of the power amplifier, they are fed to the speakers. The final voltage at the speaker terminals could be as high as 20 V. It is possible that under some bizarre set of circumstances a complete circuit diagram for the whole lot might be produced, but it is really much more useful to see the various parts of the whole and forget about individual circuit components. The system would look something like that in **Fig. 7**. Within these boxes we might say there are subsystems; the speaker box could well contain two or three speakers, one for high frequencies (a tweeter), one for low frequencies (a woofer), and perhaps something for the mid range, and this in turn would give rise to the need for a system to feed the correct frequencies to the appropriate speaker by some sort of filter system. Again, the amplifier might have a system (a scratch filter) to cut out very high frequencies that are produced by a scratch on the record. You might also want the facility at the input of the pre-amplifier to allow signals from other sources (with different impedances) to be fed in, for instance from a tape pickup or a radio tuner.

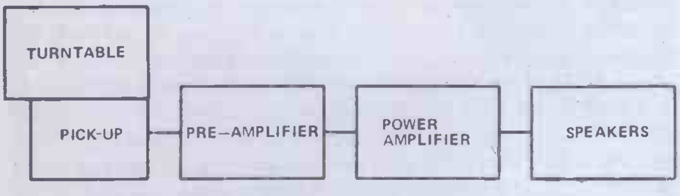


Figure 7. Systems approach to a hi-fi system

Practical Systems

Ramifications are almost endless but the important thing to do is to look initially at the system that concerns you and leave the individual components to a much later stage. Incidentally, this is how any troubleshooter will work. He or she will isolate the system or subsystem that is playing up and then narrow the field in logical stages. The garage man who comes to rescue you when you have broken down by the roadside will start by trying to establish whether it is the petrol system or the electrical system that is faulty (or something else altogether). If the fault is electrical, is it the high-voltage system or the low-voltage system?

Our own bodies are a complex mass of interacting systems (with, incidentally, lots and lots of feedback) and while it would be a fiendishly difficult task to represent ourselves fully in a systems block diagram, it would be a very good exercise for you to try to put together a block diagram for a radio system, and perhaps as a useful revision exercise you could look back over some of the previous articles in this series where some of the subsystems (tuning, detection, amplification) have been dealt with.

That just about completes matters for this month. Next month will be the end of the series, signing off with multivibrators and information storage — all coming out about a fortnight before the exam itself. Cheers!

HE

'YOUR CALCULATOR BROKEN DOWN AGAIN?'

Envelope Generator

Another simple-to-build yet fascinating musical effect from HE

NO! AN ENVELOPE generator is not a machine that keeps the postman in a job. It is, of course, a musical effect commonly used with an electric guitar (although there is little reason why it can't be used with other instruments) to increase the instrument's already versatile range. It does this by altering the envelope of the signal coming from the guitar in such a way that the overall sound gives you the impression that it is *not* a guitar at all. Instruments such as oboes, violins etc, can be successfully simulated in this way.

Attack and decay rates are altered by potentiometers and the length of the sound (the sustain) is controlled directly by the musician, holding down the pedal with his foot for as long as he wants. Thus the major variables of the envelope are all under the guitarist's command.

If you built the Fuzzbox in the March issue of Hobby Electronics (pp 54 to 56), and housed it inside the same style of case that we used, we feel sure that you were impressed by the neat appearance and versatility of the case. Our designers were so pleased with it that they decided to use it for the Envelope Generator too. In fact, the projects can be used as complementary effects to produce further exciting possibilities.

Construction

Build up the printed circuit board (PCB) first, according to its overlay in Fig 2. It's a good idea to use PCB pins for each connection point to controls, switches etc, as this means you can fasten the board into its final position and wire it up last. Insert and solder components in the following order: resistors, IC socket, capacitors and the transistor. Finally, push the IC into its socket — making sure it is the right way round. Remember that the IC will be marked with either a dot or a notch which indicates the end where pin 1 is, and this end should be lined up with the notch shown in the overlay.

Put the board aside now and concentrate on the case. Assuming that you use the same style of case as us, your first job is to adapt the internal switch so that it doesn't latch. Unsolder the screened lead which comes attached to the switch and remove it completely from the case for the time being. Unscrew the two self-tapping screws which hold the switch in place and then remove the switch itself. Underneath the coiled spring which winds around the push-button section of the switch you will see a thin metal catch which engages inside the switch body as the button is pressed, holding it in and releasing it, alternately. Pull back the spring with your finger and, with a pair of fine, snipe-nosed pliers pull out the catch. The switch should now form a momentary action, push-button ie, push in — on, release — off.

Next, mark and drill the case for the two pots, the bypass switch, and the jack socket and mount them all in their positions. You will have to bend the tags on the jack socket at right angles, in order that the case bottom fits. Secure the PCB to the inside of the case (we found that a pad of double-sided adhesive tape is ideal for this purpose) and then commence wiring up the project. Wire between the pots, SW1&3, the battery clip and the PCB first, using thin multi-strand wire, as shown in Fig 2. Finally, all audio signal leads should be made using thin screened cable, to help prevent interference and noise pickup. The output lead is, of course, the lead supplied with the case, and comes complete with jack plug.

Now you can try out the Envelope Generator with your guitar and see how it sounds. With practice and care you should be able to imitate other instruments very rapidly.

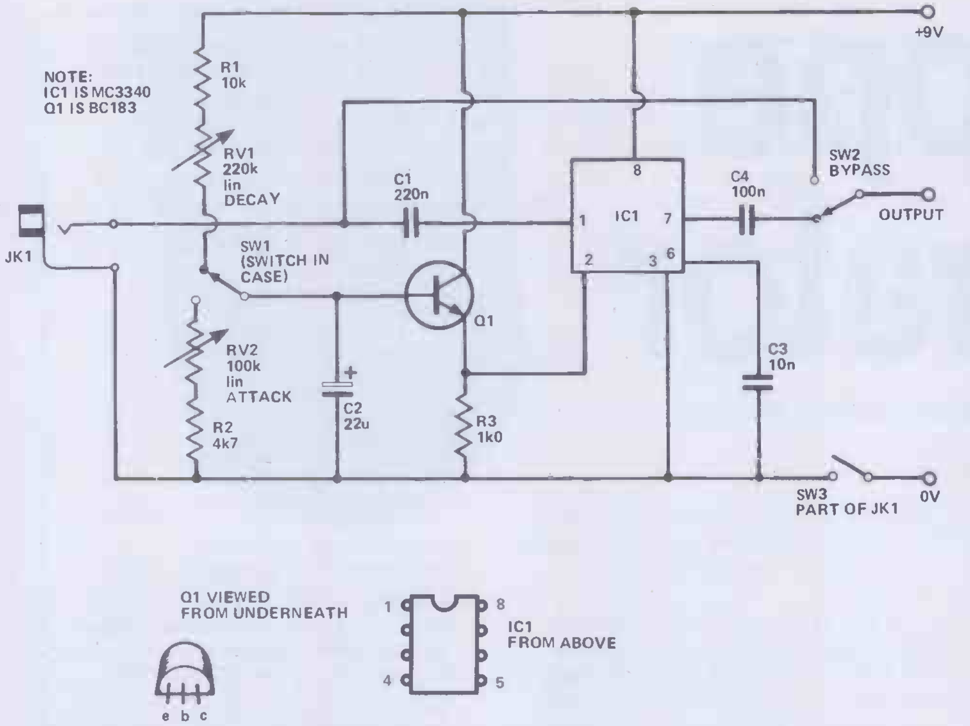


Figure 1. Circuit of HE Envelope Generator

Parts List

RESISTORS (All ¼W, 5%)

R1	10k
R2	4k7
R3	1k0

POTENTIOMETERS

RV1	220k linear potentiometer
RV2	100k linear potentiometer

CAPACITORS

C1	220n polycarbonate or ceramic
C2	22u, 16 V tantalum
C3	10n polyester or ceramic
C4	100n polyester

SEMICONDUCTORS

IC1	MC3340 voltage controlled attenuator
Q1	BC183 NPN transistor

MISCELLANEOUS

SW2	single-pole, double-throw latching push-button switch
JK1	¼" jack socket (with SW3)

Case to suit (with SW1 — see Buylines)
Knobs to suit
PP3-type battery + clip
8-pin IC socket

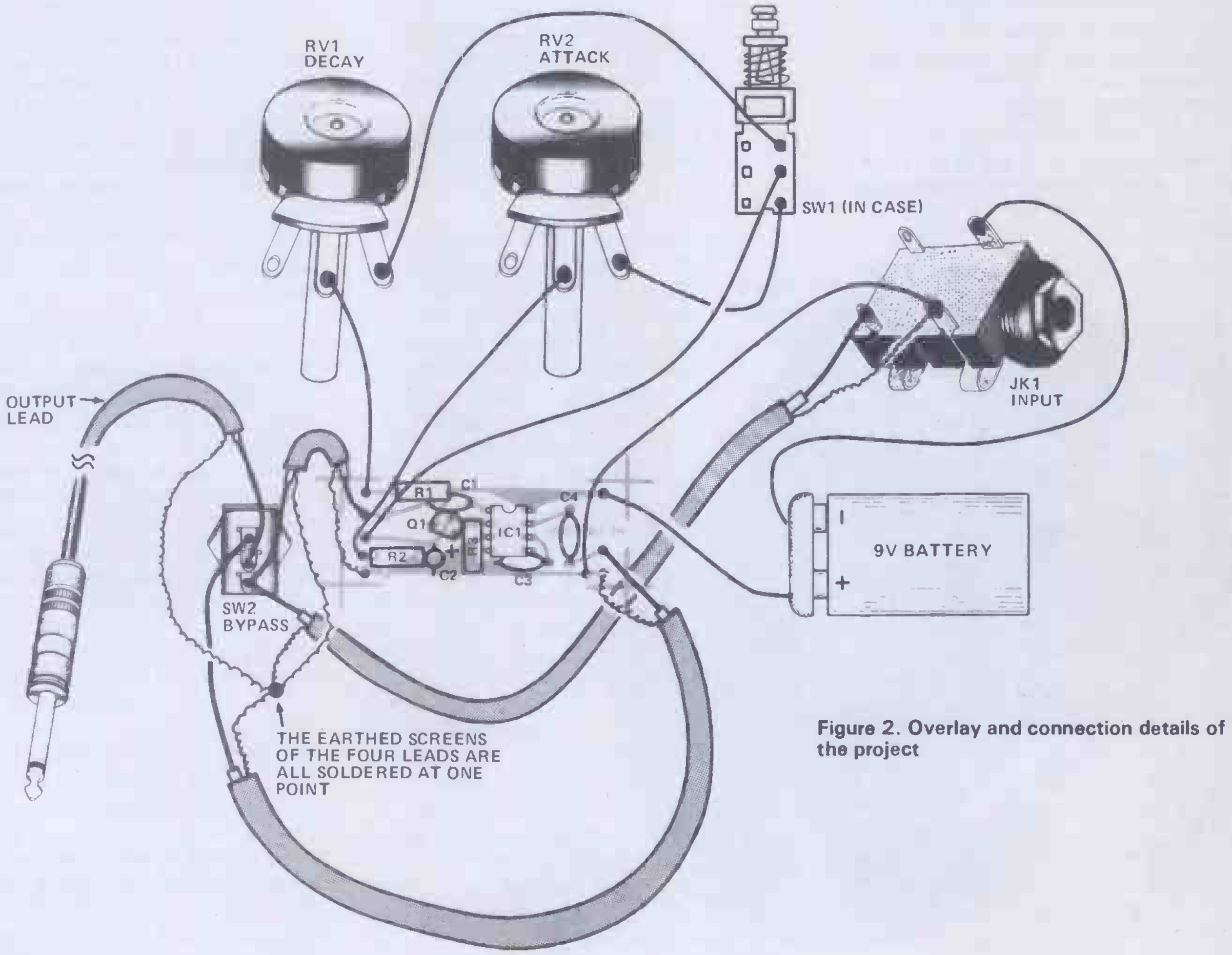


Figure 2. Overlay and connection details of the project

How It Works

One of the main parameters which allows us to differentiate between classes of musical instrument is the envelope of an instrument's sound output. Typical envelopes of four common instruments are shown in Fig. 3. Some, like the oboe or the guitar, have a fast attack (rise rapidly in volume at the beginning of the note) and others, like the violin, have a slow one. Similarly, sustain (the overall length) and decay (the fall in volume at the end) vary from instrument to instrument. The HE Envelope Generator controls these variables so that when a guitar is played through it, a different envelope can be impressed on the note. Figure 4 shows how a voltage controlled amplifier (VCA) is used along with a control voltage (which varies as the required envelope) to produce the desired effect.

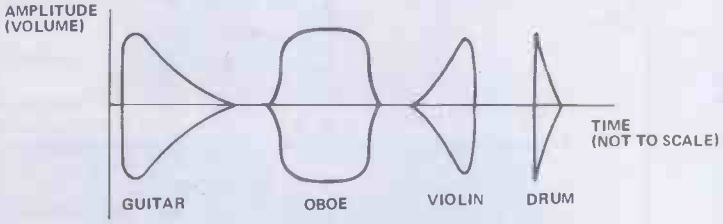


Figure 3. Envelopes of some common musical instruments

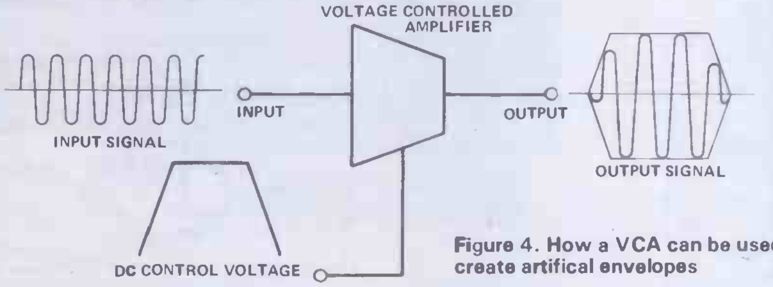


Figure 4. How a VCA can be used to create artifical envelopes

Integrated circuit IC1 is a complete, single-chip VCA and the guitar signal is applied via C1, to pin 1. The output signal comes from pin 7.

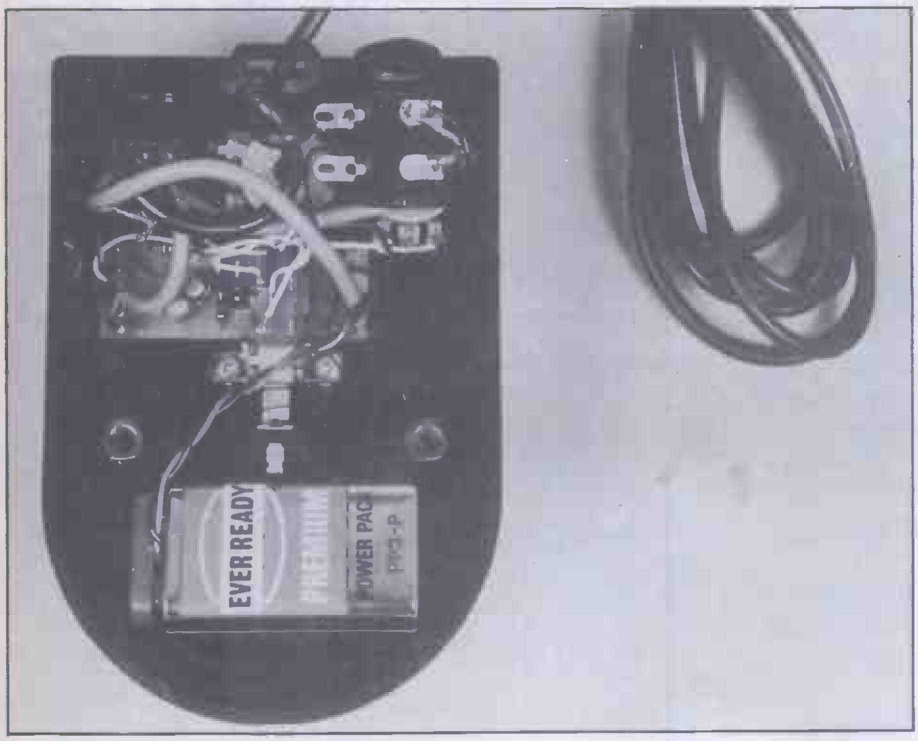
Pin 2 of IC1 is the control voltage input and a DC voltage of 0 V gives maximum output; ie, all the guitar signal is fed straight through to the output. Actually, the IC amplifies the signal somewhat, so the output will be larger than the input by a factor of four. A voltage of 6 VDC at the control input reduces the output signal to zero. Voltages in between the two produce a corresponding level of output.

All we need now is a source of control voltage which varies between 6 V and 0 V (down, then up — not up, then down, as in Fig. 4) in the form of an envelope.

The pedal's internal switch SW1 is shown in its resting position in Fig. 1. Capacitor C2 is charged up to about 7 or 8 VDC via R1 and RV1. Transistor Q1 acts as a high impedance buffer (ie, it has a high input resistance, therefore it does not discharge the capacitor) in a circuit configuration known as an emitter follower. In other words, the emitter voltage is almost at the same voltage as the base (which is connected to C2). Because of the semiconductor junction between base and emitter, the emitter voltage is about 0.7 V lower than that of the base. Pin 2 of IC1 is therefore at a voltage of about 6 to 7 V and thus no output is obtained, whatever the amplitude of input signal to the IC.

When the foot pedal is pressed, SW1 connects C2 to RV2 and R2. Therefore, C2 discharges down to 0 V at a rate determined by the value of RV2. Thus the VCA control voltage falls likewise to 0 V and the guitar signal increases to maximum at the output. Potentiometer RV2 therefore controls the attack rate.

Sustain is set by the length of time the pedal is held down and SW2 is connected to RV2. When the pedal is released, RV1 is re-connected and C2 charges up (the decay control voltage) at a rate determined by the pot. Consequently the output signal volume decreases back down to zero.



Buylines

Magenta Electronics produce a kit for the HE Envelope Generator which includes case, PCB and all components and parts for £15.32. This price includes VAT but not p & p.

The case is obtainable separately from Magenta for £5.65, again inclusive of VAT but not p&p.

Please add 40p p&p, whatever size order you place with Magenta.

Figure 5. Internal view of the case showing how tight a fit it is. Note the use of screened cable for all audio signal-carrying leads

HE

Clever Dick

Is he a man, a machine or just a figment of HE's imagination? Clever Dick, in whatever form, is back on duty

First letter I received this month, from G.S. Pierce of Halifax, West Yorkshire, contained two rude cards: one for the Editor's car and the other for the smallest room in the building. Thanks for cheering us up, and we'll see if a binder will cure your stomach problem.

Number one letter this month is yet another query about the HE Minisynth.

Dear Clever Dick
I have a question:
How can you prevent "Mini Synth With Memory" (HE, Nov. '80) from making its ignorance warning hum?
I would like to inform you that I have successfully built and installed the "Home Security System" (HE August '79). I have just turned 12 on the 5th February, 1981. I have been reading HE since the first issue appeared in Nov. 1978.
W.E. Meyer
Pretoria, Republic of South Africa

Minisynth is designed around one clever chip, the TMS 1000N MPO 121, and the warning it gives you if a note hasn't been played for several minutes cannot be suppressed. So you'll have to live with that one.

Congratulations on building the Home Security System: you'll need it to protect all those back-issues.

Nice short one next.

Dear CD
1) Could you tell me where I can get 1:1 transformer; 50 V, 2 A for use in a power supply to isolate the outputs from each other?
2) How about publishing a design for CB in the near future?
R. Sewell
London
P.S. Thanks for a great Mag
P.P.S. Short enough?

The transformer you describe would be very difficult to come by and is likely to be expensive. One way to get the isolation is to use two transformers (each 240/50 VAC) back-to-back (240 V windings coupled) but this arrangement would be costly and inefficient. I dont know what you're trying to do, so it's difficult to give any other suggestions.

For an answer to your second question, see the answer that the Editor gave to V.M. Holness in Your Letters on page 47 of last month's issue.

Dear C.D.
I would like to make the diesel horn (Feb '81) for my 00 scale railway. This works from 12 volts, whereas your project only uses 9 volts. Not being made of money, would it be possible to use the track's 12 volt supply.
The IC's could take the 12 volts but the capacitors would have to be 16 or 25 volts.
I know it is not your fault, but if there are any of those other people in your office, tell them to use 12 volts instead of the 9 volt power supply.
Peter Day
Camberley, Surrey

Yes you can make use of the 12 V supply, but make sure that it comes directly from the power supply and not through the speed controller first (some of these controller/power supply units only provide a controlled output). If you did use 12 V direct then the electrolytic capacitors would have to be replaced with higher-voltage types. A better suggestion is to derive a regulated 9 V supply from your 12 V supply.

The trouble with your last suggestion is that most people here are not model train addicts.

Call for help next.

Dear CD
This is the first time I have written to your magazine so could you please please answer my questions.
I would like to know who sells the AY-3-8610 IC and how much it costs. Also could you have a project on making a TV game as I am dying to make one.
P. Smith

The AY-3-8610 is a Superspace TV games chip and, as we discovered, difficult to get hold of. We doubt whether most suppliers want to sell it 'one off' because it is so specialised.

In answer to your second query, we have no plans to publish a TV game project. Because the electronics is so complex in these games we leave them to our sister mag ETI. (A space invasion game was published in the November '80 issue of ETI.)

Dear C.D.
I've been wanting to construct a decent spec amp for ages. Seeing the project advertised in March edition of HE for the preamp in April's issue, I looked forward to it with enthusiasm.
Now that I've found it's going to cost me about £62, just for a preamp, I'm quite dejected.
Surely you could've struck a deal for your fans whereas a Hobby Print could be available.
I mean £12 just for a P.C.B.; it's ridiculous.
Come on now, do your ever faithful fans a favour. We're not all rich.
PK Lad
Ashton U. Lyne, Lancs

I had better make something absolutely clear about HE's hi-fi project: the pre-amplifier and power amplifier together make a true hi-fi system. Trouble is, good (even moderate) hi-fi costs money. A good hi-fi pre-amp can cost you a lot more than £62. And if you saw that PCB with all the component position marked out and the copper tracks pre-tinned, you'd see that it's good value for £12.

But stick with us: we hope to be featuring another much lower-priced system in comming issue — provided we think it is up to scratch.

Last one is from someone describing himself as Prof. S. Unwin.

Dearus Mastermindibold Dick,
Oh, deep joy, deep joy, at writing to your column there is! Howeverlode, problem there is, mine for the asking. Recently fitted headphone socketer fittilode on the tape-recording contraption had speakibolds in parallel and sound was very much coming from the centre of the Id. Thenilode, with speakilodes in series, the musipoo was very much surroundsoundibold, although actual watts was reduced oh yes. Could you possibold supply answer in next few weeks?
Await deep joy at your reply,
Prof. S. Unwin
P.S. Remember, T.X. Radials give maximost milodes.
P.P.S. Actual Question: Why is this?

Well, why is it? Maybe some of you out there will be willing to help the 'Professor'. Binder to the reader sending the best suggestion.

Enough is enough for this month. Oh yes, there was something I had to mention: we will be unable to send replies by post for the time being, even for letters sent with an SAE. Sorry about this, but we need some time to clear the backlog of your queries. Stay lucky — and patient. **HE**

Famous Names

Heinrich Rudolf Hertz

With 'Radio' as the main feature this month, it seems appropriate to devote this third part of our Famous Names series to Heinrich Hertz - the man who discovered radio waves

AFTER SO MANY years of calling the units of frequency cycles-per-second, it still takes old-timers a while to get accustomed to using the name Hertz. Surprisingly few people associate the name Heinrich Rudolf Hertz with the discovery of radio waves, but the use of Hertz (usually shortened to Hz) to denote frequency shows a deserving recognition of this fact.

Hertz was born in 1857 and after a distinguished school life, he entered Berlin University to study under the celebrated Helmholtz. Helmholtz was one of the last of the great Victorian scientists — one of those men who are equally happy in any branch of science. Two of his contributions to Physics are still remembered in the textbooks: the Helmholtz coils and the Helmholtz resonator. A pair of Helmholtz coils consists of identical coils spaced one coil-radius apart, and their peculiarity is that the magnetic field between them varies only slightly from place to place between the coils. The Helmholtz pair is therefore the starting point for any TV deflection coil design. The Helmholtz resonator is a bottle with a narrow neck, and its resonance to sound waves is decided by the volume of the bottle and the dimensions of the neck. If you happen to be in the business of designing cabinets for hi-fi loudspeakers, then the Helmholtz resonator is pretty important. All in all, young Hertz must have had a good grounding both in electromagnetism and in wave motion, and the success of his studies was recognised in the award of a doctorate by the University in 1880.

He started on a career of research in electromagnetism. In 1883 he became aware of Clark Maxwell's work on electromagnetic theory, a brilliant but neglected work which predicted the existence of waves which would be invisible, but which could travel at the speed of light. Hertz was convinced that Maxwell's theory was correct, and that these waves existed in reality as well as in mathematical equations.

Hertz directed his very considerable experimental ability to the problem of generating and detecting electromagnetic waves. He reasoned that very high frequency oscillations should behave in a way similar to light waves, and decided that the resonant circuit around a spark-gap would probably provide the best conditions fo generating suitable oscillations.

His apparatus, shown in **Fig. 1**, is now one of the famous landmarks in radio history. It consisted of an induction coil capable of generating about 30 kV of low-frequency AC, and a spark gap between two copper spheres. The inductance of the leads to the spheres plus the capacitance between the spheres constituted a resonant circuit. The resonant frequency was high, much higher than the frequencies which were to be used later by Marconi and others. Recreation of Hertz's experiment has, in fact, shown that the strongest transmitted frequencies were in the lower microwave range.

The receiver was equally simple, as can be seen from **Fig. 1** — a pair of copper spheres at the ends of short pieces of wire. This constitute what we would now call a dipole aerial, and the principle on which Hertz was pinning his hopes was that electromagnetic waves picked up on the wires would create a sufficiently large electrostatic field to ensure a high voltage across the gap between the spheres. Hertz's ideas worked out perfectly. When the transmitter was sparking away, sparks could also be seen between the spheres of the 'receiver'. There was no connection of any sort between the transmitter and the receiver. None, that is, apart from the electromagnetic waves which Maxwell had so confidently predicted in 1864. It was a perfect vindication of Maxwell's theory — but the evidence was not strong enough for Hertz.

Hertz felt that, in order to vindicate Maxwell's theory fully, he must show that there were waves passing from the transmitter to the receiver, and that these waves were physically similar to light waves. He started on a long and ambitious project of discovery using methods which were ideally suited to the short wavelengths which his equipment generated. Oddly enough, had he generated lower frequencies, his measurements would have failed — these are the sort of happy accidents which continually seem to occur in the history of science.

Practical Measurements

Measurement of the wavelength of the radio waves was the first objective. The standard method of measuring the wavelength of light makes use of wave interference. Light

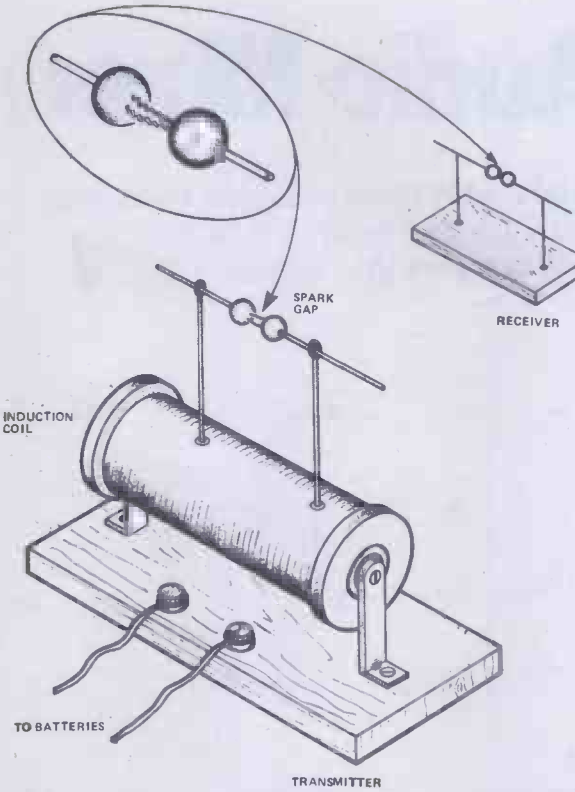


Figure 1. Hertz's transmitter and receiver. The induction coil is a DC to AC converter producing high-voltage pulses (about 40 kV)

from a source is split into two beams (Fig. 2) and these beams are aimed at a screen. Light rays which have travelled exactly the same distance will reinforce, causing a bright spot, but when the distance difference between the paths is half a wavelength, or any odd multiple (3,5,7,9, etc) of half a wavelength, the waves cancel causing a shadow. By measuring the distances between these 'fringes' of light and dark, the wavelength of light can be calculated.

Hertz used this technique, but since the waves could not be seen he had to use small spark-gap detectors instead of a screen. The wavelength of his apparatus turned out to be a few centimetres.

Hertz also measured the speed of the waves, using once again a version of the classic methods for measuring the speed of light. These make use of mirrors revolving so fast that a ray of light which has been delayed by travelling a long distance to a reflector and back finds the mirror at a

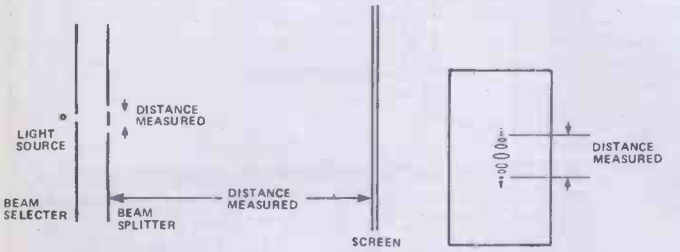


Figure 2. The method Hertz used to measure wavelength of light: (a) a slit in an opaque sheet selects one ray of light, which is then split into two by close-spaced splits in another sheet. The image projected on the screen (b), when examined with a microscope, consists of alternate dark and light bands caused by wave interference. The wavelength can be calculated from the distances indicated

different angle when it returns, so shifting the reflection. The amount of the shift, together with the speed of rotation of the mirror and the path distance, can be used to calculate the speed of the light.

To make this measurement, Hertz had first to establish that radio waves were reflected, and he was delighted to find that the newly discovered waves reflected from metal sheets in exactly the same way as light waves do, with the angle of reflection equal to the angle of incidence (**Fig. 3**). He also found, incidently, that radio waves were refracted; that is, they changed direction as they passed from one material to another exactly as do light waves.

Having made these points, Hertz succeeded in measuring the speed of the new waves. This speed turned out to be 300 million metres per second, the well established value for the speed of light. Hertz now felt that he had indeed discovered some of the waves which Maxwell had predicted. The work had taken him four years, from 1885 to 1889.

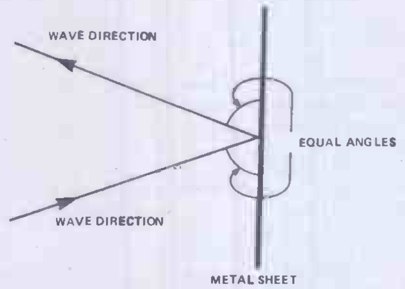


Figure 3. Wave reflection. Radio waves are reflected from a metal sheet in just the same way as light waves are reflected from any mirror

Road To Radio

In 1889, Hertz was appointed Professor of Physics at Bonn University. His work with electromagnetic waves was over for the time being, and his new line of research was to be on gas discharges, following the work of Geissler. His report, 'Electric Waves', was not published until 1893, because his health was seriously declining — a lung infection which he had disregarded was now recurring.

He died in 1894, aged 37, with a brilliant career behind him, and a promise of much more to come. His 'Miscellaneous Papers' was published in 1894, and his 'Principles of Mechanics' in 1899. These works were not his epitaph, though they hinted at the remarkable discoveries which he might have made. There is little doubt that long-distance radio would have been established much earlier than 1910 had Hertz lived. As it was, his work started an immense frenzy of experimental activity, of which the work of Marconi is best known to us. We shall remember, though, that Hertz's work caused immense excitement, and practically every country can boast of a radio pioneer. Of these who disputed Marconi's claim to be first with long-distance radio transmission, Tesla in Czechoslovakia and Popov in Russia were both serious contenders.

There is no dispute about the source of the work, though. Maxwell blazed the trail, and Hertz built the road along which all the later radio experimenters travelled. Now that we no longer measure magnetic flux in maxwells, it seems entirely appropriate to measure frequency in hertz.

Quick Project: Audio Mixer

Can it be true — a complete multichannel audio mixer project which uses only one transistor? This easily-constructed Reader's Design proves that it is. It's cheap, too — less than just a couple of pounds will buy you all the components.

This simple circuit sums the three audio signals entering at the transistor's base and produces an amplified output from the collector. More inputs can be added if required, each additional input needing a potentiometer, capacitor, resistor and input socket.

Output of the circuit is approximately 500 mV (sufficient to drive most amplifiers) for an input signal of 5 to 500 mV. Thus guitars, microphones and low-level audio signals from tape-decks etc, can be mixed to personal requirements.

Use a small metal box to house the project — a die-cast aluminium one is ideal.

All leads from input sockets to potentiometer controls, from the controls to the board, and from the board to the output socket should be made using screened cable. Make sure that you connect the screen (not the signal lead) of the cable to 0 V.

Switched potentiometers can be used if you want complete isolation of any one signal.

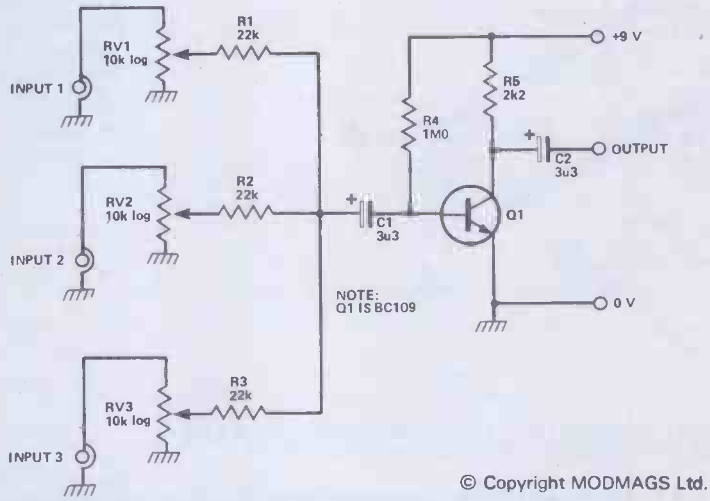


Figure 1. Circuit diagram

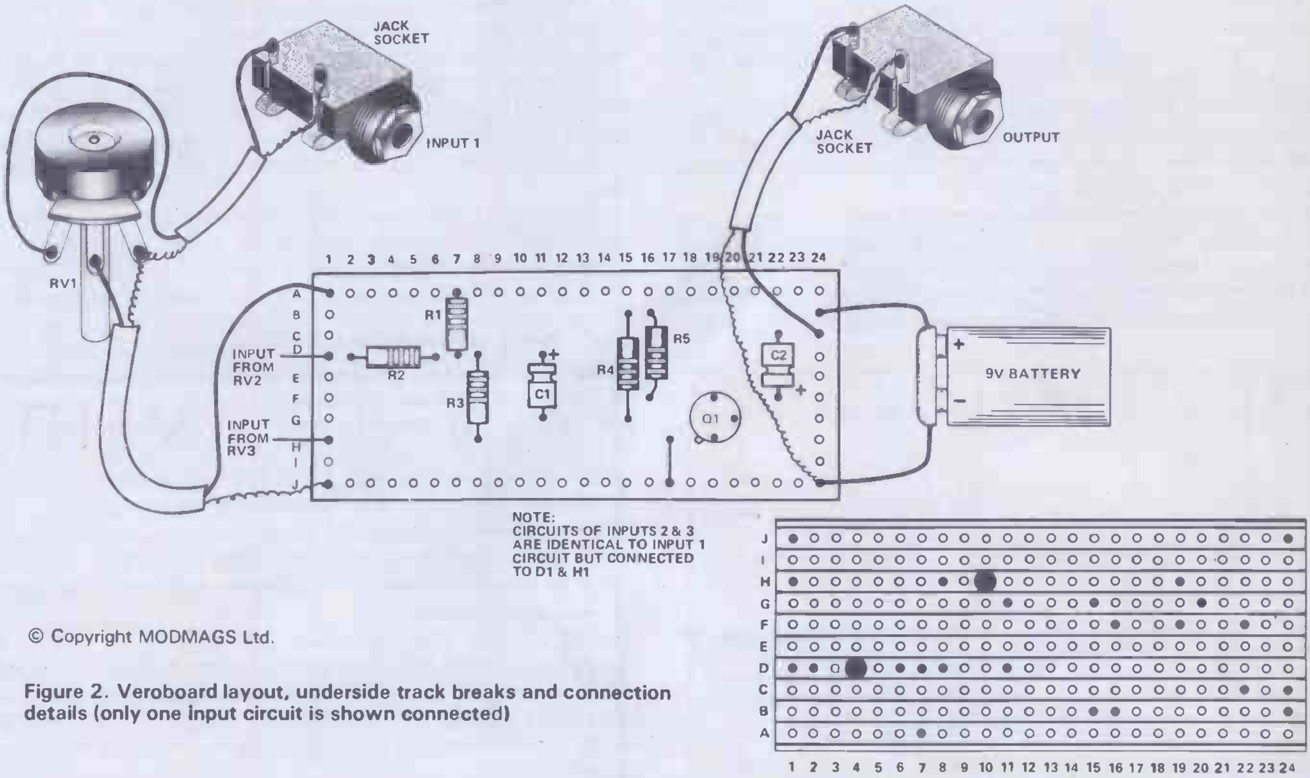


Figure 2. Veroboard layout, underside track breaks and connection details (only one input circuit is shown connected)

Video Disc Update

Hugh Davies describes recent developments in video disc systems

IN THE DECEMBER issue of HE, the article View Into Video Discs (pp 18 to 22) opened with the statement about the video disc systems: '...in 1981 we should start to see them in the UK'. The article went on to describe the activities of the three largest companies — Philips, RCA and JVC — concerned with the development of video disc players (the hardware) and the discs (the software).

At the time of writing (April '81) there are still no discs and players available in the UK. This article gives you a brief update on events.

LaserVision

Philips was originally on target for a May '81 launch of its LaserVision system but has delayed the launch until the autumn. Until December 1980, the system was called VLP — video long play.

According to Philips, a mid-year launch was commercially less attractive because of the unexpected impact of the recession, and it considered that the autumn would be the right time.

Philips said that, although the players and discs were already in production, several problems had been experienced. One of these had been associated with the master tapes submitted by some of the film companies. A spokesman for Philips said: 'We've been very strict about quality'. Although accurately specified, tapes of inferior quality or incorrect cutting lengths had been submitted. It was also said that the quality of LaserVision is such that any defects in the master tapes are immediately apparent — much more so than would be noticed on video cassette systems.

Another problem was that of low initial yield from the factory producing the discs at Blackburn. Philips has used a different production process in the UK than the one used by Magnavox, its subsidiary in the US. The spokesman said that the factory was not up to sufficient yield yet.

Not only does Philips want to have enough discs for the launch but it also wants enough in reserve for back-up orders.

The LaserVision players are being produced in Holland and Belgium.

Selectavision

RCA launched its Selectavision video disc system to the US trade in March this year. A satellite transmission from New York was used to reach 5,000 dealers. RCA claimed that Selectavision was its biggest launch of a product in business history, with $20 million spent on advertising and promotion and with 500,000 disc albums delivered to dealers in 50 American states.

According to Ken McKee, manager of RCA's European Technical Relations, hi-fi dealers handling video cassette recorders were less receptive to Selectavision than were other dealers, and saw it as a threat to their existing market. A VCR system having many technical features can cost between $600 and $700, while the Selectavision player has been selling for between $450 and $500. It appears that customers with money to spend prefer VCR players with all the extra features — including the ability to record. The irony is that although you can't record material onto a video disc, it is likely to produce a higher-quality picture and have a longer life than a video cassette.

RCA's target for a launch in the UK is still vaguely pitched at 1982.

VHD

Compared with the other two companies, JVC has been bold about the launch dates for its VHD (video high density) disc system. These are October '81 for Japan, February '82 for the US and June '82 for the UK. A total of 150 disc titles are planned for each launch.

According to a spokesman for JVC, the VHD system is undergoing some changes to make it comply with the American consumer standards. One change is to make the player less susceptible to interference from radio transmissions in the band 900 to 1200 MHz — a band likely to be allocated to radio hams in the US and CB-ers in the UK.

The spokesman went on to say that there had been less problems with the discs, which were at present undergoing test pressings with Thorn-EMI in the UK.

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ADVERTISEMENT INDEX

Infra-red Remote Controller - 2

The second part of this simple-to-build project, designed by TK Electronics, gives details of the Transmitter

IF YOU REMEMBER, last month we gave details of the Receiver/Controller construction, so this month's episode is taken up with that of the Transmitter. It is a somewhat trickier circuit to build, not because it is any more complex than the Receiver/Controller, but because it *is* a lot more compact. Design of the printed circuit board (PCB) is, in fact, almost a work of art. When building it up take great care not to form solder bridges across copper tracks on the board and not to overheat components. The procedure is as follows.

Construction

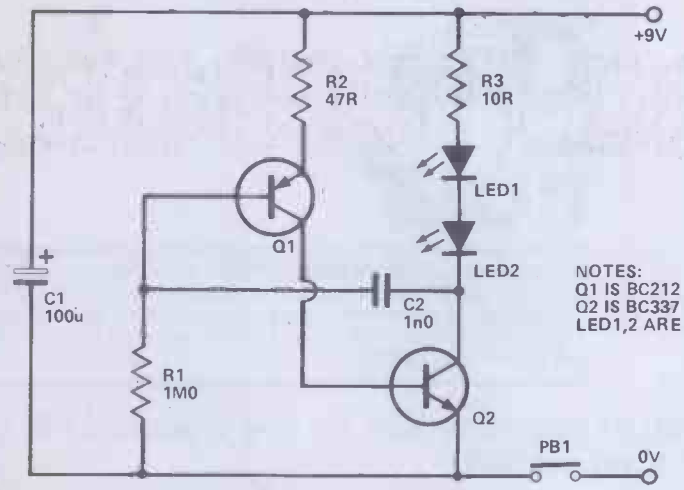
First, insert and solder all components into the PCB, including the push-button PB1, but not the two LEDs or capacitor C1. The overlay in **Fig. 2** shows component locations.

Next, fasten the two LEDs to the case using mounting clips, so that the cathodes of both devices are positioned nearest to the side of the case which the hole for the push-button is closest to. Now, cut the LED leads to a length of 7 mm from the box side.

Position the PCB into the case underneath the LED leads so that PB1 fits into its mounting hole, and solder the LED leads to the pads on the board. *Do not overheat the LEDs* as damage may result and, because they do not emit visible light, it is thus impossible to see if they are not working.

Solder the battery clip to the correct pads on the copper track, ie red to that marked '+' and black to that marked '−', then solder capacitor C1 on to the same pads making sure that you polarise it correctly.

Finally, connect a battery to the clip, insert it in the case and screw on the case back. The Transmitter is now complete, and you can try it out with the Receiver/Controller.



NOTES:
Q1 IS BC212
Q2 IS BC337
LED1,2 ARE LD271

Figure 1. Circuit of the infra-red transmitter

NOTE:
C1 AND BOTH LEDS MOUNT UNDERNEATH THE BOARD AFTER INSTALLATION INTO THE CASE

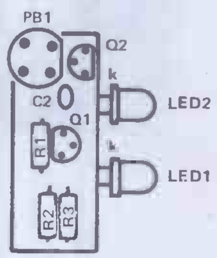


Figure 2. Overlay of the PCB

Parts List

RESISTORS (All ¼W, 5%)		Q2	BC337, NPN transistor
R1	1M0	LED 1,2	LD271, infra-red LED
R2	47R		
R3	10R		
CAPACITORS		**MISCELLANEOUS**	
C1	100u, 10 V electrolytic	PB1	printed circuit mounting push-button switch
C2	1n0 ceramic	PP3-size battery + clip	
SEMICONDUCTOR		Case	
Q1	BC212, PNP transistor	PCB	

Buylines

Kits for the receiver (£4.83 including VAT) and the transmitter (£10.35 including VAT) are available from
TK Electronics (HE)
11 Boston Road
London W7 3SJ.
Please add 50p p&p to the total order.

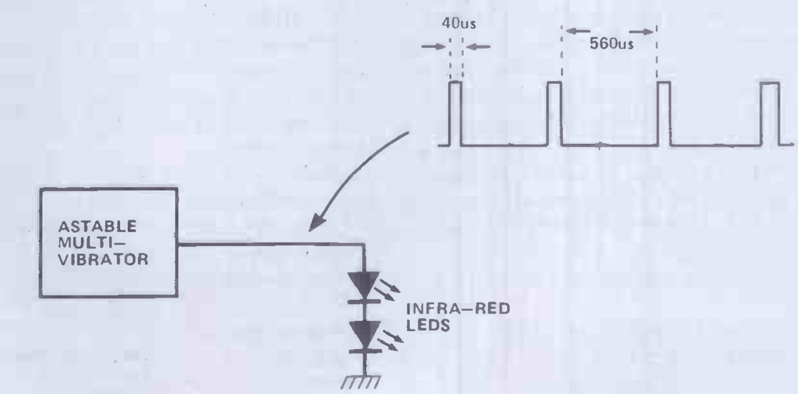
The receiver kit includes the PCB and all parts to make up the board; the transmitter kit includes PCB, all parts and the hand-held case. Also supplied with each kit is an instruction leaflet. When building your two kits, follow *either* the supplied leaflet *or* our instructions, as small discrepancies will occur in component numbering. Both sets of instructions are, however, correct.

Left. View of the project after the PCB and the two LEDs have been soldered.

Below. Capacitor C1 and the battery leads solder to the back of the PCB.

How It Works

The transmitter consists of an astable multivibrator producing a rectangular waveform, at a frequency of approximately 1700 Hz. Two infra-red LEDs are driven by this multivibrator oscillator and thus emit infra-red light, pulsed at the same frequency.



Transistors Q1, Q2 form a standard multivibrator circuit, the frequency of which is determined by the value of components R1, R2 and C2. Power to the circuit is controlled by push-button PB1, thus when the transmitter is not in use no current is drawn from the battery.

Infra-red LEDs 1 and 2 are inserted in the collector circuit of Q2 so that whenever the transistor is on, the LEDs emit infra-red light.

The values of R1, R2 and C2 are such that the two transistors are on, ie they conduct, for about 40 x 10^{-6}s (40 us) and then remain off for 560 us in every cycle. In this way the *average* current drain on the battery is kept to approximately 20 mA, while the LEDs are actually being driven by pulses of over 400 mA. This current is supplied by C1. Because of the short periods for which the transmitter is in operation, long battery life can be expected.

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CB Breaker One Four

Now that the Home Office has published its specifications for the proposed FM CB service, Rick Maybury comments on the implications

AT LAST! The specifications for the new FM CB service have been published, after considerable delay and much speculation. Regular readers to Hobby Electronics and Citizens' Band will find few surprises but before we look at them in detail let's look at some of the background to the campaign so far.

Back in January 1980 the Home Office claimed that there was no possibility of introducing a CB type service in the UK due to lack of frequency space and interference problems. In September the Home Office issued a document entitled 'Open Channel', which set out proposals for a two-way radio service operating on or around 928 MHz. At that time it was claimed that a service operating on 27 MHz was impractical. In February 1981 the Home Office issued a statement saying that it was considering setting up an Open Channel service on or around 27 MHz, but using frequency modulation instead of the American AM (amplitude modulation) system. It also pointed out at that time that there was a potential for a European band that would allow CB equipment from various Common Market countries to operate side by side.

In the last week or so details of the new service have been released to enable manufacturers to prepare for the legalisation in the autumn. Now here's the interesting bit: the service is no longer referred to as Open Channel — in all the documents we've seen so far, it is called Citizens' Band. The frequency allocations for UKCB are outside any other allocation in the world, effectively creating a non-standard system, unusable anywhere other than in this country. The band in question has somehow been found where apparently no space existed a year ago. One could construe this as being slightly perverse, but taken overall and considering the alternatives it could have been a whole lot worse. We came pretty close to getting nothing at all.

Thank you for being so patient: and now, for anyone who's interested, here are the basic specifications.

Summary Of New Specs

Two services are to be introduced, one on 934 MHz and one on 27 MHz. First 934 MHz:

Frequency range:	934.025 to 934.975 MHz
Number of channels :20	Max RF power : 8 watts
Channel spacing: 50 kHz	Max ERP : 25 watts (3 watts limit on hand-held equipment)

Next 27 MHz:

Frequency range:	27.60125 to 27.99125 MHz
Number of channels: 40	Max RF power : 4 watts
Channel spacing: 10 kHz	Max ERP : 2 watts

The above is the bare bones of it. Figures for harmonic emission, maximum frequency deviation etc, are well within normal international standards.

The first thing that most of you will have noticed is the starting point for 27 MHz — yes, it is well above the FCC and FTZ channels. In fact, it's right out on its own up with the unlicensable and largely undocumented band used by foreign embassies to keep in touch with their mother countries.

Reaction From AM CBers

So far the reaction to this announcement has raised the expected protests from the stalwart AM CBers, and the long-time campaigners for any CB system have raised the odd eyebrow. Radio modellers have naturally pointed out that the ideal solution would be for them to take this new band and let the existing illegal CBers keep what they undoubtedly already have.

I will be reporting on the ultimate outcome of this proposal in next month's BOF after the Home Office has held a series of meetings scheduled for the next few weeks. In these meetings it will be seeking the reactions of interested parties, ranging from radio modellers to the manufacturers. Meanwhile, I suspect that the figures that I have quoted will not be changed by any significant degree — not because I suppose that the objections will not be raised but simply because of the incredibly short notice given to the interested parties to respond. The specs were published on April 21 and the first of the three crucial meetings was held on April 24. The second meeting is (at the time of writing) scheduled for April 29 and the third for May 5. See what I mean about perverse?

Three FM transceivers from Binatone (these cannot be licenced for use in the UK)

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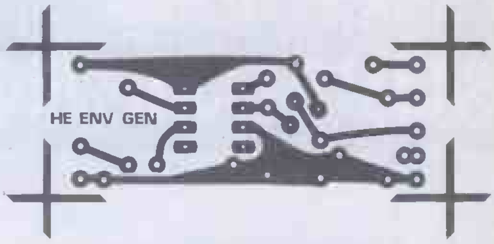
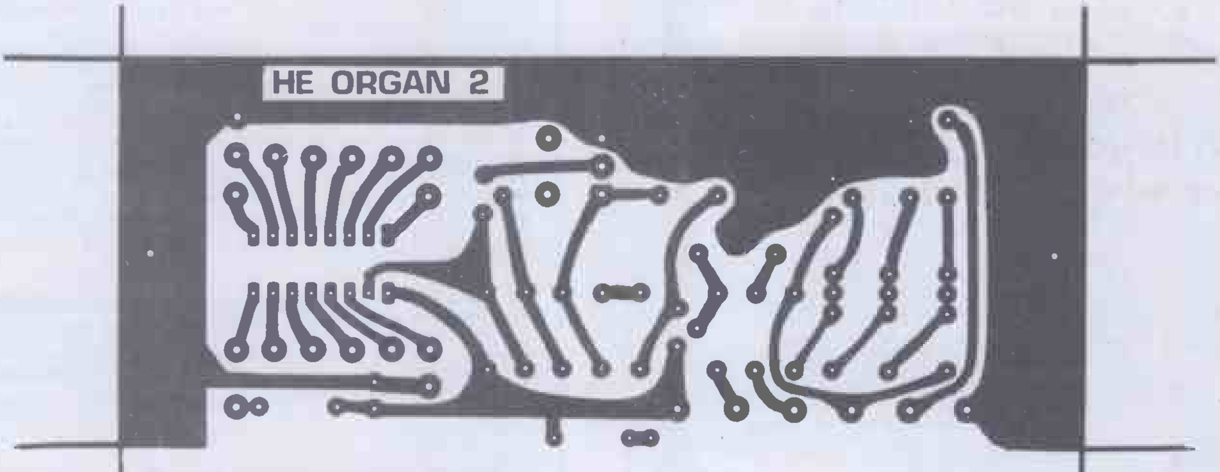
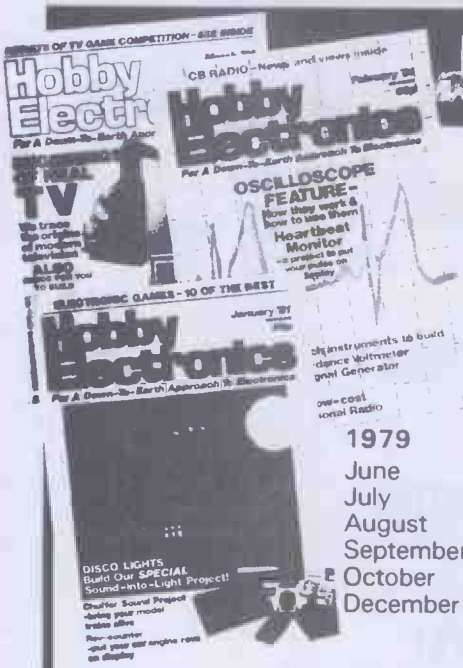


Foil pattern of the Envelope Generator



Electronic Organ foil pattern: Board 2

HE BACKNUMBERS



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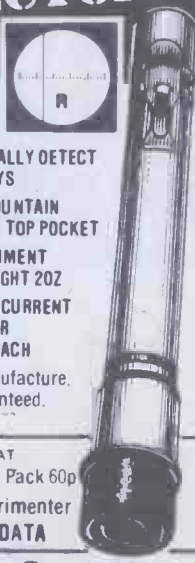

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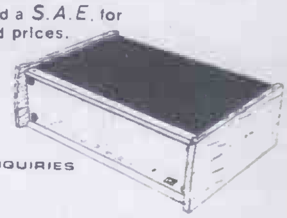

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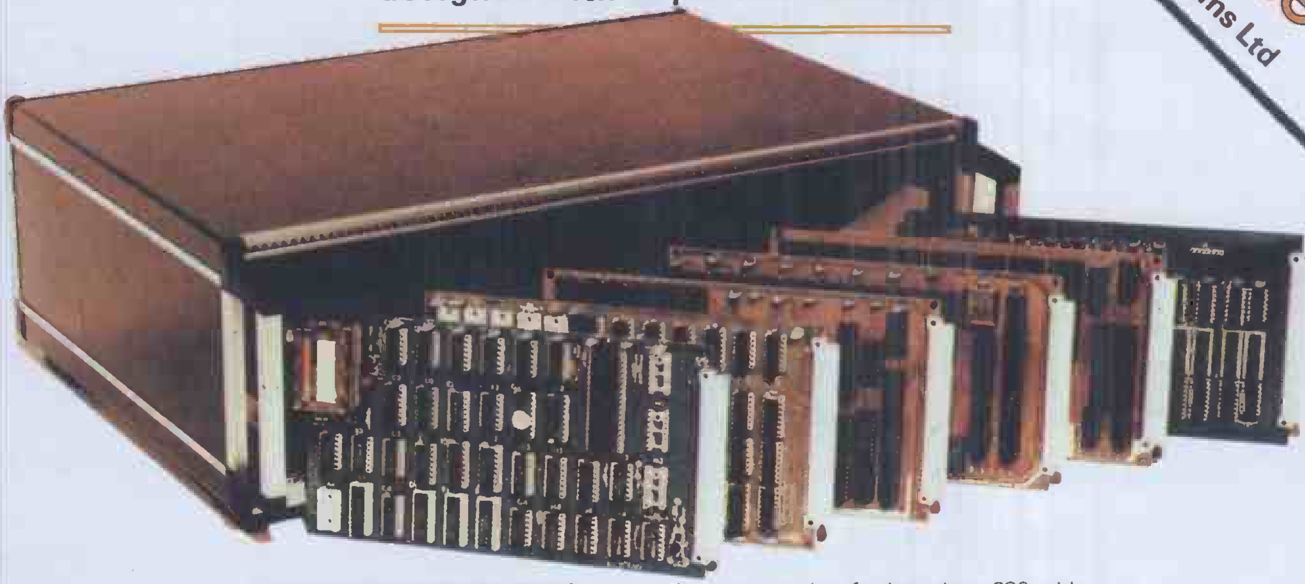
Computer Systems Ltd

microtan

designed with expansion in mind



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a one-board 6502-based microcomputer

But it doesn't stop there - Microtan is a SYSTEM

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XBUG - a firmware package with cassette file handling rountines, a line-by-line assembler/dis-assembler, 10K extended Microsoft BASIC (as used by Apple, Tandy and NASCOM).

TANRAM - up to 40K of extra memory.

The system rack houses up to 12 boards. Extra serial and parallel I/O boards offer up to 128 I/O lines (16 eight bit ports) and eight serial I/O ports.

The full system will include high definition colour graphics, A to D and D to A boards, IEEE 488 interface, PROM programmer, disc controller and TANDOS, a 6502 CPM system.

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