

Hobby

AN ARGUS SPECIALIST PUBLICATION

Electronics

Project Electronics For Everyone

**SPECIAL
SUPPLEMENT**

**TOOLS AND TEST
EQUIPMENT FOR THE
ELECTRONICS ENTHUSIAST**



**Radio
Controlled
Gerbil
Project to
Build**

**Components for Computing
Battery Auto Power Down Circuit
6502 EPROM Programmer Project to Complete**

Play the AMBIT numbers game

The long awaited implementation of on-line order processing is with us at last, and whilst this means that orders for in-stock items can now be processed more efficiently, it also means that orders should be submitted using stock codes for best results. Our current catalogue (75p) includes all order codes (watch out for the new expanded Spring edition), but here's an abstract from some of the more popular lines to use as a quick reference.

Remember that you can also access our catalogue via REWSHOP on REMTEL, which now includes on-line current price and delivery information. You need a 300 baud MODEM and RS232 terminal, (various suitable configurations based on popular micros have been published in recent past issues of Radio and Electronics World).

Prices shown here exclude VAT, and the P&P charge is currently 60p per order (unless otherwise indicated). Remember that our tele-sales service operates with human beings (not 'dumb' machines) from 8am to 7pm (and frequently later) Monday to Friday, and 9am to 6pm on Saturdays. REWSHOP operates 24 hours a day, 365 days a year with full price and delivery information.

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4000 CMOS			Type Stock No. Price			Type Stock No. Price			Type Stock No. Price			Type Stock No. Price			Type Stock No. Price			Type Stock No. Price					
4000	22 04000	0.11	4703	23 04703	4.28	74LS181	31 74181	0.87	74C914	29 74194	1.10	uA758	61 00758	2.75	HA11223	61 11223	2.15	25K134	60 00134	3.10	6V8	12 00688	0.10
4001	23 04001	0.11	4704	23 04704	4.24	74LS183	31 74183	1.85	74C918	29 74198	1.10	TB9AR2UM	61 00820	2.38	HA11225	61 11225	1.45	25K135	60 00135	4.25	6V9	12 00692	0.10
4002	23 04002	0.12	4705	23 04705	4.24	74LS190	31 74190	0.39	74C925	29 74925	6.00	TD01028	61 01028	2.11	HA12002	61 12002	1.22	25K227	60 00227	3.55	9V1	12 00918	0.10
4007	23 04007	0.13	4720	23 04720	4.00	74LS191	31 74191	0.39	74C926	29 74926	6.00	TD01029	61 01029	2.11	HA12017	61 12017	0.80	25D124	60 00124	1.10	11	12 01108	0.10
4008	23 04008	0.50	4724	23 04724	0.95	74LS192	31 74192	0.39	74C927	29 74927	6.00	25A1034	61 01034	2.10	HA12402	61 12402	1.95	BF261	58 00261	0.20	12	12 01208	0.10
4009B	22 04009	0.25	4725	23 04725	2.24	74LS193	31 74193	0.39				TD01054	61 01054	1.45	HA12412	61 12412	1.55	BF262	58 00262	0.20	13	12 01308	0.10
4011	23 04011	0.11	4726	23 04726	2.54	74LS195	31 74195	0.39				TD01062	61 01062	1.95	HA12415	61 12415	1.55	BF263	58 00263	0.20	14	12 01408	0.10
4011UB	23 04011	0.11	4727	23 04727	2.54	74LS196	31 74196	0.39				TD01072	61 01072	2.69	HA12417	61 12417	1.55	BF264	58 00264	0.20	15	12 01508	0.10
4012	23 04012	0.14	4728	23 04728	0.94	74LS197	31 74197	0.47				TD01074	61 01074	5.04	HA12420	61 12420	1.95	BF265	58 00265	0.20	16	12 01608	0.10
4013	23 04013	0.25	4729	23 04729	0.88	74LS221	31 74221	0.50				TD01083	61 01083	1.95	HA12421	61 12421	1.95	BF266	58 00266	0.20	17	12 01708	0.10
4015	23 04015	0.50	4730	23 04730	0.85	74LS243	31 74243	0.50				TD01090	61 01090	3.00	HA12422	61 12422	1.95	BF267	58 00267	0.20	18	12 01808	0.10
4016	23 04016	0.22	4731	23 04731	0.85	74LS244	31 74244	0.55				TD01098	61 01098	1.95	HA12423	61 12423	1.95	BF268	58 00268	0.20	19	12 01908	0.10
4017	23 04017	0.40	4732	23 04732	0.85	74LS245	31 74245	0.55				TD01102	61 01102	1.95	HA12424	61 12424	1.95	BF269	58 00269	0.20	20	12 02008	0.10
4020	23 04020	0.55	4733	23 04733	0.85	74LS246	31 74246	0.55				TD01104	61 01104	1.95	HA12425	61 12425	1.95	BF270	58 00270	0.20	21	12 02108	0.10
4021	23 04021	0.55	4734	23 04734	0.85	74LS247	31 74247	0.55				TD01106	61 01106	1.95	HA12426	61 12426	1.95	BF271	58 00271	0.20	22	12 02208	0.10
4022	23 04022	0.55	4735	23 04735	0.85	74LS248	31 74248	0.55				TD01107	61 01107	1.95	HA12427	61 12427	1.95	BF272	58 00272	0.20	23	12 02308	0.10
4023	23 04023	0.55	4736	23 04736	0.85	74LS249	31 74249	0.55				TD01108	61 01108	1.95	HA12428	61 12428	1.95	BF273	58 00273	0.20	24	12 02408	0.10
4024	23 04024	0.55	4737	23 04737	0.85	74LS250	31 74250	0.55				TD01109	61 01109	1.95	HA12429	61 12429	1.95	BF274	58 00274	0.20	25	12 02508	0.10
4025	23 04025	0.15	4738	23 04738	0.85	74LS251	31 74251	0.55				TD01110	61 01110	1.95	HA12430	61 12430	1.95	BF275	58 00275	0.20	26	12 02608	0.10
4027	23 04027	0.26	4739	23 04739	0.85	74LS252	31 74252	0.55				TD01111	61 01111	1.95	HA12431	61 12431	1.95	BF276	58 00276	0.20	27	12 02708	0.10
4028	23 04028	0.55	4740	23 04740	0.85	74LS253	31 74253	0.55				TD01112	61 01112	1.95	HA12432	61 12432	1.95	BF277	58 00277	0.20	28	12 02808	0.10
4029	23 04029	0.55	4741	23 04741	0.85	74LS254	31 74254	0.55				TD01113	61 01113	1.95	HA12433	61 12433	1.95	BF278	58 00278	0.20	29	12 02908	0.10
4035	23 04035	0.57	4742	23 04742	0.85	74LS255	31 74255	0.55				TD01114	61 01114	1.95	HA12434	61 12434	1.95	BF279	58 00279	0.20	30	12 03008	0.10
4040	23 04040	0.68	4743	23 04743	0.85	74LS256	31 74256	0.55				TD01115	61 01115	1.95	HA12435	61 12435	1.95	BF280	58 00280	0.20	31	12 03108	0.10
4042	23 04042	0.55	4744	23 04744	0.85	74LS257	31 74257	0.55				TD01116	61 01116	1.95	HA12436	61 12436	1.95	BF281	58 00281	0.20	32	12 03208	0.10
4043	23 04043	0.80	4745	23 04745	0.85	74LS258	31 74258	0.55				TD01117	61 01117	1.95	HA12437	61 12437	1.95	BF282	58 00282	0.20	33	12 03308	0.10
4044	23 04044	0.68	4746	23 04746	0.85	74LS259	31 74259	0.55				TD01118	61 01118	1.95	HA12438	61 12438	1.95	BF283	58 00283	0.20	34	12 03408	0.10
4046	23 04046	0.68	4747	23 04747	0.85	74LS260	31 74260	0.55				TD01119	61 01119	1.95	HA12439	61 12439	1.95	BF284	58 00284	0.20	35	12 03508	0.10
4048UB	22 04048	0.24	4748	23 04748	0.85	74LS261	31 74261	0.55				TD01120	61 01120	1.95	HA12440	61 12440	1.95	BF285	58 00285	0.20	36	12 03608	0.10
4050	23 04050	0.24	4749	23 04749	0.85	74LS262	31 74262	0.55				TD01121	61 01121	1.95	HA12441	61 12441	1.95	BF286	58 00286	0.20	37	12 03708	0.10
4051	23 04051	0.24	4750	23 04750	0.85	74LS263	31 74263	0.55				TD01122	61 01122	1.95	HA12442	61 12442	1.95	BF287	58 00287	0.20	38	12 03808	0.10
4052	23 04052	0.55	4751	23 04751	0.85	74LS264	31 74264	0.55				TD01123	61 01123	1.95	HA12443	61 12443	1.95	BF288	58 00288	0.20	39	12 03908	0.10
4053	23 04053	0.55	4752	23 04752	0.85	74LS265	31 74265	0.55				TD01124	61 01124	1.95	HA12444	61 12444	1.95	BF289	58 00289	0.20	40	12 04008	0.10
4054	23 04054	0.55	4753	23 04753	0.85	74LS266	31 74266	0.55				TD01125	61 01125	1.95	HA12445	61 12445	1.95	BF290	58 00290	0.20	41	12 04108	0.10
4055	23 04055	0.55	4754	23 04754	0.85	74LS267	31 74267	0.55				TD01126	61 01126	1.95	HA12446	61 12446	1.95	BF291	58 00291	0.20	42	12 04208	0.10
4056	23 04056	0.75	4755	23 04755	0.85	74LS268	31 74268	0.55				TD01127	61 01127	1.95	HA12447	61 12447	1.95	BF292	58 00292	0.20	43	12 04308	0.10
4058	23 04058	0.75	4756	23 04756	0.85	74LS269	31 74269	0.55				TD01128	61 01128	1.95	HA12448	61 12448	1.95	BF293	58 00293	0.20	44	12 04408	0.10
4068	23 04068	0.18	4757	23 04757	0.85	74LS270	31 74270	0.55				TD01129	61 01129	1.95	HA12449	61 12449	1.95	BF294	58 00294	0.20	45	12 04508	0.10
4069	23 04069	0.18	4758	23 04758	0.85	74LS271	31 74271	0.55				TD01130	61 01130	1.95	HA12450	61 12450	1.95	BF295	58 00295	0.20	46	12 04608	0.10
4069UB	22 04069	0.14	4759	23 04759	0.85	74LS272	31 74272	0.55				TD01131	61 01131	1.95	HA12451	61 12451	1.95	BF296	58 00296	0.20	47	12 04708	0.10
4070	23 04070	0.16	4760	23 04760	0.85	74LS273	31 74273	0.55				TD01132	61 01132	1.95	HA12452	61 12452	1.95	BF297	58 00297	0.20	48	12 04808	0.10
4071	23 04071	0.16	4761	23 04761	0.85	74LS274	31 74274	0.55				TD01133	61 01133	1.95	HA12453	61 12453	1.95	BF298	58 00298	0.20	49	12 04908	0.10
4072	23 04072	0.16	4762	23 04762	0.85	74LS275	31 74275	0.55				TD01134	61 01134	1.95	HA12454	61 12454	1.95	BF299	58 00299	0.20	50	12 05008	0.10
4073	23 04073	0.16	4763	23 04763	0.85	74LS276	31 74276	0.55				TD01135	61 01135	1.95	HA12455	61 12455	1.95	BF300	58 00300	0.20	51	12 05108	0.10
4075	23 04075	0.16	4764	23 04764	0.85	74LS277	31 74277	0.55				TD01136	61 01136	1.95	HA12456	61 12456	1.95	BF301	58 00301	0.20	52	12 05208	0.10
4076	23 04076	0.55	4765	23 04765	0.85	74LS278	31 74278	0.55				TD01137	61 01137	1.95	HA12457	61 12457	1.95	BF302	58 00302	0.20	53	12 05308	0.10
4077	23 04077	0.18	4766	23 04766	0.85	74LS279	31 74279	0.55				TD01138	61 01138	1.95	HA12458	61 12458	1.95	BF303	58 00303	0.20	54	12 05408	0.10

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Owing to space restrictions in this issue, Famous Names and The Electronic Revolution have been held over till the May issue.



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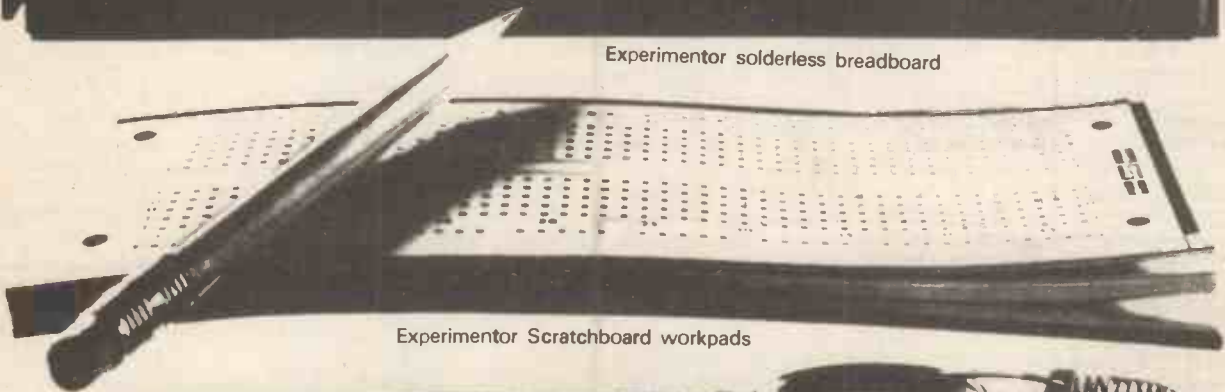
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Experimentor Scratchboard workpads



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There's even a letter-and-number index for each hole, so you can move from breadboard (where they're moulded) to Scratchboard™ (where they're printed) to Matchboard™ (where they're silkscreened onto the component side) and always know where you are.

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MONITOR

Read This NOW!

Williams and Glynn's Bank and the Department of Industry are jointly launching a national competition — called **Microquest** — for 16 — 19-year-olds who are either working in industry or are on a Government sponsored training scheme. The competition is to identify a way in which microelectronics could be used to improve efficiency in their firm and to describe it in less than 100 words.

'Microelectronics' means the whole range of microelectronic technology, not just the use of microcomputers, and the competition is looking for any ideas using existing machinery, existing microchips, self-designed machinery (or ideas for such) or self-designed chips which will improve any kind of efficiency in any part of the working environment. The 100-word outline is only an initial proposal for ideas, but obviously the more precise you can be about what you intend to use, where it can be obtained and how it is going to work, the better chance your idea has of being judged workable and going on to the next stage.

The best ideas will be selected and those contestants will then be invited to submit a detailed 2500 word project, with drawings, explaining their idea and its applications in detail. One winner from each of the Department of Industry's ten regions will receive a £250.00 prize and their entries will be put forward for the final. The overall winner will get a prize of £1,000.00, second £500.00 and third £250.00.

Initial proposals must be in by **31 March 1983**, which is very tight for Hobby readers but if you think there is no time, do not despair, send your entry anyway. If the assessors have time they may be able to consider late entries. But be as quick as you can. Further details and application forms can be had from any branch of Williams and Glynn's bank (you don't have to be a customer) or from Microquest, MAP Information Centre, Freepost, Dept. of Industry, Room 514, 29 Bressenden Place, London SW1E 5BR.

Change Of Address

Crimson Elektrik, one of the many stars of the Hobby Electronics Kits and Modules Survey, HE February '83, are operating that side of their business from a new address from mid-January. The address is: **Crimson Elektrik, 500 King St., Longton, Stoke-on-Trent ST3 1EZ. Tel: (0782) 330520.**

Crimson's 600 Series hifi amps will continue to be handled from their Leicester address.

Pro Show

This year's **All-Electronics/Electronics Components Industry Federation Show** is at the Barbican Exhibition Centre, City of London from 19 to 21 April. This is a trade show, so only go along if you want to do an in-depth survey of who is supply-

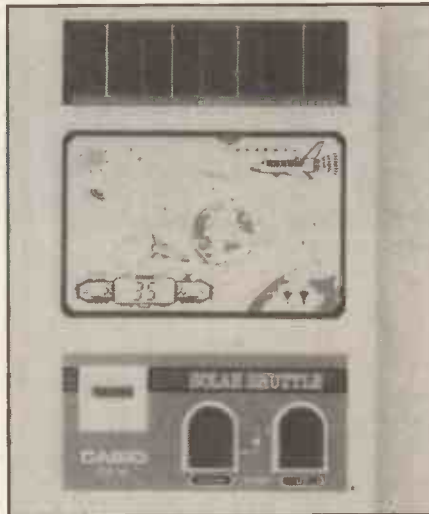
ing what component in bulk. No-one under 16, and a pound on the door. An equivalent show, the **Leeds Electronics Show**, is being held in Leeds. Information from Ms. (sic) Sam Clarke on (0799) 22612.

Shuttle Game

For a change, here's a Casio electronic game without an attached calculator. The CG10 is a 'big screen' solar shuttle game, and is appropriately solar powered — no batteries to wear out (but no news on what happens on a dull day — or after dark!).

The object is to achieve shuttle lift off from earth, enter lunar orbit and then escape orbit to dock at a space station. Acceleration and deceleration consume power, and although close approach to the sun during orbit attracts added solar energy, it is still possible to fail from lack of fuel, or from running over a time limit. Just to complicate matters, as you get more practised, higher game levels introduce the prospect of collision with UFOs.

The CG10 automatically keeps score and awards bonus points. RRP is £14.95. More information from **Casio Electronics Co. Ltd., Unit 6, 1000 North Circular Rd., London NW2 7JD. Tel: 01 450 9131.**



Components In Bulk

'More knobs than you've had hot dinners?' asks **Ambit International**, and judging by the bunch of components they've sent us, they diet mostly on bananas. Among the samples are two low-cost acoustic resonators (piezo-acoustic transducers), the PKM29-3A0 and PKB8-4A0. The former is designed to be excited externally, delivering 85dB at three metres at a frequency of 3.4KHz and costing £1.04 in one-off lots; the latter is self-excited, delivering more than 75dB at one metre at a frequency of 2.7kHz, and costs £1.43 one-off. **Ambit** also boasts a selection of over five million different styles of knobs priced from 6p to 60p and claim to have the widest choice available anywhere, including the Ritel range.

ALPS laser trimmed pots, with the 6mm round types being standard from stock; 1MHz MF ceramic resonators of a new design allowing reliable resonators in this frequency range; low-profile adjustable VHF coils, and screened coils; miniature high-value inductors and miniature keypads are among other components mentioned by **Ambit**.

Ambit intend to market many products that have not been available in the UK till now, so although they are geared primarily to the industrial market (most of their prices are given in 100-off lots) they're obviously a name to keep in mind for anyone who has an application or a design which needs some unusual component.

Enquiries to **Ambit International, 200 North Service Rd., Brentwood, Essex CM14 4SG. Tel: (0277) 232638.**

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Hobby Electronics' Monitor pages are our new products, new ideas, and forthcoming events column. The electronics fan has to know you're there before he can take advantage of your services. So please let us know, just as early as you can, when something new is coming up that you want our readers to know about.

Remember that the Hobby readership is diverse. People of all ages and walks of life, from Primary students to Professors, take advantage of our

emphasis on self-education in every field of electronics. They want to find out what it's all about. Help **MONITOR** keep them in the picture.

Note: Hobby Electronics is produced up to eight weeks before it hits the newstands, so news never comes too soon.

Send press releases and news items to **MONITOR, Hobby Electronics, Argus Specialist Publications, 145 Charing Cross Road, London WC2H 0EE.**

MONITOR

Alpha Beta

Betamax freaks will be glad to know that Beta originals Sony have produced a new video recorder, the C9. This is designed to take over from their top-of-the-range machine, the C7, which was the state-of-the-art home video recorder for a number of years.

Like Sony's current cheaper Beta, the C6, but unlike the C7, the C9 follows the current trend in being front-loading, which makes it a lot easier to store, and fits normal hifi racking systems. The C9's main attraction is its stereo sound capability.

Quite a few major movies have already been released in stereo in the Betamax format, and others will be appearing all the time. One of these is *The Complete Beatles*, a musical anthology spanning the group's entire history — obviously of special interest, being as it is a musical subject.

Among other features, the C9 boasts Beta Noise Reduction, a noise-reduction system similar to Dolby, which will reduce audio noise to a signal-to-noise ratio of better than 43dB; mono or stereo compatibility; noise-free pictures in slow motion, frame-by-frame and still modes, backwards or forwards; a signal booster for poor reception areas; automatic tuning; nine-event, two-week timer, auto programme search, a full-feature infra-red remote control and camera socket.

For more information contact your local video dealer, or the Product Manager, Sony Home Video on Staines 61600.

Keep It Clean

BIB have released a series of maintenance products for use with microcomputers at home and in the office. The first six products to hit the market are a Terminal Maintenance Kit (including, among other things, Screen-Kleen fluid for cleaning screens, Print Cleaning Fluid for ribbon guides, etc., cloth and brushes); 8" Diskette Cleaners for the wet and dry cleaning of drive heads; Anti-Static VDU Cleaner; Computer Tape Transport Maintenance Kit and Cassette Head Cleaner. More products are on the way.

BIB rightly point out that preventative maintenance is the best way to avoid breakdowns, but consult the manufacturer of your micro before you lay into it with too much gusto: over-use of cleaners could also cause problems.

For more details contact BIB Computer Care Division, Kelsey House, Wood End Lane, Hemel Hempstead, Herts HP2 4RQ. Tel: (0442) 61291.

Sapona Chemical Systems are bringing out four aerosol products for maintaining computers, videos and audio cassette recorders.

The new cleaners are a Tape Drive Cleaner, which is non-flammable, non-residual and quick-drying and will not affect rubber, paint or plastics, and is therefore safe and effective for delicate computer and magnetic recording equipment; a Pressurised Air Duster with a fine extension nozzle to blow dust away from



delicate components and inaccessible areas; VDU Cleaner Polish in the form of a dry foam that will not run into machinery, and which removes fine scratches as well as dirt and stains (Sapona remind us that a clean screen reduces eye-strain) and Anti-Static Spray to disperse static electricity which could interfere with the accurate functioning of the computer.

Sapona also do Disc Cleaning Fluid and a Print Wheel and Thimble Cleaning Kit. For further information contact Jim Palmer, Sapona Chemicals, 46-50 Upper Dean St., Birmingham B5 4SG. Tel: 021 6226442.

Look In The Book

Elkan Electronics publish a range of books for small computers, including the Tandy TRS-80 and Dragon 32 colour computers.

Some Elkan books were originally written for the Tandy only, and need minor amendments for use with the Dragon. People who already have the Tandy books and want to receive the amendments for use with the Dragon 32 can send a stamped self-addressed envelope to Elkan, and will be sent them free of charge.

There are new books and other documentation out for those two micros, and also for the Sharp PC-1211 and PC1500. SAEs and enquires to: Elkan Electronics, Freepost, 28 Bury New Rd., Prestich, Manchester M25 6LZ. Tel: 061 798 7613 (24 hours).

Sweep Statement

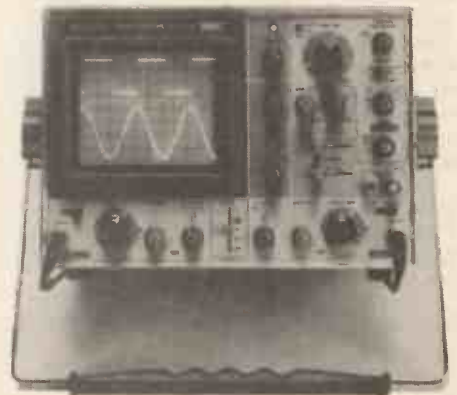
Two oscilloscopes from Hitachi Denshi are being supplied by Reltech Instruments. The V-203F is a 20MHz dual trace model with a 1mV/div vertical sensitivity, add and subtract modes, active sync separation for video and a rectangular CRT with internal graticule and variable illumination. The V-353F has a 35MHz bandwidth, a higher tube EHT, a signal delay line, and a maximum sweep speed of 20ns/div.

Both models have a variable sweep

delay system which allows any section of a waveform to be expanded for detailed examination. The delay time is variable between 1us and 100ms via a five way switch and coarse and fine controls.

A trace identity mode brightens up the portion of the waveform following the delay, providing a rapid method of finding the desired point on the waveform for expansion. Delay time jitter is better than one part in 5,000.

Both models are warranted for two years, and cost £304.00 and £480.00 (ex VAT) respectively. For more information contact Reltech Instruments, Coach Mews, St. Ives, Huntingdon, Cambs PE17 4BN. Tel: (0480) 63570.



Wrap Around Sound

Minim Audio have made an ambisonic decoder module available for hifi freaks to fit to their own systems.

Ambisonic, or 'surround sound', technology is designed to reproduce the sound-field of the original recording location, or at least give a convincing representation of it. The relative distance of a sound source from the recording microphone, and (with four speakers) its direction are captured on the recording, so that on playback the recording seems to be 'happening in the room'. The effect is very different from stereo, or for that matter quadrophonic, sound.

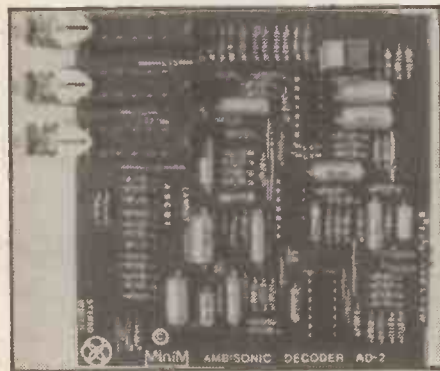
To get a complete surround sound effect, the sound has to be recorded, and

MONITOR

encoded onto the record, with this in mind, and then played back through an ambisonic decoder with four speakers. But Minim claim that their decoders have a dramatic enhancing effect on ordinary stereo recordings, played back through four speakers; the decoder module includes a layout control to account for different speaker layouts, and a bypass switch to enable the user to switch back to conventional two speaker stereo.

The module measures 100 x 100mm (4 x 4in) plus switches, and Minim stress that it is designed to close tolerances and is rigorously tested, so that it is compatible in quality with high quality hifi systems.

The module is called the AD2 and costs £49.45, inc. VAT. Further enquiries to Minim Audio Ltd., Lent Rise Rd., Burnham, Slough SL1 7NY. Tel: (06286) 63724.



Joysticks

Midwich Computer Co. are now producing high quality analogue joysticks for the BBC Micro, Dragon 32 and the Sinclair Spectrum and ZX81. The joysticks are designed to be hand held and are made of injection-moulded plastic. There is a push-button switch on the handle which can be used, for instance, as a fire button, and the works have a life expectancy of over 200,000 operations. Each joystick, or pair, is fitted with the appropriate connectors, DIN plugs for the Dragon and Sinclair and a 15-way D plug for the BBC Micro.

For the Spectrum machines, which do not have an A/D converter, a low cost,

high speed four channel joystick controller board is available. This plugs into the expansion slot of the computers, and an edge connector is provided for RAM pack, disc drives, etc.

Prices per pair of controllers, inc. VAT, are: Dragon 32: £15.98; BBC Micro: £13.00; ZX81/Spectrum: £15.98; controller board for ZX81/Spectrum: £22.95. Orders and enquiries to the Midwich Computer Co. Ltd., Rickingham House, Hinderclay Rd., Rickingham, Suffolk IP22 1HH. Tel: (0379) 898751.

Look out for a review of the Midwich joysticks in HE.

Allophone Call

A year or two ago, it seemed that speech synthesis for any but the most advanced computers was still very much a 'thing of the future'. But they were sneaking up on us faster than most people realised, and now talking toys and impertinent word-processors are virtually taken for granted.

Two new speech synthesiser units for VIC computers have appeared from Currah Computer Components. The 'Chatterbox' is designed to plug into the expansion port of the VIC 20. Currah boasts that the unit is possible for a complete beginner to use successfully, and that the method for synthesising words is simple to manipulate. The words themselves are constructed from a master list of allophones (distinct sounds which appear in the English language), so that the vocabulary is unlimited, in English at any rate.

A second module, known as the 'Mynah Module', has the same specifications as the Chatterbox, minus the integral software enhancement, which only means in effect that the user has to refer to his master list to select the allophones to be used in the programme. And it's cheaper. Current prices for the units are Chatterbox: £57.45 and Mynah Module: £49.95 (inc. VAT). For further information contact Hales Ltd., PO Box 33, Harrowbrook Rd., Hinckley, Leics. Tel: (0455) 634746.

We hope to do a review of the Chatterbox sometime in the future, so look out for that.



BATTERIES rechargeable 1.2V By GE: 74p 'AA' HP7 5AH £1.87 'C' U11 1.8AH £1.87 'D' U2 1.2AH £1.87 'D' U2 4AH £2.52 PP3 (9V) .075 AH £3.39 Alkal Universal Charger for above £5.50 CAT £2 SNAPS PPS 3p	NICAD	BRIDGES W005/W02 18p PLUGS P. SKTS S. 9p Banana Red/Black 17p DIN 3 or 5 pin P. S. 5p Earphone S. 17p Speaker P.S. 17p Atrial Speaker P.S. 17p ZENERS BZ268 3v to 18v 5p BZX61/65 1W 3v3 to 33v 7p
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1	.0022/400v 10
2.2	.0033/400v 10
3.3	.0047/400v 10
4.7	.01/630v 10
6.8	.015/630v 10
10p	.022/250v 10
10	.033/250v 10
22	.047/250v 10
47	.068/100v 10
150	.1/250v 10
220	100/16v 10
330	100/63v 10
16v at	220/16v 10
18p	330/63v 10
100	470/16v 10
2200	470/63v 10
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POLYESTER AXIAL 10% 10% .01 250v .33 100v .022 250v .47 250v .047 250v .58 400v .1 160v 1.0 250v .22 400v 1.5 100v	CERAMIC 5mm 10% 100v 10PF 4K7PF 56 ONLY 5p
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Val	BA157/8/9 5p	.125" TIL 208
.2	BY128/7 7p	Green 12p
.1	OA47/90/91 5p	Red 7p
.1	IN14/6 2p	Yellow 13p
2.2	IN4001/2/4 3p	CLIPS 3p
4.7	IN4005/7 6p	2" TIL220
10	IN4148 2p	Green 12p
22	IN5401/2 11p	Red 9p
47	IN5408 13p	Yellow 13p
100	14A 200v stud 18p	CLIPS 6p

FUSEHOLDER PCB MT4 11" 9p 20mm 7 H/SINK TO3 25p
ICs 74 LS 164 39p CMOS 17 48p 35 42p TTL
12p 90 21p 170 33p 40 N 18 42p 40 40p 74 N
00 93 21p 191 33p 01 10p 19 28p 42 36p 00 to
60 109 21p 193 33p 02 11p 20 42p 44 36p 40 15p
15 122 33p 221 43p 06 42p 21 36p 42 36p 22 25p
20 123 33p 244 53p 07 14p 22 42p 50 20p 47 36p
27 138 33p 251 33p 08 28p 23 11p 66 20p 51 15p
30 139 33p 258 53p 10 11p 24 28p 70 35p
32 153 33p 279 33p 11 10p 25 11p 71 11p 86 15p
33 157 26p 345 53p 12 15p 27 20p 76 42p 132 25p
54 158 33p 307 36p 13 20p 28 28p 81 11p 193 40p
74 160 33p 308 33p 14 42p 29 28p 82 18p 194 40p
85 161 33p 374 58p 18 42p 30 11p 93 13p 197 40p
86 163 33p 16 20p 34 30p 99 42p

ICs DIL PINNING (-) LM ANO CA	810 (12) TBA
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308 (8) 42p 556 (14) 42p	1310 (14) MC 49p
311 (8) 41p 565 (14) 95p	1458 (8) 27p
324 (14) 56p 567 (8) 59p	3046 (16) 33p
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BC184L 6p	MJE340 30p	2N3055 39p
BC212/3* 6p	MPSA05/6 14p	2N3440/2 69p
BC212L 6p	MPSA12/14 12p	2N3702/3/4 7p
BC213L 6p	MPSA42/3 21p	2N3705/5/10 9p
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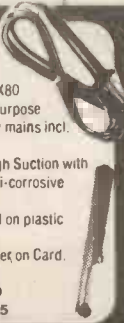
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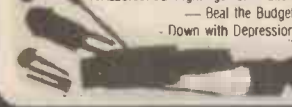
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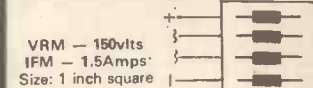
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Jumping Gerbils!

Dave Fountain

THE MODERN DAY CHILD — or, to use the technical term, 'spoiled brat' — has been raised on computer-analysed milk and scented toilet paper for so long that it much prefers the latest video game or drum synthesiser to the innocent pleasure we once had tending to the every need of small, boring bundles of fur. Give a brat a puppy these days and the first thing it does is look for the battery compartment!

It is sad that this age-old relationship with animals is being lost, so to compromise I have designed a project to bridge the gap between that old-time country feeling and today's marching electro-technology. This way they get the best of both worlds; and it's cheaper than paying for all that pre-packed food and useless plastic toys.

The control circuitry of the Gerbil (Figure 1) is straightforward enough and should not prove difficult to even the absolute beginner. It is based around the Honda SX41387/A/V/110 chip, a ROM, left-handed, index-linked bucket cascade device with fully programmable flip-flops (or plimsolls), an in-built sequential timer, and its own personalised number plates. This operates not only as a dumping point, a grid, and a basic building block in any system, but is also large enough to mix cement on and proved invaluable when they built my extension. But that's nothing to do with you.

As you can see in the graph (Figure 8), if you can find Figure 8 that is, the overall analogue curves of the circuit provide infinite design. They are actually based on the frequency pattern of Barry Manilow's voice — whoops, bang goes my credibility — and the latest Vidal Sassoon hairstyles. The figures along the axis of the graph are in ancient Egyptian script, so you probably won't understand them. You probably won't understand the rest of the design either.

Still, don't worry about it, we can't all be brilliant, can we?

The prototype was made on a cream cracker (well the wife was using the breadboard at the time) and flying leads

were connected via very long Veropins so the unit can double up as a brush for the dog. There is a printed circuit layout available but it's so messy I wouldn't bother if I were you. Component positions are not critical, though it does improve the look of the finished unit if you don't have resistors and stuff poking out of the back.

The power supply unit I used came out of an old electricity generating station and was rated at a hundred megawatts. This was buried in thirty feet of concrete, lined in lead and fed via bus bars from the National Grid. If you employ a similar PSU remember to tap it down to one and a half volts before you pour in the last of the concrete.

Alternatively, a digital watch battery will suffice. I did not have one handy at the time.

Constructing the Bodywork

It is *essential* that the electronics are screened from stray FM interference and boring political interviews on television at all times. A trailing earth is therefore recommended, and fortunately the gerbil has a fairly long tail to facilitate this. A hundred and twenty five turns of soft grade wire wound on a reasonably flexible former — I found predigested chewing gum most useful for this — creates a realistic tail and acts as an excellent aerial for Radio Three. By adding a few extra components and an amplifier, the unit becomes a tuned receiver, though the effect on people with weak hearts of an approaching gerbil blaring out Mahler can be a trifle unsettling. Before adding this refinement to your unit, our advice is to check out the insurance policies you may have on any cardiac patients in your household.

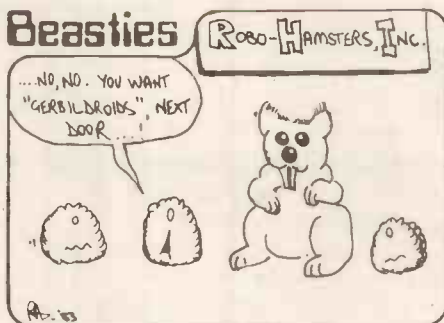
The constructional details for the bodywork are shown in Figure 115a (see overleaf). We used 12mm sheet aluminium for the shell, finished off with Artificial Gerbil Fur (AGF) which is obtainable from any quality taxidermist or Chinese take-away; old cat whiskers, obtainable from any old cat; and a cute, twitching pink nose. I could tell you where to obtain the last item, but they'd only censor it. (You're right! — Ed).

With a pair of finely-honed tin snips, cut the aluminium sheet along the lines marked A, B, and F on the template. Fold lip F over ferrule G and hammer home. Then call the hospital; you've just severed your left forefinger.

Still, we all have to learn the hard way.

Next, apply flange Q to stanchion J and seal. Now for best results this should be a braised joint. If you cannot run to the expense of your own home braising rig, follow this procedure:

- A) Fold Q over J as previously described (35 pages ago).
- B) Drill metal plate Q to line up with previously drilled holes in plate J.
- C) Tap holes in sheet J to accept suitable screws.
- D) Swear a great deal at the top of your voice because the holes do not line up.



Do you have trouble making your kids look after their pets? Do you find the rabbits kicking over the dustbins at night; the hamsters gnawing their way out of the cages and raiding the fridge; and the rattlesnake refusing point blank to take its syrup of figs? Well, don't keep going to the doctor for tranquilisers. The answer lies right here!

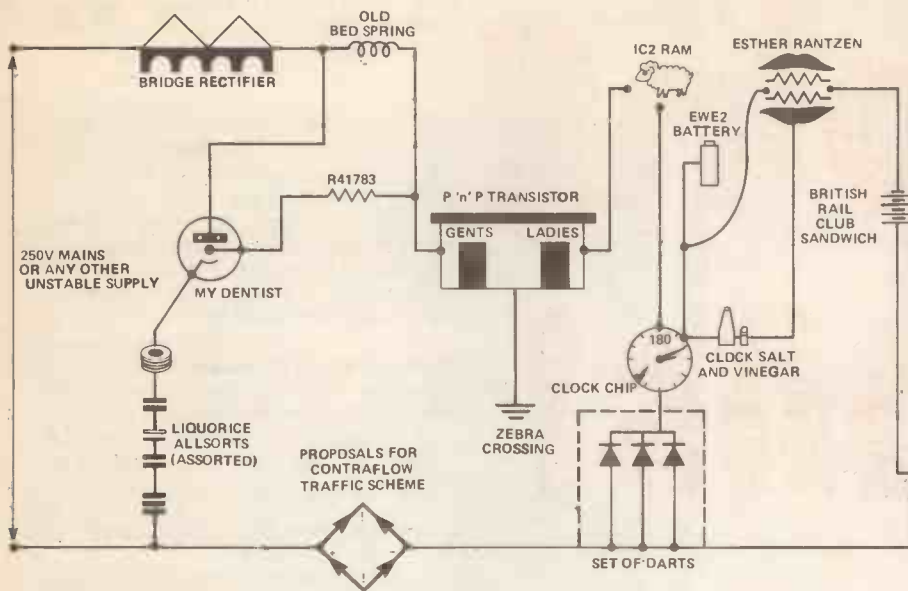
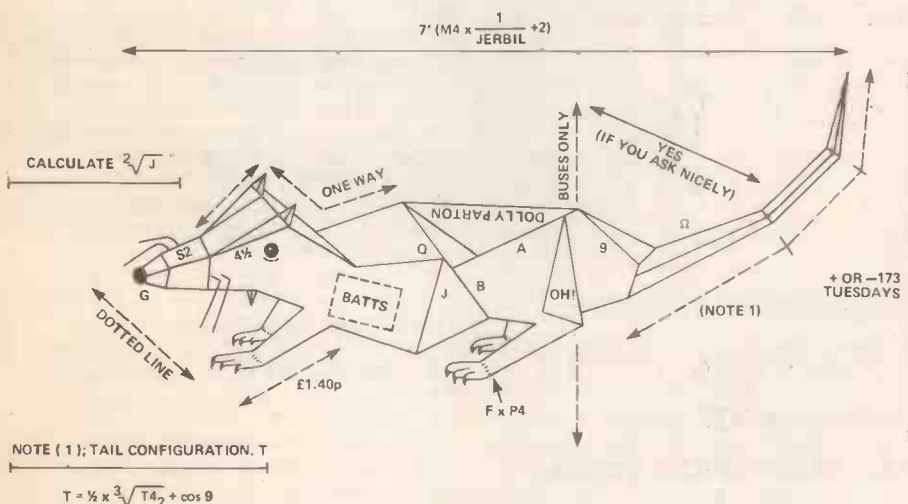


Figure 1. The gerbil circuit is easy to follow. In fact, you can go round and round for hours.



WHERE Z IS THE CIRCUMFERENCE OF A 12 YEAR OLD TORTOISE SHELL, AND T4₂ IS A SONG TITLE, COS IS A TYPE OF LETTUCE.

Figure 2. The body. If aluminium proves hard to work, Nibble-O-Brek carton is a suitable substitute, provided the greaseproof lining, transfers, crumbs etc. are removed.

E) Drill more holes in metal plate Q so they do line up.

F) Screw plate Q to plate J.

G) Swear even more at the top of your voice as the last screw-head shears off and it all falls apart.

H) Throw your bodywork away and start again, first going out to buy your own home braising rig.

(This last part was sponsored by the Home Braising Rig Sellers Federation).

When you have completed this, paid off the mortgage and sold your soul to the devil, juxtapose indented flap X to the floor, solder into position and then put out the fire you have just started in the middle of the carpet. Finish off with smooth glass-paper — if you're into that sort of thing — spread glue all over your hands, your best suit and the AGF and connect the power. Once you have replaced the fuses we are ready for test out.

(God, this is exciting).

Test Procedure

The basic principles of gerbil operation can be described as follows; it is a small fuzzy animal which spends most of its time hiding asleep in a ball of straw, wandering out occasionally to step in its water tray and throw its food about the cage. At midnight it starts running in the treadmill you meant to oil weeks ago and as you are now too tired to get up again, it keeps you awake until the early hours.

The principles behind radio control are a little more difficult to explain, so I haven't bothered.

In testing out the unit you must be aware of crossband modulation and induced phasing. Either effect would send the gerbil flying up the nearest trouser leg. To avoid accidental triggering, therefore, we advise any gerbil operator to strap his turnups to his legs by the use of elastic bands. Any

ladies present will have to make their own arrangements, though in an emergency I would be available on a consultative level providing they are young, blonde, and prone to cheap wine.

The control unit has four toggle switches, three potentiometers, and an 'O' Level in Domestic Science. Toggle One controls forward and reverse motion, and Pot One controls the speed. Toggle Two controls right and left motion, and Pot Two its speed. Toggle Three is supposed to control another motion, though it was not all that reliable, so that's why there is a third pot. If you run behind the gerbil with this you should be alright. Toggle Four throws out a blanket radio control signal that will launch all NATO missiles at Russia. Unfortunately it may be prone to generating sideband interference on local television and hi-fi sets, so before operating this control we advise you to check with the Post Office and the Kremlin.

(NB: Control of whisker twitching ie pitch, yaw, and speed, may be introduced in a future article, providing the cost of my typewriter goes down).

Application

Although designed as an educational toy for children, the gerbil can be used for practical everyday purposes such as cleaning blocked drains, running electrical cables under floorboards and scaring the hell out of nervous neighbours. We asked world-famous child expert and winner of the Nobel Prize for Talking To People Till They Die Of Boredom, Professor Hans Across-thesea, what he thought about the unit:

"Ze radio-controlled yerbil?" he said. "Vot a load of dingbat's kidneys." Still, what does he know?

Fault Finding

There were one or two problems with the prototype, though we managed to get away with a suspended sentence. However, a few brief symptoms and remedies.

- 1) No response to controls — you haven't built the project.
- 2) The unit jumps all over the furniture, screaming and shedding fur — the cat thought it was real and ate it.
- 3) The power station wants the transformer back — tough.
- 4) Your children develop an allergy to gerbils — typical. Spoiled brats.

And finally, *Buylines*. The ICs used are only obtainable from an old man in outer Mongolia who cobbles them together on wet Tuesday afternoons. However, in a special East/West deal with the USSR we have arranged for one IC to be given away free with every pair of iron curtains you buy. The bodyshell can be bought for £83 plus VAT from Rodent Projects International Ltd., Hamster Lane, Mousall, Littlesex. Good luck, and keep them whiskers twitching.

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There's no need to stop there. The ZX Printer—available now—is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232 / network interface board.



Key features of the Sinclair ZX Spectrum

- Full colour—8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound—BEEP command with variable pitch and duration.
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- High-resolution—256 dots horizontally x 192 vertically, each individually addressable for true high resolution graphics.
- ASCII character set—with upper- and lower-case characters.
- Teletext-compatible—user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE—16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC—incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

am



The ZX Printer - available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set - including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.



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ZX Expansion Module

This module incorporates the three functions of Microdrive controller, local area network, and RS232 interface. Connect it to your Spectrum and you can control up to eight Microdrives, communicate with other computers, and have a wide range of printers. The potential is enormous, and the module will be available in the early part of 1983 for around £30.

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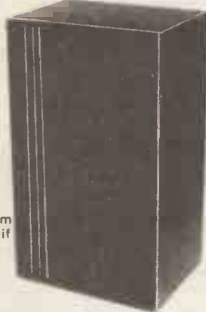


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Made to work battery lawnmower, this probably develops up to 1/2 h.p., so it could be used to power a go-kart or to drive a compressor, etc. etc. £6.90 + £1.50 post. (This is easily reversible with our reversing switch - Price £1.15).

MINI MONO AMP on p.c.b., size 4" x 2" approx. Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amplifier. Brand new, perfect condition, offered at the very low price of £1.15 each, or 10 for £10.00.

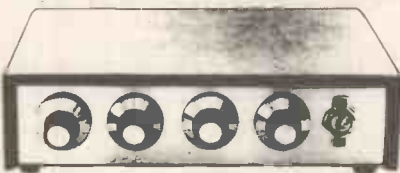


POPULAR PROVEN PROJECTS

MULTI-CHANNEL or ROBOT CONTROLLER

This is two kits. The 8 channel transmitter kit and the 8 channel receiver kit. Each kit comes with diagrams and notes, but no circuit boards, the component layout being left to you. The data shows how to drive, reverse and steer two or more motors. With spare channels to perform other functions. Price £9.50 for both kits.

3 CHANNEL SOUND TO LIGHT KIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by 1/4" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form or £25.00 assembled and tested. Case & metal Chassis No. Fully punched and prepared.

WHY BE COLD - Build a tangential blower heater.

TANGENTIAL BLOW HEATER

2.5 Kw quiet, efficient instant heating from 230/240 volt mains. Kit consists of blower as illustrated, 2.5 Kw element, control switch and data all for £4.95, post £1.50.



CAR STARTER AND CHARGER KIT

In an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250 watt mains transformer, 40 amp bridge rectifier, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price £12.50 + £3.00 post.

TRANSMITTER SURVEILLANCE

Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox - all electronic parts and circuit. £2.30. (not licenceable in the U.K.).

RADIO MIKE

Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. £6.90 complete kit. (not licenceable in the U.K.).

FM RECEIVER

Made up and working, complete with scale and pointer needs only headphones, ideal for use with our surveillance transmitter or radio mike. £5.85. or kit of parts £3.95.

3 - 30v VARIABLE VOLTAGE POWER UNIT

With 1 amp DC output, for use on the bench, students, inventors, service engineers, etc. Automatic short circuit and overload protection. In case with a volt meter on the front panel. Complete kit £13.80.

INTERRUPTED BEAM

This kit enables you to make a switch that will trigger when a steady beam of infra red or ordinary light is broken. Main components - relay, photo transistor, resistors and capacitors, etc. Circuit diagram but no case. Price £2.30.

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Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder - complete mains operated kit, case included. £11.95 plus £2.00 post.

RADIO STETHOSCOPE

Easy to fault find - start at the aerial and work towards the speaker - when signal stops you have found the fault. Complete kit £4.95.

INVISIBLE AND SILENT SENTINEL

Ultra-sonic beam when broken could warn you of visitor - two kits - transmitter & receiver. To operate light or bell. £9.50.

BURGLAR ALARM

Complete kit includes 6" external alarm bell, mains power unit, control box with keyswitch, 10 window/door switches, 100 yards of wire. With instructions. £29.50.

12v MOTOR BY SMITHS

Made for use in cars, these are series wound and they become more powerful as load increases. Size 3 1/2" long by 3" dia. These have a good length of 1/2" spindle - price £3.45. Ditto, but double ended £4.25. Ditto, but permanent magnet, £3.75.



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PROJECT CASES - CABINETS - BOXES

Black plastic boxes, 2 7/8 x 4 1/8 x 3" deep .50 Ditto 3 5/8 x 2 3/4 x 1 3/4" deep .40 Ditto 3 7/8 x 2 3/4 x 1" deep .30 Plated metal box 7 1/2 x 4 1/2 x 1 1/2" deep £1.00 Dark grey half boxes. May be joined to make three different depth boxes: 4 5/8 x 2 5/8 x 3/4" deep .20 4 5/8 x 2 5/8 x 1" deep .25 White plastic box ideal for touch switch, transmitter, etc. through top is square hole, 3 1/2 x 3 1/2" .50 Loudspeaker cabinet for 6 1/2" speaker .95 PORTABLE RADIO CASE - 5" speaker, size approx 6 1/2 x 3 1/2 x 2" deep £1.00

RELAYS & RELAY BASES

Standard open relays 3 x 8 amp c/o contacts: 6 volt dc coil .90 110 volt ac coil .50 24 volt dc coil .50 230 volt ac coil .90 1 x 8 amp changeover, 230 volt AC coil .60 Enclosed plug in round base relays - 3 changeover contacts: 50 volt coil (ex-fruit machine) .40 110 volt coil 2 changeover .50 12 volt coil 3 changeover .80 8 pin bases. Bases for 2 changeover relay .20 11 pin bases. Bases for 3 changeover relay .25 Miniature relays: 12 volt 2 changeover .60 12 volt 4 changeover .75 28 volt .50 48 volt .50

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In car, 12 volt for using 6 volt equipment £1.25 Mains to 24 volt Mullard, Stereo £1.90 Mains to 12 volt, 800mA £1.50 Mains to 10 volt 25cps for telephone ringing £2.00

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PANEL METRES & INSTRUMENTS

Volt meter 0 - 200 volts, 2 1/2" round £1.50 Milli amp meter, 500 ma 2 1/2" round £1.00 - amp meter, not wire scaled, 0 - 9 amps £1.20 Ammeter, 2 1/2" round, centre zero, 500ma £1.00 Charger panel meters. 1 1/2" dia, scaled 3 amp .35 Panel meter, 1 5/8" square, scaled Vu .60 Panel meter, Amstrad, 40mm sq, centre zero, scaled 1, 2, 3 £1.00 Edgeways panel, 3", 0 - 25 ma, ex-GPO £1.00

AMPLIFIERS

1/2 watt, Japanese made with v.c. £1.50 1 watt, Mullard Module 1172 £1.00 4 watt, Mini-amp with v.c. £1.00 Pre-amp, Mullard ref. 9001 module .80

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Torch bulbs, 3.5v MES. Box of 25 .35 Pilot light bulbs 6.2v 3A 11mm box of 50 £1.00 6.2v 3A 14mm box of 10 .30 12v 5A 16mm box of 10 .50 Car bulbs: 18 watt SBC .12 SBC Lamp holders .16

MAINS TRANSFORMERS

6 volt 1 amp .50 35 volt 2 amp £2.00 6.3 volt 2 amp £1.00 38 volt 2 1/2 amp £2.50 12 volt 1/2 amp .75 26 volt 10 amp £4.00 12 volt 4 amp £2.00 50 volt 2 amp £2.50 12 volt 1 amp £1.00 12 - 0 - 12, 2 amp 8.5 - 0 - 8.5 1 amp £1.00 12 - 0 - 12, 1 amp £2.00 18 volt 1 amp £1.50 100W auto 115v o/p £2.00 25 volt 1 1/2 amp £1.50

MOTORS - MAINS & BATTERY

3 - 6 volt battery motor, very small .15 3 - 12 volt battery motor, very low current .20 Mains motor with gear box 5 rev minute £2.25 80 rev per minute £3.00 110 rev minute £2.00 200 rev minute £1.50 Mains motor, double ended fan motor £1.20 Ditto single ended fan motor £1.00 Fan blade for above .50 Mains motor, double ended, very powerful 1 1/2" stack £1.50 Mains instrument motors 1 rev 24 hours £1.50 with gear box: 1 rev 1 hour £1.50 16 rev minute £1.50 4 rev minute £1.50 2 rev minute £1.50 1 rev minute £1.50

Motor clockwork, set up to 1 hour .38 Motor, clockwork set up to 1 hour with ringer .75 Mains motor 1/2 h.p., 1425 revs, ex-computer £4.25 Vent opening motor with end stop switches £12.50 12 volt motors, Smiths, single ended 1/2" spindle £1.50 12 volt motors, Smiths, double ended 1/2" spindle £2.00 12 volt motors, P magnet type, single ended £1.75 1 1/2 h.p. motor 3450 rpm 100 volt, 50Hz. New £5.00

SPECIAL TERMS. For items in this column. Order no less than 10 of any item. Then add VAT at 15%, and 20% for carriage in the case of transformers and electric motors. All other items in this column are free post & packing.

POINTS OF VIEW

Feel like sounding off? Then write to the Editor stating your Point Of View!

Robot Researcher

Re: Hebot II.

I was very interested in the above article as I am 12 years old and developing an interest in electronics. I have prepared a simplified design for a robot using some of the components specified for Hebot II. As an initial experiment in this area, I intend to use a wired joystick to control forward/reverse, left/right movements and would like to have information regarding the two motors which are referred to in the above project but for which there are not details provided.

Should my experiment be successful, I am considering extending it by developing an arm using two small motors based on a pulley system, and I would be most grateful for any information you could supply regarding design and components for lifting arms. Jasen Power, Barnsley, S. Yorks.

For information on the motors, and indeed any of the Hebot components, you will need to contact Powertran Cybertronics (their address is with the Hebot project in HE November '82) who supplied Hebot as a kit. For robot arms, look at recent issues of *Electronics Today International*, who are very much into robotics.

Disco Demand

Dear Sir,

I am at present studying Science Technology to 'O' level. For this I am required to construct an electronic circuit. I am therefore writing to you to ask you if you could send my any information on the subject of disco lights, which I am particularly interested in.

Any information on the subject will be gratefully received.

Stewart Dowling,
Beckenham,
Kent.

We published a sound-to-light converter in HE January '81 — see our Backnumbers page for how to obtain this article. Also, keep your eyes open for *Electronics Today International*, Dec '82 — they have just published a light sequencer.

Re-vamping the Reverb

Dear Sir,

With reference to your article on the HE Echo-Reverb Unit (HE May '82), I wonder whether you could answer a few questions for me. I'm intending to use the unit for recording effects on my portable 4-track 'portastudio', therefore noise is an important factor:

-) Are there any higher-quality components that I could use (ie direct replacements for 741s, etc.)?

2) I note that the filter limits the input signal to 7kHz; is it possible to increase this, or will this limit not be noticeable?

C. Stevens,
Leatherhead,
Surrey.

Improvements to the HE Echo-Reverb are possible but involve a little re-design work. We'll look into the matter and keep you up to date in future issues.

Dear Sir,

I've taken the mag since it first began in November '79. Great stuff. Keep it up.

How about a Flanger project for us with electric pianos? (the Envelope Generator works great).

C. L. Hutchinson,
Rotherham,
South Yorks.

Well, here's a gent we can't refer to our back issues for further advice, as he has them already. That's what we like to hear! As it happens, this is another possible modification to the HE Echo-Reverb. Watch this space...

Manual Help Required

Dear Sir,

Re: Sanyko Sound XL-60S Movie Camera No. 609130.

Being an avid reader of your magazine, especially the 'Points of View' page, could one of your readers help me by supplying a circuit diagram for the above camera, which is ten years old? I have tried Rank Audio Visual, who deal with Sanyko repairs in this country, and they regret the Manual is no longer available.

I should be very grateful for your assistance in this matter.

L. J. Hone,
Headcorn,
Kent.

We would be happy to pass on a manual or photocopy to Mr. Hone, or put anyone who can help in touch with him, if anybody with a solution contacts us here.

Cryptic Component

Dear Sir,

Can you help me? Several months ago I purchased a device with the following identification: package 6PIN DIL; identification no. MOC 3020 8017. It was meant to be an opto coupler. Unfortunately, I am unable to find this identification in any catalogue, and having been abroad until now, I have mislaid my copy of the order. Can you tell me what the device is?

I have been trying to purchase a data sheet for a Ferguson stereo tuner/record player unit 3400 with built-in FM tuner.

I have tried data sheet suppliers advertised in radio magazines, but they are out of stock. Is there any alternative source? The unit has one channel giving a low output. The fault was positively identified when a tape deck was connected, therefore I assume that one of the preamp channels is faulty. I have changed the cartridge on the record player with no effect and the fault persists with the radio on.

The unit is a mere seven watts per channel. Would it pay me to scrap the existing circuitry and install some of these nice modern IC preamps and amps?

Paul Jenkin,
St. Austell,
Cornwall.

Sorry, but we can't find any reference to your opto-coupler either. If you bought it as recently as a few months ago and have a vague memory of who you might have been buying components from then, it might be worth your while sending a few letters to suppliers on the off-chance. Somebody may still have a note of your order, especially if you paid by cheque. However, commercial components usually have unique serial numbers which don't correspond to regular IC manufacturers' numbers, which makes it easier for suppliers to keep track, but harder to identify one isolated component.

As for your stereo tuner/record player, your best hope is to contact Ferguson, who are actually at Thorn Consumer Electronics Ltd., Great Cambridge Rd., Enfield, Middx. Tel: 01 363 5353. But unless the unit is very high-priced, or you have something against IC amps, you'd probably be better off getting a new unit rather than going for a repair job.

Aliens In Our Midst

Dear Editor,

I am trying to trace an article published in the last six months which describes the building of an infra-red human pulse detection system.

If your magazine did not publish this article but you know which one did I would be grateful if you could give me this reference.

K P Quirk,
Dept. of Mechanical Engineering,
University of Birmingham.

The Pulse Detector was published in August 1981 by our sister magazine, ETI, where they use it for checking for signs of life in the staff of *Video Today* magazine. Back issues of ETI cost £1.25 each, the same as Hobby back issues, and from the same address; but please put "ETI/Backnumbers" on the envelope.

COMING SOON TO . . .

Hobby Electronics

NO FUTURE?

With unemployment standing at over three million, job prospects for this year's school leavers are few and far between. Yet even as television news shows old established industries visibly shrinking, new employment is being created in the many electronics-based industries.

No future? No way. The future is here and now, and your guide to employment in the New Technology industries is here, in the pages of Hobby Electronics.

Next month we commence a very special feature series on employment in electronics. Starting in May, "Careers in Electronics" will explore the educational qualifications and training necessary to work in any of the thousands of options in the electronics industries. The series will continue in the months to come with detailed examinations of specific occupations in, for example, radio and television, computers, and even technical journalism.

So if you are leaving school this year or next, Hobby Electronics is the essential reading for plotting your course through the years ahead. Remember, it all starts in the May issue of Hobby Electronics!

PROJECTS FOR THE MOTORIST

Spring is in the air (well, almost) and soon it will be the time, once again, when weekends mean cleaning and polishing the car! It is also the time when the enterprising car owner can make a number of small but useful improvements to the family motor.

Check out next month's issue for details of some simple circuits to fit to any car for easier and more comfortable motoring pleasure.

ALSO IN MAY . . .

THE ELECTRONICS REVOLUTION

This popular and informative series continues with the story of the Electronic Age.

POPULAR COMPUTING

Continues with a review of the Jupiter Ace microcomputer and an Interface Project for the BBC Micro, designed as a general purpose unit and also for controlling the Hobby HEBOT.

HE DIGITESTER

After months of brain-twisting effort, we have solved the problem of a compact, efficient and low cost mounting system for the HE DigiTester . . . watch this space!

Please reserve copies of the May issue of


**Hobby
Electronics**

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Name

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**Hobby
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**May issue on sale at
your newsagent
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Place your order now!**

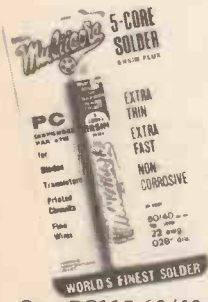
Although these articles are being prepared for the next issue, circumstances may alter the final content.



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Ersin Multicore, solder contains 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux is required. Comes in handy dispensers and tool box reels in two different alloys 40/60 tin/lead for general purpose electrical soldering and 60/40 tin/lead ideal for small components and fine wire soldering.



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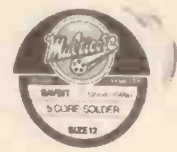


Size 19A 60/40 tin/lead
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Multicore Savbit, solder increases the life of your soldering bit by 10 times, for better soldering efficiency and economy. Comes in two handy dispensers and tool box reels.



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Auto Power-Down

James E. Aman

Remove the problems of dead batteries after a late night in the lab!

IF you are an electronics project builder, you undoubtedly have realised the usefulness and versatility of making your projects battery powered. The great drawback of this practice — apart from the ever increasing cost of batteries — is that, sooner or later, you're bound to forget to turn your equipment off. Then not only do you have to dissect cases and replace batteries, but they may have leaked causing untold troubles. But now we have the universal solution!

Battery buyers rejoice! For the price of a replacement set of batteries, here's a circuit which will automatically turn on your equipment using its present switch, and will, after a pre-determined delay of your choice, turn the circuit off again. The circuit stops the flow of current from the batteries and can be simply reset by another flip of the switch. In our great magnanimity we've also included a voltage monitor circuit which runs on miserly micro-amps and tells you when your batteries have petered out of power.

Down and Out

The Power Down circuit is built around the CMOS CD4060B IC (Figure 1). Now available for around £1, it contains an oscillator and a fourteen stage ripple-carry binary counter; eleven counter outputs are brought out to the IC pins and the count is incremented by one, binary, for each oscillator clock pulse. When the RESET input, pin 12, is taken high, the counter outputs are reset to all zeros and the oscillator is disabled; the count is then started by taking the RESET input low.

Apart from the counter, the circuit contains two transistors, Q3 and Q4, in series with the 0V and -V supply rails, and two more transistors, Q1 and Q2, which control Q3,4. The last part of the circuit, built around Q5, Q6 is the voltage monitor which warns when the batteries are about to call it a day.

When power is first applied, the ensuing pulse is conducted across C2, taking pin 12 momentarily high and accomplishing the RESET function.

After the initial transient, pin 12 falls to a low and the oscillator begins to function. At the same time, a positive power-on pulse is conducted across C1, turning on Q3 and completing the circuit for the power-on transient.

Meanwhile, the RESET to IC1 has sent pin 3 (the fourteenth counter output) low, and this turns on both Q1 and Q2, which in turn switch on Q3 and Q4. The result is that the 0V and -V supply rails are connected, and the circuit 'downstream' begins to operate. Diodes D1 and D2 are present to prevent transients on the supply rails from affecting the Power Down circuit; D1 prevents positive pulses generated by the downstream circuitry from inadvertently resetting IC1, while D2

prevents negative going pulses from switching off Q4.

The supply rails will remain connected for a period determined by the oscillator frequency; when the oscillator/divider IC has completed its cycle, pin 3 goes high, turning off Q1, 2, 3 and 4, thus disconnecting the 0V and the -V rails and turning off all the circuitry. The 'on-time' of the circuit can be altered by changing the value of the oscillator timing capacitor C3; each 100n of capacitance increases the time period by half an hour. Alternatively, shorter time periods can be realised by simply selecting a lower order divider output to drive Q1,2.

The voltage monitor circuit consists of Q5 and Q6 and an LED. When the

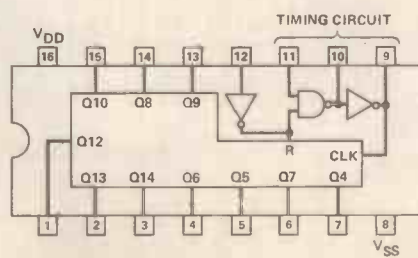
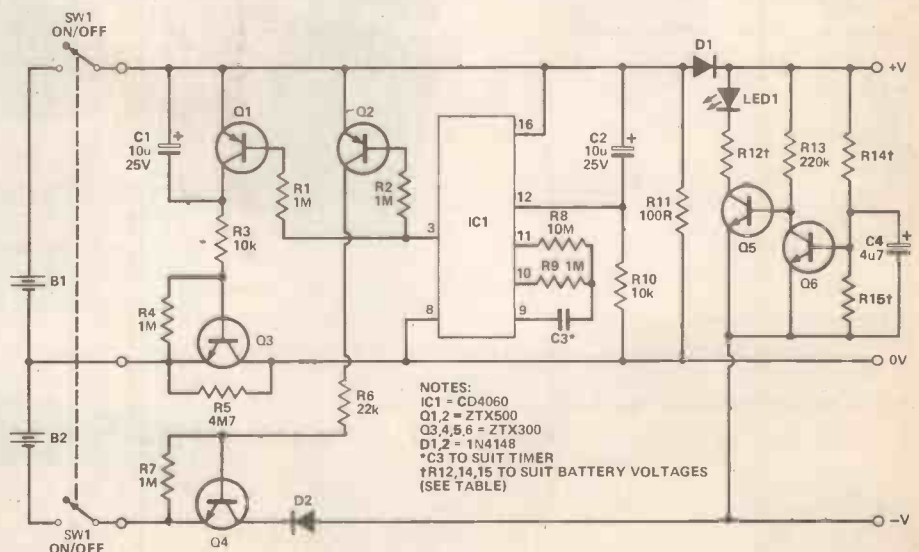


Figure 1 (above). The Auto Power-Down circuit is built around the CD4060 counter/timer IC, which switches off the 0V and -V power rails after a preset time period. The battery voltage monitor circuit, based on Q5, 6, is optional.

Figure 2 (left). The logic/function diagram of the CD4060.

Parts List

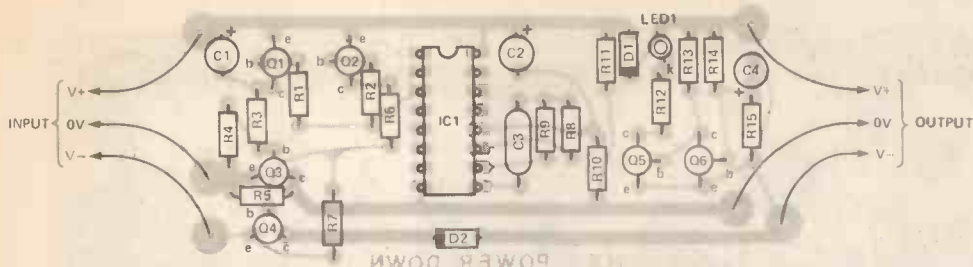


Figure 3. The PCB pattern viewed from the top, showing the position of the components. The board can either be mounted in a box for use on the test bench, or permanently built into a battery-operated project.

battery is healthy, the voltage drop across R15 is sufficient to keep Q6 turned on and this shorts out the base-emitter junction of Q5, preventing current flowing through Q5's collector and

LED1. However, when the battery voltage ebbs, it lowers the voltage drop across R15 and Q6 turns off, allowing Q5 to switch on the LED, indicating 'mal de batt' or pernicious anaemia Leclanche. The values of the resistors R12, R14 and R15 must be chosen to suit the battery supply voltage, as shown in Table 1.

TABLE 1

BATTERY VOLTAGE	R14	R15	R12
18V	470k	22k	1k5
12V	470k	33k	1k
9V	220k	22k	680R
6V	220k	33k	330R

The values of R12, 14 and 15 must be selected to suit the battery operating voltage.

Construction

Assembling the Power Down project should not present any difficulties for even the inexperienced constructor. Simply take care that the polarised components (electrolytics, diodes, transistors and IC1) are inserted with the correct polarity, and take care not to touch the pins of IC1; although it is protected against static discharge, it's better to be safe than sorry, so treat it gently!

RESISTORS

(All 1/4 watt 5% carbon)

R1,2,4,7,9	1MR
R3,10	10k
R5	4M7
R6	22k
R8	10M
R11	100k
R12	see Table 1
R13	220k
R14,15	see Table 1

CAPACITORS

C1,2	10u 25V
	radial electrolytic
C3	220n
	(see text)
C4	4u7 25V
	radial electrolytic

SEMICONDUCTORS

IC1	CD4060B
	CMOSIC
Q1,2	ZTX 500
Q3,4,5,6	ZTX300
LED1	0.2in red LED
D1,2	1N4148

MISCELLANEOUS

PCB; case and sockets if required (see Buylines); wire, solder etc.

BUYLINES Page 34

XK113 MW RADIO KIT

Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5.5 x 2.7 x 2cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. **£5.00**

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DL 1000K This value-for-money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. **£14.60**

DL2100K A lower cost version of the above, featuring unidirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. **Only £8.00**

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DL3000K This 3 channel sound to light kit features zero voltage switching, automatic level control & built in mic. No connections to speaker or amp required. No knobs to adjust — simply connect to mains supply & lamps. (1Kw/Channel) **Only £11.95**

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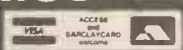
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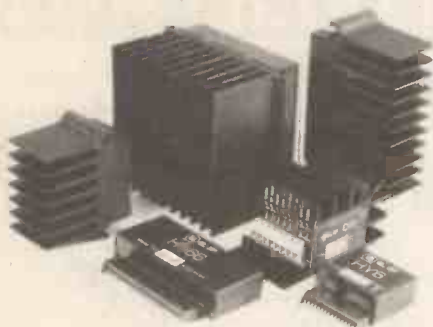
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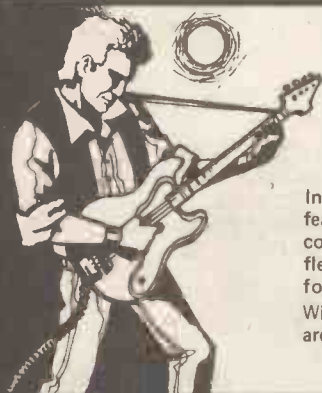
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With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.



BIPOLAR MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION		Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
			T.H.D. Typ at 1KHz	I.M.D. 7KHz 4:1				
HY30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
HY124	60	4	0.01%	<0.006%	± 26	120 x 78 x 40	410	£20.75
HY248	60	8	0.01%	<0.006%	± 35	120 x 78 x 40	410	£20.75
HY124	120	4	0.01%	<0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
HY364	180	4	0.01%	<0.006%	± 45	120 x 78 x 100	1030	£38.41
HY364	180	8	0.01%	<0.006%	± 60	120 x 78 x 100	1030	£38.41

Protection: Full load line. Slow Rate: 15 μ s. Rise time: 5 μ s. S/N ratio: 100dB. Frequency response (-3dB) 15Hz - 50KHz. Input sensitivity: 500mV rms. Input Impedance: 100K Ω . Damping factor: 100Hz >400.

PRE-AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price inc. VAT
HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/Aux + Vol/Bass/Treble	10mA	£7.60
HY66	Stereo pre amp	Mic/Mag. Cartridge/Tuner/Tape/Aux + Vol/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

Most pre-amp modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre amp modules if required for £5.47 (inc. VAT). Pre-amp and mixing modules in 18 different variations. Please send for details.

Mounting Boards

For ease of construction we recommend the B6 for modules HY6-HY13 £1.05 (inc. VAT) and the B66 for modules HY66-HY78 £1.29 (inc. VAT).

POWER SUPPLY UNITS (Incorporating our own toroidal transformers)

Model Number	For Use With	Price inc. VAT
PSU 21X	1 or 2 HY30	£11.93
PSU 41X	1 or 2 HY60, 1 x HY6060, 1 x HY124	£13.83
PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY244	£17.07

Please note: X in part no. indicates primary voltage. Please insert "0" in place of X for 110V, "1" in place of X for 220V, and "2" in place of X for 240V.

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION		Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
			T.H.D. Typ at 1KHz	I.M.D. 60Hz/7KHz 4:1				
MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	£45.54

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).

Slow rate: 20 μ s. Rise time: 3 μ s. S/N ratio: 100dB

Frequency response (-3dB): 15Hz - 100KHz. Input sensitivity: 500mV rms

Input impedance: 100K Ω . Oamping factor: 100Hz >400.

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Very easy to use.

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Robust construction.

Mounts anywhere in car.

Automatic switch over.

Output power maximum 22w peak into 4 Ω .

Frequency response (-3dB) 15Hz to 30KHz, T.H.D. 0.1% at 10w 1KHz

S/N ratio (DIN AUDIO) 80dB, Load Impedance 3 Ω .

Input Sensitivity and Impedance (selectable) 700mV rms into 15K Ω 3V rms into 8 Ω .

Size 95 x 48 x 50mm. Weight 256 gms.

C1515

Stereo version of C15.

£17.19 (inc. VAT)

Size 95 x 40 x 80. Weight 410 gms.

Model Number	For Use With	Price inc. VAT
PSU 52X	2 x HY124	£17.07
PSU 53X	2 x MOS128	£17.86
PSU 54X	1 x HY248	£17.86
PSU 55X	1 x MOS248	£19.52
PSU 71X	2 x HY244	£21.75

Model Number	For Use With	Price inc. VAT
PSU 72X	2 x HY248	£22.54
PSU 73X	1 x HY364	£22.54
PSU 74X	1 x HY368	£24.20
PSU 75X	2 x MOS248, 1 x MOS368	£24.20

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Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

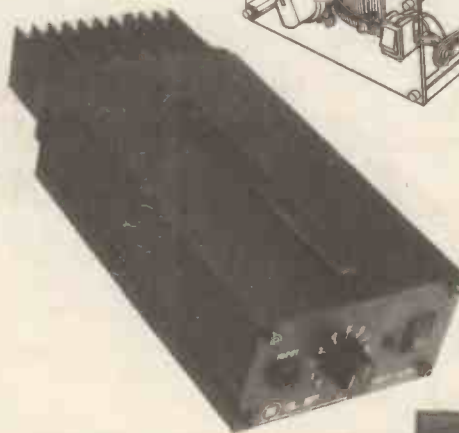
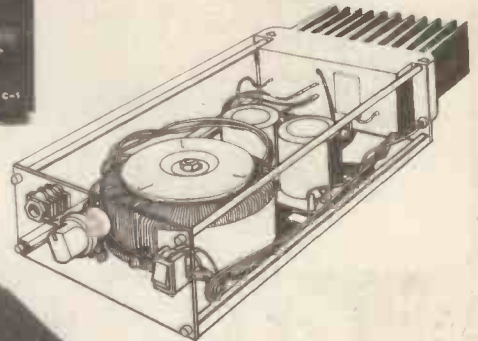
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UC1 PRE AMP UNIT: Incorporates the HY78 to provide a "no frills", low distortion, (<0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

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UNICASES

HIFI Separates					Price inc. VAT
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UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
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UP4X	120W/4Ω	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8Ω	Bipolar	Mono	HiFi	£74.95
UP6X	60W/4-8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4-8Ω	MOS	Mono	HiFi	£84.95
Power Slaves					
US1X	60W/4 Ω	Bipolar	Power	Slave	£59.95
US2X	120W/4 Ω	Bipolar	Power	Slave	£79.95
US3X	60W/4-8Ω	MOS	Power	Slave	£69.96
US4X	120W/4-8Ω	MOS	Power	Slave	£89.95

Please note X in part number denotes mains voltage. Please insert 'O' in place of X for 110V, '1' in place of X for 220V (Europe), and '2' in place of X for 240V (U.K.) All units except UC1 incorporate our own toroidal transformers.

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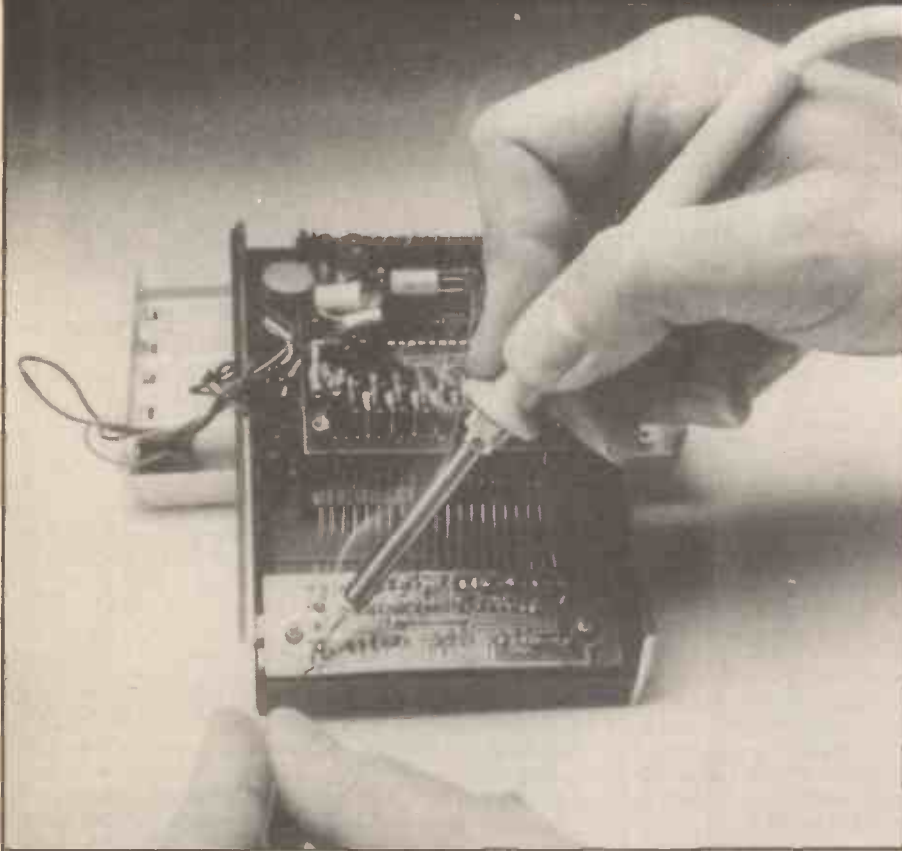
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TOOLS FOR THE TRADE



A good workman relies on his tools!

Jonathan Bird (Cooper Tools Ltd.)

THE home electronic constructor, like any other hobbyist, must first equip himself with the tools to pursue his chosen craft; they are essential to the satisfactory conclusion of any project. Dedication, interest and application are all very necessary but if you don't possess the right tools to carry out your hobby you might as well try windsurfing on a skateboard. The use of these tools is also of prime importance and the following paragraphs will summarise the basic requirements of every home electronics enthusiast, whether he be interested in computers or amplifiers.

Basic Tools

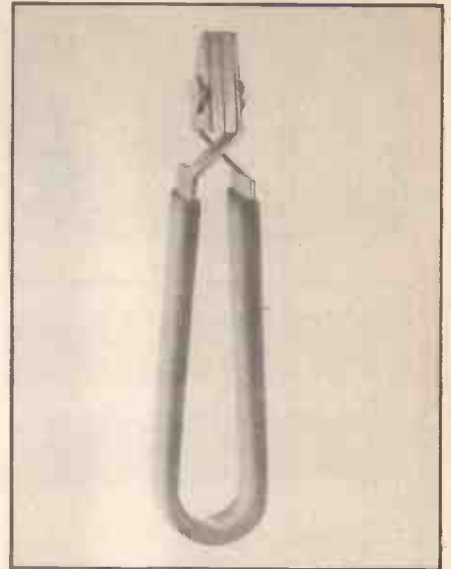
There is a basic tool kit essential to the home constructor, consisting of soldering iron (and solder!), cutters, pliers, an electrical screwdriver and a multimeter. Equipped with these items, it is possible to tackle most projects with confidence. Practical ability is necessary of course, for all readers of *Hobby Electronics*, and the

tips contained in this feature should help you to turn out working projects with the least aggravation.

The Soldering Iron

Your chosen soldering iron should be of the precision type (no heating over gas rings please!), small but powerful enough to reliably solder your components to printed circuit boards. An iron of between 25 and 40 watts with a nickel plated tip, or one of the miniature irons capable of a tip temperature of 800°F are most suitable.

The ideal tip is a single flat or chisel tip of about 2.5mm (3/32"). The old-style unplated copper tips are not very suitable, as they wear away very quickly. Always ensure that the iron can be earthed and *never* solder when the equipment you are working on is switched on; better still, unplug it before soldering. A bench iron holder and cleaning sponge are important too; the damp sponge cleaner will ensure that your solder joints are always clean and free from the contamination of ox-



A heat sink, useful to protect those very delicate components from heat damage during soldering.

idised solder — this is often the cause of dry joints and subsequent intermittent faults. Also, the holder will protect you and your carpet from the inevitable accident!

To achieve a perfect solder joint you should always try to use new components. Very old resistors and capacitors etc. can have contaminated leads that will make them difficult or unreliable to solder, due to oxidation of the tinning on the component leads, and this is another prime cause of the dreaded dry joint. Having inserted the component or wire, the lead should be laid down in the direction of the track on the PCB and cropped off using your cutters to a length of about one eighth of an inch. To solder correctly, using a multicore solder, apply the cleaned iron to the joint of lead and track for 2 to 3 seconds and then feed the solder (roughly 1/4 to 1/2 in) between the iron and the joint. When the solder has successfully flowed onto the lead and track, take the solder away and then remove the iron. So many people make the mistake of removing the iron first and this will nearly always result in a dry joint, due to the solder taking heat from the joint prematurely.

Cutters and Pliers

Good cutters are an essential tool for component lead cutting prior to soldering or preforming. Ideally they should be of the side cutter type, or electronic shears with insulated grips, and they should be slimline and lightweight for precision work. Don't be tempted to use them for trimming PCBs or metal parts other than copper wire or leads — although the cutting blades are hardened, they are easily blunted if misused. A blunt pair of cutters is worse than useless as it will not crop leads cleanly or strip insulation from wire without snagging and breaking strands. Heavy duty work needs heavy duty tools so always use equipment relevant to the job in hand. Some electronic cutters have



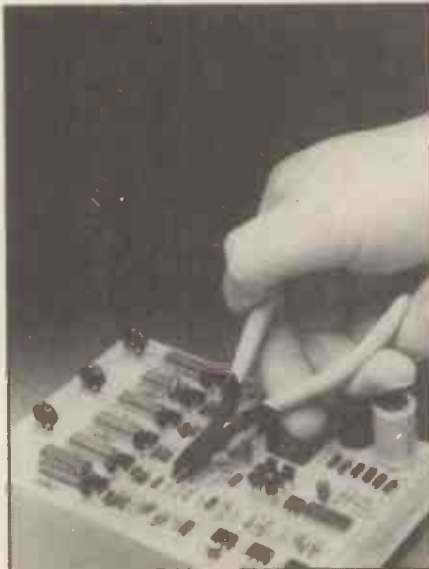
A selection of electronics pliers and cutters, essential basic items in the tool kit.

a safety clip incorporated, which traps the cut off lead and thus stops wire flying into your face or ending up all over the room. If you are unsure of using cutters to strip wire, then wire strippers and cutters are available with adjustable stops for different wire sizes. The stop ensures that the cutting action is limited to the thickness of the insulation and will prevent nicking the actual wire.

Having stripped the insulation back by about one quarter of an inch, the exposed strands should then be lightly twisted between thumb and forefinger to compact them ready for tinning. This is simply a matter of heating the wire with the soldering iron and running a small amount of solder on to it. This will give you a solid lead that is readily inserted into the PCB hole or made ready to twist around a solder tag. Then proceed to solder as with



Insertion and extraction tools reduce the risk of damage to certain components during assembly or removal.



Good cutters are an essential tool for component lead cutting prior to soldering or preforming.

a component lead, and you will get a good clean joint without making a splayed and whiskery mess.

A good pair of electronic pliers is invaluable as a precision extension of your fingers when holding and forming components for insertion or removal from PCBs. When bending resistor or axial capacitor leads to the correct pitch for your design, the pliers will give you a smart professional finish and avoid stress to the lead/component joint. To start with, a pair of 'snipe nose' pliers will suit most applications. The fine tip will enable you to use it like a strong pair of tweezers and the serrated jaws will give you good grip when holding and forming different wires and parts.

A straightforward insulated electrician's screwdriver and a posidrive are a must, though you will always find the piece of equipment you are working on needs the driver that you have not got! Of course improvisation is sometimes possible, but there is no real substitute for the right tools. The best approach from a budget point of view is to build up your collection of tools as and when you need them. The ideal answer, therefore, is to buy a universal handle that will fit a series of interchangeable blades. They are available with or without reversible ratchets and the range of screwdrivers, nutdrivers, Allen hex drivers, reamers and extensions will enable you eventually to build up a really comprehensive tool kit in easy stages.

A multimeter is also a piece of equipment you won't be able to do without. For most projects, though, a very sophisticated meter is not really required. You will need one that reads AC and DC, volts and amps and has resistance ranges with an input impedance of at least 10,000 ohms per volt. An analogue meter is quite sufficient for the purpose and these days general purpose models are quite reasonably priced. The voltage range on AC should be capable of reading up to mains voltage and the DC range, say, fifty volts. The current ranges need



An ideal way to tackle a multitude of fastener problems is to choose a driving kit with universal handle and interchangeable blades and sockets like the kit shown here.

only really measure up to five amps as most of your projects will be low current, unless you've got a short on your power supply of course! Resistance ranges should cover up to at least one megohm, preferably in two or three stages.

Added Extras

Although pliers are used to good effect when removing soldering components, the ideal method to avoid damage to the part and the board tracking is to use a desolder pump or 'solder sucker'. This device works rather like a bicycle pump in reverse. When loaded and subsequently released, a spring loaded piston creates a vacuum at the tip of the device and cleanly sucks up the molten solder. Having made the lead and track clean and free of solder the pliers can then be used to remove the component.

During soldering — and desoldering for that matter — certain delicate items such as transistors, crystals and polystyrene capacitors need to be protected from heat damage. For this purpose a spring loaded heat sink can be used. Interposed between component and solder joint on the lead, or even on the component itself as appropriate, it will make sure that the heat only goes to the joint and not into the component.

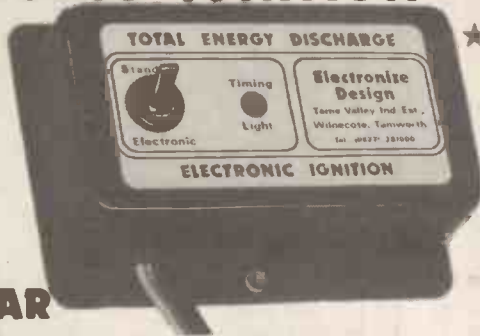
There are, of course, many other very useful tools that have not been mentioned but they are not really essential, especially when you consider the number of times you will actually use them in relation to their costs. With a bit of ingenuity the majority of problems can be tackled with the tools mentioned but if not, why not drop a few hints next Christmas or your birthday if there is something you do need. We could all make far better use of a new soldering iron than a pair of socks!

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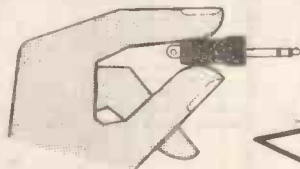
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EPROM Programmer



Our EPROM Programmer project concludes with full instructions for building and assembly, together with the listing of the operating software in BASIC.

THE HE 6502 EPROM Programmer was built into a standard plastic case with a sloping front panel, using modular construction to simplify assembly. The first module consists of the case itself, together with the transformer. A flying lead terminated in a five-way PCB socket connects 24VAC to the second module, the + 25VDC power supply board. The plug is wired symmetrically, and so is not polarised. The PSU has been laid out on Veroboard, to keep the cost down, and should not present any problems in assembly, if the component overlay (Figure 1) is followed carefully.

In a minor change from the circuit published last month, the current limiting resistor for the 'Mains On' LED has been placed on this board; another unpolished five-way PCB connector plug carries this signal, plus the + 25V and 0V supply to the third module, which is constructed on the front panel (Figure 2).

The panel carries the two DPDT function switches, all the indicator LEDs and the main EPROM socket. The prototype used a special ZIF (Zero

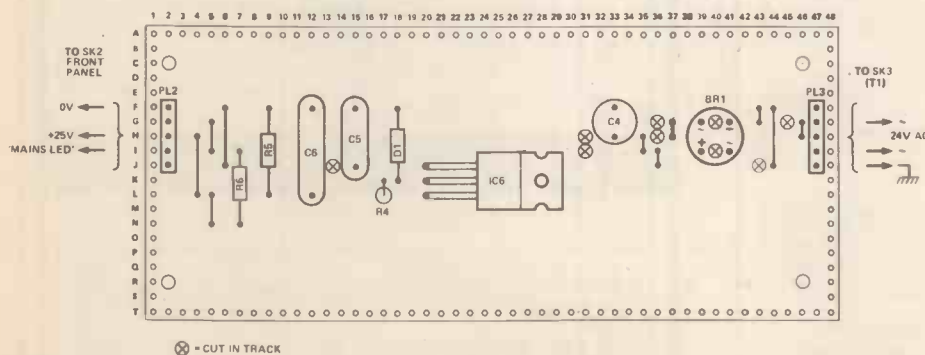


Figure 1. The power supply board has been laid out on Veroboard; it is shown here viewed from the top (component side).

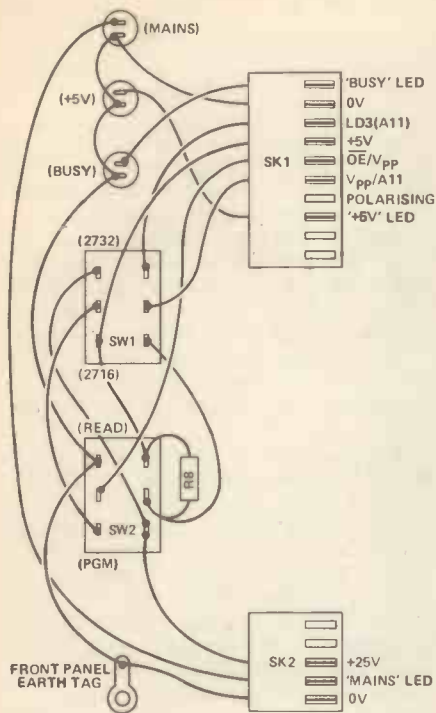


Figure 2. The wiring diagram for the front panel components; SK1 leads to the main PCB and SK2 goes to the power supply board. Be sure to check this wiring thoroughly before testing the unit.

P/A ADDRESS	ADDRESS BITS HIGH (A _x)	IC1 PINS	IC2 PINS	IC3 PIN
16128	13,12,11,10,9,8	4→15 9	1 7→15 9→23	
16384 (16K)	14	5→15 12	1 7→15 9→23	
24320	14,12,11,10,9,8	5→15 11	1 4→15 12→23	
24576 (24K)	14,13	5→15 10	1 4→15 12→23	
32512	14,13,12,11,10,9,8	5→15 9	1 7→15 9→23	
32768 (32K)	SEE PCB COMPONENT OVERLAY			
48896	15,13,12,11,10,9,8	6→15 9	1 7→15 9→23	
49512 (48K)	15,14	7→15 12	1 4→15 12→23	
57088	15,14,12,11,10,9,8	7→15 11	1 7→15 9→23	
57344 (56K)	15,14,13	7→15 10	1 4→15 12→23	
65280	15,14,13,12,11,10,9,8	7→15 9	1 7→15 9→23	
65536 (64K)	NOT APPLICABLE			

Table 1 (above) shows the link connections required to place the EPROM address at various locations in memory. Because the address bus is not fully decoded, the EPROMer will occupy a full 256-byte block upwards from the specified address.

Insertion Force) socket, but a standard 24-pin DIL socket may be substituted, provided it is used carefully. The socket is linked to the main PCB by a short length of ribbon cable terminated in a 24-pin DIL header which plugs into the PCB 'EPROM socket'. Again the original circuit has been modified to the extent that the current limiting resistor for the '+5' LED has been placed on the main PCB.

The front panel components are wired to a ten-way PCB interconnecting socket which plugs into the main PCB. This plug is polarised by removing one pin (see Figure 3) and blocking the corresponding hole in the socket with the insert provided for the purpose. Of course, the plug-and-socket interconnection system could be omitted and the modules hard-wired together, though the construction will not be as neat and will be less

convenient for assembly and testing.

The main PCB is single-sided, again to reduce the cost, and carries a number of wire links. Wherever possible, the links have been made in the power supply rails, because it is much easier to fault-find should there be a 'weak link'. The PCB carries all the ICs and associated components and should present no problems. Use IC sockets, if possible, but note that they are essential for J1, the link to the host computer, and J2, the on-board 'EPROM socket' which connects to the front panel ZIF socket. Another point to note is that the data in and out pins of ICs 1 and 2 have been left unconnected, so that the EPROM address can be programmed by means of wire links. As shown, the EPROM is placed at 32768, but can be located elsewhere in memory by making the appropriate connections, as shown in Table 1.

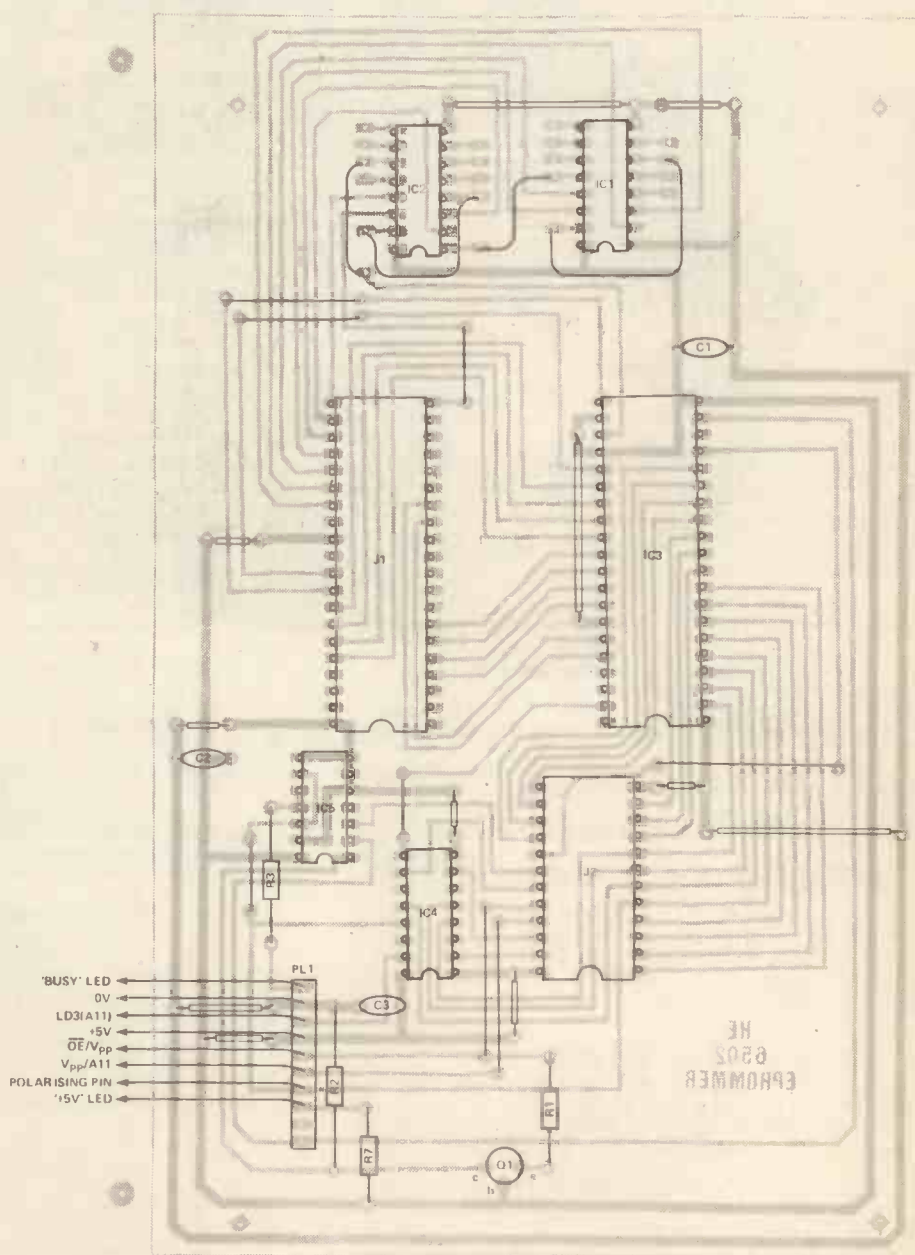


Figure 3. The component overlay of the main board. Most of the links have been put in the power rails, to simplify fault-finding.

Assembly

Assembly of the modules is straight forward, particularly if the PCB interconnecting plugs and sockets have been used. Start by drilling the holes for the front panel components; the ZIF socket (or DIL socket, as you like) is mounted on a small piece of Veroboard which bolts to the panel (Figure X). Cut this square hole before drilling the mounting holes, to ensure that the socket fits in neatly.

The PSU board is sized to fit the mounting points of the specified box, but check the hole positions before drilling. The main PCB is bolted to the front panel, using spacers to give the necessary separation. Note that an earth point on the front panel is also required.

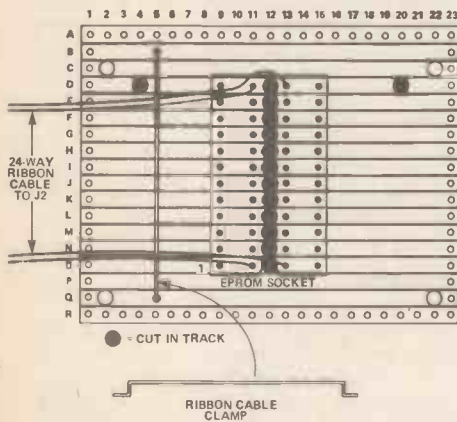


Figure 4. The ZIF socket (or low-cost 24-pin IC socket) is mounted on a small piece of Veroboard and bolted to the front panel (the track cuts prevent the mounting nuts shorting the socket pins to the chassis).

Operating Program

The listing of the BASIC operating program is shown in Table 2. It is supplied with a fair number of explanatory REMarks, but these of course may be omitted in the version actually entered into the computer when using the EPROM Programmer. The program down to Line 100 is concerned with sorting out whether a 2716 or a 2732 is to be programmed. 2516s may be programmed, as they have the same pinout as the 2716, but they must be described to the computer as "2716". 2532s have a different pinout from the 2732 and the EPROM Programmer will not program them. Down to line 300 is concerned with establishing where in RAM the data to be stored in EPROM is located — the EPROM Programmer requires that the data is stored in known consecutive locations in RAM. Down to line 420, the program establishes whereabouts in the EPROM the data is to be stored.

At this point the operating program has all the data it needs, and it proceeds to check that the target PROM is "free". After erasing an EPROM, all eight bits in every byte are at logic level '1', or "high", and the process of programming sets the required bits "low" — logic level '0'. Before attempting to program the EPROM the operating program checks that all bits in each byte of the EPROM space are high. The high and low bytes of the current PROM address are designated SEG and LO, respectively, while, SSEG and SLO are the high and low bytes of the address of the first byte in the target PROM space. The length of the target EPROM space is unrestricted, from the full 2048 (4096) bytes, right down to a single byte, starting anywhere in the EPROM.

The program down to line 750

checks that the target EPROM space is free, as described, and prints to the display the address and contents of any byte not reading 255 (all ones). Assuming the target space is free, the program requests the user to set the READ/PROGRAM switch to PROGRAM, and when this has been done, proceeds to program the EPROM (down to line 940). The user is then requested to return the READ/PROGRAM switch to READ, and the program verifies that the data burned into the EPROM agrees with the original RAM data (down to line 1180). For any bytes that have not been programmed correctly, the address, intended content and actual content are listed on the VDU.

If it is desired to program another EPROM with the same data, it is not necessary to re-enter the RAM and target EPROM address space; simply follow the instructions in the remaining lines of the program. If it is desired to copy an existing EPROM, either in whole or in part, it is a simple matter to change the VERIFY routine to POKE the data read from the EPROM into RAM, instead of comparing it with RAM.

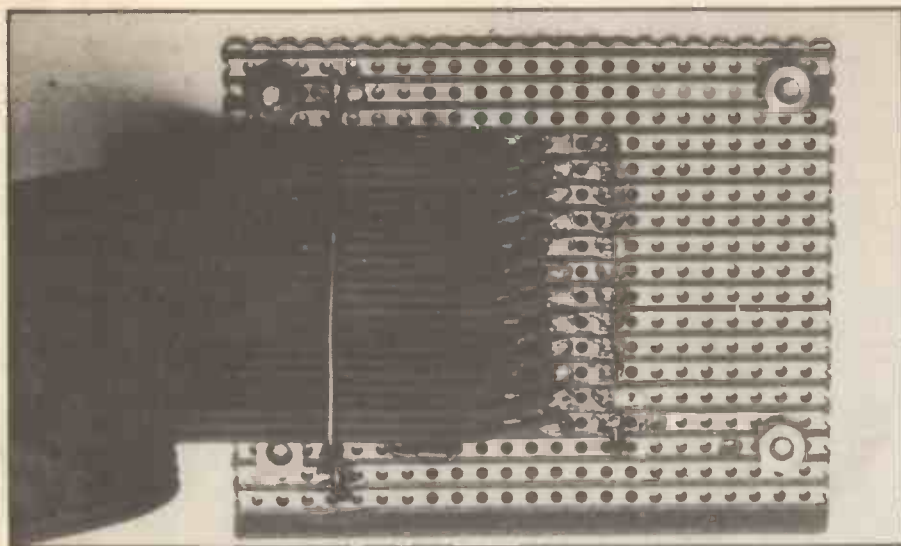
Testing

On completion, all wiring should be thoroughly checked, since +25V, applied to the wrong pin of an EPROM (or most other places, come to that), is likely to do some damage! The best way to ensure that everything is working as it should is to run some test square-waves through the system. Just crib a line or two from the BASIC operating program to set up PA0 — 7 and PB0 — 7 as outputs and then, with a loop, alternately POKE 0 and 255 to Peripheral Register A and check that you get a squarewave at each of the lines AO — 7 at J2. Repeat this with

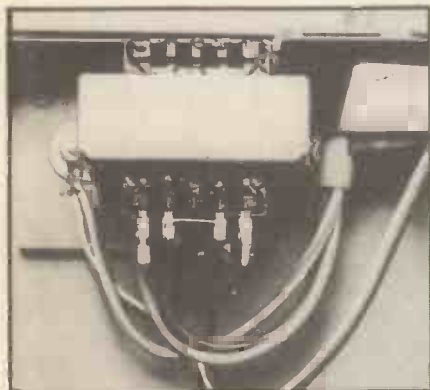
```

10 PRINT " THE H.E. PROM PROGRAMMER ":PRINT
20 PRINT " C IAN HICKMAN 1981 ":PRINT
30 PRINT:PRINT " SET PGM/READ SWITCH TO 'READ' ":PRINT
40 PRINT:INPUT " HAVE YOU DONE THAT? Y OR N ";A$
50 IF LEFT$(A$,1) <> "Y" THEN 30
60 PRINT:INPUT " ENTER ROM TYPE, 2716 OR 2732 ";T$
70 IF T$ = "2716" THEN T = 2048:GOTO 110
80 IF T$ = "2732" THEN T = 4096:GOTO 110
90 PRINT:PRINT " ONLY 2716 OR 2732 ACCEPTED"
100 PRINT:GOTO 60
110 PRINT:PRINT " SET 2716/2732 SWITCH TO ";T$
120 FOR I = 1 TO 500: NEXT
130 PRINT:INPUT " HAVE YOU DONE THAT? ";A$
140 IF LEFT$(A$,1) <> "Y" THEN 110
150 PRINT:PRINT " INSERT PROM IN SOCKET"
160 FOR I = 1 TO 500: NEXT
170 PRINT:INPUT " HAVE YOU DONE THAT? ";A$
180 IF LEFT$(A$,1) <> "Y" THEN 150
190 PRINT:PRINT " IS DATA TO BE STORED IN ROM"
200 INPUT " PRESENT IN RAM? ";A$
210 IF LEFT$(A$,1) = "N" THEN PRINT:PRINT " NO GO " :END
220 IF LEFT$(A$,1) <> "Y" THEN 190
230 PRINT:INPUT " ENTER RAM START ADDRESS RS ";RS
240 PRINT:INPUT " ENTER RAM END ADDRESS RE ";RE
250 RT = RE - RS + 1
260 IF RT < 1 THEN PRINT " NO GO - RE < RS! ":GOTO 230
270 PRINT:PRINT " MEMORY REQ. IS ";RT;" BYTES"
280 IF RT <= T THEN 300
290 PRINT:PRINT " TOO LARGE FOR PROM ": GOTO 240
300 PRINT:INPUT " ENTER ROM START ADDRESS PS ";PS
310 IF PS <= T THEN 340
320 PRINT:PRINT " NO GO, > ";T:PRINT
330 GOTO 300
340 PRINT:INPUT " ENTER ROM END ADDRESS PE ";PE
350 IF PE <= T THEN 380
360 PRINT:PRINT " NO GO, > ";T:PRINT
370 GOTO 340
380 PT = PE - PS + 1
390 IF PT >= RT THEN 430
400 PRINT:PRINT " RAM CODE TOO LARGE FOR"
410 PRINT " AVAILABLE SPACE IN ROM"
420 FOR I = 1 TO 1000:NEXT:GOTO 230
430 PRINT:PRINT " CHECKING ROM ERASED OK"
440 PRINT " FROM "; PS; " TO "; PS + RT - 1
450 X = 0
460 PIA = 32768:REM XXXXX IS BASE ADDRESS OF PIA
470 REM LO IS ROM ADDRESS LO BYTE
480 REM SEG IS ROM ADDRESS HI BYTE *
490 SSEG = INT(PS/256): SLO = PS - 256 SSEG
500 POKE PIA + 1,0: POKE PIA + 3,0
510 REM SELECTS DATA DIRECTION REGISTERS
520 POKE PIA,255:REM SETS PORT A FOR OUTPUT (ADDRESS)
530 POKE PIA + 2,0:REM SETS PORT B FOR INPUT (DATA)
540 POKE PIA + 1,52:POKE PIA + 3,52
550 REM SETS CRA & CRB, BIT 4HI, 5HI, 3LO, 2HI
560 REM (32 + 16 + 4) = 52, SELECTS OUTPUT REGISTERS
570 REM WITH CA2 AND CB2 BOTH LO
580 POKE PIA,SSEG:REM SELECTS STARTING SEGMENT OF ROM
590 POKE PIA + 1,60: POKE PIA + 1,52
600 REM TOGGLES CA2 HI LO TO LATCH SSEG
610 LO = SLO: SEG = SSEG: PRINT: PRINT " DOING SEGMENT ";SSEG
620 FOR RA = 0 TO RT - 1
630 POKE PIA,LO: I = PEEK(PIA + 2)
640 IF I <> 255 THEN PRINT " ";SEG;LO;I: X = 1
650 REM TEST BYTE AT SEG/LO FOR ALL ONES
660 REM AND PRINT ADDRESS IF BAD: X = BAD FLAG

```

Detail showing the ZIF socket wiring. A solid length of wire is bent and soldered across the ribbon cable as a strain relief.



A cable clamp should be used to secure the mains lead and the Earth wire firmly fixed to the transformer mounting points. The flying lead carries 24VAC.

Peripheral Register B, to test the data lines, then add a line to the loop to waggle CA2 up and down each time you POKE 0 or 255 to Peripheral Register A (eg line 590) and you should see the squarewave at the "latched data" outputs (LDO - 3) of IC4. Likewise, use the computer to waggle CB2 alternately high and low, but make it an asymmetrical squarewave; you can then check at pin 18 of J2 that the waveform inverts when SW1 is set to 2732 simultaneously with SW2 to PROGRAM. In this way you can use your computer to exercise the circuitry of the EPROM Programmer to verify its correct functioning. If the PIA does not respond at all, check that it is getting R/W and O2(E) signals, and that the address decoding in IC1 and IC2 is producing a negative-going CS2 signal at pin 23 of the PIA. If not, you probably have a pair of address lines, A8 and A9 for example, accidentally swapped over!

Using the Programmer

The EPROM Programmer connects to the host computer via socket J1 and a suitable cable. If the computer is a UK101, this is simply a double ended 40 way DIL jumper lead of convenient length, connecting to the expansion socket on the computer. With other models of computer, a suitable lead will have to be made up, to pick up the address, data and control buses and, of course, +5V and 0V.

Using the Programmer is simplicity itself, as the BASIC operating system leads one by the hand. The main point to watch is loading the EPROM in the ZIF socket the right way round! Some PROMs will survive being installed back to front — they just get very hot — but in other cases a little light will come on inside the EPROM (it's called a bond wire) to tell you that you have inserted it back to front. Unless you remove it very quickly indeed, the little light will then go out again, to tell you that you have a dud EPROM! Given that the PROM is inserted the right way round however, no problems of any sort should be experienced, provided the Programmer has been thoroughly checked out as described in the previous section.

Interfacing

Interfacing the HE Eprom Programmer with the UK 101 is very simple, but exactly how you do it depends on whether you already have an expansion board already connected to the computer's expansion socket, or not. The two cases are dealt with separately below.

- A) No expansion fitted: In this case, IC6 and 7 will not be present since they are not supplied as standard. The simplest procedure is to link pins

```

670 LO=LO+1
680 IF LO<256 THEN 710
690 LO=0:SEG=SEG+1:PRINT:PRINT " DOING SEGMENT ";SEG
700 POKE PIA,SEG:POKE PIA+1,60:POKE PIA+1,52
710 NEXT RA
720 IF X=0 THEN 750
730 PRINT:PRINT " TARGET ROM SPACE IS NOT FREE: ERASE"
740 PRINT " PROM, SAVE CONTENTS FIRST IF REQUIRED":END
750 PRINT:PRINT " TARGET ROM SPACE IS FREE"
760 PRINT:PRINT " SET PGM/READ SWITCH TO 'PGM'"
770 PRINT:INPUT " HAVE YOU DONE THAT":A$
780 IF LEFT$(A$,1)<>"Y" THEN 760
790 PRINT:PRINT " PROGRAMMING PROCEEDING"
800 POKE PIA+3,0:POKE PIA+2,255
810 REM SETS PORT B FOR OUTPUT (DATA)
820 POKE PIA+3,52
830 POKE PIA,SSEG:POKE PIA+1,60:POKE PIA+1,52
840 LO=SLO:SEG=SSEG:PRINT:PRINT " DOING SEGMENT ";SSEG
850 FOR RA=0 TO R-1
860 POKE PIA,LO:D=PEEK(RS+RA):POKE PIA+2,D
870 POKE PIA+3,60
880 FOR J=0 TO 50:NEXT:REM PROGRAMMING PULSE
890 POKE PIA+3,52:LO=LO+1
900 IF LO<256 THEN 930
910 LO=0:SEG=SEG+1:PRINT:PRINT " DOING SEGMENT ";SEG
920 POKE PIA,SEG:POKE PIA+1,60:POKE PIA+1,52
930 NEXT RA
940 PRINT:PRINT " PROGRAMMING COMPLETE"
950 PRINT:PRINT " SET PGM/READ SWITCH TO 'READ'"
960 PRINT:INPUT " HAVE YOU DONE THAT":A$
970 IF LEFT$(A$,1)<>"Y" THEN 950
980 PRINT:PRINT " VERIFICATION PROCEEDING":X=0
990 POKE PIA+3,0:POKE PIA+2,0:POKE PIA+3,52
1000 POKE PIA,SSEG:POKE PIA+1,60:POKE PIA+1,52
1010 LO=SLO:SEG=SSEG:PRINT:PRINT " DOING SEGMENT ";SSEG
1020 FOR RA=0 TO R-1
1030 POKE PIA,LO:I=PEEK(PIA+2)
1040 J=PEEK(RS+RA):IF I=J THEN 1060
1050 PRINT " ";SEG;LO;J;TAB(5);I:X=1
1060 LO=LO+1
1070 IF LO<256 THEN 1100
1080 LO=0:SEG=SEG+1:PRINT:PRINT " DOING SEGMENT ";SEG
1090 POKE PIA,SEG:POKE PIA+1,60:POKE PIA+1,52
1100 NEXT RA
1110 IF X=0 THEN 1170
1120 PRINT:PRINT " ABOVE ADDRESSES HAVE NOT PROGRAMMED"
1130 INPUT " DO YOU WISH TO TRY AGAIN":A$
1140 IF LEFT$(A$,1)="N" THEN END
1150 IF LEFT$(A$,1)<>"Y" THEN 1120
1160 GOTO 790
1170 PRINT:PRINT " VERIFICATION COMPLETE"
1180 PRINT " ROM IS CORRECTLY PROGRAMMED"
1190 PRINT:PRINT " DO YOU WISH TO PROGRAM"
1200 INPUT " ANOTHER ROM WITH SAME DATA":A$
1210 IF LEFT$(A$,1)="N" THEN END
1220 IF LEFT$(A$,1)<>"Y" THEN 1190
1230 PRINT:INPUT " IS PGM/READ SWITCH AT 'READ':A$
1240 IF LEFT$(A$,1)<>"Y" THEN 1230
1250 PRINT:PRINT " INSERT NEXT ROM"
1260 PRINT:INPUT " HAVE YOU DONE THAT":A$
1270 IF LEFT$(A$,1)<>"Y" THEN 1250
1280 GOTO 430

```

Table 2. The BASIC operating software listing; Line 1160 should read: GOTO 760.

2 to 3, 5 to 6, 9 to 10 and 12 to 13 at each of the IC sockets. This can either be done on the back of the board or, alternatively, the links can be made on a couple of DIL headers which are then plugged into the IC sockets designated U6 and U7. This extends the computer's data bus, unbuffered, to the Eprom Programmer, which is quite acceptable provided that the DIL jumper lead used is 18" or less in length. (The author's Programmer is fitted with a 24" jumper lead and in operation has proved 100% reliable). As mentioned last month, the Programmer draws the small amount of current it requires at +5V from the host computer. Now the computer's +5V supply does not appear at the expansion socket, so it is necessary to arrange that it does. Pin 11 is unused and could be used for the +5V supply, but it is always handy to have a spare pin, for instance, to bring out a clock or some other signal, for instance. However, no less than ten pins of the expansion socket are allocated to 0V, so isolate three of these and connect them to +5V instead. Pin 29 was used for this purpose, as shown in the circuit of the Eprom Programmer in last month's issue. Note that if you subsequently add an expansion board which plugs into this socket, pin 29 should be disconnected from +5V and reconnected to 0V.

B) Expansion board already fitted: In this case IC6 and 7 will already have been fitted, so that the data bus is buffered, the data direction being controlled by the DD signal at pin 3 of the expansion socket. This signal is derived by the expansion board from the address and control buses, and fed back to the host computer to control the data bus buffers. When an expansion board has already been fitted, no modifications to the expansion socket of the host computer should be made. However, most expansion systems (eg Watford Electronics, Merlin (Micro-systems) Ltd. etc.) provide at least one duplicate socket on the expansion motherboard, to allow for further expansion. The motherboard will have its own +5V supply and this should be made available to the Eprom Programmer at pin 29 of the "further expansion" socket. If considerable expansion by way of RAM and ROM has already taken place, the location for the Eprom Programmer at 32768 dec. (and the following 255 locations, as only partial address decoding is used) may not be free. In this case the Programmer address should be relocated, eg to the free space between BASIC in ROM and the VDU RAM, or between the VDU RAM and the polled keyboard at DFOOHX. The address decoding at IC1 and 2 of the Programmer should be changed to the new address and the address of the Programmer in the BASIC operating program altered to suit.

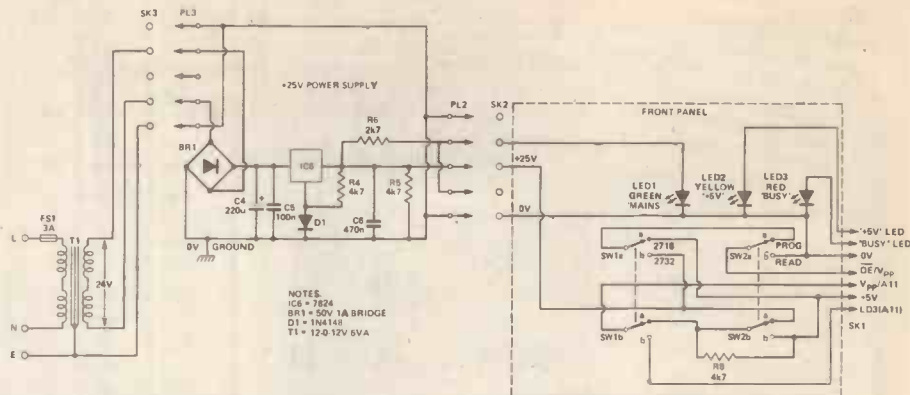


Figure 5. The power supply and front panel circuits redrawn, to show the modifications mentioned in the text.

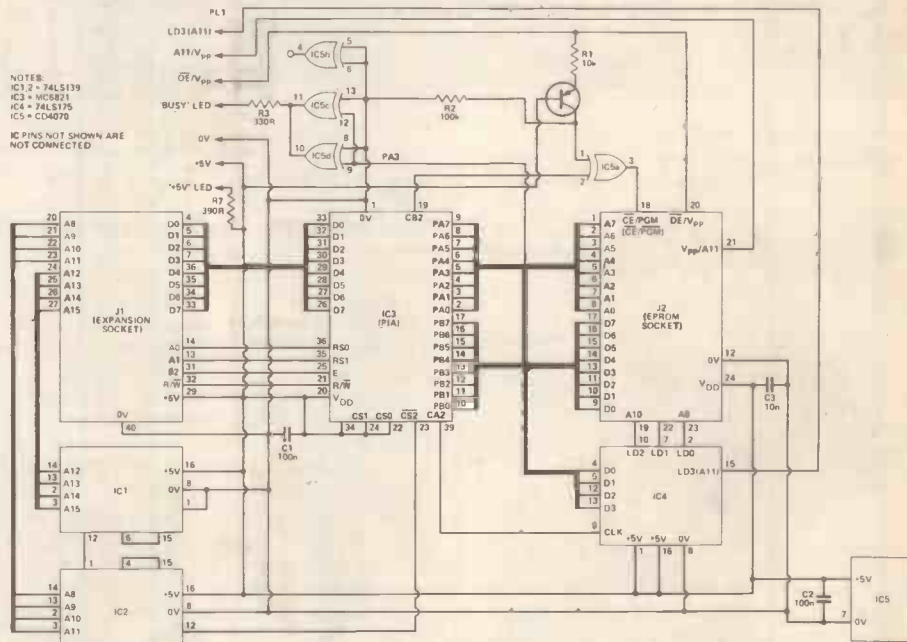


Figure 6. The current limiting resistor for the '+5V' LED has been incorporated as part of the main circuit.

Parts List

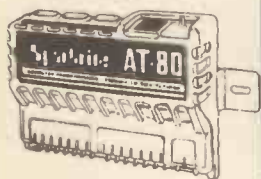
RESISTORS (All 1/4 watt 5% carbon)	IC5	CD4070	
R1	10k	quad EXOR	
R2	100k	IC6	7824
R3	330R		24v regulator
R4,5,8	4k7	Q1	2N3702
R6	2k7		PNP transistor
R7	390R	BR1	50V/1A
			bridge rectifier
CAPACITORS	D1	1N418	
C1,2	100n ceramic	LED1	red 0.2" LED
C3	10n ceramic	LED2	green 0.2" LED
C4	220u 40V electro	LED3	yellow 0.2" LED
C5	100n 63V metal foil	MISCELLANEOUS	
C6	470n 63V metal foil	SW1,2	DPDT miniature toggle
SEMICONDUCTORS	T1	24V/6VA secondary	
IC1,2	74LS139 dual 1-of-four decoder	FS1	3A mains fuse
IC3	6821 PIA	1x24-pin ZIF or DIL socket; 3 x 16-pin DIL sockets; 1 x 24-pin DIL socket; 2 x 40-pin DIL sockets; 1 x 24-pin single ended DIL jumper lead, approx. 6"; 1 x 40-pin double-ended DIL jumper lead, approx. 18"; 2 x 5-pin PCB interconnecting plugs and sockets; 1 x 10-pin; case (see Buylines), nuts and bolts, wire, solder etc.	
IC4	74LS175 four-bit latch		

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit description. Highest quality components are used throughout.

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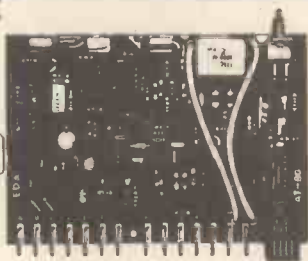
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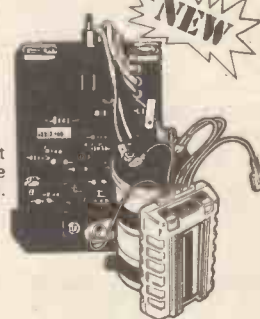


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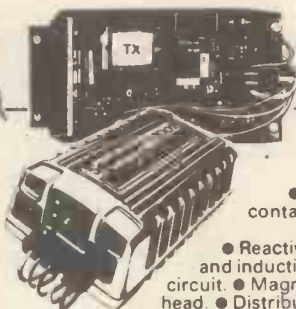
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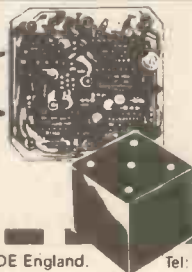
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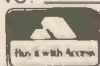
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CHECK LIST

NB: R12,14,15 and C3 values elected from Table 1 (see text).
RESISTORS
 (All ½ watt 5% carbon).
 5 x 1M; 2 x 10k; 1 x 4M7; 1 x 22k; 1 x 10M; 1 x 100k; 1 x 220k.
CAPACITORS
 (All radial electrolytics, 25V or better).
 2 x 10u; 1 x 4u7.
SEMICONDUCTORS
 1 x CD4060B; 2 x ZTX500 or BC559; 4 x ZTX300 or BC549; 1 x 0.2" red LED; 1 x 1N4148 or similar.
MISCELLANEOUS
 PCB; case and sockets (see above); wire, solder etc.

EPROM Programmer

Quite a few of the components for this project are not stock items, however Rapid Electronics (Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4

5RD) have kindly agreed to supply everything that's needed.

CHECK LIST

RESISTORS
 (All ½ watt 5% carbon).
 1 x 10k; 1 x 100k; 1 x 330R; 3 x 4k7; 1 x 2k7; 1 x 390R.
CAPACITORS
 2 x 0u1 30V ceramic; 1 x 10n 30V ceramic; 1 x 220u 40V radial electrolytic; 1 x 0u1 63V metal foil; 1 x 0u47 63V metal foil.
SEMICONDUCTORS
 1 x 6821; 2 x 74LS139; 1 x 74LS175; 1 x CD4070; 1 x 7824; 1 x 2N3702; 1 x 50V/1A bridge rectifier; 1 x 1N4148; 1 x 0.2 in red LED; 1 x green LED; 1 x yellow LED.
MISCELLANEOUS
 2 x DPDT miniature toggle switches; 1 x 24V/6VA secondary transformer; 2 x 40-pin DIL sockets; 3 x 16-pin DIL sockets; 1 x 14-pin DIL socket; 1 x 24-pin ZIF or DIL socket; 1 x 40-pin DIL header + 18" x 40-way ribbon cable or 1 x 24-pin DIL header + 6" x 24-way ribbon cable or 1 x 5-way PCB interconnecting cable shell (RS 467-627) plus terminals (RS 467-698); 2 x 5-way straight PCB plugs (RS 567-576); 1 x 10-way cable shell (RS 467-633) + terminals; 1 x 10-way straight PCB plug (RS 467-582); case; PCB; wire, solder, nuts and bolts etc.

Voice-Over Unit

Once again, the components used in this project are available from most suppliers — TK ELECTRONICS, for example — so there should be no difficulty in obtaining all the bits and pieces.

The prototype mounted the PCBs in a plastic Verobox measuring 205 x 140 x 75mm (code 202-21035F); the cost of components for the main board should be around £5.00; the Mic Preamp should cost out at about £2.00.

CHECK LIST — MAIN BOARD

RESISTORS
 (All ½ watt 5% carbon).
 1 x 5k6; 3 x 100k; 7 x 4k7; 4 x 10; 2 x 18k; 3 x 22k; 2 x 120R; 4 x 220R; 2 x 12k; 2 x 15k.
POTENTIOMETERS
 1 x 100k OW1 horizontal preset; 1 x 10k preset.
CAPACITORS
 (All electrolytics).
 2 x 100u 10V axial; 1 x 4u7 63V radial; 1 x 4u7 63V axial; 1 x 1u 63V radial; 1 x 10u 25V radial; 1 x 10u 25V axial; 1 x 2u2 63V axial; 1 x 1u 63V axial.
SEMICONDUCTORS
 1 x 741; 1 x 1458C; 1 x LM 13600N; 1 x 1N4148; 1 x BC179 PNP.
MISCELLANEOUS
 1 x rotary on/off switch; 2 x ¼" stereo jack sockets; 1 x ¼" mono jack sockets; 1 x PP3 9V battery + holder; PCB; case (see above); control knobs; wire solder nuts and bolts etc.

CHECK LIST — MIC PREAMP

RESISTORS
 (All ½ watt 5% carbon).
 1 x 3k3; 2 x 100k; 1 x 27k; 2 x 33k; 1 x 1M.
POTENTIOMETERS
 1 x 47k log carbon.
CAPACITORS
 (All electrolytic unless noted).
 1 x 100n polyester; 2 x 4u7 63V axial; 3 x 1u 63V radial; 1 x 10u 25V axial.
SEMICONDUCTORS
 1 x 1458C.
MISCELLANEOUS
 PCB, wire, solder etc.

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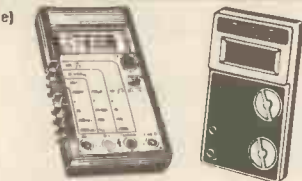
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<input type="checkbox"/>	KIT HB/5 - FULL UV/1 PHOTOKIT -	£60.00-	£ :
<input type="checkbox"/>	KITHB/6 - FULL UV/2 PHOTOKIT -	£90.00-	£ :
<input type="checkbox"/>	HB/UV1 - DIY UV EXPOSURE UNIT -	£18.00-	£ :
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	TOTAL	£ :	£ :
	Address	P & P	£ 0:60
		Cheque/POE	£ :

Name
 Address
 Please Send further details



KELAN (Hobbyboard)
 North Works, Hookstone Park,
 Harrogate, North Yorkshire.
 ☎ 0423-883672

A division of Kelan Engineering Ltd.

TOOLS AND TEST EQUIPMENT FOR THE ELECTRONIC HOBBYIST



Who has the hardware for the hobbyist? Find out here!

A.B. Engineering

An annoying yet necessary chore in electronics is the stripping of insulating materials from electronic cables and wires without damage to the conductor, and this has traditionally required time-consuming care on the part of the hobbyist. Now, however, AB Engineering, produces a wide range of wire stripping and other electronic tools for amateur and professional alike.

Recently introduced is the Micro-Strip wire stripper, which is self adjusting for depth of incision and gripping pressure on all PVC and some thermo-resisting insulations.

The Micro-Strip will cope with all sizes of wire up to a maximum of 1.5mm diameter without any adjustments; for very thin or very thick insulation, an adjustment mechanism is provided.

For those jobs which have to be redone, AB's popular de-soldering bit fits any iron which accepts a 3/16in bit and

gives accurate removal of IC and CMOS components.

In operation, the bit is placed directly on top of the soldered joint. The heat generated from the soldering iron melts the solder which through capillary action enters a hole in the de-soldering bit. A concave 'nest' allows direct leak-free contact with a specially shaped de-soldering nozzle which uses suction through the heat source to remove all traces of solder.

Also available from AB Engineering are electrical and electronic wire and cable cutters, crimping tools, tweezers, pliers, screwdrivers, spanners, location tools, mirrors and magnifying glasses.

For a catalogue and further details, enquiries should be addressed to A. B. Engineering Company, Timer Lane, Woburn, Milton Keynes, Bedfordshire MK17 9PL.



Anders Electronics

Anders Electronics is an established supplier of electrical measuring instruments and test equipment to industry. The full range is described in the 'Instruments for Industry' catalogue available free on request (please send C4 size SAE to cover 150gms).

Test Equipment of particular interest to hobbyists includes: analogue multimeters: MM201: 20kR/V, 16

ranges covers AC/DC volts, DC current, resistance and dB measurements. Current price including case and leads, £15.95 plus VAT; AMM301; 30kR/V, 21 ranges cover AC/DC volts, DC current, resistance and dB measurements. Current price including case and leads, £19.95 plus VAT; digital multimeters: the superb Fluke hand held models and accessories all available ex-stock. 3½ digit models: 8020B, 8021B, 8022B, 8024B; 4½ digit models: 8060A, 8062A.

For catalogue and further information contact: Anders Electronics Ltd., 48-56 Bayham Place, London NW1 0EU. Tel: 01 387 9092.

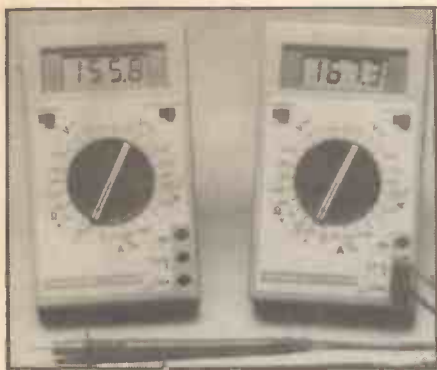
Audio Electronics

Cubegate Limited trading as Audio Electronics provides six days a week over-the-counter sales of test equipment at our Edgware Road, London, W2 branches. We also supply Mail Order for UK and export and supply equipment to educational establishments, government departments and other established companies.

Our range includes: analogue multimeters (more than 20 models); digital multimeters (more than 20 models); frequency counters (more than 10 models); signal/function/pulse generators (more than 10 models); oscilloscopes (more than 12 models), plus a comprehensive range of other equipment including insulated clamp meters, digital capacitance meter, logic probes and monitors, TV pattern generators, substitution boxes, power supplies, LCR analogue curve tracer, distortion meters, digital temperature meters, logic analyser, EHT meters, transistor testers.

We represent such companies as Trio, Hameg, Safgan, Crotech, Thurlby, Sinclair, Thandar, Leader, Sabtronics, Levell, Altai, etc., and are able to offer large ranges of in-stock equipment to suit all pockets and most requirements.

A catalogue of all equipment is available on request. We ask for a large stamped addressed envelope (20p) by post. Our Company operates from 301, Edgware Road, London, W2 1BN (Tel: 01-724-3564) and at Henry's Radio, 404 Edgware Road, London, W2 1BN.



Beckman Instruments

Beckman Instruments Ltd. entered the multimeter market only three years ago when they introduced the model 3020 hand-held digital multimeter. Now the company is the UK market leader in the hand-held professional-class field and, during this period, introduced two bench-top models.

In 1981 Beckman introduced two lower-priced instruments aimed at electrical and electronics technicians and hobbyists: the Tech 310 and the Tech 300A, both of which sell for just under £100.

However, two instruments of greater interest to the hobbyist were introduced in mid-1982. These are the 3½ digit T100 and T110 models, both of which offer five DC voltage ranges from 200mV to 1000V, five AC voltage ranges from 200mV to 750V, six DC and AC current ranges from 200A to 10A and six resistance ranges from 200R to 20R. The basic price of the T100 is £49 and of the T110 is £59.

The instruments, which are covered by a comprehensive one-year guarantee will operate continuously for 200 hours from one standard 9V battery, are compact (150 x 90 x 30mm) and light in weight (285g, including battery).

A comprehensive selection of accessories is available including a selection of current clamps, a high voltage probe, a RF probe, temperature probes and convenient carrying case.

Further information on Beckman multimeters can be obtained from Roger Doyle, Beckman Instruments Ltd, Electronic Components UK Sales and Marketing Organisation, Mylen House, 11 Wagon Lane, Sheldon, Birmingham B26 3DU. Tel: 021 742 7921.

Bib

Bib Audio/Video Products Ltd. do two pairs of wire strippers.

The Model 9 is fully adjustable and made from tempered steel with hardened, precision ground jaws. It has a heavy-duty spring release for automatic opening after each operation, splits twin flex and has shaped, easy grip plastic handles.

The Model 3A has two handy small-gauge spanners built into its handles, and is ideal for hobby and household wiring jobs. From hardware and hifi stockists, or enquire Bib Audio/Video Products Ltd., Kelsey House, Wood Lane End, Hemel Hempstead, Herts. Tel: (0442) 61291.

BICC-Vero Packaging

BICC-Vero Packaging has always been active in solderless breadboards, and the Verobloc system is well established in both the hobbyist and professional areas for prototyping purposes. Verobloc is supplied in a basic size of 81.28mm x 45.72mm, and a unique interlocking system allows three Veroblocs to be mounted in a single Eurocard.

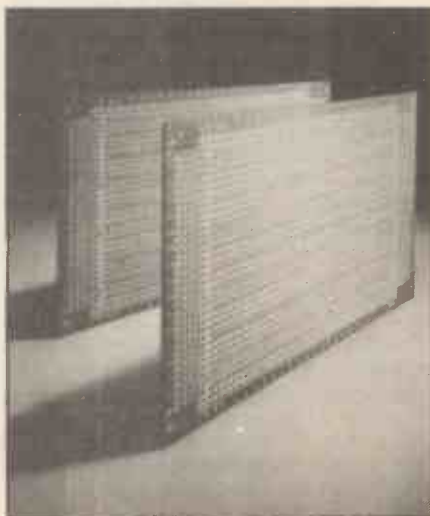
The company is the largest supplier of circuit boards in the UK, and 'Veroboard' has almost become a generic name. A wide range of Veroboards is available in the fully pierced, single-sided configuration, and other boards include prototyping boards with DIP hole patterns, Verostrips, plain fully pierced boards and single and double Eurocards. A recent development is a board specifically designed for use with the Apple microcomputer.

Connectors and cardframe systems are the next step up from boards, and here BICC-Vero provides a variety of products, many of which are based on the internationally accepted KM6 19-in cardframe system. Standard cardframes, front panels, plug-in modules, card guides, mounting brackets, heat sinks and mounting kits are all included in the range, as are accessories such as flexible card handles and direct or indirect connectors.

Enclosures supplied by BICC-Vero range from simple plastic boxes to keyboard enclosures, flip-top cases and multipurpose metal cases. Also available are such important items as tilt-leg assemblies and battery holders.

Finally, BICC-Vero provides a very wide range of accessories and tools, including pins, standoffs, sockets, etch-resist transfers, cutters, strippers and insertion tools.

For extra information contact BICC-Vero Packaging, Retail Dept., Industrial Estate, Chandlers Ford, Eastleigh, Hants SO5 3ZR. Tel: (04215) 62829.



B.K. Electronics

B.K. Electronics was formed in 1980 and is now well established as a supplier of audio equipment, loudspeakers, power amplifiers, etc., and a large proportion of business has been obtained through advertising in 'Hobby Electronics'.

During 1982, B.K. Electronics entered the test equipment market, and as with their audio products, the test equipment has been equally successful. The test equipment range consists of oscilloscopes, signal generators, pulse generators, bench and hand-held digital multimeters, analogue multi-meters, digital thermometers, digital capacitance meters etc. The Thandar range, is shown in our illustration (top to bottom): SC110A 10MHz Portable Oscilloscope £171.35, TG100 Function Generator £90.85, TG105 Pulse Generator £97.95, TF200 200MHz Frequency Meter £166.75, TM351 Digital Multimeter £113.85, Optional Bench Rack £22.94. (All prices include VAT).

An item of test equipment which has proved very popular and successful with the 'Hobbyist' is the Banana multimeter which is extremely robust and includes a shock proof movement.

The Banana multimeter is supplied with a soft carry case and is priced at £19.95. All items of test equipment purchased from B.K. Electronics are supplied carriage FREE. All items are available by Mail Order, although visitors are welcome.

For further information please contact Barry Pearce, B.K. Electronics, Unit 5, Comet Way, Eastwood, Southend-on-Sea, Essex. Tel (0702) 527572. Large SAE, 20p stamp for technical literature.



S&R Brewster

S&R Brewster Ltd. manufacture SRB and Ceco-Varistat soldering irons and accessories. There are basically six irons in the range, but all are available in various voltages, making the variations quite considerable.

The Type 1 soldering iron is the most popular in the range and it has been designed to be sold at a general purpose price, averaging £5.46 including VAT, but at the same time built to the highest quality possible, for example, each iron is individually tested when hot at 1500

The D5CTC iron is a general purpose 50 watt temperature controlled iron having a built-in thermostat in the handle, and its average price, including VAT is

£14.20. This iron is very suitable where different or stable temperatures are required. Interchangeable bits are available for this iron. The other irons in our range are larger being: Model H70, 70 watts un-controlled; Model H150TC, 150 watts temperature controlled; Model K200, 200 watts un-controlled; Model K500TC, 500 watts temperature controlled.

Brewster is proud to be able to state all spare parts for irons are readily available directly, if there is difficulty in obtaining them from your local retailer, with no minimum order charge for any components or spare parts, as long as the postage is paid for. This is marketing policy so that an iron purchased as long as five years ago can still be serviced, without the need to throw the iron away and buy a new one.

If there are any queries on this subject they will be pleased to hear from any person and will be very pleased to help in any way that they can. The address is **S & R Brewster Ltd., 86-88 Union St., Plymouth PL1 3HG. Tel: (0752) 665011.**



Candis

Candis Electronics Ltd. do a comprehensive range of temperature sensing equipment which comprises of a variety of sensors, including thermocouples, platinum resistance and thermistors, all of our own manufacture.

A wide range of instrumentation is available from temperature indicators, controllers and chart recorders to the recently introduced **Therma 1** digital thermometer, price £57.00. This is a hand held instrument with a large LCD which will measure temperature in the range of -50° to $+1150^{\circ}\text{C}$ with 0.1° and 1° resolution. The **Therma 1** enables a wide range of temperature measurement to be monitored including solids, semi-solids, surfaces, liquids, air and gases via standard plug in probes. All probes are interchangeable with miniature thermocouple plugs.

Candis Electronics are also agents for many leading instrument companies including **Avo, Thorn EMI, Electro serv and Jenway.**

Instrument repairs are also undertaken. Also most other types of instrumentation — megors, tachometers, loop test and multimeters, can be supplied. Prices on application to **Candis Electronics Limited, Highdown Works, Highdown Avenue, Worthing, West Sussex BN13 1PU. Tel: (0903) 690750.**

Centemp

Centemp specialises in measuring instruments, and the range comprises panel thermometers (£89.00 plus VAT centigrade, £95.00 plus VAT Fahrenheit); hand held digital thermometers (£64.00 to £99.00) plus accessories; a hand held digital multimeter; a hand held digital capacitance meter, and variety of thermocouples and resistance thermometers with fitted plugs.

Model **DMM3T** is a battery operated $3\frac{1}{2}$ digit hand held digital multimeter with a bold 0.5in LCD, six functions in sixteen ranges of DC and AC voltages, DC current, resistance, diode/continuity check and HFE measurement; push button control and compact, robust construction. Supplied complete with battery, test leads and instruction manual.

For more information, contact **Centemp, 62 Curtis Rd., Whitton, Hounslow, Middx. TW4 5PT. Tel: 01 894 2723.**

Crotech

Crotech Instruments Ltd. offer a complete range of six oscilloscopes, which cover the frequency range from 15 to 30MHz and include two battery operated models. Over the last two years the range has gained wide acceptance in the educational, industrial and hobby markets.

As far as the dedicated hobbyist is concerned there are two models which are of prime interest, the **3030 Single Trace** and the **3131 Dual Trace.**

The **3131** gives a bandwidth of DC-15MHz with a sensitivity of 5mV/Div on both channels, also the vertical channels can be algebraically added or subtracted. This feature is extremely useful for accurate frequency comparison, and, of course, for getting rid of unwanted noise, such as mains hum, which can sometimes mask the true waveform. If there is the need to display Lissajou's figures then the **3131** can be put into the XY mode by simply depressing a single push button. In this mode channel two becomes the X (horizontal) amplifier while channel one remains as a Y amplifier, hence matched sensitivity is maintained in both axes. The versatile amplifier system is fully complemented by a wide range timebase which operates from 200ns/Div to 0.2s/Div, while the trigger circuit is capable of reliable triggering up to 35MHz.

For further information, contact **Crotech Instruments Ltd., 5 Nimrod Way, Elgar Rd., Reading, Berks RG2 0EB. Tel: (0734) 866945.**

Cooper Tools

Cooper Tools Ltd. is one of the biggest suppliers of tools in the UK. For the electronics enthusiast, they supply pliers, cutting and long-nosed pliers, all kinds of screwdriver, measuring tapes, files, metal snippers, the **Xcelite** electrician's knife, a special heat-sink gripper for handling delicate electronic

components, and **Weller** soldering irons.

For information or product leaflets, contact **Mr. Bird, Cooper Tools Ltd., B M Group, 9 Kingsway, London WC2. Tel: 01 836 0089.**

Danesbury

Danesbury Instruments is a leading **Hitachi** Measurement distributor, specialising in oscilloscopes. Of particular interest to the amateur is **Model V-202F**, a 20MHz dual-trace instrument offering a very wide range of facilities, professional standards of construction and reliability, but at an affordable price of only £295.00 plus VAT.

The range of more basic 'scopes runs from a dual-trace 15MHz instrument (**Model V-152F** at £260.00 plus VAT) to a 35MHz type with Sweep Delay (**Model V-353F** at £495.00 plus VAT). For the more affluent user the range extends up to 100MHz Quad-trace and to Storage types!

Danesbury also offer a wide range of other test and measuring instruments ranging from simple analogue multimeters to top-quality digital multimeters, RF signal generators, frequency counters, etc. They are distributors for **Coline** and offer a selection of top-quality test lead sets and 'scope probes, together with a wide range of other accessories. Many of these are in the serious hobbyist price range.

Details of the full range are set out in an attractive short-form catalogue available from **Danesbury**, who are happy to supply direct to the amateur and home constructor. Contact: **Danesbury Instruments, 22 Parkuay, Welwyn Garden City, Herts AL8 6HG. Tel: (07073) 29112.**



Farnell Instruments

Farnell Instruments Ltd., market a wide range of test and measuring instruments of interest to the electronics hobbyist. These include multimeters, oscilloscopes, bench power supply units, sine/square wave oscillators and function generators.

Multimeters available range from $3\frac{1}{2}$ digit hand held models right up to a $5\frac{1}{2}$ digit laboratory grade instrument for professional use and prices start at around £20.00 (plus VAT).

Of great importance to the electronics hobbyist is a source of power. **Farnell** can help here too with a comprehensive range of bench power supplies that includes single, dual and triple output units, metered and un-metered, with a wide range of voltage/current output ratings.

Prices start at £84.00 (plus VAT) for a 0-30V, 0.5A or 0-15V, 1A model.

Also of interest to the hobbyist is the Farnell range of sine/square wave oscillators and function generators. Sine/square wave oscillator prices start at £135 (plus VAT) for a 10Hz to 1MHz, 1mV to 12V model, the LF1, and the FG function generator, at £170 (plus VAT), offers 0.02Hz to 200kHz, 100mV to 12V performance.

For further information contact: Farnell Instruments Ltd., Sandbeck Way, Wetherby, W. Yorks LS22 4DH. Tel: (0937) 61961.

Gould Instruments

Gould is one of the world's largest manufacturers of test and measurement instruments, in particular oscilloscopes, chart recorders and logic analysers, mostly aimed at the professional, R & D and production markets.

However, the company has always had a presence in the lower-cost end of the marketplace, ever since it acquired the British firm Advance Electronics in 1974.

The OS300, which costs £285 (plus VAT), is a dual-trace 20MHz general-purpose oscilloscope which incorporates many facilities normally included in more expensive higher-bandwidth oscilloscopes, and Gould is endorsing its confidence in the quality of this oscilloscope by offering a standard 2-year guarantee with it.

The OS300 is housed in a rugged case measuring 140 x 305 x 460mm and weighing 5.8kg, and is supplied with a fully adjustable handle.

Gould Instruments Division, Roebuck Road, Hainault, Ilford, Essex.



GSC

GSC, short for Global Specialties Corporation, is well established in the hobby electronics market as a supplier of breadboards and assembly aids, and over the last few years has become increasingly known for low-cost, professional-quality test instruments.

GSC's first move into this market was with logic probes, and the company now produces a range of models including one specifically aimed at high-speed ECL circuitry and one, ideally suited to the hobbyist, which is available in kit form. A

digital pulser is also produced.

GSC also produces a wide range of frequency counters and timers, ranging from small, direct-reading hand-held units like the MAX-550 to sophisticated benchtop instruments like the 5001 universal counter-timer and the 650MHz-bandwidth 6001 frequency counter. These are complemented by allied products such as the 4401 frequency standard, the 2001 function generator, the 4001 pulse generator, and the 3001 digital capacitance meter.

The company's latest product is the 8001 oscilloscope multiplexer, which converts a general-purpose single- or dual-channel oscilloscope into an eight-channel instrument.

The 8001 which is priced at £225 (plus VAT), allows oscilloscope users to view events occurring synchronously or asynchronously, and the user can observe all eight channels at once or one of two 4-channel combinations.

For information contact Global Specialties Corporation, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.



Hameg Ltd.,

Hameg Ltd., supply a range of low-cost oscilloscopes and accessories.

The HM203-4 is the updated version of this now most popular oscilloscope. The improvements include the addition of a new 8 x 10 cm rectangular screen with internal graticule, built in component tester, plus trace invert and Add Mode together with variable gain controls extending the sensitivity to 2 mV/cm. New in the Hameg range of low profile oscilloscopes is the HM204 Multi-Function oscilloscope, incorporating an 8 x 10 rectangular CRT with internal graticule, 2 x 20MHz, maximum 2mV/cm. (1% overshoot), built in component tester with single button operation, timebase 20ns/cm to 2s/cm (including magnification x 10), trig. bandwidth 50MHz (internal at 5mm) plus delayed sweep 100ns to 1s, Add Mode and Invert Function plus automatic peak value triggering and variable hold-off, and more.

The HM103 is the new version of Hameg's single trace light-weight portable oscilloscope with built in component tester.

The Hameg policy remains that of providing the maximum versatility with a simple operation at low cost. Performance quality and value plus great durability.

Hameg Ltd., 74-78 Collington Street, Luton, Beds LU1 1RX. Tel: L582 413174.

Hi!

House of Instruments is a specialist test and measurement company, providing a reliable service to the hobby and education market as well as to industry.

Oscilloscopes, the most used piece of test instrument, are of the well known Trio brand with more than 20 types available from DC through 1, 5, 10, 15, 20, 30, 40, 60, 70 and 100 MHz bandwidth and prices from just over £100 to suit all requirements and pockets. Also available from Trio are AF, RF, stereo, TV and function generators; grid dip oscillators; power, VSWR and frequency meters; variable bench power supplies; multimeters, both analog and digital; noise meters and acoustic measuring systems. All Trio instruments are in a short form catalogue which is available on request.

More than 30 multimeters both analogue and digital are readily available from House of Instruments with prices starting at £6.00 to meet all requirements.

Most instruments are available from stock, and purchasing is made as easy as possible with regular account, various credit cards, cheque or cash payments. Area distributors throughout the UK cater for local needs. Most instruments are fully guaranteed for one year but Trio products are fully guaranteed for two years. All data and price lists are supplied free of charge and can be readily acquired by letter or telephone; just say you saw it in Hobby Electronics. Write to: House of Instruments, Clifton Chambers, 62 High Street, Saffron Walden, Essex CB10 1EE. Tel: (0779) 24922.

Lascar

Lascar Electronics have a range of test instruments in kit form which would interest Hobby readers.

The DP100K is a handheld thermometer capable of measuring between -50° to +150°C with a resolution of 0.1°C. The sensor is a small integrated circuit, the AD 590KF, giving excellent accuracy.

The DP2010K is a digital multimeter with six functions (DC volts, AC volts, DC current, AC current, resistance, diode check) and 21 different measurement ranges. The instrument has an extremely low current consumption, giving a battery life of 2,000 hours.

A small instrument especially for vehicle use, the DP400 Minitune will measure volts, resistance, RPM and dwell angle. It is very useful on all types of vehicle for optimum engine setting.

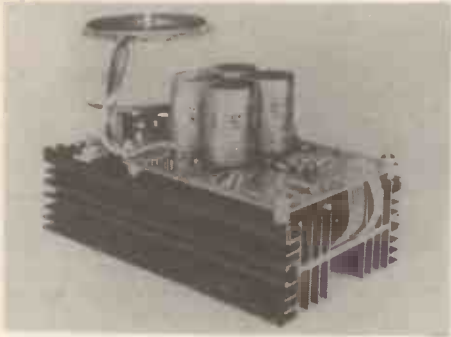
The DP600K is a digital capacitance meter capable of measuring between 1pF and 20 microfarads. The display is automatically updated with changes of capacitance.

All these kits are supplied fully complete (except PP3 battery), including probes or test leads as appropriate. They contain comprehensive assembly instructions and clear descriptions of operation.

At the moment all these instruments

THE VELLEMAN KIT K2587 MOSFET POWER BOOSTER

240WATT



Specification:

- 240 watt power at 4 Ohm load
- Frequency Response: 20-20KHz + 0.1db
- THD (1KHz): 0.05%
- IMD: 0.07%
- Signal/Noise Ratio: 100db
- Damping (4 ohm, 40Hz): 200
- Output impedance: 4-8 Ohms
- Input Sensitivity: 800mV
- Quiescent current compensation
- Thermal protection: 75 °C + 5%
- Short Circuit Protected
- Heatsink, toroidal transformer and all assembly parts included.

MORE NEW KITS IN THE VELLEMAN RANGE:

- K2580** Electronic powerswitch dimmer
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- K2583** Heating controller
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- K2588** 3 channel sound to light unit

Plus ... **NEW MEMBRANE KEYBOARDS** with or without legends

PRICE £140.57 + VAT

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Tel 0424 753246



THANDAR PORTABLE TEST BENCH

A wide range of high performance instruments, at prices that are hard to beat, puts professional test capability on your bench.

COUNTERS—TF200 10Hz to 200MHz; TF040 10Hz to 40MHz; PFM200A 20Hz to 200MHz (hand-held model); TP600 prescales to 600MHz; TP1000 Prescales to 1GHz.

MULTIMETERS—TM351 0.1% 3½ digit LCD; TM353 0.25% 3½ digit LCD; TM355 0.25% 3½ digit LED; TM354 0.75% 3½ digit LCD (hand-held model); TM451 0.03% 4½ digit with autoranging and sample hold.

OSCILLOSCOPE—SC110A 10MHz, 10mV sensitivity, 40mm CRT with 6mm graticule divisions.

THERMOMETERS—TH301 —50°C to +750°C, 1° resolution; TH302 —40°C to +1100°C and —40°F to +2000°F, 0.1° and 1° resolution. Both accept any type K thermocouple.

GENERATORS—TG100 1Hz to 100kHz Function, Sine, Square, Triangle Wave; TG102 0.2Hz to 2MHz Function, Sine, Square, Triangle Wave; TG105 5Hz to 5MHz Pulse, Free Run, Gated or Triggered Modes.

LOGIC ANALYSERS—TA2080 8 channel 20MHz; TA2160 16 channel 20MHz.

ACCESSORIES—Bench rack, test leads, carrying cases, mains adaptors, probes, thermocouples etc.

Send for our latest catalogue and price list.
Thandar Electronics Ltd,
London Road, St. Ives,
Huntingdon, Cambridgeshire PE17 4HJ.
Telephone (0480) 64646. Telex 32250.



TH12

 **thandar**
ELECTRONICS LIMITED

PUTTING THE BEST WITHIN YOUR GRASP

COMPONENTS DIRECTORY UPDATE

Electronics suppliers who missed last October's directory.

J. Birkett,

25 The Strait, Lincoln LN2 1JF. Tel: (0522) 20767.
Shop open Monday to Saturday 9am to 5.30pm, closed Wednesday. Postage = 50p on orders under £5.00.

Candis Electronics Ltd.,

Highdown Works, Highdown Avenue, Worthing, W. Sussex BN13 1PU. Tel: (0903) 690750.
Specialists in temperature sensing equipment of all kinds, including thermocouples, digital thermometers, resistance and thermistor sensors. Postage = £1.50 minimum.

Cardigan Electronics,

Chancery Lane, Cardigan, Wales. Tel: (0239) 614483.
Cardigan also stock BBC, Acorn and Sinclair computers, televisions and general electronics. Opening: 10am to 5pm Monday to Saturday, closed Wednesday. Cardigan don't generally do mail order business but will accept enquiries.

Comtech Electronics,

205 Sturdee Rd., Leicester LE2 9FY. Tel: (0533) 779578.
Comtech can supply low-priced semi-conductors and passive components by return. Callers by arrangement, trade enquiries welcome. Postage = 30p on orders less than £10.00.

Crystal Electronics,

209 Union St., Torquay, Devon. Tel: (0803) 22599.
Specialists also in microcomputers. Open 9.30am to 5.30pm Monday to Saturday, closed Wednesday afternoon.

CTS,

20 Chatham St., Ramsgate, Kent CT11 7PP. Tel: (0843) 54072.
"The best little component shop in Kent" — no mail order.

Deltatech & Co.,

62 Naylor Rd., London N20 OHN. Tel: 01 445 8224.
Specialist dealer in semiconductors, mail order only. Credit = Access only.

Hobby Electronics, April 1983

Douglas,

90 Wellington St., Stockport, Cheshire SK1 3AO. Tel: 061 480 8971.
Also main stockist for Wharfedale speakers; do crossover networks, etc. Open 10am to 5pm Monday to Saturday, closed Thursday. No postal charges on orders over £5.00, otherwise by weight. Overseas customers write for quote. Credit = Access only.

J. T. Filmer,

82 Dartford Rd., Kent DA1 3ER. Tel: (0322) 24057.
Established 30 years. Shop open Tuesday to Saturday 9am to 5.30pm, Monday 9am to 5pm, closed 1-2 except Saturdays, closed all day Wednesday.

Garland Bros Ltd.,

Chesham House, Deptford Broadway, London SE8 4QN. Tel: 01 692 4412.
Established 20 years, we deal in components, audio equipment, in-car entertainment and a very large range of CB equipment, including audio and CB repairs. No mail order.

Happy Memories Ltd.,

Gladestry, Kinston, Herefordshire HR5 3NY. Tel: (054 422) 618 or 628.
Computer specialists. No shop as such, but callers are welcome. Mostly mail order; postage = 50p on orders under £5.00.

Jeel Distribution,

43 Strathville Rd., London SW18. Tel: 01 870 0075.
"We are originally industrial suppliers who opened a shop for hobby buyers six months ago. Please drop in." Shop hours 9am to 5pm weekdays
Orders (and postage) will be invoiced.

Letchworth Electronic Components,

25 Ridge Rd., Letchworth, Herts SG6 1PW. Tel: (04626) 79681.
Specialists in valves, as well as general components; can get old valves to order. Mail order only. Postage = 57p minimum.

Pops Components,

38 Lower Addiscombe Rd., Croydon CRO6AA. Tel: 01 688 2950.
Open 9.30am to 5pm Monday to Saturday, not Wednesdays. General component suppliers, also carry quite a large range of valves.

Roadrunner Electronic Products Ltd.,

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Open 9am to 6pm Monday to Friday, half day Thursday. Will supply all kinds of components to hobbyists; also to government departments, schools, colleges with official orders.

Shudehill Supply Co. Ltd.,

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Target Electronics,

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64 Broad Street, Staple Hill, Bristol BS16 5NL. Tel: (0272) 565472.
We are major stockists of obsolete electronic components, especially valves, and operate on a mail order basis as well as personal calls. We try and offer a personal service and have a huge library of service data. The range of services include: sale of TV and radio receivers, 1914 to 1954; spare parts for the same; radio, TV and industrial valves, service data, sales data, vintage radio and TV; restoration and overhaul (but not basic repairs) of valve domestic and car radios of all types; new and used books and magazines, often dating back to the First World War!; hire of radio props for drama; sale of restored radios with guarantee; publication of *The Antique Wireless Newsheet* — contact us for subscription rates. Credit card orders accepted by phone. Catalogue £1.50, refundable with order £10.00 or over; monthly newsletter sub. £3.00 a year, free sample on request.

NOTES:

- (1) Including ferrites, RF chokes, etc.
- (2) Discrete Devices.
- (3) Other than optoelectronic.
- (4) Access and Barclaycard, where marked.
- (5) See company listings, overleaf.
- (6) In pence. N = no minimum. SAE = please send stamped self-addressed envelope. W = please write with requirements for carriage charges.

	RESISTORS	CAPACITORS	POTENTIOMETERS	TRANSFORMERS	INDUCTORS (1)	DIODES, SCRs TRIACS	TRANSISTORS (2)	LINEAR ICs	DIGITAL ICs	LINEAR MSI/LSI	DIGITAL MSI/LSI	OPTOELECTRONICS	VALVES	RELAYS	SWITCHES	FUSES AND PROTECTION	BATTERIES AND PSUs	ANALOGUE PANEL METERS	TRANSDUCERS (3)	PCB HARDWARE	
J. S. BIRKETT																					
CANDIS ELECTRONICS																					
CARDIGAN ELECTRONICS																					
COMTECH ELECTRONICS																					
CRYSTAL ELECTRONICS																					
CTS																					
DELTATECH																					
DOUGLAS																					
T. T. FILMER																					
GARLAND BROS.																					
HAPPY MEMORIES																					
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LETCHWORTH COMPONENTS																					
POPS COMPONENTS																					
ROADRUNNER ELECTRONIC																					
ROBEK ELECTRONICS																					
SHUDEHILL SUPPLY																					
SPECTRON ELECTRONICS																					
TARGET ELECTRONICS																					
VINTAGE WIRELESS CO.																					

PLUGS AND SOCKETS	ENCLOSURES, CASES	HEATSINKS	KNOBBS, MISC. HARDWARE	CABLE AND WIRE	BREADBOARDS	TOOLS	PCBs and/or MATERIALS	CHEMICALS	CUSTOM KITS, MODULES	SURPLUS SUPPLIES	BARGAIN PACKS	BOOKS	CATALOGUE/PRICE LIST (6)	MAIL ORDER MINIMUM (6)	P&P (6)	OVERSEAS ORDERS	CREDIT CARDS (4)	SHOPS	OTHER
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NOTES:
 (1) Including ferrites, RF chokes, etc.
 (2) Discrete Devices.
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													SAE	(5)						J. S. BIRKETT
													SAE	(5)	W					CANDIS ELECTRONICS
													(5)							CARDIGAN ELECTRONICS
													SAE	(5)						COMTECH ELECTRONICS
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													SAE	20						DELTATECH
													SAE	(5)						DOUGLAS
																				T. T. FILMER
																				GARLAND BROS.
														(5)						HAPPY MEMORIES
													45		(5)					JEE DISTRIBUTION
													65							LETCWORTH COMPONENTS
														60						POPS COMPONENTS
													SAE (5)	(5)		(5)				ROADRUNNER ELECTRONIC
													SAE 200	35						ROBEK ELECTRONICS
														(5)						SHUDEHILL SUPPLY
													SAE (5)	(5)						SPECTRON ELECTRONICS
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6522 340p	2114L 90p	BC108 12p	BD680A 65p	TIP36B 189p	2N3823 95p	6.000MHz 180p
6800 290p	2716 210p	BC108B 15p	BF50 24p	TIP36C 199p	2N3824 95p	6.144MHz 180p
68800 450p	2532 380p	BC109 12p	BFY51 24p	TIP41 50p	2N3866 90p	6.880MHz 240p
6802 345p	1116 75p	BC109B 12p	BFY90 85p	TIP41A 50p	2N3903 15p	8.000MHz 180p
6809 845p	4164 500p	BC109C 15p	BZ44A 30p	TIP41B 60p	2N3904 15p	10.000MHz 170p
68B09 135p	6116P3 39p	BC109C 15p	BSX19 28p	TIP41C 50p	2N3905 15p	16.000MHz 190p
6809E 1295p	6116LP3 45p	BC117 9p	BSX20 20p	TIP42 58p	2N3906 15p	16.000MHz 190p
6810 120p		BC117 9p	MJ2955 95p	TIP42A 60p	2N4123 25p	18.432MHz 150p
68B21 215p		BC158 9p	MJE241 80p	TIP42B 75p	2N4125 25p	19.608MHz 240p
6840 390p		BC178 25p	MJE251 80p	TIP42C 65p	2N4331 70p	20.000MHz 200p
68B40 450p		BC179 25p	MJE340 35p	TIP47 50p	2N4332 70p	27.000MHz 170p
6844 1295p		BC182 10p	MJE350 90p	TIP48 50p	2N4400 20p	48.000MHz 170p
6845 795p		BC182A 10p	MJE370 95p	TIP49 50p	2N4401 25p	
6850 140p		BC182B 10p	MJE520 90p	TIP49 50p	2N4402 25p	
6852 250p		BC182C 10p	MJE2955 90p	TIP110 30p	2N4403 25p	
6854 680p		BC183A 10p	MJE3055 65p	TIP111 35p	2N4410 45p	
6875 490p		BC184 95p	MJE102 25p	TIP112 50p	2N4416 95p	
8126A 120p		BC184C 10p	MR475 290p	TIP115 40p	2N4856 80p	
8128 120p		BC184C 10p	MPS2369 25p	TIP116 73p	2N4857 80p	
8195 90p		BC184C 10p	MPS3640 30p	TIP117 45p	2N4818 95p	
8197 90p		BC184C 10p	MPS3646 30p	TIP120 39p	2N4819 120p	
8198 90p		BC184C 10p	MPSA06 20p	TIP121 80p	2N4920 130p	
8198L 340p		BC184C 10p	MPSA12 35p	TIP122 75p	2N4921 105p	
8039L 290p		BC184C 10p	MPSA13 20p	TIP125 45p		
8080A 360p		BC184C 10p	MPSA14 20p	TIP126 80p		
8085A 450p		BC184C 10p	MPSA18 20p	TIP140 130p		
8155 450p		BC184C 10p	MPSA27 45p	TIP141 140p		
8212 155p		BC184C 10p	MPSA42 25p	TIP142 180p		
8216 100p		BC184C 10p	MPSA56 25p	TIP145 140p		
8224 160p		BC184C 10p	MPSA63 40p	TIP147 170p		
8226 195p		BC184C 10p	MPSA77 50p	TIP2955 70p		
8228 250p		BC184C 10p	MPSA92 30p	TIP2955 70p		
8243 210p		BC184C 10p	TIP29 35p	TIP3055 70p		
8251 300p		BC184C 10p	TIP29A 35p	TIS43 30p		
8253 450p		BC184C 10p	TIP29B 55p	TIS88A 48p		
8255 280p		BC184C 10p	TIP29C 40p	TIS151 50p		
8257 450p		BC184C 10p	TIP30 50p	2N1613 25p		
8259 450p		BC184C 10p	TIP30A 35p	2N1711 25p		
8279 450p		BC184C 10p	TIP30C 40p	2N1893 35p		
75451 65p		BC184C 10p	TIP31 40p	2N2218A 45p		
75452 65p		BC184C 10p	TIP31B 42p	2N2219 25p		
75491 70p		BC184C 10p	TIP31C 45p	2N2221A 30p		
75492 70p		BC184C 10p	TIP32 50p	2N2222 25p		
AY-3-1015D 300p		BC184C 10p	TIP32A 50p	2N2222A 25p		
AY-5-1013A 300p		BC184C 10p	TIP32B 60p	2N2369A 20p		
MC1408 295p		BC184C 10p	TIP32C 45p	2N2904A 25p		
MC1488 55p		BC184C 10p	TIP33 65p	2N2905 25p		
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MC3459 265p		BC184C 10p	TIP33B 70p	2N2907A 25p		
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280APID 300p		BC184C 10p	TIP34 75p	2N3054 70p		
280AOCTC 300p		BC184C 10p	TIP34A 75p	2N3055 45p		
280ADART 750p		BC184C 10p	TIP34B 99p	2N3439 80p		
		BC184C 10p	TIP34C 90p	2N3440 80p		
		BC184C 10p	TIP35 160p	2N3771 160p		
		BC184C 10p	TIP35A 165p	2N3772 160p		
		BC184C 10p	TIP35B 170p	2N3773 250p		
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are subject to a Special Offer which is due to expire on 31.3.83, but we would be pleased to extend this to 30.6.83 to readers mentioning Hobby Electronics with their order.

Write to Lascar Electronics, Oaklands House, Reeves Way, South Woodham Ferrers, Chelmsford, Essex CM3 5XQ. Tel: (0245) 329797.

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The Adamin 12 miniature 12 watt iron which weighs only 15 grams (less flex), handles like a ball-point pen and is particularly suitable for really fine work and to fit the small hands of young beginners. Like the LC18 and LA12 irons, this model is available in mains or low-voltage version. All the above irons feature non-seize bits, mounted over the heating elements for exceptionally high thermal performance from comparatively low wattages. A wide range of interchangeable shapes and sizes is available, in both copper and long-life finishes.

Litesold also offer many other essential items, including pliers, cutters, tweezers, cordless irons, miniature tool sets and wire strippers. Details are available in a 16 page full colour catalogue, price 60p.

For further details contact: **Ann Storer, Light Soldering Developments Limited, 97/99 Gloucester Road, Croydon, Surrey. Tel: 01 689 0574.**

Magenta Electronics

The tools and test equipment stocked by **Magenta Electronics** have been chosen with the beginner in mind. Our range includes soldering equipment, multimeters, magnifiers, pliers, cutters, 12V PCB drill and accessories, PCB materials, vices, punches, test leads and probes, etc. Details and pictures of the above are in our illustrated catalogue (80p in stamps, please). Also in the catalogue are details of our wide range of components and kits.

Magenta Electronics Ltd., 135 Hunter Street, Burton-on-Trent, Staffs DE14 2ST. Tel: 02 83 65435.

Neill Tools

Neill Tools is one of Europe's leading hand tool manufacturers. Their extensive range of high quality products includes: Eclipse hacksaw blades, general purpose and small saws, DIY tools, magnets and magnetic tools; Moore & Wright micrometers and other precision measuring tools; Stubs engineers' files, precision and needle files; Elliott Lucas engineers' and electricians' pliers, wire strippers and cable cutters.

Many of these tools will be of particular interest to readers of Hobby Electronics. For cutting sheet metal and other light section there is a choice of the Eclipse 20T hacksaw which takes a 10in or 12in blade or the 657 hacksaw and 14J junior saw which both take 6in blades. The Stubs range of files has hand files for general smoothing and fitting through to needle files for precision work on chassis units, escutchion plates etc. Measurement and marking out tools such as calipers, dividers, punches, scribes, rules etc. are catered for in the Eclipse and Moore & Wright ranges and Elliott Lucas covers practically every type and pattern of plier. The 1000 series pliers are particularly useful, being specially designed for instrument and electronic technicians.

All these tools are available from leading tools dealers throughout the UK. Neill Tools do not supply direct but they will be pleased to give assistance when required (ask for extension 392). Contact **Neill Tools Ltd. Tel: Sheffield (0742) 71281.**



Philips

The Philips test and measurement range, among the world's largest, includes many good buys for the hobby engineer — high-performance, high-reliability instruments at reasonable cost and good investment value.

The still-unique PM 2521 multimeter — the first 'digital measurement centre' or DMC — is a microprocessor-controlled multipurpose meter that gives you more than twice the capability of a medium-price DMM for about the same of £338 (plus VAT).

Other multimeters in the range include the ever-popular PM 2517 DMM, a full four digit instrument with choice of LED or LCD display, measuring current up to 10A, voltage up to 1000VDC/600VAC and resistance up to 10MΩ. A range of accessories brings in temperature, data-hold, high current (100A) and high voltage (30kV) capability. UK price is £165 (plus VAT). Philips analogue multimeters include the sophisticated 62-range PM 2505 with 0.01 μA — 10A 1mV, 1000V, 1R to 30MΩ capability and accurate linear resistance scale (£151 plus VAT) and the budget-price PM 2502 with only slightly lower performance for only two-thirds the cost.

The PM 3207 15MHz dual-trace oscilloscope is certainly well-proven and still in great demand (in a now-improved high-brightness version). It offers auto, TV triggering, large 8 x 10cm screen, same sensitivity on X and Y channels, B-invert, triggering from A or B channel and double insulation — all for £372 plus VAT.

Philips test and measurement instruments are marketed in the UK by the **Philips Electronic Instruments Department of Pye Unicam Ltd, York Street, Cambridge CB1 2PX. Tel: (0223) 358866.**

Henri Picard

Henri Picard specialises in the supply of small tools for non-automated printed circuit board production. These include pliers, cutters and tweezers in all shapes and sizes; soldering and de-soldering irons and accessories; board holders; insertion and extraction tools; lead benders; fault markers; drills and inspection lenses.

Picard also does a miniature screwdriver, which can be carried on a key ring. The body is brass, and the blade width of 1.5mm makes it suitable for screws in spectacle frames, cameras and small electrical assemblies. The price is £0.80p each, £2.30 for three, including

Feature

p&p and VAT. Quantity discounts are available.

A new 48 page, fully illustrated catalogue has just been published. Copies are available price £1.50. Write to: **Henri Picard & Frere Ltd., 357-359 Kennington Lane, London SE11 5HV. Tel: 01-735 9805.**

Roadrunner

Developed and manufactured in Haslemere, our most well known product is the Roadrunner prototype wiring system. This system uses the 'solder wrap' technique and consists of a wiring pencil, and wire retention channels (or strips). Using your parts list and circuit diagram the components used are laid out on the circuit board.

Next, the wiring channels are positioned next to the component leads on the wiring side of the board. Two types of channel are available, press fit for use on boards having 1.02mm diameter holes or 2.54mm pitch matrix, and glue fix, which can be used on any board and are simply fitted using a contact adhesive.

To make a connection the wiring pencil is used. Fitted with a full bobbin of quick soldering enamel (QSE) wire, the pencil routes the wire from one component lead to the next in the circuit via the wiring channels (clearly indicated in the photograph). Having completed the circuit, all joints are then soldered (tip temperature 420°C min.).

As mentioned above we supply a range of prototyping boards. We also stock various other wiring aids and tools, particularly useful for the home engineer. Please note: our wiring system and boards are now available from Watford Electronics.

Contact: **Tim McBrown, Roadrunner Electronic Products Limited, Unit 3, The Haslemere Industrial Estate, Weydown Road, Haslemere, Surrey GU27 1DW. Telephone: (0428) 53850.**

Scopex

In a recently conducted market survey Scopex Instruments have discovered that the most requested item to complement the oscilloscope is a function generator.

The SG315 is a 14MHz precision oscilloscope combined with a function generator providing a comprehensive test, measurement and demonstration instrument at the incredibly low price of £270 plus VAT.

The function generator part of the instrument reflects the careful thought for the user given to all Scopex products. The generator features sine, square and triangular waveforms over the range 0.2Hz to 250KHz, frequency selection is by push buttons and calibrated variable. A VCF input provides the means by which an external voltage can sweep the generator over its frequency range.

Both oscilloscope and function generator are available as separate instruments and the function generator is available in chassis form for retro-fitting to any of the Scopex present or past range of dual trace oscilloscope.

The SG315 is the combined 15MHz oscilloscope and function generator. The FG4 is the function generator in chassis form for fitting to the 4D10, 4D10A or 4D10B. The FG14/25 is the function generator in chassis form for fitting to the 4D25, 14D10, 14D10V, 14D15. The FG1 is the function generator in its own instrument case.

The SG315 is the fifth model in the Scopex range. For details of the other four (all in a similar price bracket) contact: **Scopex Instruments Ltd., Pixmore House, Pixmore Avenue, Letchworth, Herts SG6 1HZ. Tel: (04626) 72771.**



Black Star

A wide range of low-cost test instruments are available from **Black Star Ltd.** who are the exclusive importers for Sabtronics and Elemic and provide a complete service facility for these products.

Sabtronics: The large range of Sabtronics portable test instruments are manufactured in Switzerland and include frequency counters, multimeters, signal generators and a logic probe. Originally renowned for their Test Instrument Kits, Sabtronics now concentrate on assembled products.

The three models of bench/portable frequency counters, 8110A — 100MHz, 8610B — 600MHz and 8000B — 1GHz, have exceptional sensitivity ie 20mV at 100MHz, 30mV at 600MHz and 45mV at 1GHz. Operating from either 4 x 'C' cells or an optional mains adaptor, Sabtronics frequency meters offer a professional specification at a low price with the 8110A 100MHz model at £77.05, the 8610B 600MHz model at £113.85 and the 8000B 1GHz model at £178.25 (prices include VAT).

The 2037A hand-held 3½ digit LCD multimeters, in addition to high accuracy (basic DC 0.1%) and measurements up to 1000V (AC and DC), 2A (AC and DC) and 20MR resistance, also offers temperature measurement from -50°C to +150°C.

The low cost hand-held 3½ digit LCD multimeter model 2033A at £42.26 (including VAT) offers 0.5% basic DC accuracy.

Elemic: The Elemic analogue and digital multimeters feature superb Italian styling and craftsmanship and full mains protection on all ranges.

The Super Series of analogue meters are protected up to 50,000V. The Super

Electro model with 20kR/V sensitivity has 56 ranges

Crotech: Black Star also stock the complete range of Crotech oscilloscopes, 15MHz — 30MHz single and dual trace.

An illustrated catalogue and price list for low cost test instruments is available from: **Black Star Ltd., 9A Crown Street, St. Ives, Huntingdon, Cambs PE17 4EB. Tel: (0480) 62440.**

Tele-Production

Tele-Production Tools Ltd., as the name implies, specialises in production of quality tools and aids for tele-communications and electronics industries, and their products are in daily use by small and multinational companies.

The new illustrated two-colour brochure for the electronic hobbyist describes along with the whole range a temperature controlled soldering station which incorporates a temperature indicating meter on the front panel, and the iron is continuously variable from 100-500°C.

Two de-solder guns are offered. One is a standard 19mm diameter gun, whilst the other is a miniature version only 14mm diameter x 165mm long. A selection of de-solder wicks are also offered, from 0.8mm wide (for cleaning plated through holes of PCBs) to 2.7mm wide for larger terminals and lugs.

Another interesting item is a Solder-Aid Set for PCB work. The set comprises three double-ended tools incorporating a stainless steel brush, a fork, fine knife, scraper, hook and a reamer.

A selection of miniature and standard size cutters and pliers are also included in the brochure, as well as ratchet clamps, general purpose knives, and hand-vices.

The brochure is available free of charge upon receipt of a stamped, addressed envelope. Contact **Tele-Production Tools Ltd., Electric Avenue, Westcliffe-on-Sea, Essex SS0 9NW. Tel: (0702) 352719.**

Telonic Instruments

Telonic Instruments Ltd. was originally established in Maidenhead in 1965 as the subsidiary of an American company to sell and service the range of RF products of its then US parent to the professional market. Telonic Instruments Ltd. has also for the past three years been marketing the products of Kikusui Electronics Corporation. In particular Kikusui's oscilloscope range has found considerable acceptance by many of UK's largest electronic companies, universities, government research departments and others.

During 1982 Kikusui introduced a new range of middle performance oscilloscopes — the COS 5000 series. The COS 5000 series, a range of five oscilloscopes with bandwidths ranging from 20 to 60MHz although designed primarily for professional usage COS 5000 oscilloscopes have a number of features which make them attractive to the serious hobbyist.

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nel oscilloscopes with 10 x 8cm flat screen CRTs with internal graticules, Channel 1 only, Channel 2 only, dual channel, Add and Invert vertical modes. All are capable of XY operation using Channel 1 as the horizontal input and Channel 2 as the vertical input.

Enquiries to Telonic Instruments, 2 Castle Hill Terrace, Maidenhead, Berkshire. Tel: Maidenhead 73933.

Thandar

Thandar Electronics, the St Ives based instruments manufacturer and supplier, offers a broad range of test equipment covering most applications. Thandar's policy of providing quality cost-effective products means that in each range more facilities are provided with high specification. Professional instruments are reasonably priced.

The product range includes multimeters (analogue and digital) from £39 to £149, counters to 1Ghz (£60 to £160), oscilloscopes 4MHz to 100MHz quad trace (£100 to £1400), generators function and pulse (£80 to £350), RF signal generators (£60 to £250), AF signal generators (£70 to £300), digital thermometers (£59 to £75), audio test, TV test plus logic analysers and probes.

The Thandar range of test and measurement equipment is ideally suited to the amateur, hobby and professional user. Maximum attention has been spent on ensuring adequate protection circuitry — eliminating damage caused by occasional misconnection, which of course is very important to the inexperienced user.

Thandar distributors are available in most areas willing to offer both technical and advisory support where required. For extra information contact: Thandar Electronics Ltd., London Rd., St Ives, Huntingdon, Combs PE17 4HJ. Tel: (0480) 64646.



Thorn/EMI Instruments

Thorn Instruments covers two brand names of interest to hobbyists: Avo (incorporating Taylor), and Meggar.

Avo, best known for its legendary Avometer portable all purpose meter, was formed in 1923 and has become largely synonymous with multimeters. The Avometer brand name covers a number of models apart from the 'black box'.

The Avometer 8 Mk. 5 is a general purpose multimeter for electrics and electronics. It measures up to 3000V and 10A on both AC and DC, and resistance up to 20MR. It has a two-switch range

selection and a sensitive overload cut out. It costs £120.10.

The Model DA211 is a digital hand-held multimeter which is robust, portable, especially easy to use and powered to a single PP3 battery. It can measure DC voltage over five ranges and AC voltage over two ranges; DC current over five ranges and AC voltage over two ranges; DC current over four ranges and a fifth current range to 10A DC can be introduced. Resistance can be measured over four ranges from 0 to 2MR. A low voltage diode test facility is also provided. The price is £56.50 plus VAT.



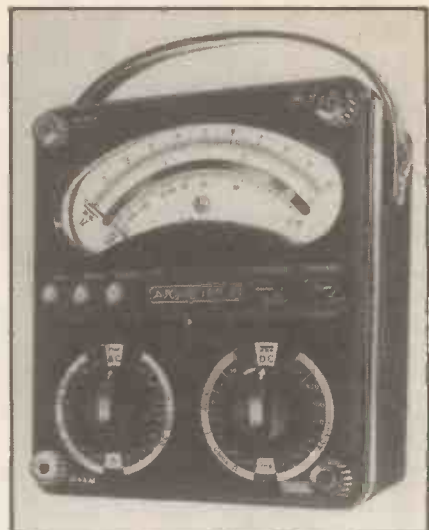
The Avo catalogue also includes the Taylor range of low-cost, analogue, hand-held multimeters for servicing and general electrical work. The Model 131 has a sensitivity 20kR/VDC and 10kR/VAC. There are six DC voltage ranges, four AC voltage ranges, three DC current ranges and three ranges of resistance. Selection of function and range is by a single rotary switch. Price is £17.10 plus VAT.

A new Avo concept in hand-held digital multimeters was launched in September 1982. The Avo 2000 series concentrated on offering a host of 'easy to use' features. The series comprises three instruments for specific applications: the Avo Digi-minor 2000, the Avometer 2000 and the Avo Vehicle Test 2002.

Housed in tough ABS cases and fitted with non-slip safety pads, the important new features of all three instruments include: direct entry probes, giving true one-hand operation; 3 1/2-digit LCD display at the base of the housing improves readability by being closer to the user; positive action slide switching with dustproof, positive range selection; improved safety, with fully shrouded plugs for the lead set; and a three-position stand so that the instrument can be used in the hand, on a bench or while hung from a hook.

The Avo catalogue also includes digital thermometers, clampmeters, light meters and a variety of multimeters in the ranges described and others.

The manufacture of Megger instruments for the purpose of electrical measurements commenced in 1903.



These include Models BM6, BM7 and BMV7, battery operated testers suitable for single voltage insulation resistance and continuity testing on domestic wiring systems and equipment, transformers, motors and generators.

All these test instruments are in a three-figure price bracket (excepting the BM7s), so are more suitable for the more serious hobbyist or for school labs, etc.

For catalogues, specifications and price lists on Avo and Megger instruments, consult your local stockist or contact: Thorn EMI instruments Ltd., Kent House, 81 Station Rd., Ashford, Kent TN23 1PJ. Tel: (0233) 36845.

Verospeed

Verospeed, part of the BICC-Vero Electronics Group, is Britain's leading distributor of branded electronic components, and its latest catalogue features over 4000 product lines from wiring aids to test instruments.

A major new development in the company's spring 1983 catalogue is the Speedwire point-to-point interconnection system, manufactured by BICC-Vero Packaging. Speedwire provides rapid point-to-point wiring using a novel insulation-displacement contact and a specially designed hand wiring pen.

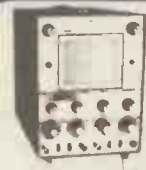
Speedwire is offered as two kits. The first, for the engineer who needs to produce simple circuits cheaply, quickly and without the need to solder, wire-wrap or crimp, contains a 100 x 160mm plain unpopulated Eurocard, contacts, hand insertion tool, wiring pen and spare wire; while the second, more comprehensive kit, designed for the engineer wishing to produce a finished product, contains a fully populated plated-through-hole Eurocard, a wiring pen, a spool of wire, spare wire spools, and a pair of Speedwire miniature cutters.

Also available from Verospeed is a high-quality range of tools aimed at the electronics industry. Made by CK Tools, the range includes pliers, tweezers, drills, instrument screwdrivers, and hexagon keys in both Imperial and metric sizes.

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BC140	28p	BD137	30p	2N2906A	23p	CA3189	280p	CA3189	280p	Green	10p	40 pin *	25p	10 BC182 NPN	
BC141	28p	BD138	35p	2N2907	23p	ICM7556	150p	ICM7556	150p	Yellow	16p			10 741 Op. Amps.	
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BC169C *	9p	BD222	60p	2N3441	120p	LF357 *	110p	LF357 *	110p	OA80	9p			2 2N5061 SCRs	
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BC182B/C	9p	BFY53	30p	2N3771 *	170p	LM380	68p	LM380	68p	BA118	7p				
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BC183B/C	9p	BU205	150p	2N3773 *	195p	LM384	125p	LM384	125p	1544	8p				
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BC213B/C	10p	BU208	160p	2N3903	10p	LM388	72p	LM388	72p	1N916	4p				
BC214B/C	9p	MJE340	40p	2N3904	10p	LM711 *	54p	LM711 *	54p	1N4148	2p				
BC237B	10p	MJE320	65p	2N4037	40p	LM741	14p	LM741	14p	1N4001	3p				
BC238B/C	10p	MJE321	78p	2N4058 *	9p	LM747	58p	LM747	58p	1N4002	4p				
BC239B/C	10p	MJE3055	68p	2N4061/2	10p	LM748	35p	LM748	35p	1N4003	4p				
BC251	10p	MPSA06	20p	2N5457	28p	LM1458	30p	LM1458	30p	1N4004/5	5p				
BC257/8	16p	MPSA07	20p	2N5458	27p	LM3900	47p	LM3900	47p	1N4006/7	6p				
BC259	16p	MPSA12	24p	2N5489	24p	MC1455	16p	MC1455	16p	1N5401 *	11p				
BC301/2	40p	MPSA15	22p	2N5550	23p	MC1458 *	33p	MC1458 *	33p	1N5402	12p				
BC303/4	40p	MPSA17	24p	2N6027	20p	MC1748	35p	MC1748	35p	1N5403	13p				
BC307A/B	10p	MPSA55	24p	2N6028	23p	RC4558	44p	RC4558	44p	1N5404/5	14p				
BC308B/C	10p	MPSA66	22p			SN76115	125p	SN76115	125p	1N5406/7	15p				
BC309A/B	10p	TP229A	34p			SN76660	110p	SN76660	110p	1N5408	16p				
BC327	12p	TP29C	30p			TA1024	130p	TA1024	130p	6A/100V	29p				
BC328	12p	TP30A	30p			TDA2002 *	96p	TDA2002 *	96p	6A/200V	32p				
BC337 *	12p	TP30C	36p			TDA2030	200p	TDA2030	200p	6A/400V	35p				
BC338	12p	TP31A	33p												
BC384	10p	TP32A	33p												
BC413C	10p	TP41A	42p												
BC414C	10p	TP42A	45p												
BC415C	10p	TP3055	59p												
BC416C	10p	TIS43	40p												
BC477	25p	TIS44	45p												
BC478 *	25p	TIS90	24p												
BC479 *	25p	TIS91 *	28p												
BC546	10p	TIS92 *	24p												
BC547B	09p	2N1613	30p												
BC548B	9p	2N2218A	25p												
BC549C	9p	2N2219A	25p												
BC556	10p	2N2221A	24p												
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THIS MONTH the component for micro-computing is the microprocessor itself! The principles of this device have already been described in the earlier 'Micro-Trainer' series, but now we return to look at a so-far-unmentioned subject, namely, 'interrupts'.

Every microprocessor system has at least one input port and one output port to interface with a human operator or with the machinery of a control system; however, most systems interface with many peripheral devices and hence possess many input/output ports. A commercial desk-top computer, for example, will have a keyboard (input), a VDU (output), a dual floppy disc unit (two inputs and two outputs) and a printer (output). During the execution of a given task, any number of the available peripheral devices may be in use (eg the operator types in a command, which is echoed by the VDU, to cause the transfer of a file on floppy disc to the printer). We would hope that the operating system of the microcomputer (ie its software) would co-ordinate the transfers of data between the various peripherals in the most time efficient manner; however if the timing and sequencing of all the processes is to be controlled entirely by the system's software, then the overheads of the 'co-ordinating' software can be quite considerable.

To illustrate this point, let us look at two of the devices we have mentioned: the keyboard and the floppy-disc drive. Taking the keyboard example first, it should be obvious that the computer has no way of knowing when the operator will choose to strike the next key on the keyboard; in order to cope with this kind of asynchronous input it is necessary for the software to test the appropriate input port for the availability of data on a regular and repetitive basis and with a frequency at least equal to the highest possible rate at which the operator may type. Typically, the microcomputer may test the keyboard input once every 20ms, but the actual execution of this test may take as little as 200ns, depending on whether data is found and precisely what is to be done with it. If the microprocessor's time is to be used efficiently, other tasks can be performed in the time between two keyboard tests, however we have to be careful to divide the tasks up into sections, each of which can be executed in less than 20ms. If the times for the keyboard test and the software switching between tasks are totalled up, we may find that 0.5ms of time is taken up in each 20ms period.

Poll Time

This method of handling inputs is described as software 'polling' and is often used to handle many input devices, often with widely different data transfer rates. It is important to realise, though, that as the number of devices being polled increases, and as the data transfer rates become higher, the time during which the software is simply switching between tasks and device tests becomes significant. The greatest difficulty of using this method of I/O device handling then lies in writing the software, which has to cope with the critical timing of data transfers

COMPONENTS FOR COMPUTING

Paul Kelly

Interrupts allow a microprocessor to work continually, rather than idling the time away waiting for something to happen!

whilst still using the idling time to execute other tasks; with systems of more than two or three peripherals, the software requirements can become impossibly difficult!

The floppy disc controller illustrates another problem with polling I/O devices, again relevant to the system efficiency. During data transfers between floppy disc and the microcomputer memory, the microprocessor has no time to perform other tasks because of the high data rate. However, there is a long delay between the MPU requesting data and the beginning of the data stream, as the pick-up head moves to the required track on disc and the required sector rotates into position. This time varies, depending on the particular track selected; however, the MPU must be ready and waiting for the data stream whenever it arrives, to avoid loss of data. In these circumstances, the MPU must assume a minimum delay time for the data search and begin testing for data within that time; this means that for most track searches (which take longer than this assumed minimum) there will be an idle period during which the MPU can do nothing but wait!

Any Time At All...

A method of 'interrupts' provides a neat hardware solution to these problems in any computer system where efficiency is important. In order to explain how this method operates, it is useful to begin with the analogy of, say, the tasks of a housewife (sorry, houseperson)...

While performing her main allotted task of the morning, the ironing of a mountainous stack of clothes, our housewife is interrupted by the sound of the front doorbell and, leaving her iron in a suitable position, moves to answer the door. She invites in her friendly caller and offers her a seat in the front room, then she returns to her ironing. At a suitable break in these proceedings, it is agreed that our housewife should make some coffee and so, leaving her iron once again, she goes into the kitchen and puts on the kettle but returns immediately to her iron-

ing again. Half a shirt later, the whistling of the kettle intervenes and once again our housewife leaves her ironing and proceeds to the kitchen to make coffee.

Dramatically, before the coffee is poured, a screaming siren announces the imminent arrival of a nuclear missile attack and the two ladies scuttle off to their nuclear shelter in the back garden. Many curious sounds are heard during their two weeks voluntary imprisonment, but the ladies remain in the shelter. Finally, the all clear is sounded and our housewife and friend return to the task of making coffee. Then our housewife recommences her ironing chores whilst her friend, with coffee, melts back into the chair. 'That's strange' says the housewife, 'You'd think that after two weeks the water would have cooled'.

In the course of this story, the housewife performs several tasks, which are: ironing clothes; answering the door and inviting in the caller; making coffee; and surviving in the shelter. From the management of these four tasks by the housewife, we note several important points:

1. When the doorbell rings, the lady immediately responds by answering it — she does not wait until she has completed her current task of ironing; this is because the caller is unlikely to wait for a long time. Having serviced this interruption, she is able to continue her first task, picking up where she left off.
2. The task of making coffee is initiated by 'putting on' the kettle; however, the housewife then continues the ironing until the kettle whistle signals that something else must be done.
3. Although the housewife has been interrupted already to make coffee, the warning siren signalled a more urgent priority and so the coffee making was in turn interrupted in the interests of self survival.

This analogy is a precise illustration of how tasks related to peripheral device handling may be executed by a microprocessor. Point 1. is a description of the basic interrupt principle which, translated into computing terms, is as follows:

Table 1

EXIT:	RET	; return from interrupt leaving R(1) pointing to INTROU.
INTROU:	DEC R(2)	; free space in stack.
	SAV	; save T register in stack via index register.
	DEC R(2)	; next stack location.
	STR R(2)	; save accumulator.
	DEC R(2)	; next stack location.
	SHRC R(2)	; shift right with carry
		; stores carry flag in accumulator.
	STR R(2)	; save carry flag.
	DEC R(2)	;
	STORE OTHER REGISTERS.....
	XXX	;
	XXX	;
	CORE OF INTERRUPT ROUTINE
	XXX	;
	XXX	;
	UNSTACK OTHER REGISTERS
	INC R(2)	; increment stack pointer.
	LDN R(2)	; unstack carry flag into accumulator.
	SHL	; shift left (accumulator).
	INC R(2)	;
	LDN R(2)	; unstack accumulator.
	BR EXIT	; branch to return from service routine.

Interrupt service routine for the 1802.

An interrupt service routine (in Assembly Language) must save all the working registers to 'clear the decks' for whatever operations are required by the interrupting device. Although the 'listing' above is for the 1802 MPU, the principle is the same whatever the 'processor'.

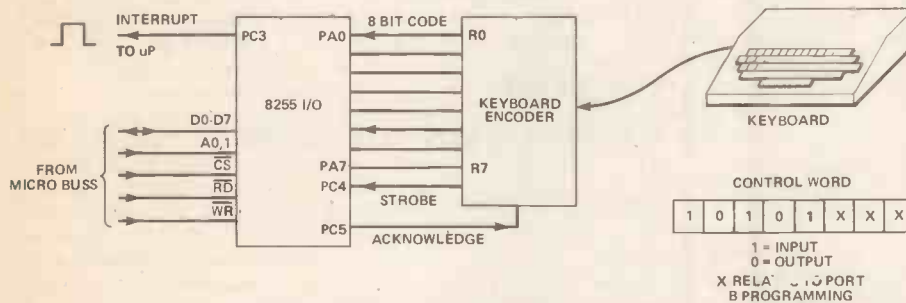


Figure 1. An outline of the hardware needed to handle an interrupt-driven keyboard system. Note that the interrupt to the MPU is actually generated by the 8255 I/O device, not the keyboard itself.

peripheral input device (eg keyboard) generates an interrupt signal when data becomes available and causes the microprocessor to drop its current task and jump to a piece of software called an interrupt service routine; this routine, primarily, will read in the data from the interrupting peripheral and store it in memory for later use; when the interrupt routine is complete the processor will return to its previous task and will continue 'as though nothing has happened'.

Service Please

Once again we will use the 1802 microprocessor to illustrate our discussion. To facilitate interrupts, the 1802 has a single input pin (pin 36) called INTERRUPT which can be pulled 'low' by an I/O device to signal that an interrupt is required. Table 1 contains a sketch of a typical interrupt service routine (in Assembly Language) which will illustrate the action of the 1802 during interrupt servicing. When interrupts are used on the 1802, it is necessary to reserve register R(1) as a pointer to the beginning of the interrupt servicing software (wherever it is stored

in memory) and register R(2) as an index register for 'register stacking'.

The microprocessor recognises an interrupt request when pin 36 goes low and responds by setting the Program Counter to R(1) and the Index Register to R(2) after first having stored the old values of X and P (Index and Program Counter designators) in the temporary register T. Register R(1) must have previously been set up to point to the beginning of the interrupt routine so that, following an interrupt, it is immediately executed by the microprocessor. The first few instructions of the routine involve storing the contents of the 1802 registers such as the accumulator, carry flag, and any others that are likely to be used by the interrupt routine. R(2), which has been set as the index register, is used to point to an area in memory for this storage. Observe, from the listing of Table 1, that each time data is stored in memory, R(2) is decremented to a 'free' byte and that at the end of the routine, when registers are being reloaded with their old values, R(2) is incremented each time, so as to back track over the storage area. The use of memory in this way is called 'stacking' — the

memory area being used is a first-in-last-out stack. The SAV instruction at the beginning of the routine causes the T register to be 'pushed' onto this stack. The final instruction of the routine, RET, 'pulls' this back from the stack and uses the data to re-establish the previous values of X and P, thus effecting a return of control to previous task of the microprocessor. R(1) is left pointing to the beginning of the interrupt routine, by the branch back to the byte just before this address, before executing the RET.

Generating Support

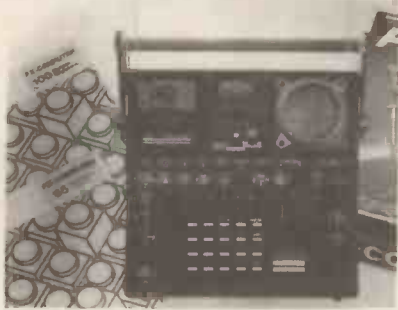
Most of the microprocessor I/O support ICs offer the facility of generating processor interrupts, and we will use as an example the 8255 (described in the December '82 issue), which is a three-port I/O device. In the article on I/O ports, we described the programming of the 8255 without explaining the use of Modes 1 & 2. In fact in Mode 1, Port A, for example, can operate in conjunction with PC3-5 as an interrupt driven input or output port (also Port B with PC0-2). Referring to Figure 1, when the keyboard encoder has generated valid data it strobes PC4, causing data to be latched into Port A. The 8255 acknowledges receipt of this data through PC5 (if used) and simultaneously PC3 generates a signal that can be used to interrupt the MPU. In this system, then, interrupts are only generated in response to a strobe to PC4, which only occurs after each key depression on the keyboard.

Several devices that generate an interrupt may be used in one system, and in this instance the signals are ORed to the same interrupt line. In the interrupt service routine, the microprocessor must poll (as described earlier) each I/O device to determine which had generated the interrupt and, on that basis, jump to the appropriate section of the routine to service that device.

Most processors have the facility to enable or disable interrupts (1802: RET for enable, DIS for disable). This facility can be used to ignore interrupts from one device when a routine of a higher priority is being serviced (eg to prevent a disc data transfer being interrupted by a keyboard entry, which would cause loss of data. Some sophisticated processors (like the 16-bit 68000) have 'multiple auto-vectoring prioritised interrupts'. Breaking this down into smaller mouthfuls, the processor may accept independent interrupt requests from many devices (up to 8 say) but each has a different priority so that if the interrupts from several devices arrive simultaneously, that of the highest priority will be serviced first; auto-vectoring means that each interrupt line has an associated address or 'vector' from which an address for the start of the interrupt routine can be fetched by the processor (the vector is usually a fixed function of the particular MPU but its contents in RAM can be varied). With an interrupt structure of this sophistication, I/O may be handled very efficiently; hence for many eight-bit processors (eg 6800, 8085, Z80), prioritised interrupt controller chips are available to expand the MPU to this capability.

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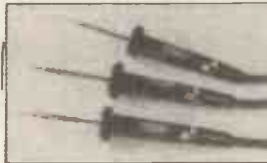
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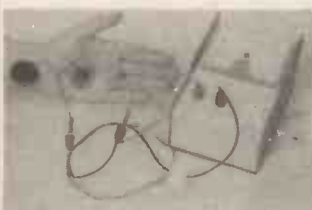
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Clever Dick

At absolutely no cost (we're not paying him this month), CD answers another selection of tricky questions from his fans.

Dear CD,
In your September '81 issue you featured an article entitled "Electronics in Diagnostic Medicine" by Graham Thirk.

I would be grateful if you could let me know of some sources of further information on this subject and, if possible, of related educational courses.
K. Rawsthorne,
Whiston,
Merseyside.

I have good news and bad news. The bad news is that I don't have the information to hand — but the good news is that the subject of educational courses in Medical Electronics will be covered in a new series starting in the May 1983 issue of HE. The series is titled "Careers in Electronics", and it will discuss all aspects of education and the qualifications required for pursuing a career in any branch of the electronics industry.

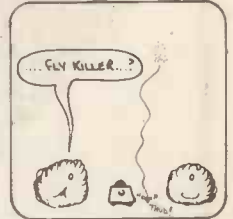
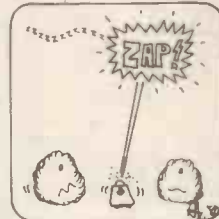
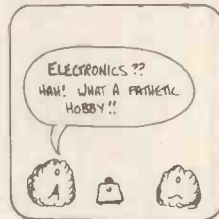
As all my readers know, I'm always willing to help with technical problems . . . but I'm not a reference library.

Dear Clever Dick,
I WANT A BINDER . . . please?
P. Carroll,
Barking,
Essex.

PS I am a final year student at East Ham College of Technology, and in my final year studying a TEC Diploma in Electrical Engineering. For one of my final year subjects, I must construct and write a report on an electrical project, and the project I have chosen is a 'Touch Dimmer'. I would be much obliged if you could supply me with any sources of information on lighting and light dimmers.

Thanking you in anticipation of your binder . . . oops, I mean assistance . . . in this matter.
PPS Excellent mag.
PPPS Sorry about the layout of this letter — the typewriter was not working correctly.
PPPPS Sorry about the letter — it was ME not working correctly.

Quite so. Perhaps you'd like me to write the report for you, too? Never mind . . . you'll find quite a lot of information in back issues of Hobby Electronics (consult the Cumulative Index 1979 — 1983, published in the January issue; you have it, of course?) and also in many of the excellent titles available through the HE Book Service — why don't you ask them? And you could, if



you really wanted to, consult the College library.

Dear CD,
Recently I completed building the I/O Port published in the September '82 issue, for the ZX81. When I use the port on an unexpanded ZX81 everything works as it should do. However when I connect a speaker to the port and then use it on the 16K ZX81 there is always a lot of interference through the speaker, preventing a pure sound being produced through it.

Please could you tell me if you encountered such background noise when using the I/O Port in conjunction with the 16K expansion, and could you tell me how it may be cut out.

P. Tushingham,
Manchester.
PS In case it has any relevance to the problem, I am using the Memotek 16K RAM Pack and the I/O Port was connected in the socket provided at the back of the pack.

I must admit this one threw me, for a moment. So you've connected the speaker directly to one of the I/O Port outputs, have you? Well, if it works . . . why not? However, TTL is quite noisy because of feed-through from the supply rails and, obviously, the more TTL you have connected in, the greater the noise. You could simply try low-pass filtering the I/O Port output or, better still, construct a small amplifier with a separate power supply and low-pass filter the input. You'd also gain some control over the volume!

Dear CD,
First let's sort out my problem, then I shall try to help you with yours. My problem (be it small — 82pf, I think) is that in an American book I read of a capacitor referred to as being 82mmF: what, exactly, is our own equivalent of this value?

Now, I gather that you are having problems finding ideas for your projects and this is causing grave concern to the extent that the merest mention of the

subject causes a severe attack of GREMLINS. So, to save readers' brains, I have listed a few ideas that I hope will prove helpful to you.

Some of them you may have done already. You see, my collection of HEs consists of all copies from August '81 to the present, purchased monthly, plus eight assorted copies from September '79 to May '81, purchased at a jumble sale with a whole bunch of other mags too numerous to mention; at 50p for the whole bunch it was a real bargain, so I bought them. Yours is the one I like best, though, and if I had a binder I could treat them with the prestige they deserve instead of keeping them mixed up in a box with the rest . . . couldn't I?

Right, now here are those ideas I mentioned: with the summer coming how about an electronic mosquito repellent (stop that laughing — there really is such a thing); the way these work is an interesting innovative idea, implying that mosquitos, unlike Gremlins, are easily fooled. And how about some car projects? A dwell angle meter and ignition points tester, a good battery charger, indicator flasher, seat belt reminder, wash/wipe controller, timing light and heat controller, say. Keep 'em coming,
M. Bronze,
Corryham,
Essex.

I'm not sure about the size of your problem, but I'm sure a good psychiatrist could help!

You've correctly guessed the answer to your own question 'mmF' means 'micro micro Farads', that is, 10^{12} , and is equivalent to picofarads. I'm sorry to hear that a reader was so philistine as to actually dispose of his precious copies of HE at a jumble sale, but pleased to hear they have found a happy home. A binder will presently be despatched to assure their continued comfort!

We'll look into the idea of a mosquito repeller project, and perhaps research a Gremlin Repeller at the same time. Finally, our very next issue has not one but four projects for the motorist — now isn't that nice of us?

HE

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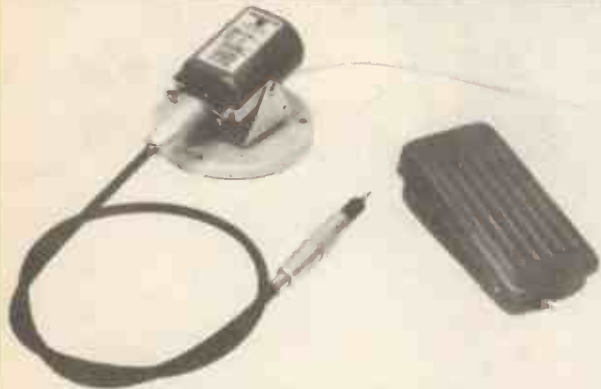
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74LS19	74LS168	85p	7416	BC549C	14p	CA3280G
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74LS21	74LS170	70p	7418	BC558	15p	LF351
74LS22	74LS171	70p	7419	BC559	15p	LF353
74LS23	74LS172	70p	7420	BFY50	23p	LF356
74LS24	74LS173	55p	7421	BFY51	23p	LF357
74LS25	74LS174	40p	7422	BFY52	23p	LM301A
74LS26	74LS175	40p	7423	TIP29A	32p	LM310
74LS27	74LS183	120p	7424	TIP30A	35p	LM311
74LS28	74LS190	36p	7425	TIP31A	38p	LM318
74LS29	74LS191	36p	7426	TIP32A	38p	LM319
74LS30	74LS192	36p	7427	TIP33A	65p	LM324
74LS31	74LS193	36p	7428	TIP34A	74p	LM334Z
74LS32	74LS194	36p	7429	TIP41A	50p	LM335Z
74LS33	74LS195	35p	7430	TIP42A	55p	LM339
74LS34	74LS196	45p	7431	TIS43	32p	LM348
74LS35	74LS197	45p	7432	2N2646	45p	LM380
74LS36	74LS221	50p	7433	2N2905	26p	LM381N
74LS37	74LS240	50p	7434	2N2906	26p	LM382
74LS38	74LS241	50p	7435	2N2907	26p	LM384
74LS39	74LS242	50p	7436	2N3053	26p	LM386
74LS40	74LS243	50p	7437	2N3055	48p	LM387
74LS41	74LS244	50p	7438	2N3070	10p	LM389
74LS42	74LS245	70p	7439	2N3703	10p	LM393
74LS43	74LS247	50p	7440	2N3704	10p	LM3900
74LS44	74LS249	50p	7441	2N3705	10p	LM3909
74LS45	74LS251	35p	7442	2N3706	10p	LM3909N
74LS46	74LS252	35p	7443	2N3707	10p	LM3911
74LS47	74LS253	35p	7444	2N3708	10p	LM3914
74LS48	74LS254	35p	7445	2N3709	10p	LM3915
74LS49	74LS255	30p	7446	2N3819	22p	LM3916
74LS50	74LS256	30p	7447	2N3903	15p	LM13600
74LS51	74LS257	30p	7448	2N3905	15p	NE531
74LS52	74LS258	35p	7449	2N3906	15p	NE544
74LS53	74LS259	35p	7450	2N457	30p	NE555
74LS54	74LS260	20p	7451	2N458	30p	NE556
74LS55	74LS261	138p	7452	2N459	30p	NE564
74LS56	74LS262	20p	7453			NE565
74LS57	74LS263	60p	7454			NE566
74LS58	74LS264	60p	7455			NE567
74LS59	74LS265	60p	7456			NE570
74LS60	74LS266	20p	7457			NE571
74LS61	74LS267	60p	7458			NE592
74LS62	74LS268	60p	7459			NE534P
74LS63	74LS269	60p	7460			NE5534AP
74LS64	74LS270	60p	7461			TA8110
74LS65	74LS271	60p	7462			TA8120
74LS66	74LS272	60p	7463			TA8135
74LS67	74LS273	60p	7464			TA8148
74LS68	74LS274	60p	7465			TA8151
74LS69	74LS275	60p	7466			TA8154
74LS70	74LS276	60p	7467			TA8157
74LS71	74LS277	60p	7468			TA8160
74LS72	74LS278	60p	7469			TA8163
74LS73	74LS279	60p	7470			TA8166
74LS74	74LS280	100p	7471			TA8169
74LS75	74LS281	40p	7472			TA8172
74LS76	74LS282	40p	7473			TA8175
74LS77	74LS283	40p	7474			TA8178
74LS78	74LS284	140p	7475			TA8181
74LS79	74LS285	140p	7476			TA8184
74LS80	74LS286	140p	7477			TA8187
74LS81	74LS287	140p	7478			TA8190
74LS82	74LS288	140p	7479			TA8193
74LS83	74LS289	140p	7480			TA8196
74LS84	74LS290	140p	7481			TA8199
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74LS86	74LS292	140p	7483			TA8205
74LS87	74LS293	140p	7484			TA8208
74LS88	74LS294	140p	7485			TA8211
74LS89	74LS295	140p	7486			TA8214
74LS90	74LS296	140p	7487			TA8217
74LS91	74LS297	140p	7488			TA8220
74LS92	74LS298	140p	7489			TA8223
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74LS94	74LS300	140p	7491			TA8229
74LS95	74LS301	140p	7492			TA8232
74LS96	74LS302	140p	7493			TA8235
74LS97	74LS303	140p	7494			TA8238
74LS98	74LS304	140p	7495			TA8241
74LS99	74LS305	140p	7496			TA8244
74LS100	74LS306	140p	7497			TA8247
74LS101	74LS307	140p	7498			TA8250
74LS102	74LS308	140p	7499			TA8253
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74LS161	74LS367	140p				TA8430
74LS162	74LS368	140p				TA8433
74LS163	74LS369	140p				TA8436
74LS164	74LS370	140p				TA8439
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74LS167	74LS373	140				

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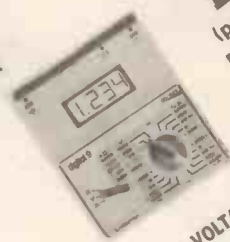
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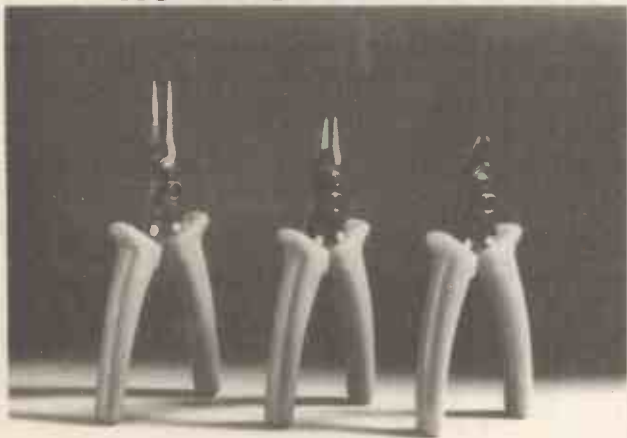
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Stereo Voice -Over Unit

R.A. Penfold

Don't quack up in the disco, Donald . . . duck!
(A voice-over unit or 'ducker' makes mixing voice and music an easy task).

IN applications where it is necessary to mix a voice signal over a music signal (such as at discos or when making tapes to accompany slide or cine shows etc.) it would obviously be possible to use an ordinary mixer. This would not be without its disadvantages though, as the music would need to be manually faded each time the voice signal was introduced and manually restored to its normal level again at the end of each voice-over. It would probably be inconvenient to have to do this, and it would certainly be difficult to achieve really good results. The alternative of simply failing to fade out the music could easily result in overloading, or the voice signal being indistinct.

A much better solution is to use a voice-over unit which, in addition to mixing the voice and music signals automatically, fades out the music in the presence of the voice signal. This gives really professional results, with the music fading in and out in perfect synchronisation with the voice-over.

This voice-over unit has stereo inputs and outputs for the music signal, and it acts rather like a unity voltage gain buffer stage so that there should be no difficulties when it is added into a signal path. The microphone signal is mixed equally into both music channels so that the voice appears in the central stereo image area, and the music channels are faded by about 20dB. The microphone input can either be at line level, or a built-in preamplifier for high impedance dynamic or electret microphones can be fitted to the unit.

The Circuit

IC3 is a dual transconductance operational amplifier, and is used as the basis of the two VCAs (each half of the device is the heart of one VCA). The amplifier configuration is quite straightforward, that is, the normal non-inverting mode circuit. The gain of a transconductance amplifier is normally controlled by varying the current to the

amplifier bias input of the IC (pins 1 and 16 in this case), and the gain of the device is roughly proportional to the bias current. However in this circuit, the bias input of each transconductance amplifier is fed with a fixed current, using a single bias resistor for each amplifier (R12 and R25).

The LM13600N has 'linearizing diodes' and these are normally either supplied with a small bias current to give improved signal handling, or would be left unused. But feeding a bias current to the linearizing diodes also has the effect of reducing the gain of the amplifier, and this can be used to provide a simple voltage or current controlled amplifier function. In most applications it is more convenient to use the bias input as the control input, but in this case it is more convenient to apply the control signal from the microphone to the linearizing diodes to give the required reduction in gain. R13 and R24 are used in series with the diode bias inputs, so that a voltage rather than

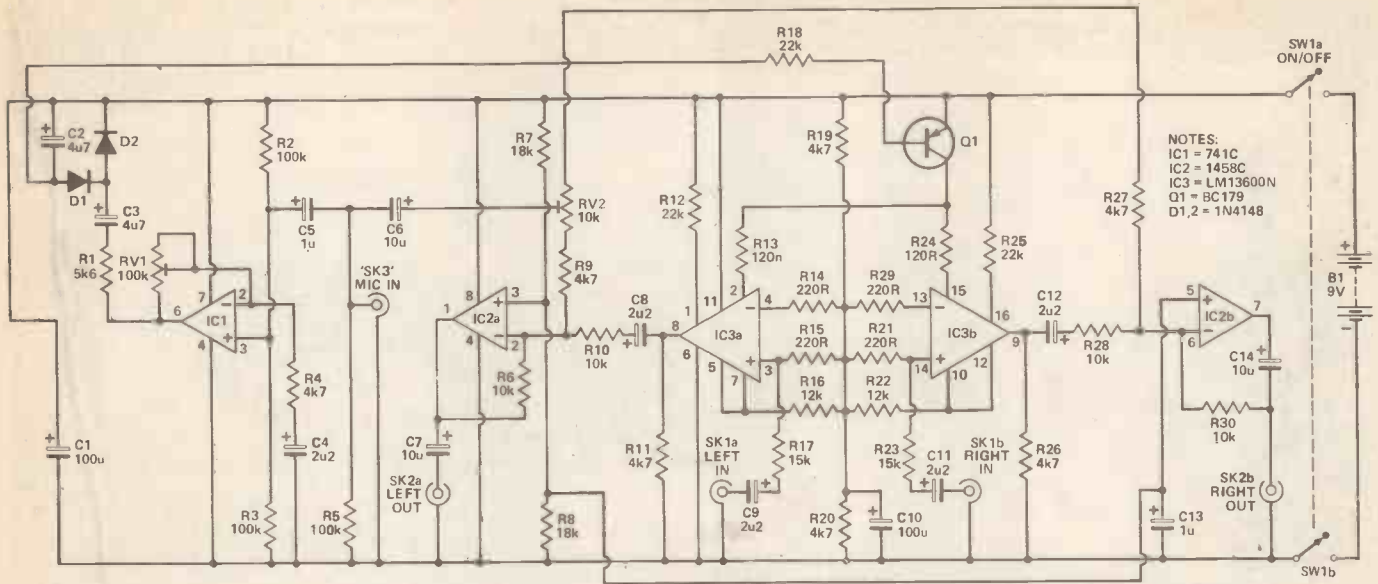
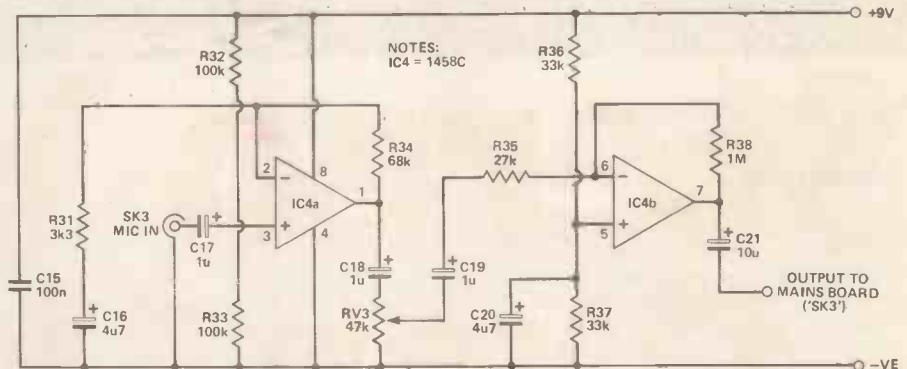


Figure 1 (above). The Ducker circuit looks more complicated than it really is due to the intricate biasing network for IC3, the dual transconductance amplifier.

Figure 2 (right). The circuit of the optional microphone preamplifier, which provides a high level drive to the mic input of the Ducker.



current controlled circuit is produced. The nominal voltage gain through each transconductance amplifier and its associated circuitry is unity with no control signal, but this becomes a loss of about 20dB with maximum control voltage.

The signal present at the microphone input, SK3 needs some amplification in order to produce a reasonably strong control signal, and IC1 is used to boost this signal; RV1 controls the closed loop gain and therefore acts as a sensitivity control. The output of IC1 is rectified and smoothed by D1, D2, and C2, and this DC control signal is coupled to the VCAs via a simple common emitter amplifier, Q1. This is really just being used as a buffer amplifier to match the fairly high output impedance of the smoothing circuit to the low input impedance of the VCAs. The attack time of the smoothing circuit has been made quite short, so that the music signal is almost instantly faded in the presence of a voice signal, but R1 prevents the attack time from being so short as to produce a 'click' each time the unit is activated. The decay time is somewhat slower; it normally takes under one second for the music signal to be returned to full volume.

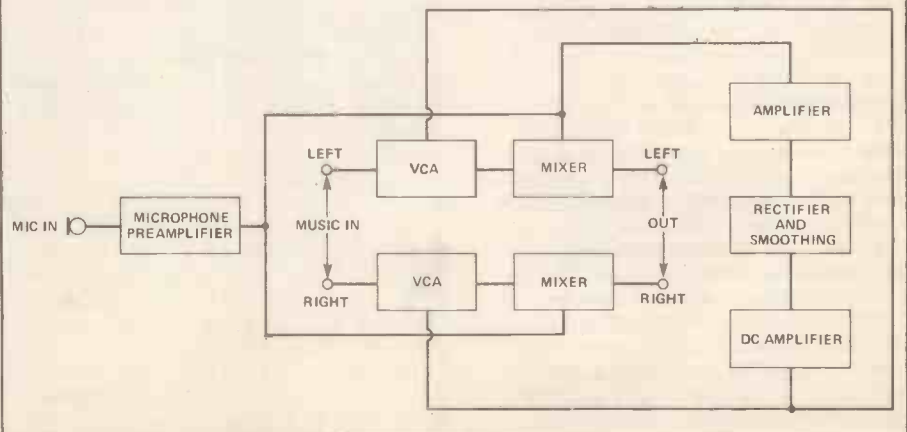
The two operational amplifiers of IC2 are used as simple 'summers' to mix the microphone signal into each stereo channel, and there is approximately unity voltage gain through each mixer circuit. RV2 enables the microphone signal to be properly balanced in the stereo outputs so that the signal appears at the centre of the stereo image.

How It Works

THE LEFT HAND music channel is fed to a voltage controlled attenuator (VCA) and then to a mixer, where the microphone signal is added. A microphone provides a very low level output signal, and a preamplifier is therefore used to provide a suitable boost to this prior to mixing it with the music signal. The right hand signal is processed in precisely the same manner, but using a separate VCA and mixer.

With no signal from the microphone, the left and right music channels both receive no attenuation through their respective VCAs.

However, in the presence of a significant output from the microphone, the situation is different, since some of this signal is amplified, rectified, and then smoothed to produce a DC signal. This is fed to the VCAs and has the effect of reducing their gain by (roughly) a factor of ten; a DC amplifier is used to ensure that a suitably strong control signal is fed to the VCAs. Thus, the microphone signal is mixed into the two music channels and these are automatically faded into the background in the presence of a voice signal from the microphone, giving the required effect.



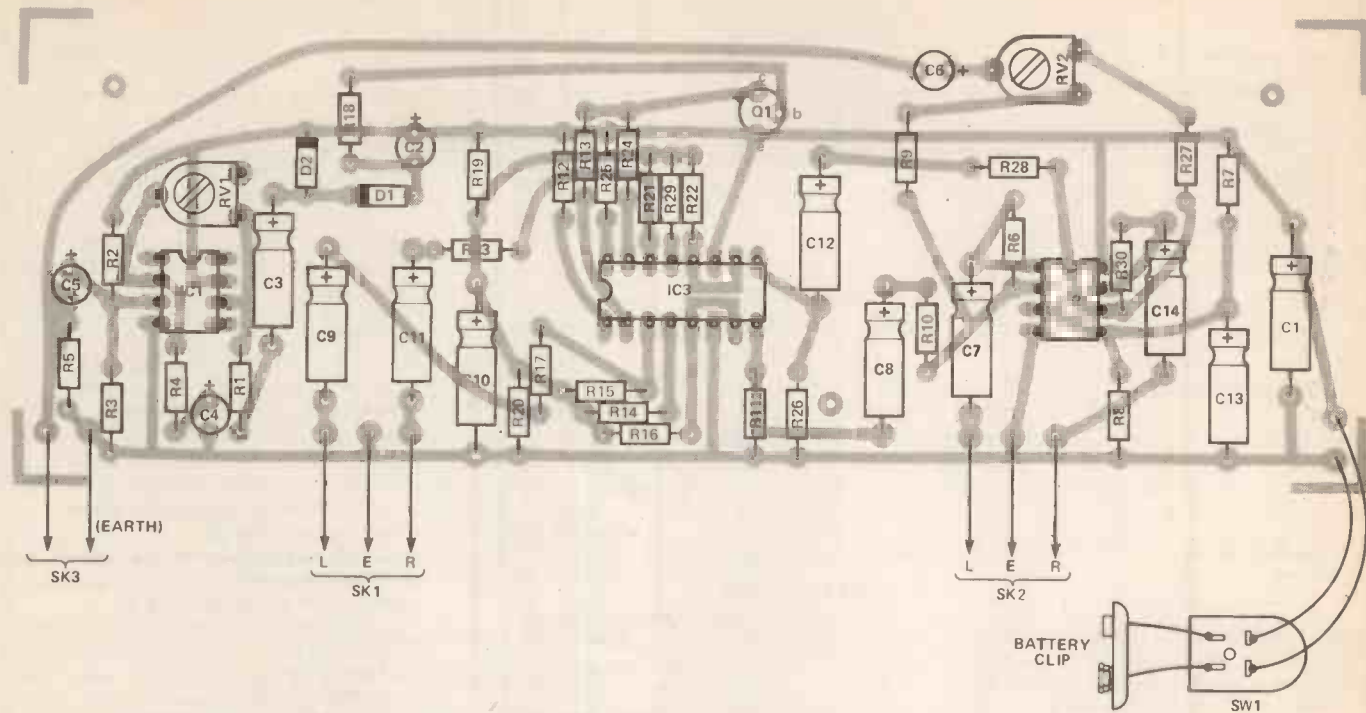


Figure 3. The component overlay for the main Ducker circuit board.

Preamplifier

In use SK3 can be fed from an external microphone preamplifier, or it might be fed from the output of a tape deck, say, depending on the exact application. However, in most cases it will probably be more convenient to have a built-in microphone preamplifier, and Figure 2 shows the circuit diagram of a simple design for use with dynamic or electret types; the circuit is also adequate for use with some 600 ohm impedance dynamic microphones.

It is a simple two stage circuit, with IC4a being used as a non-inverting amplifier with a voltage gain of about 26dB or so (20 times), and IC4b operating as an inverting amplifier with an approximate voltage gain of 32dB (40 times). The overall voltage gain of the circuit is quite high, and an input of only 1 mV RMS is sufficient to give an output signal of more than 2 volts peak to peak amplitude. RV3 is a gain control, and this is adjusted to match the music and microphone signal levels.

The signal to noise ratio of the circuit depends on the exact operating conditions, but typically it would be better than 60dB.

Construction

A Verocase having approximate outside dimensions of 205 by 140 by 75mm comfortably accommodates all the components and makes an attractive housing for the unit. The three sockets and two controls are mounted on the front panel, as shown in the photographs.

Details of the main printed circuit board are shown in Figure 3, and there are only the normal pitfalls to avoid when building the board. Make sure the integrated circuits and other semicon-

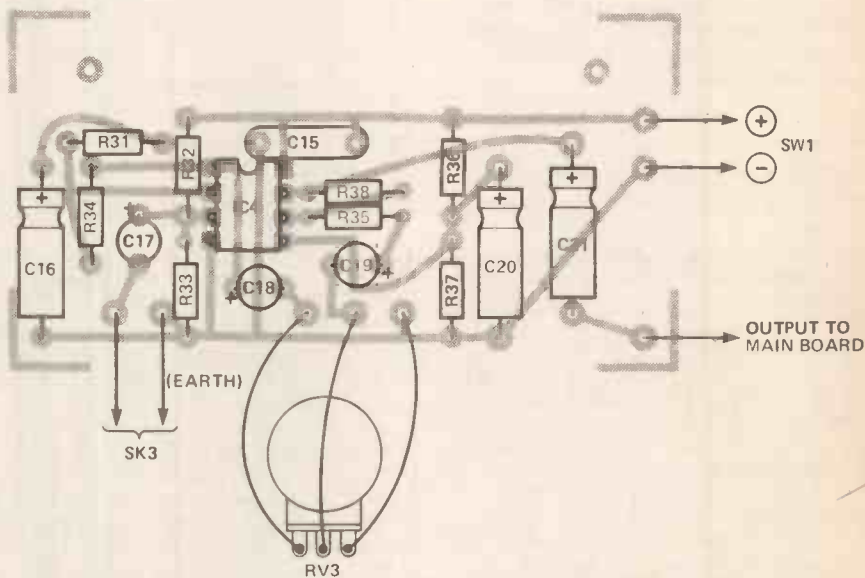


Figure 4. The mic preamp board should present no construction problems.

Optional Microphone Preamplifier

RESISTORS

(All 1/4 watt 5% carbon)

R31	3k3
R32,33	100k
R34	68k
R35	27k
R36,37	33k
R38	1M

POTENTIOMETER

RV3	47k log carbon
-----	-------------------

CAPACITORS

C15	100n polyester
-----	-------------------

C16,20	4u7 63V axial electro
C17,18,19	1u 63V radial electro
C21	10u 25V axial electro

SEMICONDUCTORS

IC4	1458C dual op-amp
-----	----------------------

MISCELLANEOUS

PCB; control knob; wire, solder etc.

BUYLINES page 34

Parts List

RESISTORS

(All 1/4 watt 5% carbon)

R1	5k6
R2,3,5	100k
R4,9,11,19,20,26,27	4k7
R6,10,28,30	10k
R7,8	18k
R12,18,25	22k
R13,24	120R
R14,15,21,29	220R
R16,22	12k
R17,23	15k

POTENTIOMETERS

RV1	100k
	0.1W horizontal preset
RV2	10k
	0.1W horizontal preset

CAPACITORS

(All electrolytic)

C1,10	100uF
	10V axial
C2	4u7
	63V radial
C3	4u7
	63V axial
C4	2u2
	63V radial
C5	1uF
	63V radial

C6	10uF
	25V radial
C7,14	10uF
	25V axial
C8,9,11,12	2u2
	63V axial
C13	1uF
	63V axial

SEMICONDUCTORS

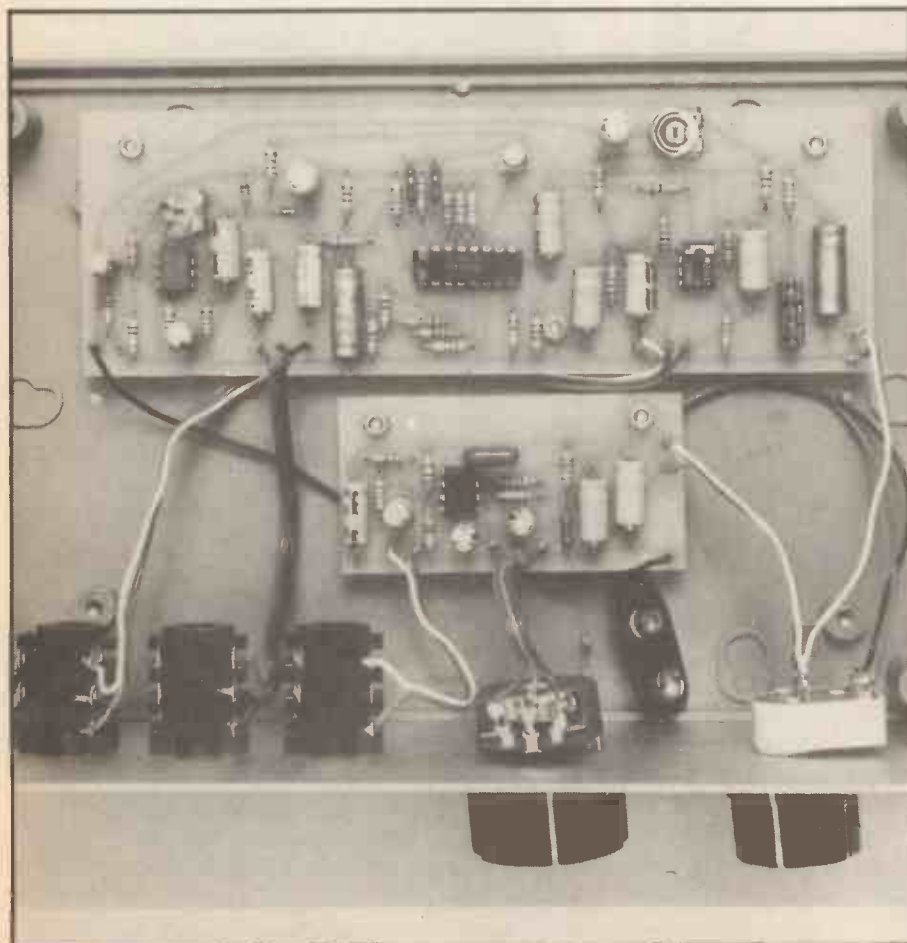
IC1	741C
	op-amp
IC2	1458C
	dual op-amp
IC3	LM13600N
	dual transconductance amp
D1,2	1N4148
	silicon signal diode
Q1	BC179
	silicon PNP

MICELLANEOUS

SW1	rotary on/off switch
B1	.9 volt PP3
SK1,2	1/4" stereo jacks
SK3	1/4" mono jack
	Printed circuit board; case; control knob; battery connector; PCB pins, wire, etc.

BUYLINES page 34

There's plenty of space in the box for the two PCBs to be mounted side-by-side, with room to spare for the single PP3 battery.



ductors are fitted the right way round before soldering them in place; the capacitors must also be fitted with the correct orientation, since these are all electrolytic types. Ideally they should also be axial (horizontal) or radial (vertical mounting) types, as specified in the parts list, or the finished board may not look as neat as it might otherwise and it could also be physically weaker. Connections to off-board components are made by way of PCB pins, but do not make the connections to them until the board has been fitted in the case.

The board is mounted well towards the rear of the case, so that there is sufficient space to fit the preamplifier board between RV3 and the main board if necessary. 6BA fixings are suitable. Figure 4 gives details of the preamplifier printed circuit board and wiring; there are no special points to bear in mind when building this.

To complete the unit, the battery clip is wired into place and the other hard-wiring is added. If the built-in preamplifier is used, then the connections in Figure 3 from the main board to SK3 are omitted, and SK3 is connected to the preamplifier board instead. The output of the preamplifier then connects to the SK3 pin on the main board. There is no direct link between the earth (negative) rails of the two boards; the indirect link via SW1 is sufficient.

Adjustment

Provided the input to SK1 is at a normal line level, around 100mV to 1 volt RMS, there should be no problems with overloading and a good signal to noise ratio should be obtained. Initially, RV1 is set well in an anticlockwise direction and RV2 is given a roughly central setting. With an input applied to the microphone input (SK3) RV2 is adjusted to give the correct stereo balance with the voice signal at the centre of the sound stage. RV1 is to give reliable automatic fading action, but this adjustment is unlikely to be very critical. If there seems to be a lack of sensitivity, RV1 should be advanced in a clockwise direction; excess gain would result in the automatic fader action tending to operate accidentally with unacceptable frequency, and RV1 should then be backed-off slightly.

If the built-in preamplifier is used, RV3 is adjusted to bring the microphone signal to approximately the same level as the (unfaded) music signal. If the unit is used with an external preamplifier or other high level signal source, this source will presumably incorporate some form of signal level adjustment.

As stated earlier, the music channels are faded by about 20dB, but this figure can be altered somewhat, if desired, by changing the values of R13 and R24. A higher value reduces the level of fade, while a lower value gives increased attenuation.

If the unit is only used with a mono music signal, one of the stereo channels can be ignored, along with the passive components associated with that channel, but that channel only can be omitted from the printed circuit board.

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+12V	0.5A	T0220	35p	
+12V	1.5A	T03	140p	
-12V	1A	T0220	40p	
-12V	1.5A	T03	150p	
+15V	1A	T0220	40p	
+15V	1A	T0220	40p	
-24V	1A	T0220	70p	

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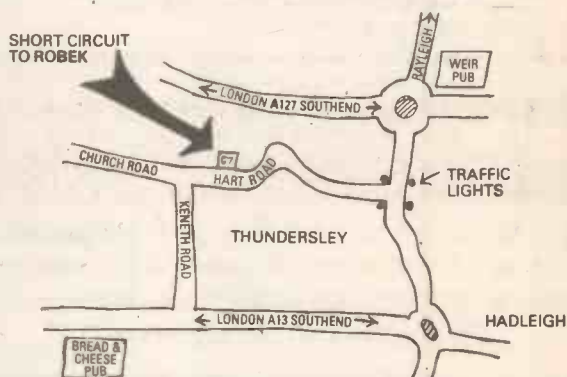
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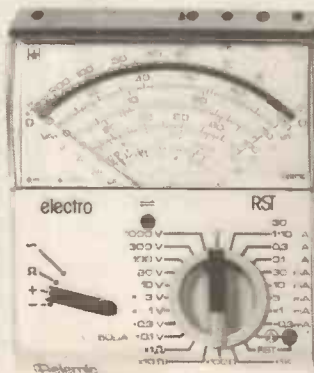
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INTERFERENCE is a constant worry for any conscientious operator of an amateur transmitting station. No matter how thick-skinned you are, the thought that your voice may be rising above that of Hilda Ogden, or causing fluttering interference in tellys all round you is daunting, even if the interference is due to badly designed TV receivers rather than to a badly designed or maintained transmitter. One of the main reasons that TV interference is not a more common complaint is that so many amateurs enjoy long distance contacts, and so do a lot of transmitting in the wee sma' hours when all good tellys are switched off for the night.

What we're going to do in this issue is to look at the symptoms of each type of interference, and what you can do about it. We have to start by assuming that you either have a commercially made rig or one which has been built to a circuit diagram and layout which is well tried and tested. If you are experimenting with your own designs, then you will have to sort them out for yourself!

Let's start with a few basic points which are very often neglected. One is that amateur radio should *not* cause interference to audio amplifiers. If your transmitter causes sound on your neighbour's stereo outfit when he is listening to records or tape, it's certainly not the fault of your transmitter, and there's nothing much you can do about it beyond checking the earthing (do your power lines share an earth, by any chance?). Transmitter interference to audio systems is caused by poor design of the systems, and it's up to the manufacturer of the equipment to put it right. Having said this, it's not always easy to convince the owner of a £500 Super XYZ that the input circuits have omitted RF filtering so as to save 10p on components! A little bit of tact is needed. Don't offer to suppress his hi-fi unless you are very confident — remember that you will be blamed if it ever fails for *any* reason ('it was all right until he started fiddling with it...'). If you really have a lot of regard for your neighbour and he is a reasonable guy, you may be able to agree to share the costs of suppression — otherwise, he'll just have to learn the hard way that elegant boxes with a 50% markup are not a guarantee of high quality in audio equipment!

Make sure that you are not radiating in the 90-105MHz VHF range, however, because this will cause interference with stereo radio listening, and the fault will undeniably be yours. Since TV moved to the UHF channels, cases of interference from amateurs working the popular 28MHz (and below) frequencies have been much reduced, though a few TV receivers are still inadequately protected against breakthrough on the IF frequencies. Operators who work in the 144MHz band, however, can cause quite severe interference with UHF TV in some districts where the lower TV channels are used and come within the range of the third or fourth harmonic of the transmitter. A point to watch is the increasing number of video cassette recorders, all of which incorporate frequency-changing circuits that make interference easier, though most of them appear to be very well designed from this point of view. It is

RADIO

Interference and RF Measurements

usually possible, as a first step, to eliminate the interference by changing your operating frequency so that the harmonics which cause the problem are no longer in the bandwidth of the TV channel which they were affecting.

Reducing Harmonics

If you have an efficient RF power stage, then you have an efficient harmonic generator — the two go together. One way of avoiding problems is to operate all frequency multiplier stages, which generate a lot of harmonics, at low power levels, a few mW perhaps, and to get to the final power level in as few stages of amplification as possible. This is only a small part of the problem, though, because no amount of good design procedure can compensate for sloppy construction. In any PA stage, there will be large radio frequency currents and substantial amounts of harmonic frequencies, and only good construction will ensure that these do not get to the aerial.

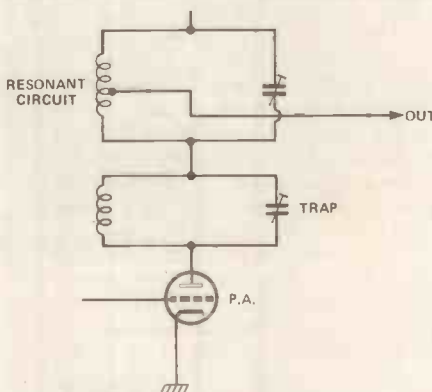


Figure 1. Using a harmonic trap in series with the main resonant circuit of the PA stage — NOT for transistor PAs.

The harmonic frequencies can be bypassed, and will then do little harm unless you happen to have a circuit somewhere which is resonant. Your normal coil-and-capacitor load ('the tank circuit') will, of course, be resonant at the frequency that you want to use — what you have to be careful about is the effect of the stray capacitances and inductances of connecting leads. One of the dodges used in high-power valve output stages is to use flat strips of copper in place of wire, because such strips have a much lower stray inductance. These points need not concern you too much if you are working to a published design, but you should know that you can't just make substitutions any old how — there's a good reason if the in-

structions specify copper strip rather than wire!

If there is a harmonic that you can't suppress, then one way out of it may be to trap that harmonic, either at the PA or as close to the PA as you can get. When a transistor PA is used, you can't just go adding traps because these can upset the matching, but with a valve PA, (which is more likely to cause trouble with its high power output) you can add a parallel resonant circuit (Figure 1) in series with the load to trap an unwanted harmonic. It's rather a last-resort measure, but if it makes the difference between getting out with no interference, and staying closed down, it's worthwhile.

Shielding

Another defensive measure for avoiding interference is the use of shielding. There are two types of shielding — all types of metal will produce electrostatic shielding, which is generally more important, but only a few metals will shield magnetic fields. As far as we're concerned, 'shielding' will mean electrostatic shielding.

To be really effective in preventing RF radiation from transmitter circuits, the shielding metal must completely enclose all the circuits that might be radiating. Because the field is electrostatic rather than electromagnetic, we can't get away with wire mesh whose spacings are a small fraction of the wavelength — any opening in an electrostatic shield will release some of the field. Holes, however, let through much less than slits, and a well-made shield of wire mesh can be more effective than a solid can in which the seam has not been properly soldered.

Electrostatic fields can be very strong close to the wiring of the circuit, but their strength decreases considerably as you move away. It makes sense, then, to have this fact working for you, and place your shielding as far from components and wiring as possible. Copper and aluminium are preferable to steel, and copper, being easy to solder, is generally preferred.

Shielding can never be 100%, however, because leads have to be taken to and from the circuits. One potent source of trouble is a power supply to a shielding circuit. Unless this lead is well decoupled, it can have the effect of an aerial, making your efforts at shielding quite useless. One effective way round this is to use screened cable for all power supply connections, with a capacitor soldered between the inner conductor and the output braid at each end of the cable (Figure 2) and several earthing points connected to the outer braid at places along the length of the cable. Another very useful aid to removing unwanted radiation from cables

RULES

Ian Sinclair

is to have ferrite beads threaded onto the wire. Remember that every piece of wire inside the transmitter can pick up and radiate. Wires to panel lights or to meters are no exception, and they should be decoupled at each end by 1nF capacitors (ceramic discs), with ferrite beads in addition if this proves insufficient.

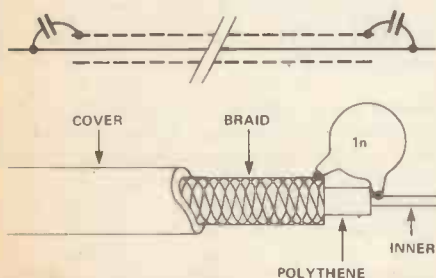


Figure 2. Decoupling a coaxial cable used for supply feeding to a screened stage.

Filters

The ultimate weapon in the fight against harmonic radiation is the low-pass filter. Having eliminated all radiation of harmonics from the other wiring, any remaining harmonic interference must be caused by harmonics leaving the transmitter along the only route left open — the aerial feeder. A low-pass filter in this line should then eliminate the last trace of harmonics. To be effective, such a filter has to be carefully designed and constructed, using a shielding box. The beginner should stick to ready-made filters, because this is not something that can be done on a cut-and-try basis.

We've spent a lot of space on this problem of harmonic radiation, ignoring sideband splatter or self-oscillation. That's because harmonic radiation is always a problem, whereas sideband splatter can be cured by careful use of the rig, and self-oscillation should never occur on a well-designed and constructed rig. Harmonics are always with us, however, because the whole system depends on harmonic generation, and we always have to guard against the unintended radiation of such harmonics. The next obvious topic is how to track them down, and we'll combine this with measuring techniques.

TVI Tracking

The best instrument for tracking down TVI interference is a portable telly operating from its built-in aerial. If you can operate such a device with no trace of interference in the same room as your rig, then you can be sure that you are innocent of

any TVI around your neighbourhood. If your transmitter causes interference now, it's because of faults in the TV receivers or their aerials. One problem that can cause interference is the presence of rectifying contacts in the TV aerial leads, particularly when these are old. These problems arise where aerials are connected to cables or cables to plugs — anywhere, in fact, where metals are connected, and particularly when the metals are dissimilar (copper to aluminium, copper to steel). The rectifying contacts can cause harmonics to be generated in the receiving aerial, and nothing you do to your transmitter can alter that! Another similar effect will occur if the first RF stage of the TV is being overloaded by your signals — this is bad design and can be overcome by a filter (high-pass if you are on the 28MHz band for example) in the TV aerial lead.

While we're on this subject, a quick look at suppressing stereo systems may be useful (especially if it's your own one!). The most likely pickup places are the long unscreened leads, which are the mains cables and the loudspeaker leads. When the volume control of the stereo outfit has no effect on the interfering signal, it's a pound to a penny that the signal is being picked up on the speaker leads and fed into the amplifier through the negative feedback loop. If the speaker leads are just the right length to resonate on an amateur band, or on a harmonic, then the interference can be very strong.

The easiest suppression method is to put bypass capacitors between the speaker leads and the earth of the amplifier end of the cable. Ceramic disc capacitors of 10nF should be sufficient for all but the worst interference (33nF may be needed for that). There should be no effect on the sound output, because the speaker leads are at low impedance. In stubborn cases, a ferrite bead on each wire and at each end of the leads may be needed.

Pickup on the mains lead arises only in rather low-grade stereo equipment which does not use mains filters. Here also, bypassing is usually effective and in severe cases a mains filter such as the QED can be fitted.

If the interference is picked up when the stereo system is switched to disc play, and is controlled by the volume control, then the pickup cartridge is the usual culprit. Ferrite beads on the cartridge leads (not a simple piece of fitting!), along with a check for poor connections which could cause rectification, are useful here. It's worth noting that FM transmissions do not generally cause these problems, because a simple rectifier does not demodulate the FM signals.

Measurements

You can't get very far in amateur radio work without some measuring instruments and some simple test rigs. The difference is important. A test rig gives you some simple indication, like whether you are approaching 100% modulation or not. A measurement is more precise, and its result is a numerical reading. Of all the measuring instruments that are available, the most essential is a good multimeter, one with a range of voltage and current scales (AC current too, if possible), along with resistance and diode test. A good instrument like this is worth its weight in gold. Even with two other meters at hand, my digital multimeter gets a lot of use.

The important measurements and tests for the radio amateur, however, relate to items such as frequency measurements, because any DC meter is usually adequate to measure DC current to the PA, so that power can be calculated (except for SSB). If you work near the limit of 150W, incidentally, it's a good idea to have an ammeter permanently connected to the PA supply, and mark it in terms of watts so that you can be sure that you are not exceeding limits. Apart from that, the multimeter will be used mainly in checking operating conditions if something goes wrong, and the frequency measuring equipment is more likely to be in continuous use.

Of all these instruments, one of the most useful is an absorption wavemeter, because it's an excellent way of checking for stray emissions. The principle is very simple — a tuned circuit provided with a set of plug-in coils to cover a wide range, along with a diode and a sensitive meter (Figure 3). Any radiation picked up is rectified and will operate the meter. It won't detect a leaky microwave oven, because the diode isn't up to it, but it will detect harmonic radiation provided that the variable capacitor has a calibrated scale. You can make such a meter for yourself, provided that you have some way of calibrating it, like access to a good RF signal generator (are you near a Technical College?) or you can buy the instrument ready made — the calibration is the expensive bit.

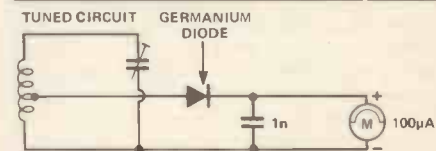


Figure 3. Principle of an absorption wavemeter. Any signal picked up on the coil, and resonant, will be rectified by the diode and will cause the meter to deflect.

Adding a bit of amplification to a simple absorption meter gives a field-strength meter, which is useful to make readings of the radiated power from your transmitter. It's a more specialised instrument than the wavemeter, but it's of particular interest if you specialise in aerial design. If you are a problem district for aerials, with very low received signal strength and great difficulty in getting your transmissions out, the field strength meter can be very useful indeed to find

out what the effect of changes in aerial design can be.

Another useful test instrument is a crystal frequency marker generator (Figure 4). The principle is to use a 100kHz crystal in a multivibrator circuit, with IC dividers to produce 50kHz and 25kHz frequencies. Since the outputs are square waves, rich in harmonics, it will provide signals which are detectable even on the VHF bands. With a stabilised voltage supply and a well designed layout, the accuracy can be very good. The frequency markers are used to check the accuracy of transmitter settings. If the output of the marker is taken to a receiver, it will beat with the transmitter carrier frequency using the VFO only, with the PA switched off, to produce a note which you will hear when the transmitter is set to a multiple of the marker frequency. For example, with the transmitter set to 10MHz052 you should get a 2kHz beat, because 10MHz052 is 10052kHz, and the 50kHz output from the meter will have a harmonic (the two-hundred-and-first) at 10050kHz. You can check the calibration of your meter by reference to standard transmissions such as MSF (Rugby) at 2MHz5, 5MHz and 10MHz.

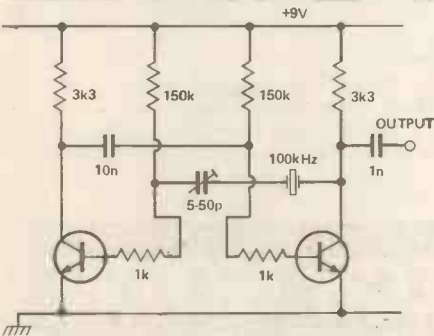


Figure 4. A 100kHz spot frequency generator. This is a multivibrator with a 100kHz crystal, and commercial circuits use ICs, with frequency dividers to provide 50kHz and 25kHz.

Digital frequency meters were at one time regarded as an expensive luxury, but the drop in prices of digital ICs and displays has now made the cost of a DFM lower than that of many of the more traditional methods of frequency measurement. If you build your own, make certain that it is a design suitable for this use, because not all digital ICs will cope with high frequencies. The accuracy of a digital meter (to about 5Hz) is its strong point, and it is also much easier to use than traditional meters.

Modulation Indicators

Accurate measurements of modulation depth are not easy to achieve, and the methods that are illustrated using oscilloscopes are not necessarily applicable because, apart from the cost, oscilloscope amplifiers do not generally cope with the frequencies involved — most RF uses mean dispensing with the amplifiers (the expensive part!) and using connections to the tube directly, and not all oscilloscopes are easy to use in this way.

A modulation indication is just as useful as a measurement for many purposes,

so that the simple circuit of Figure 5 is serviceable. The circuit works by detecting the negative peak in the wave from the PA. If this negative peak reaches earth level, the modulation is 100%, and over-modulation is almost inevitable. By biasing the diode, it can be made to conduct when the negative peak of the carrier reaches some percentage of the supply voltage — the example shows the diode set to detect 90% modulation. Modulation over this level will be indicated by the meter needle flickering, and this is as useful to know as an actual measurement of modulation depth. Don't be tempted to use an LED for D1, incidentally — the circuit needs a diode with a large peak inverse voltage capability, at least three times the DC supply voltage. An LED can, however, be used in place of a milliammeter.

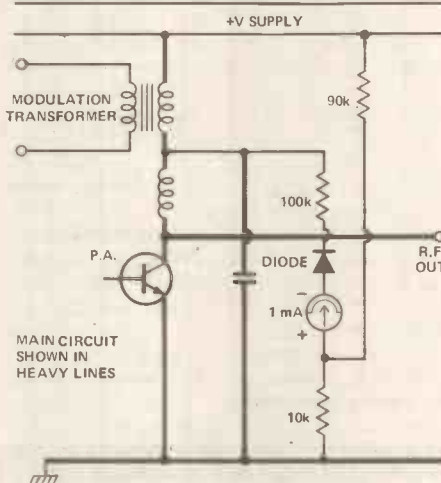


Figure 5. An indicator for 90% depth of modulation.

Standing Wave Ratio

SWR meters are quite simple instruments, but it's not so easy to understand how they work. It's hardly worth while to make your own, because commercial instruments are comparatively cheap, but it's useful to know the working principle. Most SWR meters depend on a type of design called a reflectometer bridge; one example is shown in Figure 6. When the RF-out terminals are joined by a resistor of the correct terminating value, the circuit behaves like a bridge with two capacitors and two resistors (Figure 7). The voltages will be out of phase, and if the transformer is wound so that the voltages are equal, the meter reading will be zero. If the termination is not a pure resistor, then the bridge will be unbalanced, and the meter will read a current whose value is proportional to the VSWR. There are many variants on this scheme, some of which use a wire inserted between the inner and the outer of a coaxial cable to detect the signal on the feeder.

The toughest of all measurements is the measurement of the peak envelope power of a SSB transmitter. Unlike the maximum input power to the power PA, which is the measurement method used for all other forms of modulation, peak envelope power cannot be measured by DC methods, and since most SSB transmitters will be commercial products,

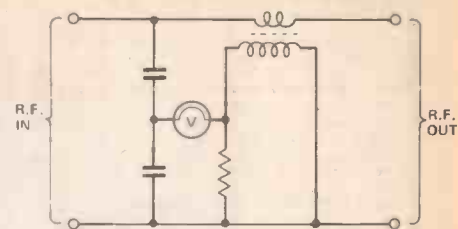


Figure 6. Circuit of one type of SWR meter.

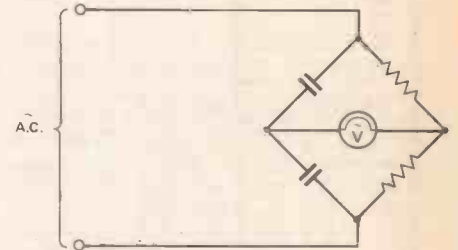


Figure 7. SWR meter principle: the AC bridge circuit.

designed to produce an output that is within the rated limit, there is seldom any need for the measurement. Some of the methods that are described using an oscilloscope will need direct connection to the plates of the oscilloscope tube. It's not really something to attempt for yourself.

Tolerances

One final point on measurements concerns the effects of tolerances, which are inevitable inaccuracies of any meter reading. If you are working near the limits of output power or near the frequency edge of a band, then you need to pay attention to tolerances, because they can have the effect of throwing your calculations out. Every meter measurement will have a tolerance, measured as a percentage and this, remember, makes no allowance for any reading errors on your part. If your meter is of $\pm 5\%$ tolerance, a fairly common standard, then you can expect a voltage which reads as 100V to be in reality anything from 95V ($100V - 5\%$) to 105V ($100V + 5\%$).

Similarly, if you have a current meter which has a tolerance of 5%, then 1A5 on the meter may mean 1A425 (5% less) up to 1A575 (5% more). Serious problem? It is if you are measuring PA volts and amps, and what you think is 150W ($100V \times 1A5$) is actually 165W375 ($105V \times 1A575$) — and that puts you over the top. A similar situation can occur with frequency tolerances. These are usually quoted in parts per million rather than as percentages, because they would all be fractional percentages. For example, if your frequency meter has a tolerance of 15 parts per million, and you want to work on the upper edge of the 28MHz band, which is 29MHz7, then you can't rely on being able to set to 29MHz7. At this frequency, the tolerance of your meter is $15 \times 29\text{Hz}7 = 445\text{Hz}5$, half a kilohertz, and you would have to ensure that you kept at least this far inside the band limits.

Next month — Winding up on licence conditions, operating procedures and all that jazz.

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2N6027	18p	7426	21p	74193	46p
3N128	20p	7427	16p	74194	46p
		7428	17p	74195	46p
		7432	17p	74198	89p

CMOS

4000	11p	7433	22p	74198	89p
4001B	11p	7441	58p		
4006B	40p	7442	25p		
4007	10p	7444	72p		
4008	33p	7445	38p		
4009	28p	7446	57p		
40108	33p	7447A	35p		
4011B	11p	7448	25p		
4012	25p	7472	25p		
40138	23p	7473	14p		
4014	52p	7474	18p		
40158	40p	7475	20p		
4016	20p	7476	18p		
4020B	45p	7479	110p		
4021	43p	7482	56p		
4022	40p	7483	35p		
4023	11p	7489	110p		
4025	14p	7490	20p		
4027	20p	7492	26p		
4028	42p	7493	27p		
4029	45p	7494	27p		
4030	14p	7495	35p		
4035	46p	74100	70p		
4041	42p	74105	46p		
4042	44p	74107	18p		
4043	46p	74109	19p		
4044	40p	74110	53p		
4048	43p	74118	81p		
4049	24p	74121	21p		
4050B	24p	74122	30p		
4056	25p	74123	40p		
4058	14p	74126	33p		
4069	11p	74125	35p		
4070B	15p	74126	33p		
4071	15p	74132	33p		
4072	15p	74141	48p		
4073	15p	74145	40p		
4077	15p	74147	86p		
4081	14p	74150	51p		
4082	14p	74151	36p		
4516	58p	74153	40p		
4518	45p	74155	36p		
		74157	35p		
		74161	29p		
		74162	26p		
		74163	46p		
		74164	38p		
		74165	46p		
		74167	70p		
		74174	40p		
		74175	20p		
		74177	37p		
		74180	30p		
		74184	70p		
		74185	32p		
		7420	9p		

TTL LS

LS00	10p
LS01	10p
LS02	10p
LS03	12p
LS04	13p
LS06	11p
LS10	11p
LS12	11p
LS13	22p
LS14	22p
LS20	11p
LS21	14p
LS32	13p
LS42	28p
LS47	36p
LS48	45p
LS73	20p
LS74	18p
LS75	20p
LS76	19p
LS78	20p
LS86	18p
LS90	22p
LS93	24p
LS95	40p
LS122	28p
LS123	36p
LS167	26p
LS163	38p
LS221	52p
LS261	32p
LS253	36p
LS279	30p

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7812	8C167	10p	BU205	105p
7905	8C173	7p	BU208	115p
7912	8C177	10p	MJ2955	90p
7915	8C178	13p	OC28	50p
7918	8C179	12p	TIP298	28p
7924	8C182	9p	TIP30	25p
BRIDGE RECTIFIERS	8C184L	9p	TIP30B	28p
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1A/200V	8C213	9p	TIP295	86p
1A/400V	8C213L	9p	ZTX300	9p
1A/600V	8C214	9p	ZTX800	11p
2A/100V	8C214L	9p	2N1131	11p
DIODES	8C477	18p	2N1304	23p
1N4148	8C547	7p	2N2222A	15p
1N4005	8C549	9p	2N2389	14p
INFL SOCKETS	8C557	7p	2N2484	18p
18 pin	8C558	7p	2N2904	17p
22 pin	8C559	13p	2N2906	17p
24 pin	8D131	35p	2N2907	17p
28 pin	8D132	35p	2N2928G	10p
40 pin	8D135	10p	2N3053	25p
TRANSISTORS	8D138	27p	2N3055	44p
RS	8D139	35p	2N3702	10p
AC127	8D140	35p	2N3711	6p
AC128	BF180	22p	2N3823	52p
AC187	BF181	7p	2N3866	40p
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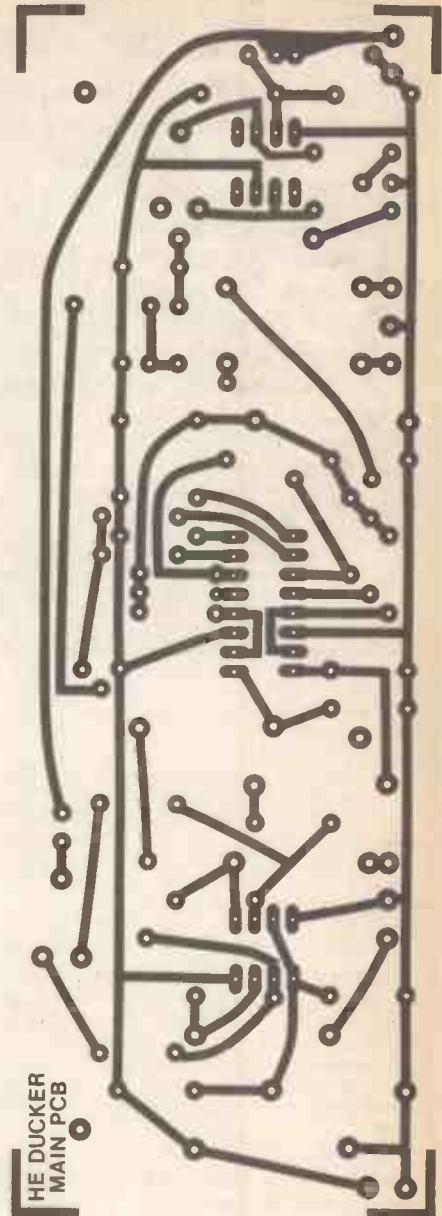
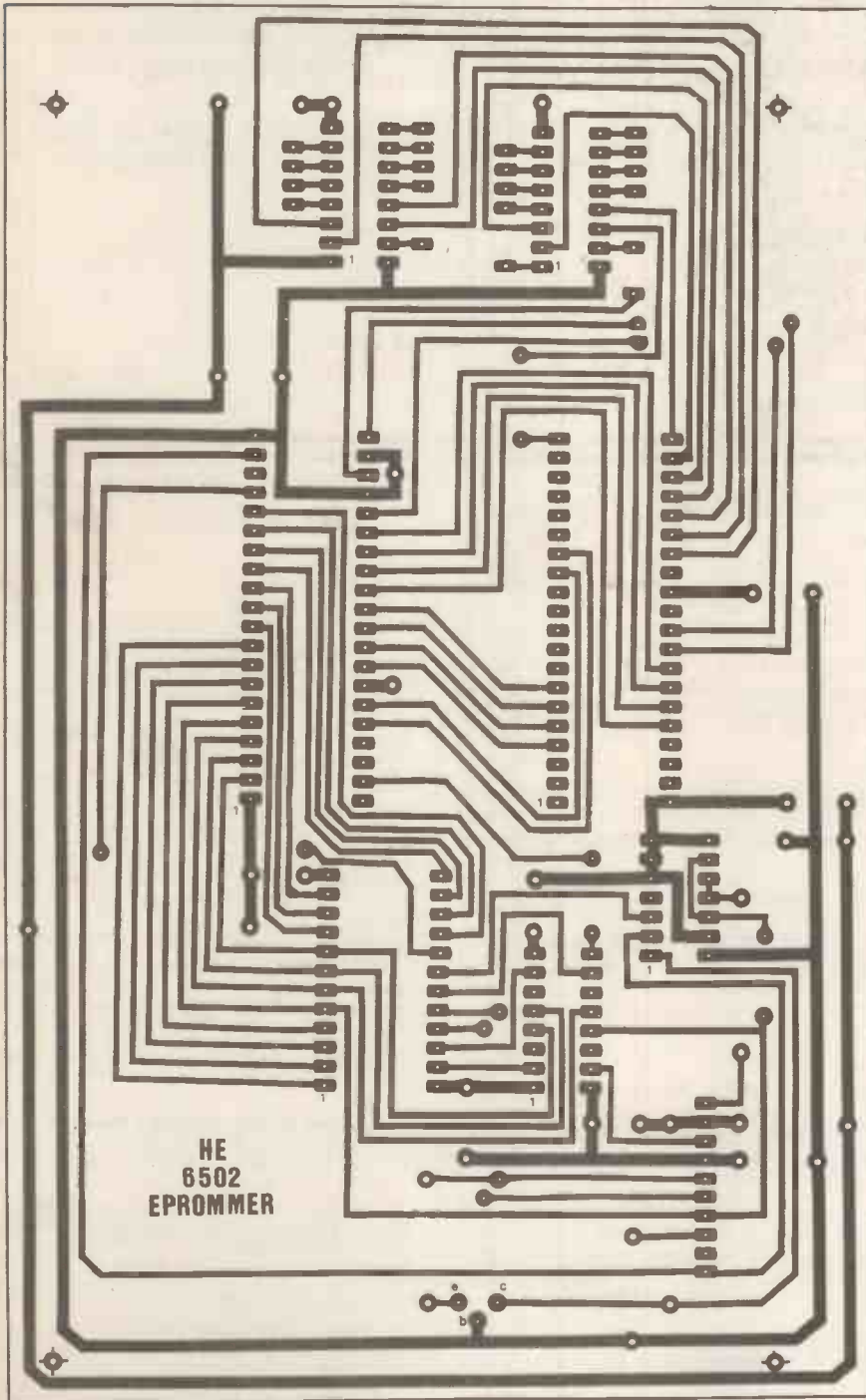
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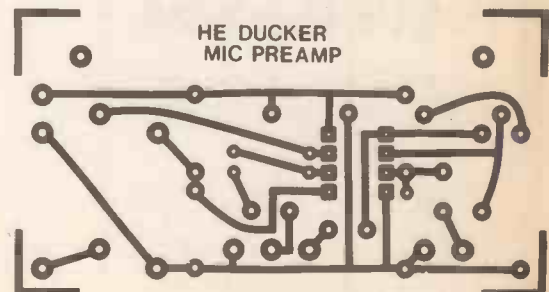
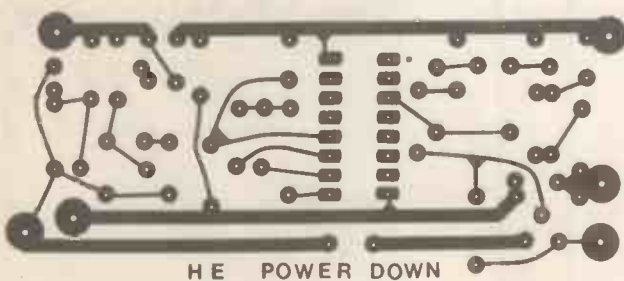
HE PCBs



Above left, the PCB foil pat tern for the HE EPROM Programmer.

Below left, the Auto Power Down PCB

The main PCB for the Voice-Over Unit (Ducker) is reproduced above, and the Mic Preamp foil pattern is shown below.



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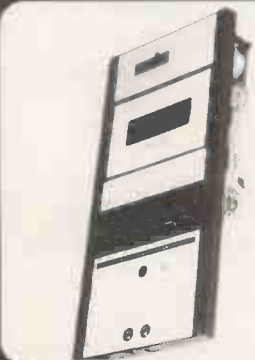
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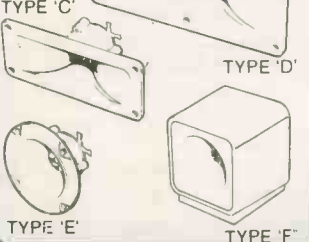
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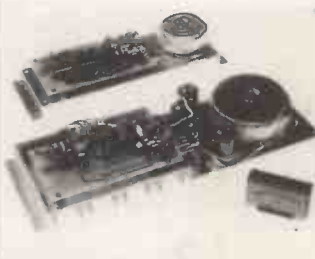
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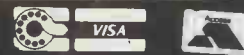
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