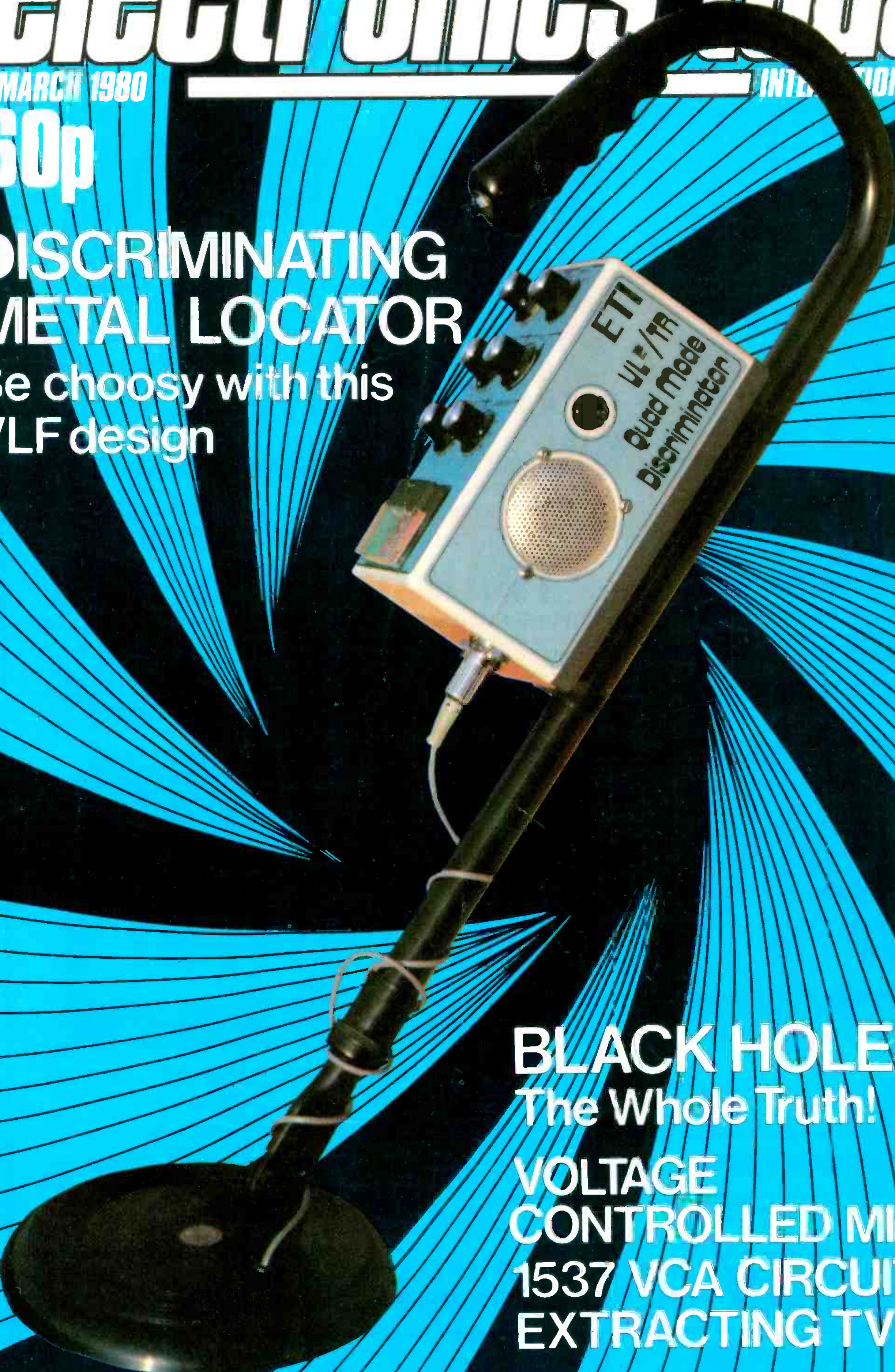
ISSN 0142-7229

electronics today INTERNATIONAL

MARCH 1980
60p

DISCRIMINATING METAL LOCATOR

Be choosy with this VLF design



BLACK HOLES

The Whole Truth!

VOLTAGE CONTROLLED MIXER

1537 VCA CIRCUITS

EXTRACTING TV HI-FI

. . . NEWS . . . . PROJECTS . . . . MICROPROCESSORS . . . . AUDIO . . .

TRANSCENDENT 2000
SINGLE BOARD SYNTHESIZER

LIVE PERFORMANCE SYNTHESIZER DESIGNED BY CONSULTANT TIM ORR (FORMERLY SYNTHESIZER DESIGNER FOR EMS LIMITED) AND FEATURED AS A CONSTRUCTIONAL ARTICLE IN ELECTRONICS TODAY INTERNATIONAL.

The TRANSCENDENT 2000 is a 3 octave instrument transposable 2 octaves up or down giving an affective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with both low and high pass outputs and a separate dynamic sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.

The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal trim!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready-built units selling for between £500 and £700!

Cabinet size 24.6" x 15.7" x 4.8" (rear) 3.4" (front)

COMPLETE KIT ONLY £168.50 + VAT!

Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more elaborate than a multi-meter and a pair of ears!

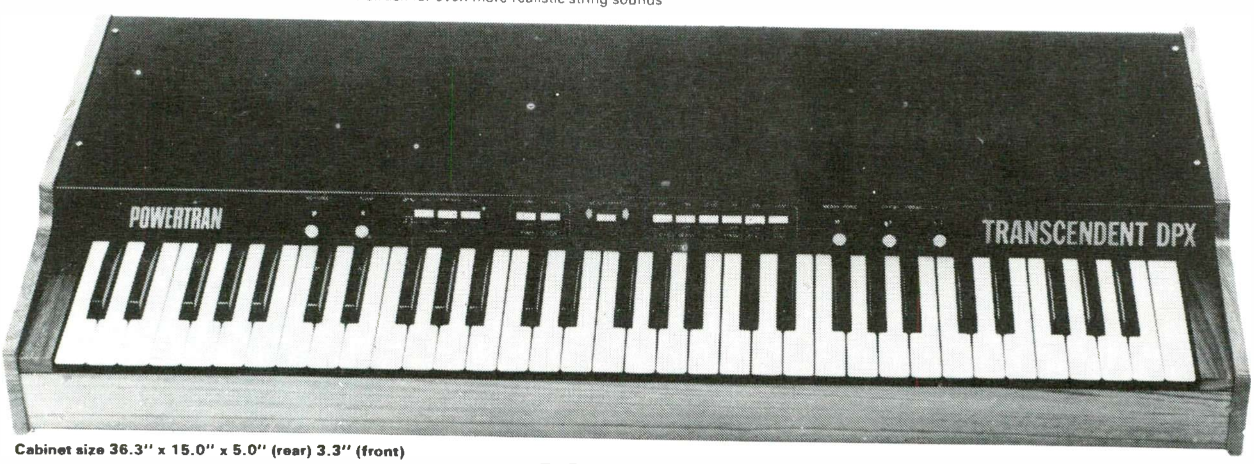
WE'VE MOVED! NEW FACTORY UP! PRICES DOWN!

INCREASED CAPACITY AT OUR BIG NEW FACTORY MEANS MANY PRICES DOWN! ALL OTHERS FROZEN!

TRANSCENDENT DPX

DIGITALLY CONTROLLED, TOUCH SENSITIVE, POLYPHONIC, MULTI-VOICE SYNTHESIZER

The Transcendent DPX is a really versatile new 5 octave keyboard instrument. There are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound — fully polyphonic i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano or a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass at the lower end (the keyboard is electronically split after the first two octaves) or vice versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrato comes in only after waiting a short time after the note is struck for even more realistic string sounds.



Cabinet size 36.3" x 15.0" x 5.0" (rear) 3.3" (front)

COMPLETE KIT ONLY £299.00 + VAT!

To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects.

As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing etc. etc.) and an interface socket (25 way D type) is provided for this purpose.

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.

The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug — you need buy absolutely no more parts before plugging in and making great music! When finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200!

POWERTRAN

ORDERING INFORMATION AND MORE KITS ON PAGE 8

All kits also available as separate packs (e.g. P.C.B., component sets, hardware sets, etc.). Prices in FREE CATALOGUE.

electronics today INTERNATIONAL

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start digging here p.78

guess what p.51

FEATURES

PROJECTS

INFORMATION

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145 Charing Cross Road, London WC2H 8DEE. Telephone 01-437 1002/3/4/5

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Ian Graham B.Sc	Assistant Editor
Diego M. Rincon	Art Director
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ABC

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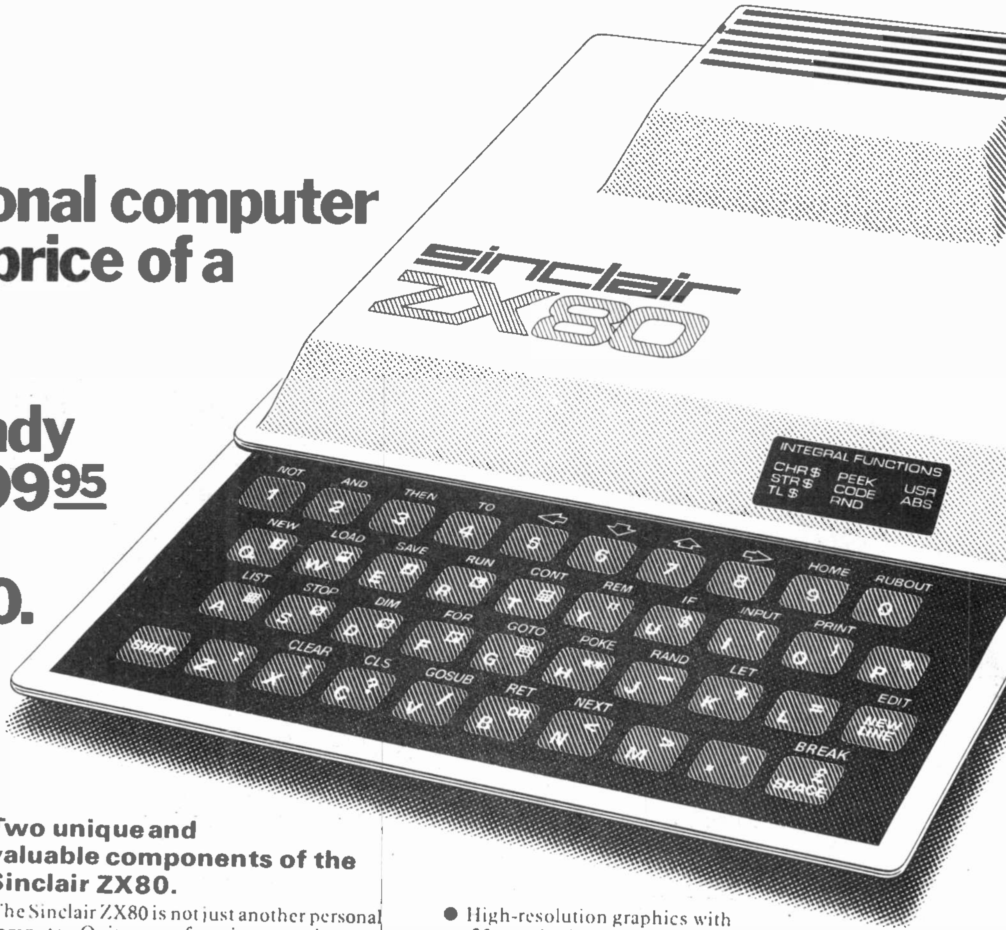
Britain's first comp



A complete personal computer for a third of the price of a bare board.

Also available ready assembled for £99.95

The Sinclair ZX80.

Until now, building your own computer could easily cost around £300 – and still leave you with only a bare board for your trouble.

The Sinclair ZX80 changes all that. For just £79.95 you get *everything* you need to build a personal computer at home...PCB, with IC sockets for all ICs; case; leads for direct connection to your own cassette recorder and television; everything!

And yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers on the market at several times the price. The ZX80 is programmed in BASIC, and you could use it to do quite literally anything from playing chess to running a power station.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. Once assembled, it immediately proves what a good job you've done. Connect it to your TV set...link it to an appropriate power source*... and you're ready to go.

Your ZX80 kit contains...

- Printed circuit board, with IC sockets for all ICs.
- Complete components set, including all ICs – all manufactured by selected world-leading suppliers.
- New rugged Sinclair keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to any portable cassette recorder (to store programs) and domestic TV (to act as VDU).
- FREE course in BASIC programming and user manual.

Optional extras

- Mains adaptor of 600 mA at 9 V DC nominal unregulated (available separately – see coupon).
- Additional memory expansion board plugs in to take up to 3K bytes extra RAM chips. (Chips also available – see coupon.)

*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).

Two unique and valuable components of the Sinclair ZX80.

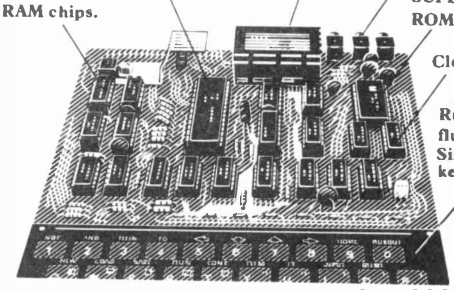
The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

The unique Sinclair BASIC interpreter... offers remarkable programming advantages:

- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input – to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

...and the Sinclair teach-yourself BASIC manual.

If the features of the Sinclair interpreter listed alongside mean little to you – don't worry. They're all explained in the specially-written 96-page book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs. (Available separately – purchase price refunded if you buy a ZX80 later.)



lete computer kit.

Fewer chips, compact design, volume production – more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed onto fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer, because the ZX80's brilliant design packs the RAM so much more tightly. (Key words, for instance, occupy just a single byte.)

To all that, add volume production – and you've that rare thing: a price breakthrough that really *is* a breakthrough.

The Sinclair ZX80. Kit: £79.95. Assembled: £99.95. Complete!

The ZX80 kit costs a mere £79.95. Can't wait to have a ZX80 up and running? No problem! It's also available, ready assembled, for only £99.95.

Whether you choose the kit or the ready-made, you can be sure of world-famous Sinclair technology – and years of satisfying use. (Science of Cambridge Ltd is one of the Sinclair companies owned and run by Clive Sinclair.)

To order, complete the coupon, and post to Science of Cambridge for delivery within 28 days. Return as received within 14 days for full money refund if not completely satisfied.

sinclair ZX80

Science of Cambridge Ltd

6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Tel: 0223 311488.

Order Form

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Remember: all prices shown *include* VAT, postage and packing. No hidden extras.

Please send me:

Quantity	Item	Item price £	Total £
	Sinclair ZX80 Personal Computer kit(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	79.95	
	Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	99.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	8.95	
	Memory Expansion Board(s) (takes up to 3K bytes).	12.00	
	RAM Memory chips – standard 1K bytes capacity.	16.00	
	Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer).	5.00	
		TOTAL	£

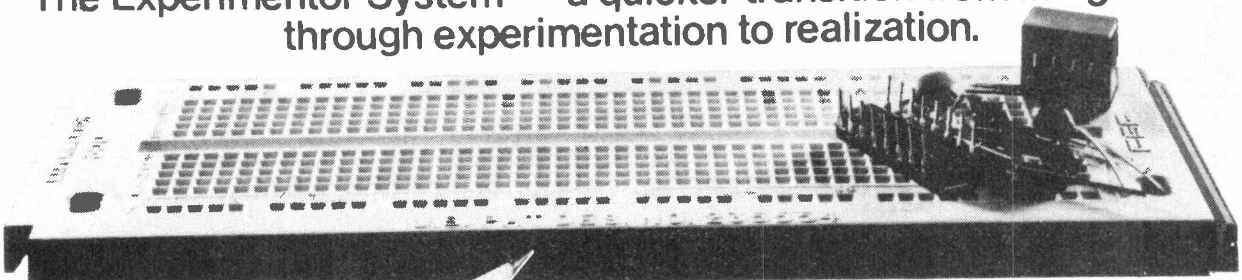
NB. Your Sinclair ZX80 may qualify as a business expense.

I enclose a cheque/postal order payable to Science of Cambridge Ltd for £

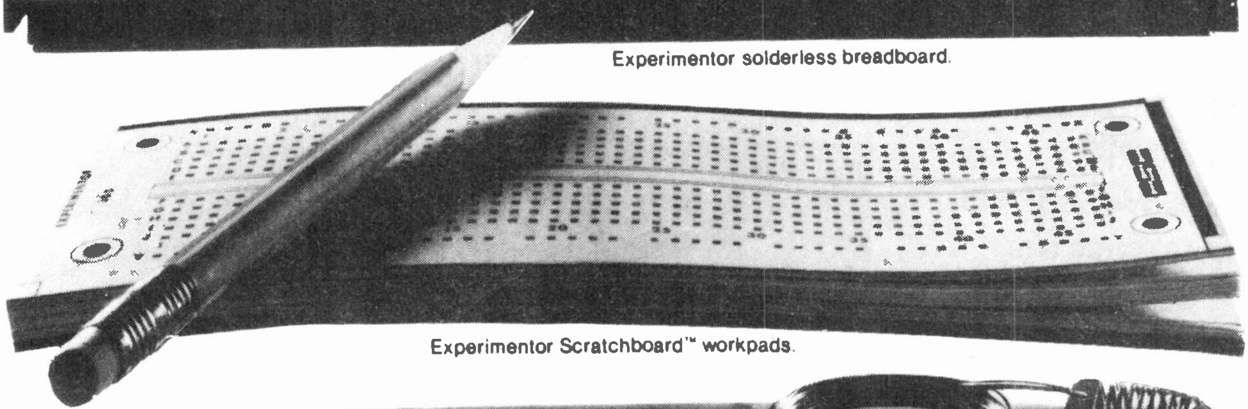
Please print
Name: Mr/Mrs/Miss

Address

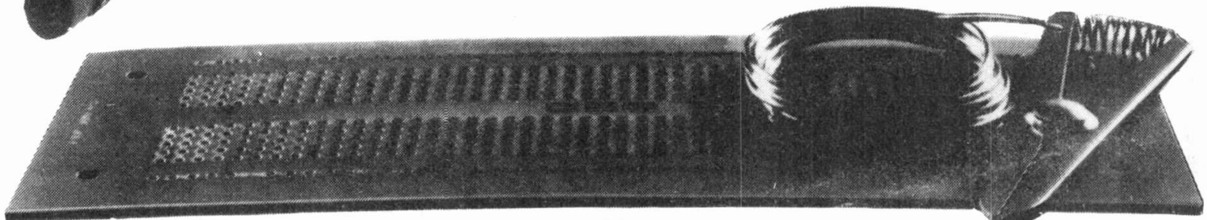
ET1/3/80



Experimentor solderless breadboard.



Experimentor Scratchboard™ workpads.



Experimentor Matchboard™ pre-drilled PCBs.

DIGEST

For Starters

The Dema System is a compact electronic ignition unit introduced by Maywood Technical Developments. Priced at £49.50 including VAT and postage, the unit is aimed at both the private motorist and the fleet operator.

The system incorporates a variable pulse width circuit to determine when the voltage stored on capacitors should be swtiched by thyristor to the HT coil and spark plugs. It monitors the revs and varies the duration of the spark to achieve as near as possible complete initiation of combustion.

The system can be installed by unskilled staff in about half an hour without having to make any alterations to the vehicle.

The Dema System is available from Maywood Technical Developments Ltd, Peake House 232 High Street, Harlington, Hayes, Middlesex UB3 5DS.

Tantless

It seems that there isn't a lot of tantalum ore about these days. Although it hasn't exactly been the first item on News at Ten, it means there's a shortage of tantalum powder, from which the capacitors are made. Supply and demand just isn't working in our favour. As demand keeps on rising, the known reserves are being exhausted. That inevitably means that tantalum capacitors are bound to increase in price rapidly over the next year or two.

Red Hot Radar

Under Chairman Brezhnev Soviet defence spending has increased from half to almost double that of America.

A Senate Subcommittee heard recently that the latest Soviet airborne tactical look-down/shoot-down radars are believed to be superior to any system now used by American forces.

Russian missile guidance systems can now match their American counterparts. Russia is also annually devoting several times America's spending on research into high energy laser research.

Radiation Hazard

Have you any old ex-government equipment with luminous dials or pointers? (They may not now be luminous because of phosphor degeneration).

Mr. Manning of Birmingham University has informed us of a radiation hazard that may exist from some ex-government equipment.

He was moved to write to us after examining a revolution counter, containing two large moving coil meters with edgewise scales about 100 mm long, scaled 6-14-18-22-26-30 and marked 'Engine Speed Hundreds of RPM'.

The graduations and numbers are filled with radium activated luminous paint, applied very thickly. At 10 cms from the scales a Geiger counter registered 1000 counts per second. With alpha and beta radiation blocked, the count rate was still 100 cps. As Geiger counters are only one or two per cent efficient for gamma rays, the true rate may be several thousand per second. In that event the radioactive paint used is such a strong source (several millicuries) that one would require a licence to use it for teaching purposes.

If you have any ex-government equipment with luminous dials or pointers – better safe than sorry, have it properly disposed of if you think it may be a radiation hazard. Warning – don't burn the equipment; that will simply spread the radium through the air.

TTLs by TEXAS

7400	11p
74S00	60p
7401	12p
7402	12p
7403	14p
7404	14p
74S04	90p
7405	18p
7406	32p
7407	32p
7408	17p
7409	19p
7410	15p
7411	24p
7412	20p
7413	30p
7414	50p
74C14	90p
7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	34p
7425	30p
7426	40p
7427	34p
7428	17p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
7442A	60p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	50p
7448	80p
7450	17p
7451	17p
7453	17p
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7460	17p
7470	36p
7472	30p
7473	34p
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7475	38p
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74293	150p
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74LS348	200p
74LS365	100p
74LS367	100p
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74LS378	200p
74LS390	160p
74LS393	160p
74LS445	140p
74LS668	100p
74LS669	100p
74LS670	400p

4000 SERIES

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4002	17p
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4007	18p
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40108	470p
40109	100p
40110	300p
40114	250p
4411	1100p
4502	120p
4503	70p
4507	55p
4508	290p
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4724	250p
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40097	90p
14411	1100p
14412	1100p
14433	1100p
14500	700p
14599	290p
CD22100	350p
CD22101	700p
CD22102	700p

INTERFACE ICs

DM8123	175p
MC1488	100p
MC1489	100p
25S10	350p
75107	160p
75150	175p
75154	175p
75182	230p
75322	300p
75324	375p
75325	375p
75361	300p
75363	400p
75365	350p
75451	72p
75491/2	96p
BT26	250p
BT28	300p
8T95	200p
8T97	200p
81LS95	140p
81LS96	140p
81LS97	140p
81LS98	140p
9601	110p
9602	220p
9603	180p

93 SERIES

9301	160p
9302	175p
9308	316p
9310	275p
9311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	380p
9368	200p
9370	200p
9374	200p

VEROBOARDS

	0.1	0.15
(copper clad)		
2.5×3.75"	48p	43p
2.5×5"	57p	51p
3.75×3.75"	57p	—
3.75×5"	64p	64p
3.75×17"	222p	194p
4.75×17.9"	290p	—
Pkt of 100 pins		50p
Spot face cutter		86p
Pin insertion tool		118p
Vero Wiring Pen + 2 wire spools + combs		370p
Combs		7p

LINEAR I.Cs

AY1-0212	600p
AY1-1313	668p
AY1-1320	320p
AY1-5050	140p
AY3-1270	840p
AY5-1224A	240p
AY5-1315	600p
AY5-1317A	775p
CA3019	80p
CA3046	70p
CA3048	225p
CA3080E	72p
CA3086	48p
CA3089E	225p
CA3090AQ	375p
CA3130E	90p
CA3140E	50p
CA3160E	100p
CA3161E	140p
CA3162E	450p
CA3189E	400p
DAC1408-8	200p
FX209	750p
ICL7106	850p
ICL8038	340p
ICM7555	80p
LF356P	95p
LF358P	75p
LM10C	425p
LM301A	30p
LM311	120p
LM318	200p
LM319	225p
LM324	50p
LM339	75p
LM348	95p
LM377	175p
LM380	75p
LM381AN	160p
LM709	36p
LM710	50p
LM725	350p
LM733	100p
LM741	18p
LM747	70p
LM748	35p
LM2917	250p
LM3900	70p
LM3909	70p
LM3911	130p
LM3914	250p
LM4136	120p
MC1310P	150p
MC1458	48p
MC1495L	360p
MC1496	100p
MC3340P	120p
MC3360P	120p
MK50398	750p
MM57160	620p
NE531	160p
NE555	22p
NE556	70p
NE561B	425p
NE562B	425p
NE565	130p
NE566	155p
NE567	175p
NE571	425p
RC4151	400p
SAD1024A	1250p
SFF96364	£11
SN76003N	175p
SN76013N	140p
SN76013ND	120p
SN76023N	140p
SN76023ND	120p
SN76477	200p
SP8515	750p
TAA621	275p
TBA641B11	225p
TBA651	200p
TBA800	90p
TBA810	100p
TBA820	90p
TCA940	175p
TDA1004	300p
TDA1008	320p
TDA1010	225p
TDA1022	800p
TDA1024	120p
TDA1034B	250p
TDA1170	250p
TDA2002V	325p
TDA2020	320p
TL071	50p
TL072	95p
TL074	150p
TL081	45p
TL082	95p
TL084	130p
TL170	50p
UAA170	200p
UAA180	200p
UDN6118	320p
UDN6184	320p
ULN2003	100p
XR2206	400p
XR2207	400p
XR2211	600p
XR2216	675p
XR2240	400p
ZN414	90p
ZN419C	POA
ZN424E	135p
ZN425E	400p
ZN1034E	200p
95H90	800p
11C90	1400p

VOLTAGE REGULATORS

Fixed Plastic TO-220

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

OTHER REGULATORS

LM309K	135p
LM317T	200p
LM323K	550p
LM723	37p
TBA625B	120p
78HGKC	725p
78HO5KC	625p
78MGT2C	135p
78P05	900p

OPTO-ELECTRONICS

2N5777	45p
OCP71	130p
ORP12	90p
ORP60	90p
ORP61	90p
TIL78	70p

OPTO-ISOLATORS

ILD74	130p
MCT26	100p
MCS2400	190p
TIL111	90p
TIL112	90p
TIL116	90p

LEDS

0.125"		0.2"	
TIL32	75p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	MV5491 TS	120p
TIL216 Red	18p	Clips	3p

DISPLAYS

3015F	200p	NSB5881	570p
DL704	140p	TIL311	600p
DL707 Red	140p	TIL312/3	110p
707 Gr	140p	TIL321/2	130p
DL747 Red	225p	TIL330	140p
747 Gr	225p	7750/60	200p
FND357	120p	**DRIVERS**	
FND500	120p	9638	200p
FND507	120p	9370	200p
MAN3640	175p	UDN6118	320p
MAN4640	200p	UDN6184	320p

TRANSISTORS

AC126	25p
AC127/8	20p
AC176	25p
AC187/8	25p
AF116	50p
A0149	70p
AD161/2	45p
AU107	200p
BC107/8	11p
BC109	11p
BC117	20p
BC147/8	9p
BC149	10p
BC157/8	10p
BC159	11p
BC169C	12p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	16p
BC337	16p
BC338	16p
BC461	36p
BC477/8	30p
BC516/7	50p
BC547B	16p
BC548C	9p
BC549C	18p
BC557B	16p
BC559C	18p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD135/6	54p
BD139	54p
BD140	60p
BD189	60p
BD232	95p
BD233	75p
BD235	85p
BD241	70p
BD242	70p
BDX53B	150p
BDY56	200p
BF200	32p
BF244B	35p
BF256B	70p
BF257/8	32p
BF259	36p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFX29	30p
BFX30	34p
BFX84/5	40p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	30p
BFY51/2	30p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	20p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU205	200p
BU208	200p
BU406	145p
E300	50p
E308	50p
E310	50p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJE340	50p
MJE2955	100p
MJE3055	70p
MPF102	45p
MPF103/4	40p
MPF105/6	40p
MPS6531	50p
MPS6534	50p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSU06	60p
MPSU07	90p
MPSU45	90p
MPSU65	78p
OC28	130p
OC35	130p
R2008B	200p
R2010B	200p
TIP29A	40p
TIP29C	55p
TIP30A	48p
TIP30C	60p
TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP54	160p
TIP120	120p
TIP122	130p
TIP142	160p
TIP147	160p
TIP2955	78p
TIP4055	70p
TIS43	34p
TIS93	30p
ZTX108	12p
ZTX300	13p
ZTX500	15p
ZTX502	18p
ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N698	45p
2N706A	20p
2N708A	20p
2N918	45p
2N930	18p
2N1131/2	20p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	30p
2N2369A	16p
2N2484	30p
2N2646	45p
2N2904/5	25p
2N2906A	24p
2N2907A	30p
2N2926	9p
2N3053	30p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
2N3565	30p
2N3584	250p
2N3643/4	48p
2N3702/3	12p
2N3704/5	12p
2N3706/7	14p
2N3708/9	12p
2N3773	300p
2N3819	25p
2N3820	50p
2N3823	70p
2N3866	90p
2N3902	700p
2N3903/4	18p
2N3905/6	20p
2N4037	65p
2N4058/9	12p
2N4060	12p
2N4061/2	18p
2N4123/4	27p
2N4125/6	27p
2N4401/3	27p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5179	90p
2N5191	83p
2N5194	90p
2N5245	40p
2N5296	55p
2N5401	50p
2N5457/8	40p
2N5459	40p
2N5460	80p
2N5485	44p
2N5875	250p
2N6027	48p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2N6292	65p
2SC1172	150p
3N128	120p
3N140	100p
3N141	110p
3N201	110p
3N204	100p
40290	250p
40360	40p
40361/2	45p
40364	120p
40408	70p
40409	85p
40410	85p
40411	300p
40594	97p
40595	105p
40673	75p
40841	90p
40871/2	90p

DIODES

BY127	12p
BYX36-300	20p
OA47	9p
OA81	15p
OA85	15p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

HEAT SINKS

For TO220 Voltage Regs. and Transistors	22p
For TO5	12p

BRIDGE RECTIFIERS

1A	50V	19p
1A	100V	20p
1A	400V	25p
1A	600V	30p
2A	50V	30p
2A	100V	35p
2A	400V	45p
3A	200V	60p
3A	600V	72p
4A	100V	95p
4A	400V	100p
6A	50V	80p
6A	100V	100p
6A	400V	120p
10A	400V	200p
25A	400V	400p

ZENERS

2.7V-33V

400mW	9p
1W	15p

TRIACS PLASTIC

3A 400V	60p
3A 500V	65p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

1A 50V	40p
1A 400V	65p
3A 400V	90p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
16A 600V	220p
BT106	110p
C106D	45p
MCR101	36p
2N3525	120p
2N4444	140p
2N5060	34p
2N5064	40p

LOUDSPEAKERS

Size		
2½"	64R	70p
2½"	8R	70p
2"	8R	80p
1½"	8R	80p

MEMORIES

2102-2L	120p
2107B	500p
2111-2	225p
2112-2	300p
2114	525p
2114-2L	600p
4027	375p
4044	900p
4116	900p
5101	510p
6810	350p
74S201	325p
82S16	325p

ROM/PROMs

71301	700p
74S188	225p
74S287	350p
74S387	350p
74S470	650p
74S471	650p
74S571	650p
82S137	750p
93427	400p
93436	650p
93446	850p
93448	1000p

CPUs

1600	£12
2650A	£20
6502	£10
6800	900p
6802	1250p
8080A	550p
8085A	1400p
INS8060	1100p
Z80	1100p
Z80A	1250

EPROMS

1702A	500p
2516	£29
2708	800p
2716	£29

SUPPORT DEVICES

3245	400p
6532	1100p
6820	500p
6821	500p
6850	500p
8205	320p
8212	225p
8216	225p
8224	400p
8228	525p
8251	700p
8253	1200p
8255	550p
8257	1100p
8259	1400p
Z80P1D	650p
Z80CTC	650p
MC14411	1100p
MC14412	1100p

UART

AY-3-1015P	500p
AY-5-1013P	400p
IM6402	500p
TMS6011NC	400p

CHARACTER GENERATORS

3257ADC	990p
MCM6576	£10
RO-3-2513 U.C.	600p
RO-3-2513 L.C.	650p
SN74S262AN	1350p

KEYBOARD ENCODER

AY-5-2376 £9

TRANSFORMERS

(prim 220/240V)

6-0-6	100mA	88p
9-0-9	75mA	92p
12-0-12	100mA	95p
0-120	12500mA	280p
0-25V (5VA)		250p
9-0-9 1A		270p*
12V 2A		350p*
0-12-15		
20-24-30 1A		340p*
15-0-15 1A		265p*

(Please add 50p p&p charge to all marked * above our normal p&p charge)

RESISTORS High Stab 5% E12 Carbon Film

¼W 10R-1M 7p/5pcs one value
½W 10R-10M 5p/3pcs one value

Miniature Presets Hor/Vert 100R-1M 12p

Carbon Track Pots 5K-1M Log or Lin
Single 30p
Single with Switch 60p
Dual 72p

SLIDER POTS 60mm Track
LIN 5K, 10K, 50K, 100K 60p
LOG 10K 60p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	10p	18 pin	22p	24 pin	30p
14 pin	11p	20 pin	25p	28 pin	38p
16 pin	12p	22 pin	28p	40 pin	48p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	70p	24 pin	90p
14 pin	40p	20 pin	75p	28 pin	110p
16 pin	50p	22 pin	80p	40 pin	140p

SUBMINIATURE SWITCHES

Toggle SPST	60p
SPDT	65p
DPDT	70p
DPDT (centre off)	85p
Push to make	15p
break	25p
Push latching SPCO	60p
SLIDE DPDT	18p
ROCKER SPST	28p

WAFER

1P/12W	45p
3P/4W	45p
4P/3W	45p
2P/6W	45p

CRYSTALS

100KHz	300p
1MHz	370p
1.008MHz	370p
3.2768MHz	350p
3.579545MHz	200p
4MHz	350p
8.867237MHz	400p
10.7MHz	350p
18MHz	300p
26.690MHz	210p
27.145MHz	210p

ANTEX SOLDERING IRONS

C-15W	400p
CX-17W	415p
CCN-15W	415p
X25	415p

SPARE BITS

C/CX/CCN	46p
X25	50p

SPARE ELEMENTS

C/CX/X25	180p
CCN	200p

ADCOLA IRONS

K1000	550p
K2000	550p

VEROBOARDS

DIP Breadboard 4.15 × 6.15 (Suitable for 20 × 14 pin or 16 × 16 pin DIL ICs) DIP 270p
Breadboard as above with tracks for 31 way connector 340p
V-Q Boards for ICs (No track cutting) 105p

CONNECTOR PLUGS

31 way Plug	110p
31 way Socket	110p
S-100 Busboard	£12

EDGEBOARD CONNECTORS 0.156" PITCH

2 x 10 way	85p	2 x 22 way	135p
2 x 15 way	100p	2 x 25 way	160p
2 x 18 way	120p		

COUNTERS

74C925	475p
74C928	600p
ICM7216B	£20
ICM7217A	850p
ZN1040E	700p

TTL & ECL

MC4024	325p
MC4044	325p
10116	70p
10231	350p

SPECIAL OFFERS TO 31.1.80

555	£18/100	7805	£5/10
741	£16/100	7812	£5/10
2114L-3	£4.50	7905	£6/10
2708	£6.75	7912	£6/10
2716 (Plus 5V only)	£21.00	P&P+VAT Extra	

BREADBOARDS

EXP350 3.6" x 2.1" (Up to 3 x 14 pin ICs)	£3.15
EXP650 3.6" x 2.4" (Up to 1 x 40 pin IC)	£3.60
EXP300 6" x 2.1" (Uto 6 x 14 pin ICs)	£5.75
EXP600 6" x 2.4" (Up to 1 x 40 pin DCs)	£6.30

IC TEST CLIPS

14 pin	£2.60	24 pin	£2.90
16 pin	£2.75	40 pin	£2.90

PROTOBOARD (R) SOLDERLESS BREADBOARDS

Socket Strips/Bus Strips/Binding Posts mounted on sturdy base plate

PB6	6 x 14 DIL ICs	£9.20
PB100	10 x 14 DIL ICs	£11.80
PB102	12 x 14 DIL ICs	£22.95
PB103	24 x 14 DIL ICs	£34.45
PB104	32 x 14 DIL ICs	£45.95

(The above boards are suitable for all DIL ICs)

16 KEY KEYPAD (Reed Switches)	£4.00
UHF Modulators	£3.75
Reed Switches (12VA)	£0.25
LOGIC PROBE	£18.00
MULTIMETERS	
SUPERTESTER 680R	£33.00
MICROTEST 80R	£17.00
TMK500	£22.00
Pocket multimeter	£4.75

COMPUTER KITS

MEMORY MAPPED VDU INTERFACE KIT	£45.00
SERIAL I/P VDU INTERFACE KIT	£56.00
ELF II MICROCOMPUTER KIT	£79.95
ELF II WIRED AND TESTED	£99.95
GIANT MONITOR BOARD KIT FOR ELF II	£35.00
4K STATIC RAM BOARD FOR ELF II	£69.44
ASCII KEYBOARD KIT	£50.58

(Please add 75p p&p to all above items)

We carry a large stock of 74 and 74LS TTLs, CMOS, Linears, Memories, etc. and can normally offer ex-stock deliveries. We welcome inquiries for volume quantities both from local and overseas buyers.

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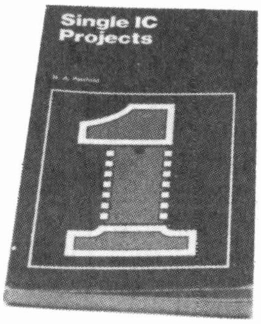
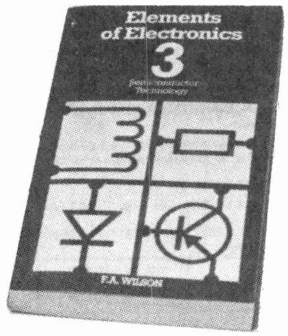
New Babanis





Amaze your friends with the number of uses to which you can put a single IC. You won't be short of ideas with 'Single IC Projects' by R. A. Penfold. This 127 page volume from Bernard Babani is divided into five sections, covering low level audio circuits, audio power amplifiers, timers, operational amplifiers and miscellaneous circuits.

Each circuit suggestion begins with a brief description of the chip used, together with a table of its chief characteristics. In each case a circuit diagram, practical layout, constructional details and parts list is given. These twenty simple projects could be yours for £1.50.

Also from Babani is Book 3 in their Elements of Electronics series. Book 3 continues this introduction to electronics with sections on semiconductor physics and characteristics. Basic semiconductor applications are described, including rectifiers, amplifiers, oscilators and switches. Book 3 of Elements of Electronics by F. A. Wilson (204 pages) is priced at £2.25.

If you have trouble getting these books they are available direct from the publisher, Bernard Babani (Publishing) Ltd, The Grampians, Shepherds Bush Road, London W6 7NF. A complete catalogue of Radio and Electronics Books is also available from this address. Please sent a stamped, addressed envelope. When ordering books, please send enough to cover postage.

Anti-Gravity Meter

You won't have a smashing time with this meter. The 3012 from Dorman Smith Instrumentation is a drop proof pocket tester giving DC volts (0V3 to 1000V), DC current (50 uA to 300 mA), AC volts (10V to 1000V) and resistance (10k to 1M ranges).

The meter will withstand being dropped from one metre — the height of the average workbench or jacket pocket. It incorporates a taut band movement and fuse protection. Power is from a size AA 1V5 battery.

The 3012 pocket test is available for £27 plus VAT including batteries, test leads, soft case and strap from Dorman Smith Instrumentation, Blackpool Road, Preston PR2 2DQ.

Tick Talk

If you have about a hundred dollars to spare you can invest it in the latest in alarm watches. The communicator, from Windert, uses a 64 kilobyte memory chip to carry its computer voice. It 'tells' you the time, talks you awake in the morning and nags you if you don't get up (makes the wife redundant).

The time, alarm and snooze messages are to be available in English, French, German and Spanish. In the not-so-distant future Windert have prophesied the development of programmable voice command watches and even the sci-fi cliché — watches with built-in TV screens and transmitters.

See-Thru Tops

Boss Industrial Mouldings have extended their BIM 2000 range of Bimboxes to include a new two part, deep profile version. Base and lid are available in black, grey, orange or blue, with the additional option of a clear lid. As with the rest of the Bimbox range, the new versions have 5.08 mm (0.2in) spaced slots on all sides of the base to support 1.5 mm PCBs.

The clear lid version is ideal for applications where viewing of, but not necessarily access to, internal components is required. The new Bimboxes, each 80.2×150.4×76 mm, are available from Boss Industrial Mouldings Ltd, 2 Herne Hill Road, London SE24 0AU.

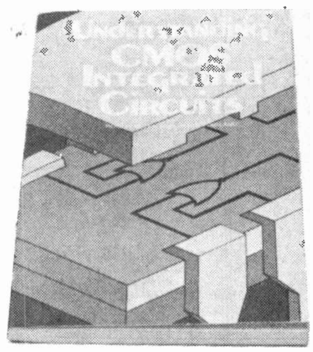
Sat 54 Where Are You?

Well, it was Satcom 3 actually, but the plot is reminiscent of that old, old American telly series. The Car 54 in this case, however, was an RCA communications satellite, last heard of in December, 22,000 miles above mother Earth.

If anyone finds a communications satellite answering to the name of Satcom 3, send it to RCA, nto us. Mind you, if it has gone up in a puff of smoke, it has probably burned up on its way back to Earth. NASA quick to assure us that it won't cause another Skylab incident. So, you needn't dust off your anti-Skylab umbrella, yet.

CMOS Class

Having trouble getting to grips with your CMOS? Understanding CMOS Integrated Circuits by Roger Melen and Harry Garland is an introduction to CMOS, covering everything from how the chips are made to a few simple practical CMOS circuits.



Almost half of the book is devoted to a summary of types of logic gates, semiconductor physics and CMOS fabrication techniques. The remainder gets down to the nitty gritty — CMOS circuit design, including waveform generators and information-processing circuits.

This 144 page American paperback is available in the UK from Prentice/Hall International, 66 Wood Lane End, Hemel Hempstead, Herts, HP2 4RG for £3.60.

Key Box

If you have a QWERTY keyboard, we can now tell you where to put it. Vero have introduced an attractive two-tone brown 17in. wide modular keyboard enclosure designed to house most universal layout QWERTY keyboards.

The front panel can be slid out for service or programming by removing the base screws and the end moulding, so there are no visible fixing screws on the front panel.

The enclosure can be supplied in non-standard lengths to allow the addition of extra keypads, etc.

The modular keyboard enclosure is available from Vero Electronics Ltd, Industrial Estate, Chandler's Ford, Eastleigh, Hampshire SO5 3ZR.

Direct Meter

Zycomm's combined VSWR and power meter offers direct reading of both functions without interpolation.

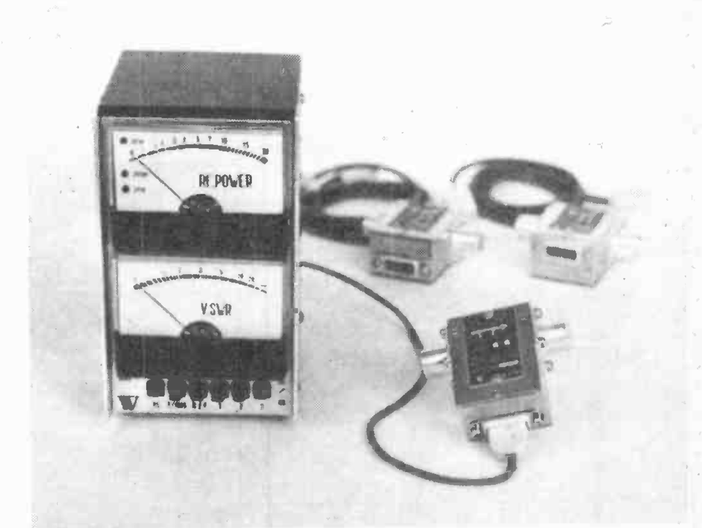
Autoranging for power output covers 20 W to 2 kW in three ranges. VSWR can be measured from 1:1 to infinity.

Separate sensing heads, supplied to cover each frequency range, can be connected at any position in the feed line. Forward and reverse power can be displayed as either peak or rms readings.

The electronic comparator included in the meter allows constant readout of VSWR regardless of power variation. It gives a true indication during speech on SSB.

You'll need a 240 V 50 Hz supply to operate the meter.

The combined VSWR and power meter is available from ZycommElectronics Ltd, 47-51 Pentrich Road, Ripley, Derbyshire DE5 3DS.



End of Chess

If you saw our survey of Chess Machines in December, you will have gathered that the idea is to play a game from start to finish against the computer. The latest chess machine is a little different in that it only plays end games.

It's a mini machine, measuring only 105 x 63 x 8 mm — not much bigger than a credit card calculator. It looks a bit like a calculator, too. On the front panel there are eight buttons numbered one to eight (for listing moves) and five instruction buttons — E (to enter move), C/E, S (score), P (peek?) and R (response). On top of all that there is a four digit LCD display.

With the mini mind you get seven booklets, each containing fifty different problems. More booklets will be printed to catch up with the Chess Master's memory of several thousand problems. Each booklet represents a different level of play.

Li and Fung Trading are making a thousand Chess Masters everyday in Hong Kong. More on the mini mind when we can get one to play with.

Vee Needen Sie

With a bit of luck we will once again be amazed, astounded and generally boggled by the versatility of ETI readers. This time, we'd like to hear from anyone who can translate technical German (ideally Dutch, too) into English for us.

We could employ the services of professional agencies in the field, but we'd prefer to get an ETI reader in on the act. So, if you think you're up to taking the odd page of unpronouncable tutonic text and turning it into the equally odd page of English, why not drop us a line or two or three.

Although we moved offices a few months ago, a lot of our mail is still being sent to our old address, so make sure you send the account of your terrific translational talents to us at 145 Charing Cross Road, WC2 (full address on the contents page.)

Greenweld 1980

We've just received our copy of Greenweld's 1980 component and equipment catalogue.

Every catalogue is sent out complete with a first class reply paid envelope (worth a small fortune these days) and five 12p discount vouchers to offset the cost of the catalogue.

Why should you buy the latest edition, if you have last year's? Well, if you don't send off for the 1980 edition, you'll miss out on all the new lines appearing in the catalogue AND somehow Greenweld have managed to reduce some of their prices. You'll also miss out on a copy of the latest bargain list (sent with every catalogue). As soon as the new Vero catalogue is available, that will be included too.

You can get all this for 40p plus 20p postage from Greenweld Electronics, 443 Millbrook Road, Southampton SO10HX.

Sci-Fi Easter

If you're into sci-fi, don't make any plans for Easter. Write 100 times in your gold embossed, leather-bound, page-a-day desk diary (or the nearest cigarette packet) – Albacon 80, the 31st UK Science Fiction Convention will be held in Glasgow over the Easter weekend.

From 4–7 April 1980 at the Albany Hotel, Glasgow, you can drift off into another world of sci-fi movies, lectures, discussions, a banquet and even a fancy dress do. You can join Albacon by sending off your £7 to the membership secretary Gerry Gillin, 9 Dunnottar Street Ruchazie, Glasgow G33.

Synthesiser (Feb)

There were a couple of minor errors in the Synthesiser project last month. The circuit diagram of the Power Supply on page 65 of the February issue shows C3 and C8 as 2n2. The correct value is, as shown in the Parts List, 2u2 25V tantalum. Now have a look at Fig 4 on page 69. C1-4 should go to ground. Also, PR3 should go to ground.

Now the bad news for anyone who uses the foil patterns published in ETI. The synthesiser foil patterns somehow got turned round the wrong way.

Audiophile AMP (Oct)

Some readers have experienced problems with RF oscillation in the power amp modules. If you're having trouble with this, place a 1000 p capacitor across each output transistors base/collector leads.

Super Index

In January we published an index to our 1979 projects and features. Thank goodness indexing only comes round once a year. We recently received a copy of a monster catalogue, listing projects published during 1978 in sixteen popular electronics and hi-fi magazines, including ETI, Hobby Electronics and Computing Today.

The projects are listed under 36 subject headings, from aerials to time-keeping. Also included are dates of publication of alterations and amendments to projects published up to August 1979, together with additions to the 1972-77 index. Unlike our own index this one includes ETI Tech Tips features.

The 1978 volume of the Electronics Projects Index is available for £1.30, including post and packing, from its compiler (obviously a very patient man) Mr M L Scaife, Central Library, Northumberland Square, North Shields, Tyne & Wear, NE30 1QU.

Vero Cat

Last month, we gave you details of the new Vero packaging catalogue. Vero Electronics have asked us to point out that this catalogue is only available to the electronics trade. Their press release was sent to us in error. However, the good news is that Vero's new catalogue for the hobbyist will be available at the beginning of March.

Pet Chip

This should appeal to those of you who spent your hard-earned pennies on a 'pet rock,' when they were all the rage.

We recently received a letter from an anonymous dad who made an apparently trivial Christmas presi for his daughter. However, since then he has been inundated with orders.

Mr A. Nonymous painted a face on one end of an IC (pet IC, you see) and made a matchstick cage for it complete with watch battery feeding bowl.

The chip should quickly LATCH on to its new OHM. As for feeding, a few BITS of CURRENTS a day should be AMPle. Just let it NOR away to its heart's content. You can teach it tricks. In time it will learn to CHARGE and FLIP-FLOP, or even VOLT small objects.

Ta, Mr Nonymous. We haven't had a good groan in ages.

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BLACK HOLE THEORY

You've read the book and seen the film, now hear the gospel on Black Holes according to Ian Graham

To understand what a black hole is and how it is formed, let's first have a look at the life of a star, for under the right conditions, the death of a star may herald the birth of a black hole. The birthplace of stars is within the clouds of material between the stars. These clouds collapse under their own gravitational fields. Local regions of increased density form condensation nuclei whose gravitational fields grow gradually stronger as more and more material is attracted towards them. As these embryonic stars (protostars) continue to contract their temperature begins to rise, producing internal heating and emitting radiation into the surrounding space. When the temperature is high enough for hydrogen fusion to begin, contraction ceases.

The greater part of the star's life-time is then occupied with burning its hydrogen fuel, forming helium, which sinks deep into the core. Eventually, when the hydrogen is almost exhausted, the star's temperature begins to fall and the core begins to contract. We must now look at the star, not as a homogeneous ball of burning gas, but as a relatively heavy core surrounded by a lighter envelope. There is a constant battle between thermal forces, trying to blow the star apart and gravitational forces trying to crush it. Contraction of the core causes a rise in temperature, temporarily halting contraction and causing an expansion of the envelope ie the star appears to be growing larger. The remaining hydrogen is burnt off in the outer layers, sending more helium to the core. Eventually the core collapses under the immense pressure of the upper layers and this is accompanied by an enormous expansion of the envelope, forming a red giant.

Great Balls Of Fire

The final episode in the star's life depends on its mass. Let's take the route that will take us to a black hole. The core continues contracting; helium fusing to form carbon and successively heavier elements. Eventually it collapses rapidly, blowing off the envelope in a supernova explosion, during which the single star may outshine an entire galaxy.

The explosion may destroy the core completely or it may leave a small core. However, if the star was more than two or three times as massive as our own Sun, the core surviving a supernova will rapidly collapse. Theorists predict that the collapse will continue until the core radius reaches zero. This hugely massive, but dimensionless point in space is called a singularity.

No Escape

The singularity has such a strong gravitational field that light itself cannot escape ie the escape velocity of the body is greater than the speed of light. The further we are from the black hole, the lower is the escape velocity (the gravitational force decreases with the square of our distance from the body). At a particular distance from the singularity, the Schwarzschild radius, the escape velocity equals the speed of light. Within this event horizon, nothing escapes.

For a body of mass (M), the Schwarzschild radius (R_S) is given by:

$$R_S = \frac{2GM}{C^2}$$

(G is Newton's gravitational constant and c is the speed of light).
If we let M be the mass of our own Sun, R_S turns out to be 3 kms. So, why isn't the Sun a black hole? Its radius is much larger than 3 kms, so beyond this event horizon the Sun's hydrogen fusion reactor can radiate its energy out into space, but if the Sun's mass was to be compressed to a diameter of less than 3 kms, it would become a black hole.

If we look at our own Earth and the bodies around us in the solar system and even the Milky Way galaxy as a whole, we find that they all rotate ie they all have angular momentum.

The angular momentum (L) of a rotating body of mass (m), radius (r) at an angular velocity of w is given by:

$$L = mwr$$

If a rotating body such as the remnant of an exploded star, begins to contract ie r gets smaller, the angular velocity (w) must increase in order that angular momentum may be conserved. Depending on its mass a black hole may rotate at about 1000 times a second. A black hole is such a dense body that one the size of a proton would weigh in at about ten thousand million tonnes!

Just as the Earth bulges slightly at the equator and is flattened at the poles due to centrifugal force, the much greater rotation of a black hole results in a much more severe deformation. The equations predict that a black hole is not a sphere at all. It may be similar in profile to a spiral galaxy (like the Milky Way) ie a disc with a bulge at its centre.

All this speculation on the formation and structure of a black hole may seem to be purely academic. After all, how do you go about finding a black hole to prove that it exists and verify its structure and behaviour? Even if you knew where to look, how would you observe something from which no light can escape?

Stellar Striptease

You may not be able to see the black hole itself, but it should be possible to observe what it does to any matter near it. The best candidate for detection would be a black hole and a star orbiting each other — a binary system. Material should be stripped from the star and wind its way round the black hole, forming a disc, finally disappearing beyond the Schwarzschild radius like water funnelling down your bath plug-hole. As the matter crowds together for its last dive to oblivion, its temperature rises until it is hot enough to radiate at X-ray wavelengths.

The search for X-ray sources could not begin until the space age because radiation in the X-ray region of the spectrum cannot penetrate the Earth's atmosphere. One of the earliest X-ray sources discovered by orbiting telescopes was Cygnus X-1, in the constellation of Cygnus. The X-ray source accompanies a visible blue giant star. The visible star's speed was found to be varying along a sine wave, so it must have an invisible companion around which it is orbiting.

Most of the light emitted by the system appears to arise, not from the visible blue star, but from helium gas sucked from it and circulating around its invisible companion. The companion's mass has been calculated as more than the critical three solar masses, so it is likely to be a black hole.

Another system likely to become a household name among black hole hunters is V861 Scorpii (the V indicates that its brightness appears to vary). This variation over a period of about eight days is due to a dark body orbiting (and eclipsing) a blue supergiant. Like Cygnus X-1, V861 Scorpii is a binary system.

Dark Star

In both these cases, the dark star could be either a black hole or a neutron star. A neutron star is a body where the matter from a collapsed star core is compressed so tightly that electrons and protons are pushed together to form neutrons. Again, mass is the determining factor. If the mass is less than about three Suns, the body will be a neutron star. If it is above the critical mass, it should be a black hole.

Shaking The Edifice

Life was much simpler for scientists in Victorian times. Through classical Newtonian physics, everything under the Sun (and beyond it) seemed describeable and predictable. It was just a matter of time before the scientists achieved a comprehensive understanding of the universe and determined the physical laws to describe all the processes therein, from the subatomic level upwards. Then along came trouble-makers like Planck and Einstein, who showed that an electromagnetic wave could behave like a steam of particles. In classical physics a wave is not the same as a particle and never the twain shall meet. Not content with shaking the foundations of prevailing physics, Einstein (leader of the popular front for the liberation of physics) went on to predict the effects of very dense bodies on time itself.

Space and time are inextricably intertwined. Close to a black hole space is curved so severely that time itself loses its meaning. Stephen Hawking and Roger Penrose working at Cambridge saw the possibility that any object (including a spacecraft) falling towards a rotating black hole may not fall into the murderous singularity, but may miss it, to reappear elsewhere in our universe (or another universe) an instant later. Einstein's theories predicted the possibility of bridges between the warped planes of space. However, black holes were then believed to be non-rotating bodies, so that any matter falling over the event horizon could not help but hit the singularity.

Instant Travel

If only a small fraction of the matter falling into a rotating black hole misses the singularity, what becomes of it? It must reappear at the other end of the tunnel an instant later, maybe light years away from where it disappears. So, there must be points in space where matter appears to be spewing forth from nowhere — white holes. Now, if black holes are almost undetectable because of their blackness,

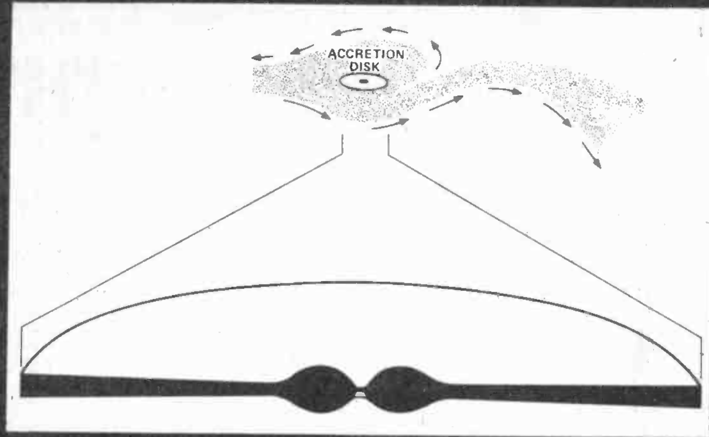

Fig. 2. As matter is sucked from the giant star towards the black hole, it builds up an accretion disc around the event horizon.

the detection of white holes should be simplicity itself. Indeed there are galaxies, known as Seyferts (after the man who identified them in 1943) which resemble galaxies like the Milky Way, but for one characteristic. The centre of a Seyfert is very bright and smaller than usual, and it emits radiation at frequencies which the Milky Way absorbs. The galactic nucleus seems to be an exploding ball of matter and energy — possibly a white hole.

Sci-Fi

The black hole may seem to be a futuristic concept. In fact, Laplace realised that if a body was massive enough, its escape velocity would exceed that of light, as far back as 1798. That black holes might make possible travel across light years of space in an instant (*or even* time travel) sounds more like science fiction.

Before we can verify the theories and check out the equations we will have to get the hang of interstellar travel, or find a black hole in the solar system. Cygnus X-1 is about 600 light years away. As for black holes in the solar system — it's not as crazy as you might at first imagine. The Big Bang, from which the universe is believed to have begun, would have produced the magnitude of pressures necessary to produce black holes in their millions. Our galaxy could be sprinkled with these tiny Big Bang black holes. When a study of the Sun, looking for neutrinos produced in nuclear reactions at its centre, found none, one researcher suggested that a small black hole in the Sun itself may satisfy the findings.

It may sound like science fiction . . . but for how much longer?

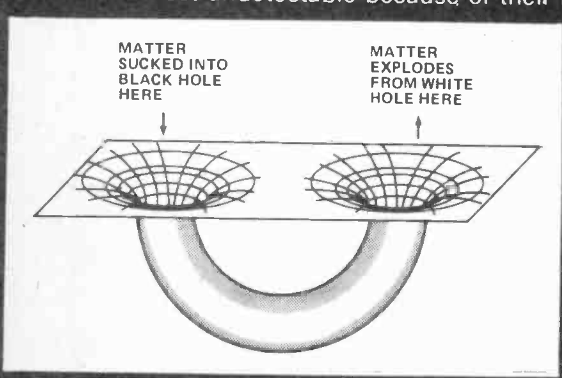

Fig. 1. If all the matter disappears into a black hole, it must appear somewhere else at a White Hole.

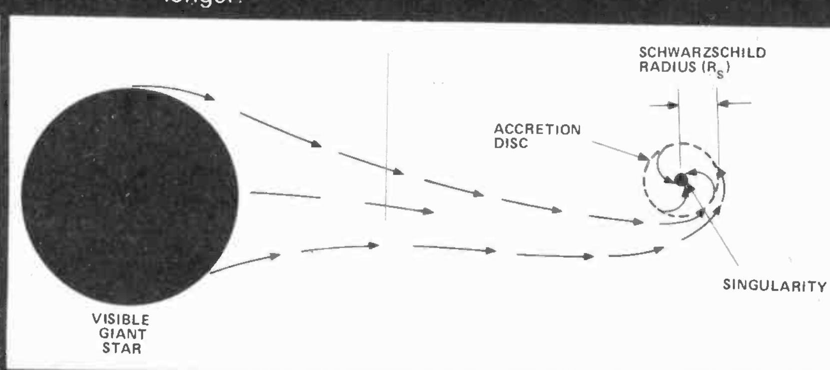

Fig. 3. The black hole and its giant companion star orbit one another, as the hole strips material from the star.

SIGNAL TRACER

10M 10pF signal probe detects audio, mains fields and amptitude modulated RF.

It has been said that a signal tracer is just an amplifier with a diode at the front. In fact, for many applications, just such an arrangement is all that is required. This design fulfills the above description and then some!

Boasting a high input impedance and good sensitivity, the unit drives a small loudspeaker or personal earphone with good volume. Power may be derived from the equipment under test or a separate nine volt supply may be used. Use of the specified case ensures a neat and attractive project. The case is identical to that used in the CSC logic probe kit and comes complete with detachable probe, power supply leads and a small piece of perforated board (not needed here). Its place is taken by the PCB. The case comes complete with cut-outs for three indicator LEDs. Only one is used in this design to accommodate the power indicator LED and the other two may be blanked off or simply left vacant.

Construction

Use of the PCB is really essential. Quite apart from the problem of fitting all the bits in the case, layout is critical to avoid stray feedback and spurious oscillation. Owing to the limited space available in the case, the physical size of the components is important and the smallest available components should be used. Note that C3 lies over R3, 4 and capacitors C5, 9 need to lie on their sides. A flying lead link should be taken from R2 (Q1 drain) to C2. This may be done on the underside of the board and should be as short and direct as possible. LED 1 is mounted on the board and is self-supporting.

In use, the unit should be connected to a nine volt supply and a loudspeaker plugged into SK1 ; use screened cable to avoid stray feedback. As a simple test, hold the probe within a couple of centi-

PARTS LIST

Resistors

R1	10M
R2,12	1k0
R3,10	1k5
R4	2k7
R5	150k
R6	18k
R7	10k
R8	470R
R9	2k2
R11	10R

Capacitors

C1	10p ceramic
C2,4,6	10n ceramic
C3	6u8 tantalum
C5,9	47u tantalum
C7	220u electrolytic
C8	2u2 tantalum
C10	47n ceramic
C11	100u tantalum

Semiconductors

IC1	LM386
Q1	2N3819
Q2	BC109
LED 1	any 0.125" LED
D1	1N4004

Miscellaneous

case, socket, 8 ohm earphone or loudspeaker.

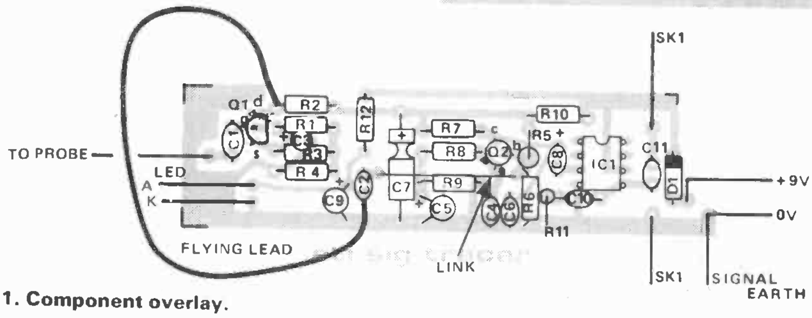

Fig. 1. Component overlay.

HOW IT WORKS

To provide high input impedance with good sensitivity a FET input stage is used. Q1 is connected as a common source amplifier, decoupled to AC by C3, with the output taken across R2. This stage is coupled to Q2 by C2. Q2 operates as an AM detector and audio amplifier. The output is taken across R7 and is decoupled to RF by C6. The power supply to this section of the circuit is provided via R10 smoothed by C7. A small integrated audio amplifier forms the output stage. IC1 provides its own input bias and the output automatically centres at half the supply voltage. C10 and R11 prevent instability. The output is coupled via C11 to an eight ohm personal earphone or loudspeaker. Shielded cable should be used to prevent stray feedback to the input stage. Overall power is supplied via D1 which protects against accidental reversal of the supply leads. Power is indicated by LED 1. As this component is sited near the input stage its power supply is decoupled by C9 to prevent instability due to stray feedback. When used with 9 volt battery equipment, power may be derived from the circuit under test. When a separate supply is used to power the probe. A connection should be made from 0 V to the earth of the equipment under test. Bear in mind the voltage rating of C1. For a small ceramic capacitor, this may be only fifty volts or so.

BUYLINES

The LM386 is available from Watford Electronics. The remaining components are unexceptional and should be readily available. The case is manufactured by Continental Specialties Corporation, type CTP–1.
Continental Specialties Corporation,
Shire Hill Industrial Estate,
Saffron Walden,
Essex CB11 3AQ.

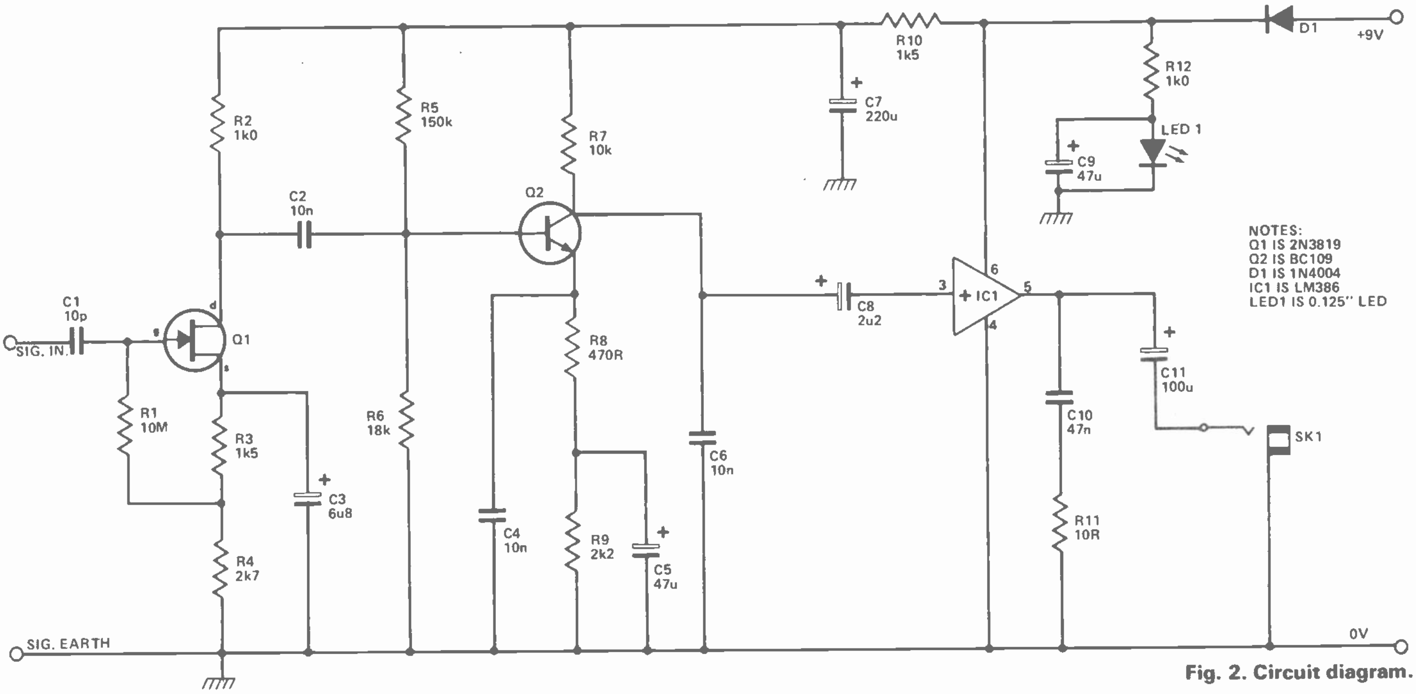

Fig. 2. Circuit diagram.

metres of a live mains lead. A loud hum or buzz should be heard. When using the tracer with a separate power supply from the equipment under test a wire should be taken from 0 V to the equipment's earth to provide a signal return path. Remember that the input capacitor C1 may only be rated at about fifty volts if you are thinking of working with high voltage equipment. As well as detecting low level audio, the probe may also be used to detect radio-frequency signals at frequencies up to and above 10 MHz. Sensitivity is quite adequate to make the unit useful with TRF receivers and signals are easily detected in conventional medium-long wave superhets. ETI

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COMPONENTS

1N4148 **0.9p**. 1N4002 **3.1p**. 741 8 dil **18p**. 723 14 dil **33p**. NE555 8 dil **24p**. bc183, bc213, bc547, bc549 **4.9p**. bc182, bc184, bc212, bc214, bc548 **5.5p**. tip31C, tip 32c **36p**. tip41c **40p**. bd131, bd132 **27p**. Plastic equiv bcy72 **5p**. Fuses 20mm × 5mm cartridge .15, .25, .5, 1, 2, 3, 5 Amp quickblow 1p, anti-surge **3.6p**. Resistors 5% ¼W E12 10R to 10M 1p, **0.8p** for 50+ of one value. Polyester capacitors 250v .015, .068, .1mf **1.5p**, 0.1mf **3.0p**, .022, .033mf polystyrene capacitors E12 63v 10 to 1000 pf **3p**, 1n2 to 10n **4p**. Ceramic capacitors 50V E6 22pf to 47n **2p**. Electrolytic capacitors 50v .5, 1, 2mf **5p**, 25v 5, 10mf **5p**, 16v 22, 33mf **5p**, 47, 68mf **3.5p**, 100mf **6p**, 330, 470mf **9p**, 1000mf **10p**. Zeners 400mW E24 2v7 to 33v 7p. Preset pots subminiature 0.1W horiz or vert 100 to 4M7 **7p**. Potentiometers ¼W 4K7 to 2M2 log or lin single **27p**, dual **71p**. ⅛" red LEDs **9.7p**. IC sockets 8 dil **8.7p**, 14 dil **10.1p**, 16 dil **12p**.

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1uF: **14p** 2.2uF: **20p**	
3.3uF: **22p** 4.7uF: **24p**	
ELECTROLYTIC CAP (uF/V)	
1/25 to 47/25	6p
68/50, 100/35	8p
150/25, 200/12	9p
220/25, 250/12	10p
470/25, 500/30	13p
1000/10: **14p** 1000/25: **22p**	
1500/25: **26p** 2200/6: **20p**	

OPTO/DISPLAY	
2N5777	55p
OCP71	65p
ORP12	60p
DL704	110p
DL707	110p
0.125" & 0.2" LEDs:	
Red	10p
Green	14p
Yellow	14p
.125" Clip	3p
.2" Clip	4p
DIL SOCKETS	
8 pin	11p
14 pin	13p
16 pin	14p
18 pin	18p
22 pin	22p
24 pin	24p
28 pin	28p
40 pin	40p
BRIDGE RECTIFIERS	
1A/50V	22p
1A/100V	27p
1A/200V	32p
1A/400V	34p
2A/50V	40p
2A/100V	42p
2A/200V	48p
2A/400V	55p
VOLTAGE REGULATORS	
7805	70p
7812/5	70p
7818/24	70p
7905	90p
7912/5	90p
7918/24	90p
DIODES	
BY127	10p
OA47	8p
OA91	8p
OA200	6p
OA202	9p
1N916	5p
1N4148	4p
1N4001/2	4p
1N4003	5p
1N4004/5	6p
1N4006/7	8p
1N5400	13p
1N5401	14p
1N5402	15p
1N5404	16p
LINEAR CIRCUITS	
709-8	40p
709-T05	40p
710-14	33p
741-8	22p
747-14	48p
748-8	44p
CA3018	70p
CA3028A	85p
CA3046	70p
CA3054	60p
CA3080	75p
CA3130	100p
CA3140	55p
LF351N	65p
LF356N	85p
LM301AN	32p
LM308N	60p
LM318N	200p
LM324N	75p
LM339N	60p
LM348N	90p
LM377N	175p
LM380N	90p
LM381N	140p
LM382N	130p
LM1310N	150p
LM3900N	55p
LM3909N	70p
MC1496P	85p
NE531	150p
NE555	25p
NE556	60p
NE566	140p
TBA641A	180p
TBA800	75p
TBA810S	110p
ZN414	100p
ZN1034	200p

CMOS	
4000	18p
4001/2	18p
4006	70p
4007	18p
4008	84p
4009	40p
4010	42p
4011/2	18p
4013	40p
4014	85p
4015	75p
4016	44p
4017	55p
4018	80p
4019	45p
4020	95p
4021/2	85p
4023	18p
4024	58p
4025	18p
4027	45p
4028	70p
4029	82p
4030	60p
4035	107p
4041	75p
4042	70p
4043/4	88p
4047	92p
4048	55p
4049	35p
4050	44p
4066	50p
4069	18p
4070/1	18p
4072/3	18p
4081/2	18p
4086	80p
4510	100p
4511	100p
4516	100p
4518	100p
4520	100p
4528	100p

TTL	
7400/1	13p
7402/3	13p
7404/5	13p
7406/7	20p
7408/9	13p
7410	13p
7411	18p
7412	15p
7413	27p
7414	31p
7416/7	25p
7420	14p
7421/2	17p
7427	20p
7428	25p
7430	14p
7432	18p
7433	24p
7437/8	15p
7440	10p
7441	56p
7442	51p
7443	70p
7444	80p
7445	75p
7446	65p
7447	55p
7448	62p
7450	10p
7451/3	13p
7454	10p
7460	13p
7470	20p
7472	21p
7473	28p
7474	24p
7475	34p
7476	30p
7480	25p
7485	80p
7486	25p
7490	36p
7491	45p
7492	30p
7493	35p
7494	50p
7495	40p
7496	50p
7497	200p
74100	70p
74105	43p
74107	20p
74109	40p
74110	40p
74118	90p
74121	26p
74122	30p
74123	45p
74125/6	37p
74132	48p
74141	50p
74145	55p
74150	78p
74151	48p
74153	43p
74154	90p
74155	46p
74156	40p
74157	43p
74160	64p
74161	55p
74162/3	64p
74164	78p
74165	70p
74166	85p
74173/4	70p
74175	60p
74176	64p
74177	60p
74180	50p
74181	80p
74182	45p
74190	75p
74191	70p
74192	50p
74193	64p
74194	70p
74195	57p
74196	100p
74197	80p
74198	135p
74199	90p

TRANSISTORS	
AC126/7	23p
AC128	23p
AC128/176 Mt. pr.	42p
AC153	30p
AC176	23p
AC187/8	23p
AD149	70p
AD161/2	40p
AF114	30p
AF124	45p
AF125	35p
AF126/7	37p
AF139	40p
AF239	47p
BC107/8	10p
BC109	10p
BC117	25p
BC142/3	30p
BC147/8	10p
BC149	10p
BC157/8	12p
BC159	12p
BC167	14p
BC169C	13p
BC171	10p
BC173	8p
BC177/8	18p
BC179	20p
BC182/3	12p
BC184	12p
BC186	30p
BC207/9	13p
BC212/3	12p
BC214	12p
BC214L	14p
BC238	18p
BC261B	14p
BC301/3	32p
BC328	17p
BC338	17p
BC461	40p
BC477	27p
BC478/9	27p
BC547/8	14p
BC549	14p
BC557/8	15p
BC559	15p
BCY70	18p
BCY71/2	18p
BD115	58p
BD121/3	75p
BD124	81p
BD131 TO BD140	42p
BF178	32p
BF180	30p
BF181	8p
BF183	34p
BF184	25p
BF185	25p
BF194/5	12p
BF196/7	12p
BF224B	14p
BF244B	35p
BF258	34p
BF259	40p
BFR39	32p
BFR40	20p
BFR79	32p
BFR80	20p
BFX29	25p
BFX84	25p
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MPF102/3	40p
MPF104/5	40p
MPF106	50p
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MPSA56	26p
MPSU06	61p
OC28	92p
OC35	92p
OC72	20p
TIP29	40p
TIP29B	48p
TIP30	40p
TIP30B	48p
TIP31	40p
TIP32	40p
TIP33	60p
TIP33C	80p
TIP34A	90p
TIP35B	240p
TIP36B	280p
TIP41A	60p
TIP42A	60p
TIP2955	70p
TIP3055	55p
ZTX107/8	13p
ZTX109	13p
ZTX300	16p
ZTX301	18p
ZTX302	20p
ZTX303	24p
ZTX304	27p
ZTX311	19p
ZTX341	22p
ZTX500/1	16p
ZTX502	21p
ZTX503	17p
ZTX504	28p
2N696	35p
2N697	25p
2N698	35p
2N706	14p
2N914	20p
2N918	35p
2N1131	20p
2N1132	13p
2N1302	35p
2N1303	40p
2N1304	50p
2N1305	13p
2N1306	30p
2N1308	22p
2N1613	25p
2N1711	13p
2N1893	25p
2N2222A	25p
2N2217	18p
2N2219	23p
2N2369	17p
2N2484	30p
2N2646	55p
2N2904	23p
2N2905	23p
2N2906	20p
2N2907	20p
2N2926G	11p
2N3053	20p
2N3054	50p
2N3055	50p
2N3442	140p
2N3702 TO 2N3711	11p
2N3772	150p
2N3773	250p
2N3819	22p
2N3820	40p
2N3823	70p
2N3866	90p
2N3903/4	10p
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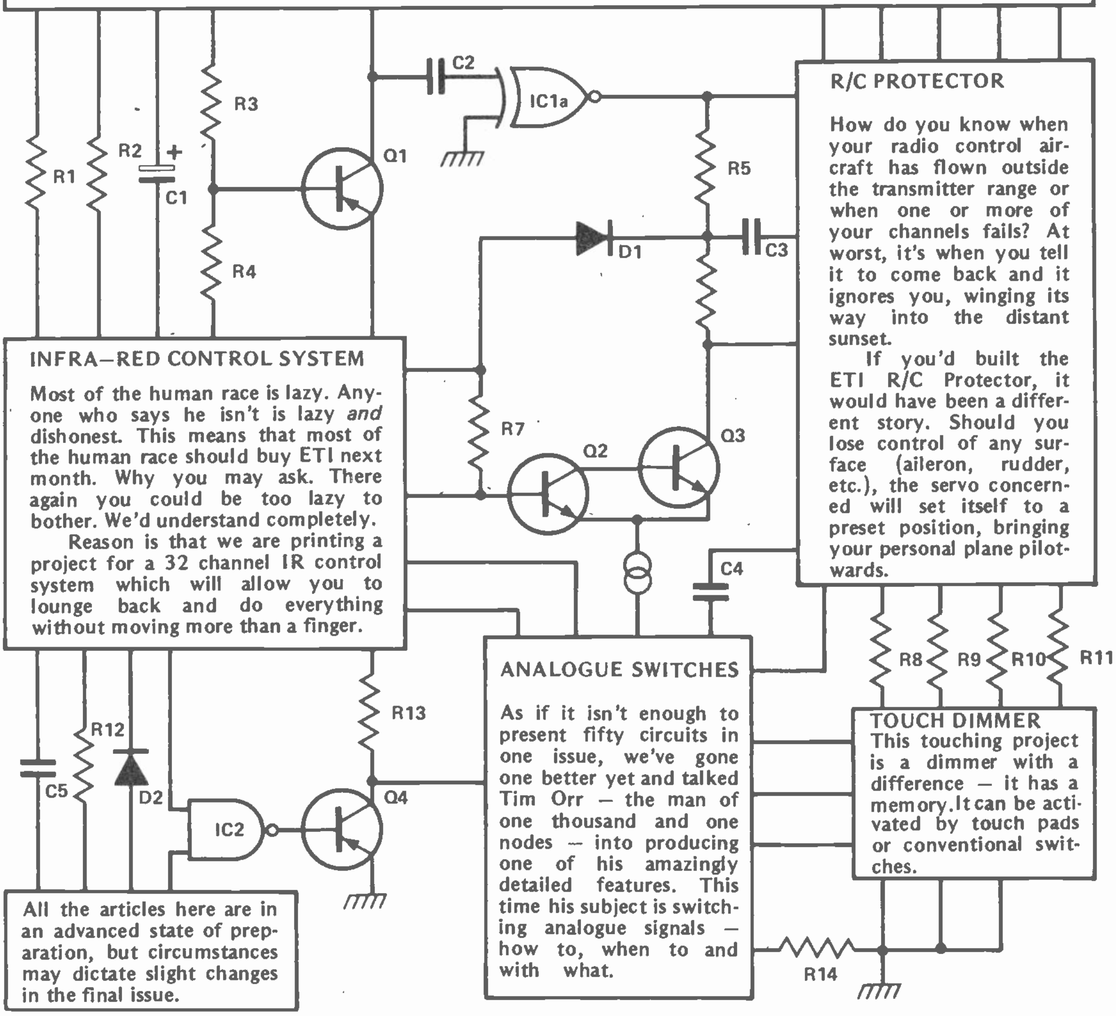
What to look for in the April issue: on sale March 7th

CIRCUIT SUPPLEMENT

50 TESTED CIRCUITS TO BUILD

Next months ETI carries something really special — a SIXTEEN PAGE circuit supplement for the experimenter. All the circuits have been tried and tested by us, making this the most reliable reference yet. If there is anything you need a circuit for or any circuits you need something for this is the place to find it. No less than 50 in all. Half a hundred of the best you'll find anywhere.

Well worth keeping for that inevitable future time when you'll NEED ONE or more of the priceless little gems lying amid these pages.



R/C PROTECTOR

How do you know when your radio control aircraft has flown outside the transmitter range or when one or more of your channels fails? At worst, it's when you tell it to come back and it ignores you, winging its way into the distant sunset.

If you'd built the ETI R/C Protector, it would have been a different story. Should you lose control of any surface (aileron, rudder, etc.), the servo concerned will set itself to a preset position, bringing your personal plane pilotwards.

INFRA–RED CONTROL SYSTEM

Most of the human race is lazy. Anyone who says he isn't is lazy *and* dishonest. This means that most of the human race should buy ETI next month. Why you may ask. There again you could be too lazy to bother. We'd understand completely.

Reason is that we are printing a project for a 32 channel IR control system which will allow you to lounge back and do everything without moving more than a finger.

ANALOGUE SWITCHES

As if it isn't enough to present fifty circuits in one issue, we've gone one better yet and talked Tim Orr — the man of one thousand and one nodes — into producing one of his amazingly detailed features. This time his subject is switching analogue signals — how to, when to and with what.

TOUCH DIMMER

This touching project is a dimmer with a difference — it has a memory. It can be activated by touch pads or conventional switches.

All the articles here are in an advanced state of preparation, but circumstances may dictate slight changes in the final issue.

THE 1537 VCA

Keith Brindley brings you up to date with the latest offspring of the silicon chip family - complete with practical applications.

There is always a great deal of excitement generated in electronics on the arrival or introduction of a new circuit, concept or chip, particularly if the system is potentially a field leader. The 1537A chip is just that! The specifications which the device can offer in situ are well above those of any similar preceding systems. Table 1 gives a listing of specifications, which can be obtained in the correct applications.

Parameter	Specification
Bandwidth	DC-200kHz
T.H.D., 20Hz-20kHz	0.004%
I.M.D. (SMPTE TEST)	0.03%
Noise	−90dBv, ± 1dB (worst case, unity gain)
Overshoot and Ringing	None
Slew Rate	> 10v/usec, symmetrical & constant
Input Impedance	20KΩ
Maximum Input Level	+20dBv
Gain	0dB (Unity)
Maximum Attenuation	>94dB
Control Voltage	0 to +10V
DC shift vs. Attenuation	⩽ 5mV
Power Requirements	Regulated ± 15V at +25, -33mA

Table 1. The maximum possible specifications available from a 1537A system.

With harmonic distortion of 0.004% and a signal/noise ratio of over 90 dB the system is of course well suited to studio applications, although use in this environment is by no means its only area of involvement. The IC itself seems at first glance, somewhat highly priced at around £6, but nevertheless, it requires few extra components to produce a VCA system of the superb quality (suggested in the specifications of Table 1) and overall represents good value for money to the amatuer and professional engineer alike.

Amplifier Or Attenuator

The term VCA is normally used as an abbreviation of the phrase Voltage Controlled Amplifier, but in its simpler modes the 1537A is, strictly speaking, a voltage controlled attenuator ie with a maximum gain of unity. The inventors, do, however, stress that connection of the 1537A into the feedback loop of an amplifier (such as an op amp) produces a voltage controlled amplifier. The applications section of this article show how this can be achieved.

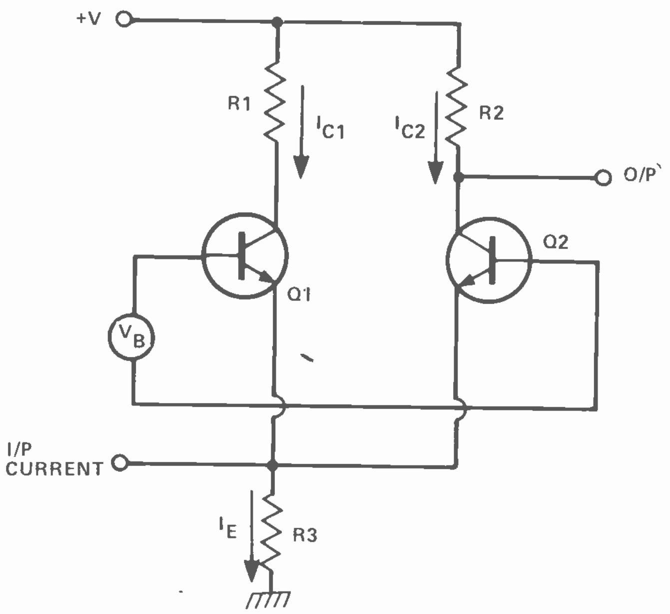


Fig. 1. A differential pair of transistors — the basis of a VCA.

The operation of the 1537A VCA depends upon the gain control function of a differential pair of transistors as in Fig. 1. The transistors in Fig. 1 are connected at their emitters. The current through R3 (I_E) is, therefore, approximately equal to the sum of their two collector currents I_{C1} and I_{C2} through R1 and R2 respectively. The relative bias voltage, V_B, between the two bases determines the relative collector currents. If we now apply an input signal current to the joined emitters we obtain output signal currents through R1 and R2, the sizes of which are determined by the bias voltages. In other words, by altering this bias voltage we alter the size of the output signals.

Figure 2 shows a simplified internal circuit of the 1537A chip giving pin numbers and external load and emitter resistors necessary for operation. There are two basic gain control circuits within the chip, similar to that in Fig. 1 (built around Q1, 2 and Q5,6) except for three main differences:

— the diode connection of the transistor pair not used for signal output ie Q1 and Q6, which reduces the distortion due to transistor gain differences.

— the addition of buffers around Q4 and Q8 to reduce loading of the output collectors of the gain transistors, in turn allowing idealised characteristics over the full gain range.

— the use of transistors Q3 and Q7 as voltage to current converters enabling the input to be applied as a voltage rather than as a current.

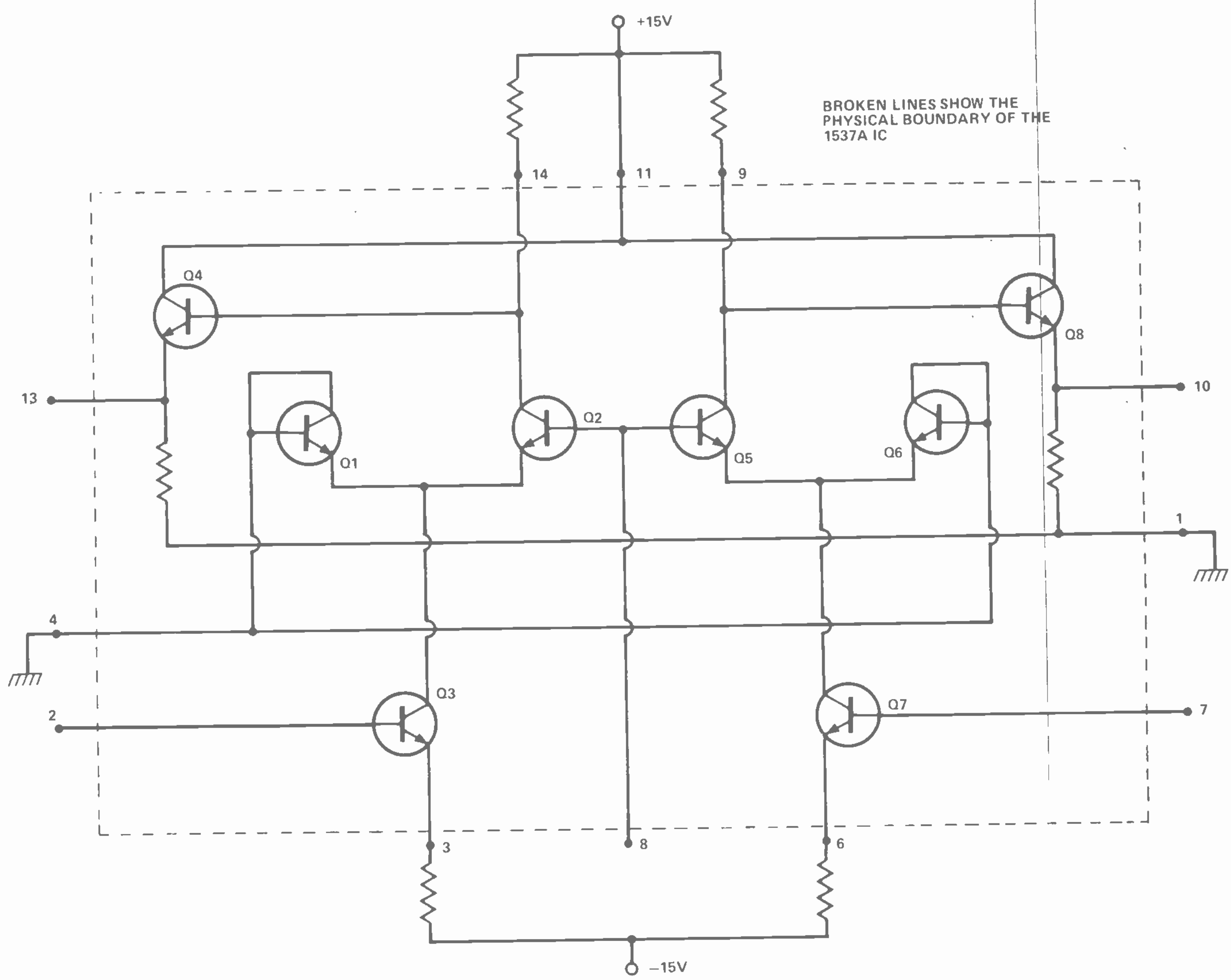


Fig. 2. A much simplified internal circuit of the 1537A IC, showing external load and emitter resistors.

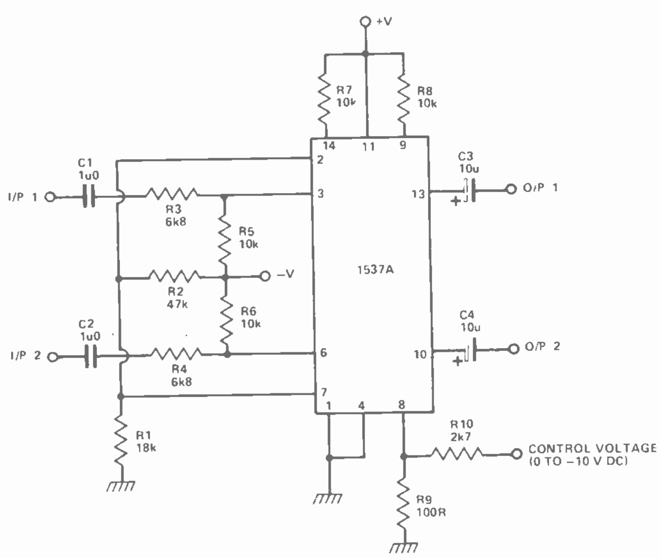


Fig. 3. The simplest mode of operation of the 1537A — a low input impedance stereo VCA with a negative going control voltage.

There is, however, a much more subtle difference, on top of this and that is the use of large geometry transistors. The effect of larger geometry transistors can improve second order intermodulation by as much as ten times for a tenfold increase in transistor size. Noise can also be reduced by about 10 dB for a similar increase in geometry.

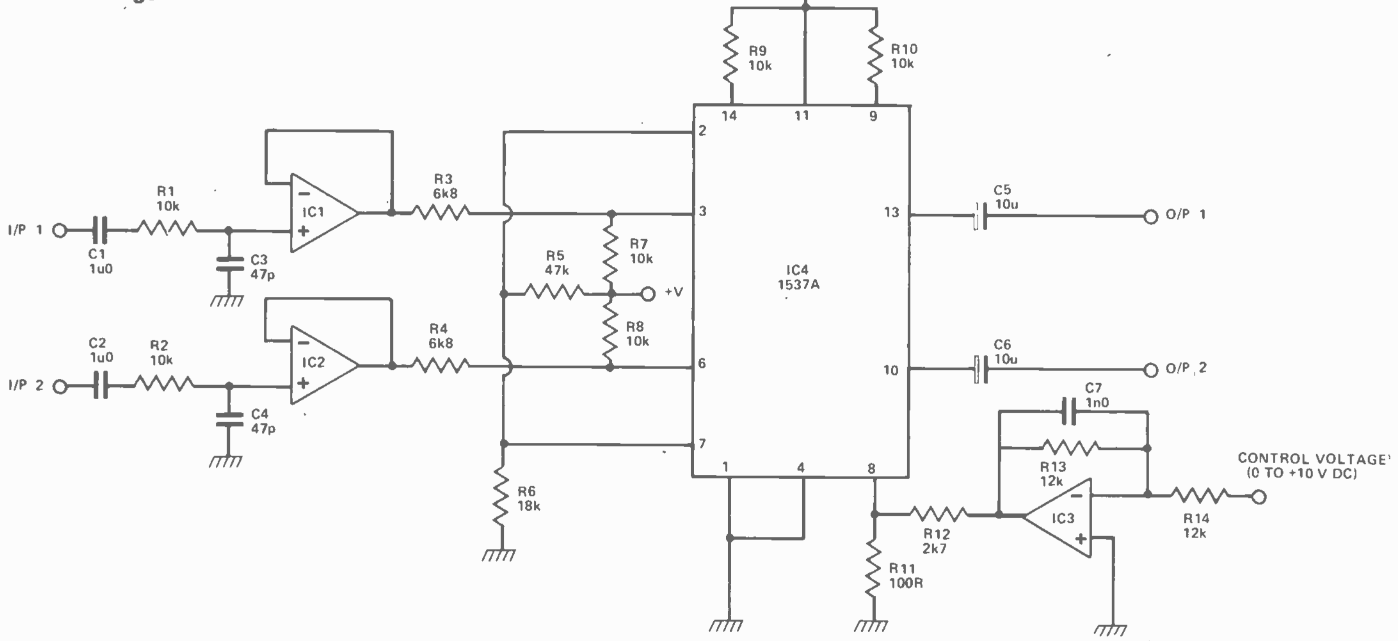
This leads us now to the simplest mode of operation of the 1537A using each gain control circuit individually, although the control voltage affects the gain of each circuit simultaneously (Fig. 3).

The ratio of R9 and R10 is calculated to allow a control voltage range of 10 volts (ie 0 to minus 10 V), altering the gain of the system from 0 dB to about −90 dB. The input impedance of the circuit to applied signal is low and ideally buffers should be placed before this circuit. Although this circuit does not give studio quality specifications it will, however, still produce results in the "high fidelity" range, providing impedance matches are considered.

Figure 4 shows a circuit application which gives a higher impedance input. Also included is an inverting stage in the control voltage link which allows a voltage of 0 to + 10 volts to be used for controlling attenuation.

Although any operational amplifier could be used for ICs 1, 2 and 3 in the previous circuit, it should be fairly ▶

Fig. 4. A higher input impedance stereo VCA with positive going control voltage.



apparent that the noise, distortion and bandwidth specs of the circuit are limited to those of the op amps used.

Either of the two circuits of Figs. 1 and 2 can be adopted as the voltage controlled gain heart of a stereo system. Their outputs are about 10 dB down on the inputs so necessary amplification should be given before or after the attenuator.

Coming Up To Scratch

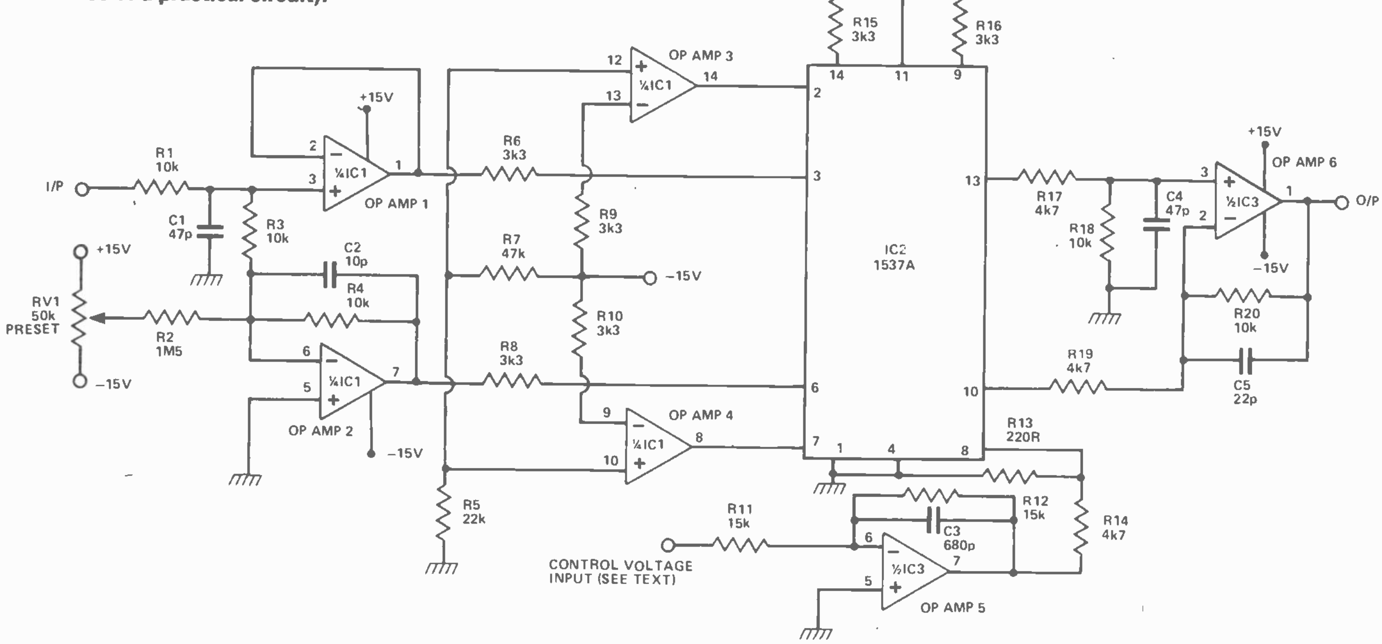
Now, three more developments to the circuitry can be undertaken to improve the specifications to those of Table 1. Figure 5 shows the circuit of the ideal system capable of these high specs.

Firstly, actively linearised voltage to current sources (op amp 3 and 4 in Fig 5) improve distortion figures when using a wide range of input signal voltages.

Secondly, parallelling of the two individual gain control circuits (ie the same input signal is fed to both devices at their inputs and mixed at their outputs) gives a 3 dB improvement in S/N ratio.

Finally, a technique is utilised which is complementary to the previous development of parallel devices, whereby the same input is applied to both gain control devices but 180 degrees out of phase. The two outputs are combined in a differential amplifier to give a single ended output. The differential amp is formed around op amp 6. This technique has the effect of reducing DC shift caused by bias and control voltages and with careful adjustment of RV1, the minimal DC shift now left at the output can be reduced even.

Fig. 5. Full specification mono VCA (showing component numbers and values of a practical circuit).



further to near (if not actually) zero. The prototype circuit shown, upon testing, actually gave no DC shift at all (or at least none measureable on our test equipment).

The complete circuit can be used as an exceptionally high quality VCA whose signal input can be anything from a few millivolts through to about 20 volts pk to pk without distortion. The lack of DC blocking capacitors at the input and output means that the system can be used to control a DC voltage applied to the input. AC signals up to well over 200 kHz are easily catered for, due to the system's wide bandwidth.

The overlay in figure 6 shows the component layout on printed circuit board of the circuit. The PC design is given in the Foil Pattern section of this issue and will enable interested readers to build the system and get first hand experience of it. As far as we know this article is the first of its kind to present a circuit in a form where "experimenters" can benefit easily and directly from the written text whilst simultaneously using the device in a tried and tested form.

Construction

If the circuit board layout is followed then there should be no problems. IC holders are advisable though by no means necessary. RV1 should be a good quality type (cermet), to assist in setting up the output offset shift to zero, cheaper quality presets can sometimes be tricky to adjust in low voltage DC applications of this nature. Op amps 1 to 4 in the circuit are combined in IC1 and can be of a wide range of types from a quad 741 type (3403) upwards. Obviously, if you wish to obtain the best specs the quality of the op amps are critical. LF 347 or TL 074 will give the best results.

Similarly op amps 5 and 6 are included in IC3 and LF 353 or TL 072 are of optimal quality.

Setting Up

The system should work without any adjustment for an AC signal and varying the control voltage from 0 to 10 volts should give total control over the output amplitude. Some setting up will be required if the input is to be DC, though. This is best achieved by earthing the input. Measure the output voltage using a high impedance voltmeter (it should only be the order of a few millivolts). Adjust RV1 until a complete sweep of control voltage ie from 0 to 10 volts produces only minimal change in DC output voltage. The▶

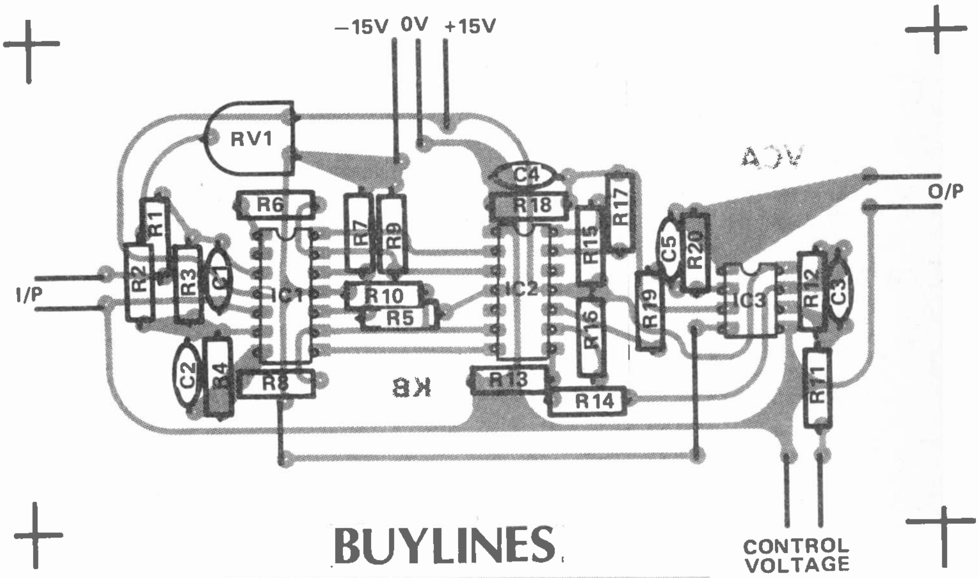


Fig. 6. Overlay of PCB of the 1537A VCA module.

PARTS LIST

RESISTORS	All ¼W, 5%
R1,3,4,18, 20	10k
R2	1M5
R5	22k
R6,8,9,10, 15,16	3k3
R7	47k
R11,12	15k
R13	220R
R14,17,19	4k7
PRESET	
RV1	50k min horiz cermet
CAPACITORS	
C1,4	47p polystyrene
C2	10p polystyrene
C3	680p polystyrene
C5	22p polystyrene
SEMICONDUCTORS	
IC1	TL074, LF347 etc.
IC2	1537A
IC3	TL072, LF353 etc.
MISCELLANEOUS	
IC Holders	
PCB	

BUYLINES

Most of the larger mail order companies will be able to help with the quad and dual op amps if you experience any difficulty in obtaining them.

The 1537, however, is presently obtainable only from Aphex Audio Systems Ltd. Their address is 35 Brittania Row, London N1 8QH. They have kindly agreed to offer the IC to ETI readers at the reduced rate of £5.85 each including VAT, which is 15% off the normal price. However, this is dependent on small quantity CWO orders and the special code 'ETI APHEX 101' must be quoted with your order.

All other components should be easily obtainable.

circuit is now completely set up to accept an input signal in the frequency range DC to 200 kHz. At minimum attentuation the system operates as a unity-gain wide range, high quality buffer, with a reasonably high input impedance and low output impedance. Variation of the DC control voltage over the range 0 to 10 volts will produce over 90 dB of attenuation of the output signal.

If an overall gain is required in the circuit, resistors R18 and R20 can be changed as in Table 2.

GAIN	R18 & R20
0dB	10k
6dB	22k
10dB	33k
15dB	56k

Table 2. The values of R18 and R20 to give the required overall gain in the VCA system of Fig. 5.

The control voltage range of 10 volts can be altered as required simply by changing the ratio of resistors R13 and R14 to suit.

To our knowledge, there is no officially recognised standard symbol for a VCA and rather than redraw the whole circuit of figure 5 upon every reference to the circuit we thought it better to invent a symbol for the purposes of this article. A horizontal trapezoid shape appeared to be the ideal symbol, as shown in Fig. 7. It symbolizes the system as a modular buffer amplifier, whose output (symbolized by the top line), decreases as the control voltage (the bottom line). increases. We shall use the modular sumbol of a VCA whenever reference is made to the circuit of Fig. 5, although any VCA module of another design should function in the applications which we give.

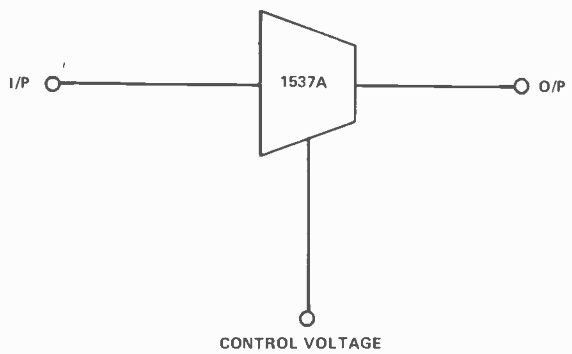


Fig. 7. The ETI symbol of a VCA module.

Use of the 1537A system module as a DC controlled analogue gate can produce many effects. Amplitude modulation of the signal occurs and the usual associated effects are observed. For instance, in Fig. 8 we can see a simple but high quality tremelo unit. Transistors Q1 and Q2 are connected as a phase shift oscillator and buffer, with speed and depth controls whose varying DC output is connected directly to the control port of the 1537A module. The frequency range of the oscillator is approximately 2 to 5 Hz. Altering the values of all three capacitors will change the main frequency, though that stated will give the best results.

The control voltage in the last application was varied as a sine wave of course, but there is no reason why other waveforms eg square, could not be used for control purposes. Figure 9 shows a 555 operating in the astable

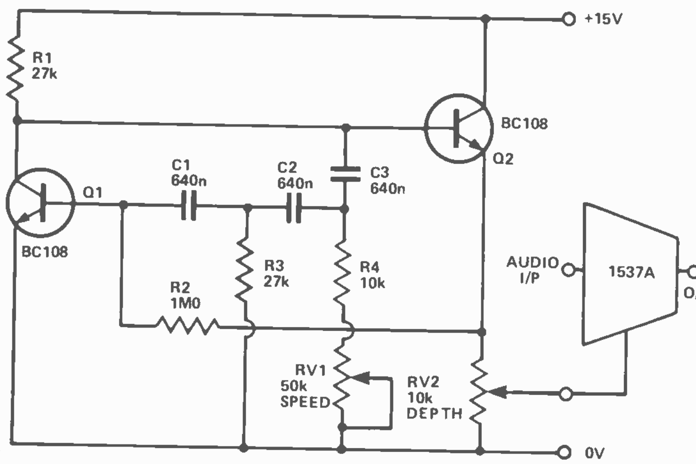


Fig. 8. A simple tremolo circuit.

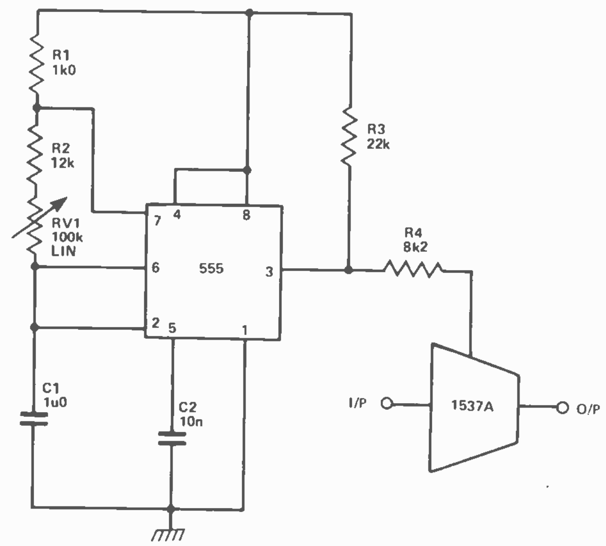


Fig. 9. A Dalek type sound generator.

mode with a frequency range of approximately 5-50 Hz. The output signal will be modulated with the square wave and the overall product is a Dalek type sound if a vocal signal is applied to the 1537A module.

This square wave control can be taken one stage further if the control voltage is the output from a monostable as in Fig. 10. A tone burst generator can be very easily constructed with this mode of operation. In a tone burst

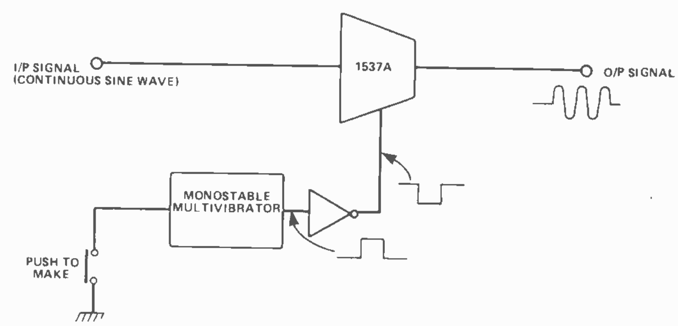


Fig. 10. A simple system enabling the construction of a tone burst generator.

generator, a rectangular envelope 50-500 uS long is formed around a single sine wave frequency of normally 1 kHz. Tone burst generators are useful for testing the transcient response of speakers, A push to make switch is used to provide the trigger to fire the multivibrator, producing the correct length pulse which in turn is inverted to form the control voltage pulse, applied to the control port of the 1537A.

The previous applications have all used automatic waveform control of the applied signal to produce the required attenuation characteristics, but this is not a necessary trait. The control voltage can be simply tapped off a variable resistor having the maximum control voltage range (ie 10 volts) across it. In this way, altering the position of the wiper alters the attenuation of the applied signal. The pot acts quite simply as a volume or level control. Ordinary non-DC volume controls can suffer from pick-up problems because the signal itself is being rotated through the pot. As only DC is applied to the pot in this application no pick-up can occur and the control can be remotely mounted from the module with no screened cable being necessary. Figure 11 shows such a volume control.

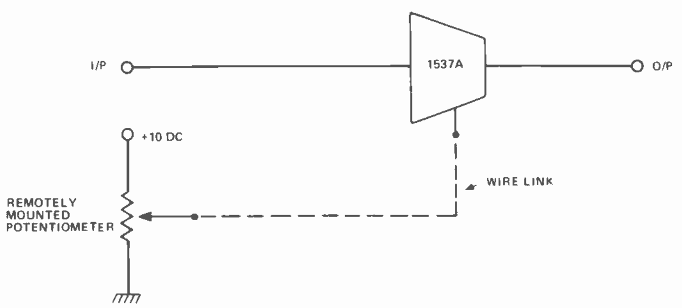


Fig. 11. Remotely (wire-linked) controlled volume control.

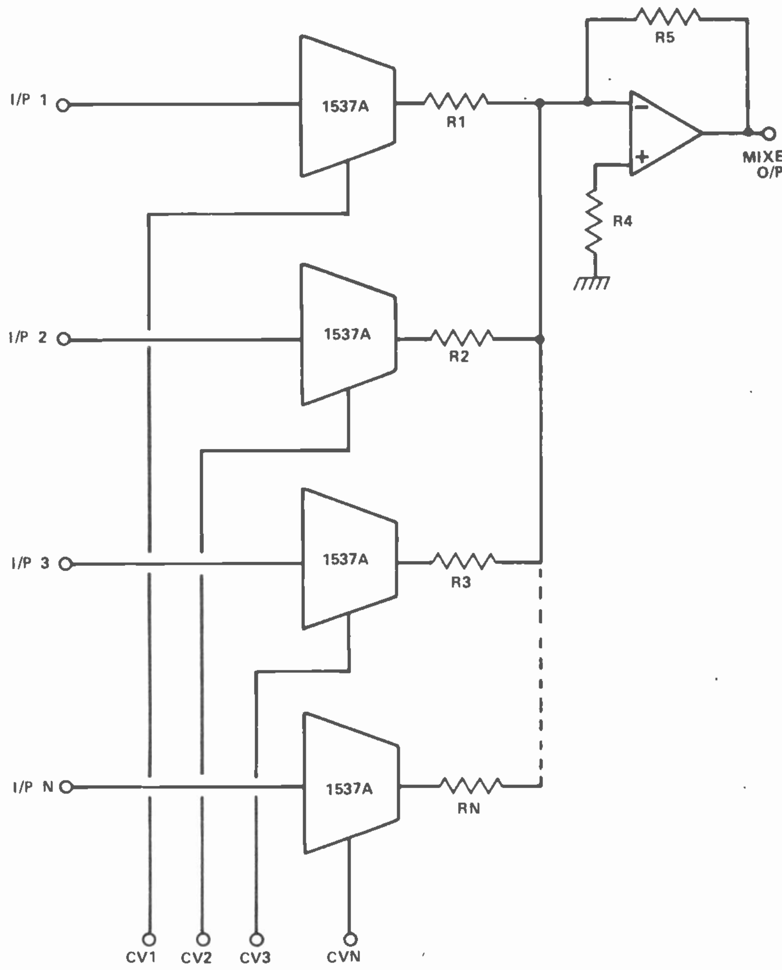


Fig. 12. High quality, remote fader controlled mixer.

This remote control facility can be utilised in an audio mixer which includes remote faders for each channel. Figure 12 shows the general idea of such a circuit, An op amp is used as a summing amplifier into which the output of each channel's VCA is fed and mixed. The mix is relative to the control voltage applied from the remote faders to each VCA. The circuit allows for up to N inputs, where N to practical limits will probably be a maximum of about 12, but with careful layout techniques, there is no reason why this cannot be increased further.

Figure 13, shows an interesting outline to enable digital control of the VCA, say from a computer link. In order that the computer can operate in real-time, ie control of the VCA is not just its only job, it is necessary for the interface to provide a latch for the digital word. The output of this latch is changed to a linear DC voltage by the D/A (digital to analogue) convertor whose output is taken to the control port of the VCA.

The digital latch, once set by a strobe pulse, provides the facility that after the volume required has been found, the computer is free to perform other tasks, When the volume is to be altered, the latch is reset to the new digital input.

The last six applications of the 1537A VCA system have simply shown methods of providing a control voltage (automatically, manually or digitally) to control the module in its function as an analogue gate. The following section begins with the assumption that the control voltage is already present, perhaps by one of the previous methods.

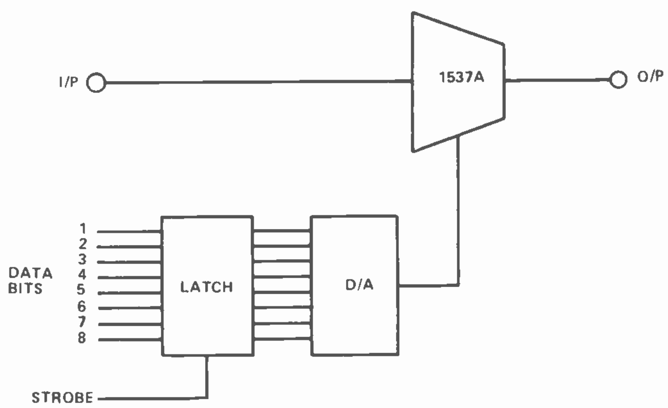


Fig. 13. Main components of a digitally controlled attenuator.

Applications

Consequently the next few circuits show the system in a much more versatile role — not just as an analogue gate, but one in where the system itself becomes part of a larger system. Figures 14 and 15 give details of circuit in which the 1537A module is used in the feedback loop of conventional operational amplifiers to allow voltage controlled ▶

amplifiers to be constructed. The resistance values used give gains of approximately 1 to 100 over the VCA control voltage range and an inverting VCAmp and a non-inverting VCAmp can be easily built as shown.

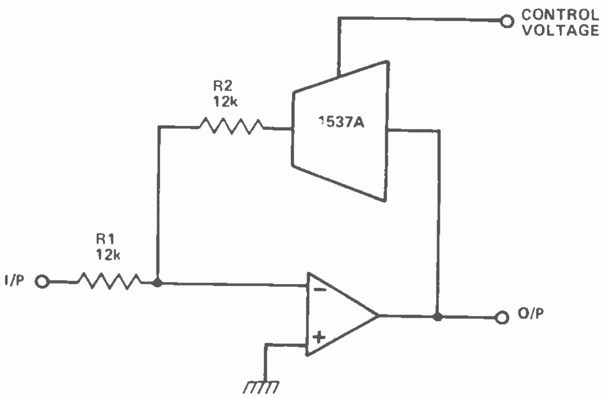


Fig. 14. A non-inverting controlled attenuator.

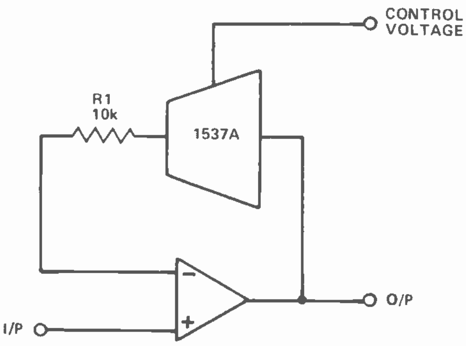


Fig. 15. An inverting voltage controlled amplifier.

A voltage controlled resistor is shown in the application of figure 16. The apparent resistance, R¹, is given approximately by the formula

$$\frac{R1}{1 - A}$$

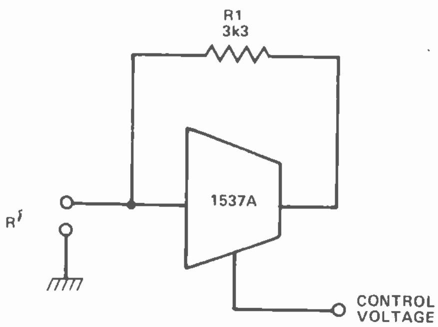


Fig. 16. A voltage controlled variable resistor.

where A is the gain of the VCA module (remembering that it has a maximum gain of unity). The value of R1 shown gives an apparent voltage controlled resistance of 7 k to 100 k over the ten volt control voltage range.

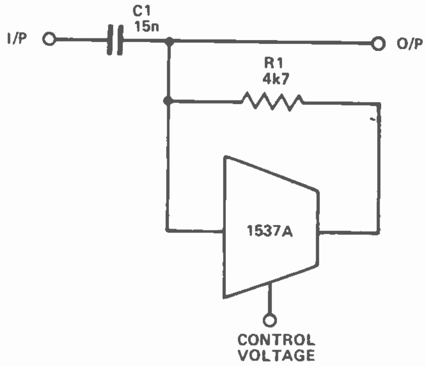


Fig. 17. A voltage controlled High Pass Filter.

The effect of a VCR (voltage controlled resistor) is used in the final two applications as the control element in filter circuits. Figure 17 shows a simple voltage controlled high pass filter. The component values shown filter out all frequencies below the variable limit of 1-2 kHz. Adjustment of the control voltage alters the lower cutoff point.

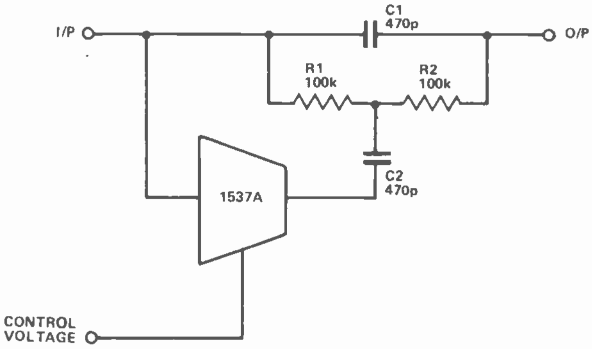


Fig. 18. A voltage controlled Band Reject (Notch) Filter.

Figure 18 consists of the circuit of a voltage controlled band reject or notch filter whose depth of notch is adjusted by the control voltage. The component values shown set the frequency at about 300 Hz and depth of notch is variable from 0 dB to about —15 dB.

Conclusions

The applications given in this article show the 1537A chip to be a very versatile device. It is remarkably easy to work with, a fact which is borne out by the quality (in technical terms) of the circuitry in the breadboarded fashion of our experimental design work, let alone in the modular fashion allowed by the use of our PCB layout. We can foresee many more applications of this device to come in the future. Thanks go to Aphex Audio Systems UK Ltd for their help in obtaining data on the 1537A. They are at present the only suppliers of the chip in this country and have kindly offered a 15% reduction in price to ETI readers quoting the code given in Buylines. ETI

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7410	10p	7492	30p	74165	55p
7413	22p	7493	25p	74170	100p
7414	39p	7494	45p	74174	55p
7420	12p	7495	35p	74177	50p
7427	20p	7496	45p	74190	50p
7430	12p	74121	25p	74191	50p
7432	18p	74122	35p	74192	50p
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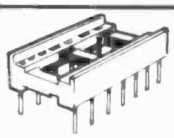
LED's	0.125in.	0.2in	each	100+
Red	TIL209	TIL220	9p	7.5p
Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		

DISPLAYS

DL704	0.3 in CC	130p	120p
OL707	0.3 in CA	130p	120p
FND500	0.5 in CC	100p	80p

SKTS



Low profile by Texas

8pin	8p	18pin	14p	24pin	18p
14pin	10p	20pin	16p	28pin	22p
16pin	11p	22pin	17p	40pin	32p

3 lead T018 or T05 socket. 10p each
Soldercon pins: 100:50p 1000:370p

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VEROBOARD

Size in.	0.1in.	0.15in.	
2.5 x 1	14p	–	Vero Cutter 80p.
2.5 x 3.75	45p	45p	
2.5 x 5	54p	54p	Pin insertion tool 108p
3.75 x 5	64p	64p	
3.75 x 17	205p	185p	
Single sided pins per 100	40p	40p	

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'Dalo' pens. 75p each.
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E12 series. 4.7 ohms to 10M. Any mix:

	each	100+	1000+
0.25W	1p	0.9p	0.8p
0.5W	1.5p	1.2p	1p

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		LM308	60p	NE556	60p
		LM318N	75p	NE567	100p
		LM324	45p	RC4136	100p
709	35p	LM339	45p	SN76477	230p
741	16p	LM378	230p	TBA800	70p
747	45p	LM379S	410p	TBA810S	100p
748	30p	LM380	75p	TDA1022	620p
7106	850p	LM3900	50p	TL081	45p
7107	900p	LM3909	65p	TL084	125p
CA3046	55p	LM3911	100p	ZN414	80p
CA3080	70p	MC1458	32p	ZN425E	390p
CA3130	90p	MM57160	590p	ZN1034E	200p

TRANSISTORS

				ZTX500	16p
				2N697	12p
		BCY72	14p	2N3053	18p
AC127	17p	BD131	35p	2N3054	50p
AC128	16p	BD132	35p	2N3055	50p
AC176	18p	BD139	35p	2N3442	135p
AD161	38p	BD140	35p	2N3702	8p
AD162	38p	BFY50	15p	2N3703	8p
BC107	8p	BFY51	15p	2N3704	8p
BC108	8p	BFY52	15p	2N3705	9p
BC108C	10p	MJ2955	98p	2N3706	9p
BC109	8p	MPSA06	20p	2N3707	9p
BC109C	10p	MPSA56	20p	2N3708	8p
BC147	7p	TIP29C	60p	2N3819	15p
BC148	7p	TIP30C	70p	2N3820	44p
BC177	14p	TIP31C	65p	2N3904	8p
BC178	14p	TIP32C	80p	2N3905	8p
BC179	14p	TIP2955	65p	2N3906	8p
BC182	10p	TIP3055	55p	2N4058	12p
BC182L	10p	ZTX107	14p	2N5457	32p
BC184	10p	ZTX108	14p	2N5459	32p
BC184L	10p	ZTX300	16p	2N5777	50p
BC212	10p				
BC212L	10p				
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BC214L	10p				
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BC478	19p				
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			22	33	47	7p
	100					13p
			220			20p
25V	10	22	33	47		5p
	100					8p
		220				10p
				470		15p
	1000					23p

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Standard	16p	30p	15p
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5pin 240°	13p	10p	16p

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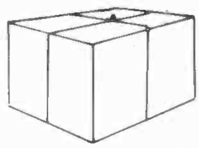

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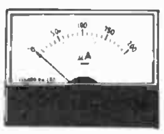

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DESIGNER'S NOTEBOOK

ETI's chief design engineer, Ray Marston, discusses the use of CMOS counter/divider ICs.

A common task facing the electronics design engineer is that of producing simple digital counter/divider networks, which produce an output frequency or count rate that is some fixed fraction of the original input frequency or count rate. This month's "Notebook" discusses the use of CMOS ICs in such applications.

4013 and 4027 Flip Flops.

The two most basic counter/divider ICs in the CMOS range are the 4013 dual D-type flip-flop and the 4027 dual J-K flip-flop. Figure 1 shows the outlines and pin notations of these two devices, which each contain two independent flip-flop stages sharing common supply connections. Each of these packages can be used to give division ratios of 2, 3 or 4.

Fig. 1. Outlines and pin notations of the 4013 dual D and the 4027 dual J-K CMOS flip-flops.

A single 4013 'D' stage can be made to act as a divide-by-two counter by grounding its SET and RESET pins and coupling its DATA pin to its Q̄ output, as shown in Fig. 2a. A single 4027 J-K stage can be made to act as a divide-by-two counter by grounding its SET and RESET pins and connecting its J and K pins to the positive supply rail, as shown in Fig. 2b. Both of these circuits change state on the positive-going transition of the input clock signal, which must have rise and fall times of less than 5 uS. The 4013 is very fussy about the shape of its input clock signals and tends to be rather temperamental in operation. The 4027 is not too fussy about its clock signals and is very easy to work with.

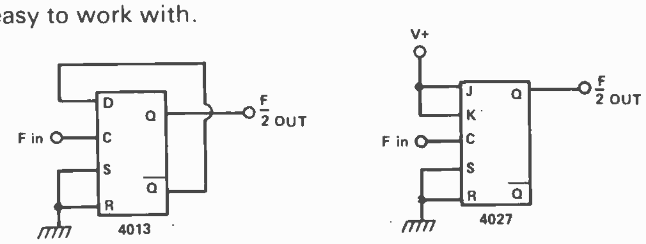

Fig. 2. Divide-by-two counters made from D-type (left) and J-K (right) flip-flop stages.

Ripple Counters

Figure 3 shows how two divide-by-two 'D' or J-K flip-flop stages can be wired in series to give an overall division ratio of four (2^2). Fig. 4 shows how three such stages can be

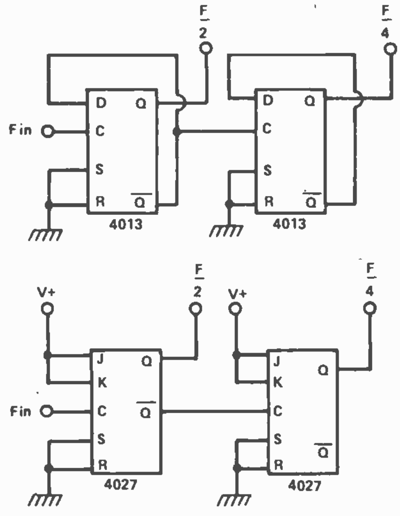

Fig. 3. D and J-K versions of divide-by-four ripple counters.

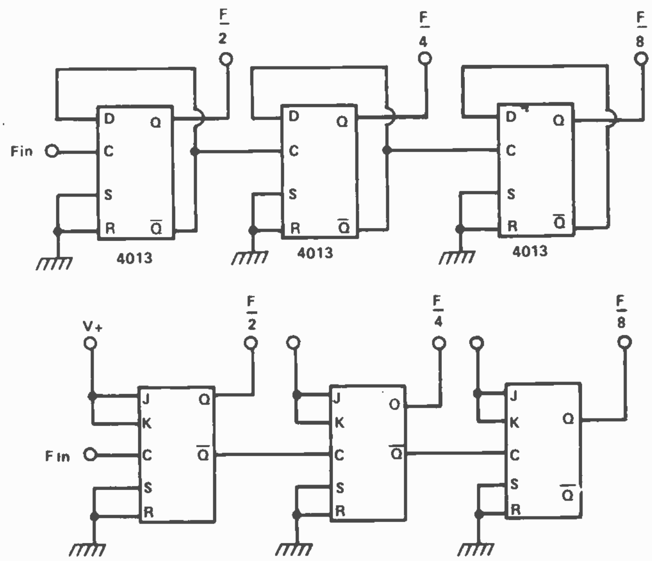

Fig. 4. D and J-K versions of divide by eight ripple counters. ▶

wired in series to give a division ratio of eight (2^3). Note that each counter stage is clocked at precisely half the rate of (an octave below) the preceeding stage, so that the clock signal seems to 'ripple' through the counter chain. Also note that, as is made clear in Fig. 5, the final division ratio is equal to 2^n, where 'N' is the number of counter stages. Thus, four stages give a ratio of $2^4=16$, five stages give $2^5=32$, six give $2^6=64$, seven = 128 and so on.

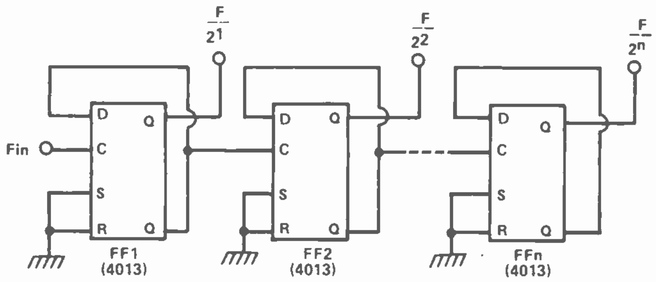

Fig. 5. D version of divide-by-2^n ripple counter.

A detail not made clear in the above diagram is that, since the counters of a 'ripple' circuit are effectively wired in series, the propogation delays of the individual stages in the counting chain add together to give a fairly long total delay at the end of the chain. If each stage has a delay of 100 nS and there are ten stages, the total propagation delay is 1 uS. Consequently, the final output signal will not change state until 1uS after the arrival of the original input clock signal that initiates that change of state. The counter states of the 'ripple' type of counter are thus not in pefect synchrony with the original clock signal and this type of circuit is consequently known as an asynchronous counter.

4013 and 4027 counters can be cascaded to give any desired number of ripple stages. When more than two stages are required it is usually economic, however, to use a special-purpose MSI ripple-carry binary counter/divider IC. Figure 6 shows the outlines and functional diagrams of three popular ICs of this type.

The 4024 is a seven-stage ripple unit with all seven outputs externally accessible: it gives a maximum division ratio of 128. The 4040 is a twelve-stage unit with all twelve outputs accessible: it gives a maximum division ratio of 4096. The 4020 is a fourteen-stage unit with all outputs except 2 and 3 externally accessible: it gives a maximum division ratio of 16 384.

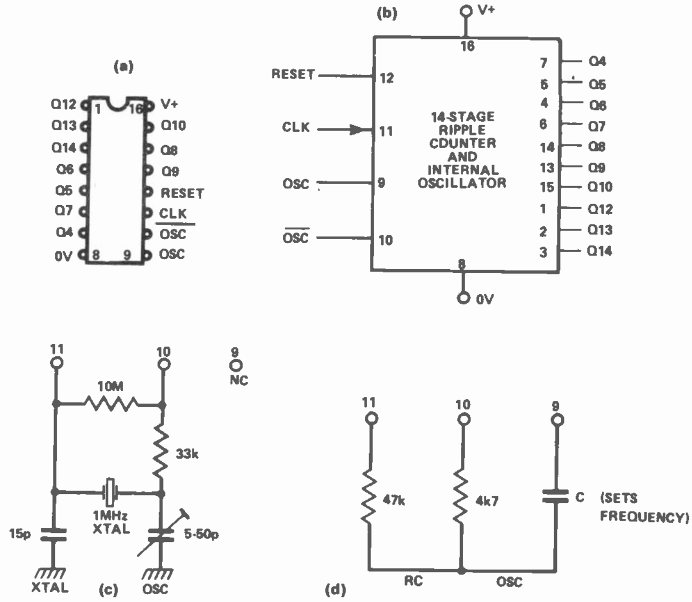

Fig. 7. Outline (a), functional diagram (b), and alternative oscillator connections (c and d) of the 4060 fourteen-stage ripple counter.

Fig. 7 shows the outline and functional diagram of a special-purpose ripple-carry unit, the 4060. This is another fourteen-stage unit, but does not have outputs 1, 2, 3 or 11 externally accessible. The special feature of the 4060 is that it incorporates a built-in clock oscillator circuit. The diagram shows the connections for using the internal circuit as either a crystal or an RC oscillator.

The 4020, 4024, 4040 and 4060 ICs are all provided with Schmitt trigger action on their input terminals and trigger on the negative transition of each input pulse. All counters can be set to zero by applying a high level on the RESET line.

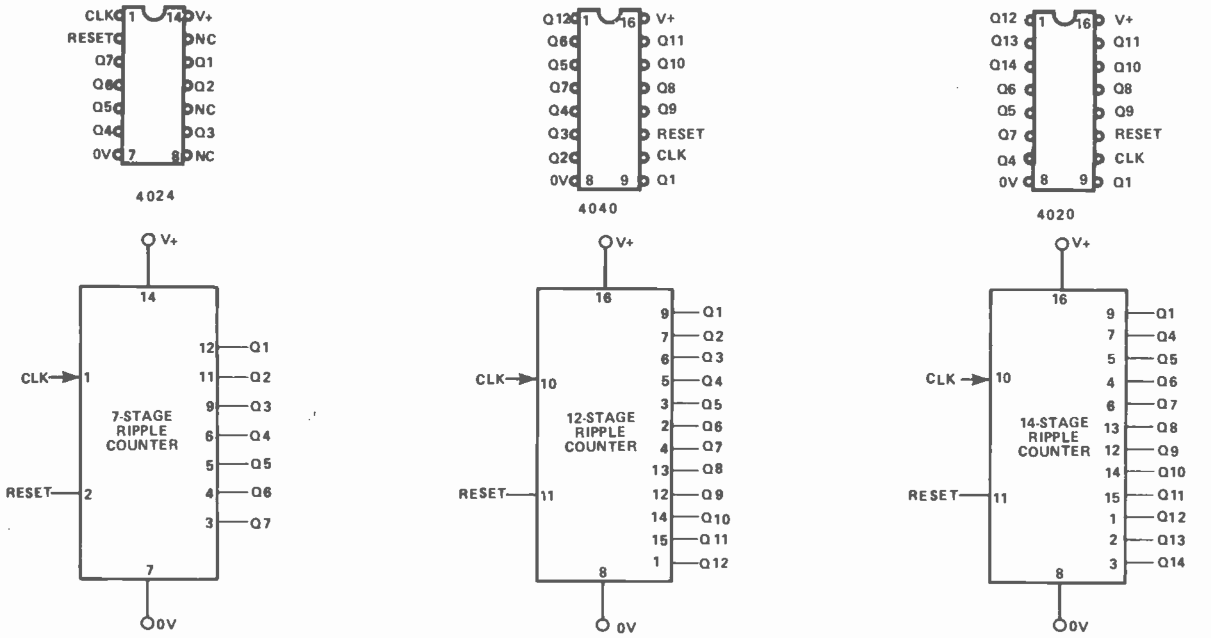

Fig. 6. Outlines (above) and functional diagrams (below) of three popular CMOS multi-stage ripple counters.

'Walking Ring' or 'Johnson' Counters

An alternative to the ripple type of counter is the so-called 'walking ring' or 'Johnson' counter. In these counters, all counter stages are clocked in parallel and the stages are cross-coupled so that the response of one stage to a clock pulse depends on the states of the other stages. Fig. 8 shows the connections for making a divide-by-three counter from two J-K stages and Fig. 9 shows the connections for making a divide-by-five counter.

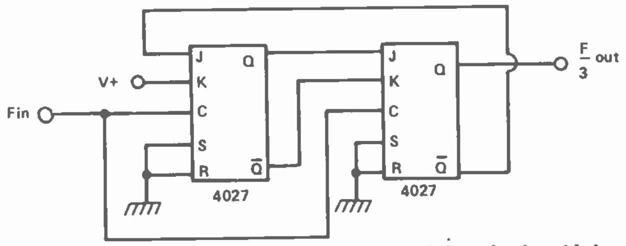

Fig. 8. J-K version of a divide-by-three 'walking ring' or 'Johnson' counter.

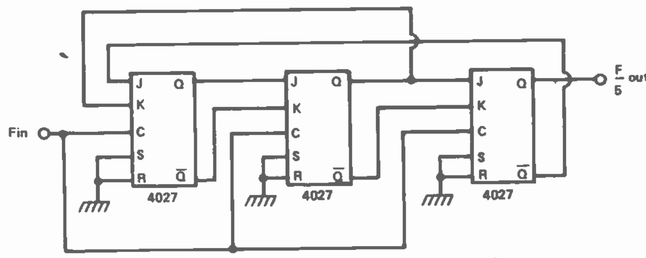

Fig. 9. J-K version of a divide-by-five 'walking ring' or 'Johnson' counter.

A major advantage of the 'walking ring' or 'Johnson' counter is that, since all stages are clocked in parallel, the outputs of the completed counter are subjected to only a single stage of propogation delay. Consequently, the system gives synchronous operation and outputs give glitch-free decoding.

4018 Divide-by-N Counter

When count numbers greater than four are required, it is economic to use MSI ICs such as the 4018, rather than the 4013 or 4027. The 4018 is a five-stage 'Johnson' counter that can be made to divide by 2, 3, 4, 5, 6, 7, 8, 9 or 10 by merely cross-coupling its terminals in suitable ways. The IC features a Schmitt trigger on its clock input line and clocks on the positive transition of the input signal.

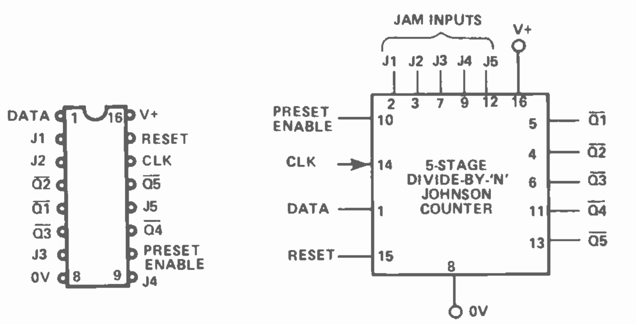

Fig. 10. Outline and functional diagram of the 4018 presettable divide-by-N counter.

Figure 10 shows the outline and functional diagram of the 4018. Fig. 11 gives methods of cross-coupling the IC to give division ratios from two to ten. On even division ratios, no additional components are needed. On odd ratios, a two-input AND gate is required in the feedback network. This gate can be a single 4081 AND stage, or can be made from two 4011 NAND stages.

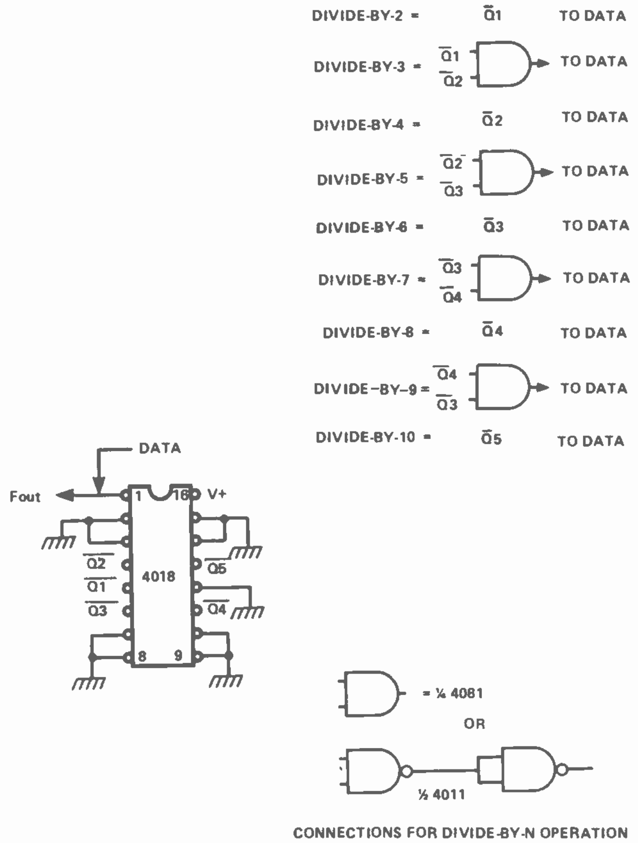

Fig. 11. Methods of connecting the 4018 for divide-by-two to divide-by-ten operation.

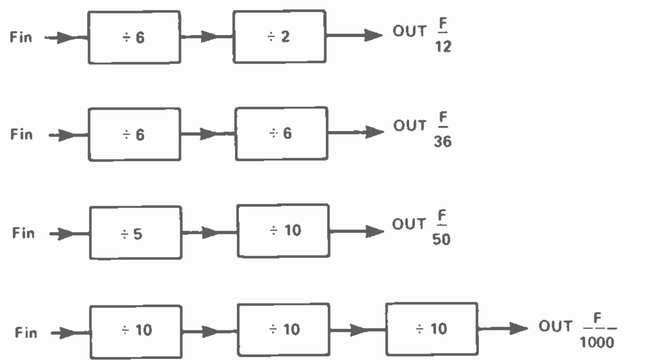

Fig. 12. Typical examples of division by numbers greater than ten.

Greater-Than-Ten Division

Even division ratios greater than ten can usually be obtained by simply cascading suitably scaled counter stages, as show in Fig. 12. Thus, a divide-by-two and a divide-by-six stage give a ratio of twelve, a divide-by-six and a divide-by-six give a ratio of 36 and so on. Non-standard and uneven division ratios can be obtained by using standard counters such as the 4018 and decoding their outputs to generate suitable counter-reset pulses on completion of the desired count. ETI

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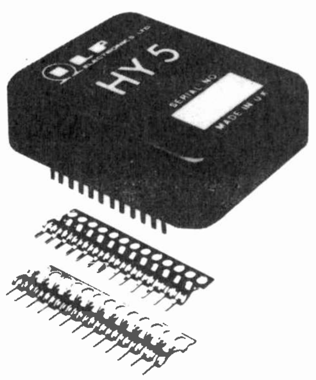

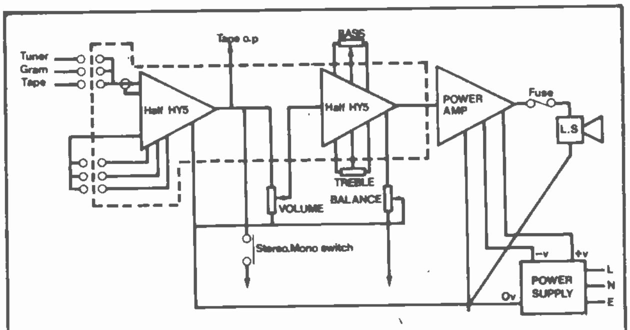

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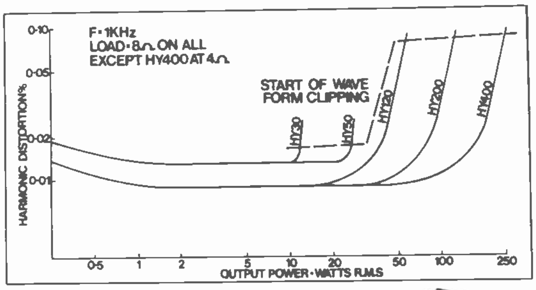

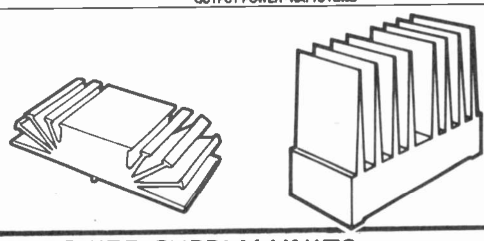

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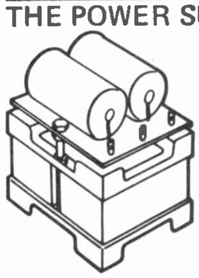

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RAVEN ON...

Dave Raven looks at the High Street discount war and suggests how you can spend £2500

High street discounting is not a topic we normally discuss in the annals of a high technology magazine.

However, it does have a special relevance to ETI, since we are not against a bit of discount, but more important, the discounting of electronic goods is directly related to the subject of high technology. With 17% inflation, in what other field can you predict with confidence that prices of certain manufactured goods will fall. This ironic contradiction of market forces is brought about by the rapid development of micro-chip technology. Products which contained two components are quickly reduced to one, assembly operations are halved producing double the output, which effectively reduces the price.

This is clearly very confusing to consumers of these goods, but conserve your energy worrying about it, since the customer is on a winner. The man to spare a thought for is your local High Street retailer of electrical goods and, of course, the local jeweller. Cast your mind back to 1964 before the end of retail price maintenance. For years it was simple to place an order with a firm of reputable wholesalers who promptly deliver a mixed variety of stock items which are marked up with the usual standard profit margin and proudly displayed in the window, end of selling job. Customers came streaming in, picked up the goods and paid him his profit, thank you kindly. No point in the customer shopping around, since everything costs the same in all the shops.

Then, at a stroke, Mr Heath removed retail price maintenance, making it illegal for a manufacturer to dictate at what price his goods must be sold. In addition, our membership of the common market introduced further legislation forbidding any form of price rigging by a manufacturer. This resulted in one recent case where a company was fined nearly £200,000 by the EEC for its part in a breach of these regulations.

The effect of discounting on small traders was severe. However, they were afforded some protection by manufacturers who have blatantly broken the laws, but now, in addition to the normal type of discounting which usually works by operating on a smaller profit margin, cutting out the wholesale operation and going for a high turnover, we have the introduction of a fast moving technology which causes discounting of a new kind. This threat protects no one including the large multiple suppliers, as it takes them so long to select a product and

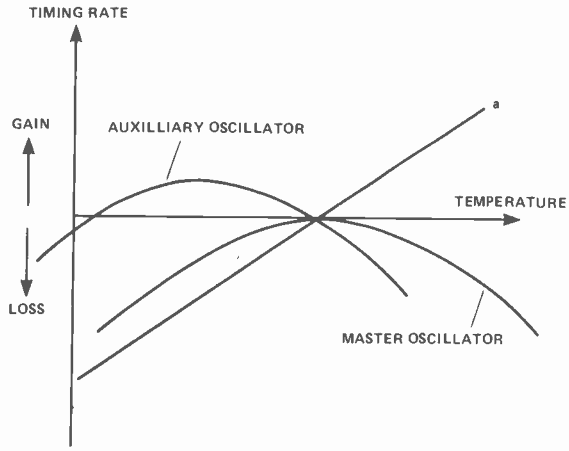


Fig. 1. The difference in oscillating frequency between the master oscillator and auxiliary oscillator is computed line (a).

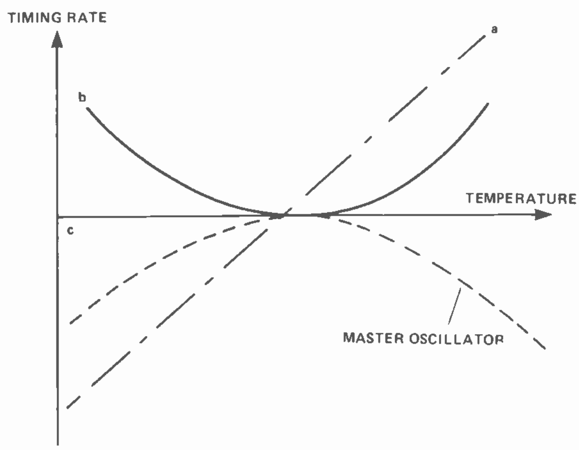


Fig. 2. The straight line (a) obtained by computation is squared and compensated for through a microprocessor in the circuit curve (b). The sum of curve (b) and the characteristic curve for the master oscillator is computed to form a straight line, which is not affected by temperature change.

promote it. Also, their buyers are not up to date with the technological changes. We now have a situation whereby the large chain stores who have grown to fame on the bulk purchase of items which are then distributed throughout their retail outlets, suddenly find that the electronic clock, watch, TV game, etc. selected for promotion in May or June is out of date and over priced by Christmas.

The effect of this during Christmas 1979 was clear to see. Apart from brand leaders such as Casio in the watch field there was little choice in the multiple stores. The shops that I did see selling unknown brands of electronic watches were grossly over priced and the product was out of date. It is obvious that buyers have been very cautious in their purchases of electronic products, probably hoping that soon there will be some sort of price stability.

The future for the small retailer in all of this looks very bleak. First he suffers a loss of trade due to discounting and now he suffers further losses because his wholesaler supplies him with out of date products at too high a price. The only way around this one, I am afraid, is for him to get his jacket off and run round to the wholesaler/importer and see what is going on. Probably he should travel wider for his purchases (even to Hong Kong if necessary).

For the big retail chain more misery is on the horizon, since the price rigging and cartel type operations which have been in existence are soon to crumble. The relevant government department has already invited companies which practice discounting such as Argos, Comet and Tesco to submit evidence of manufacturers that are refusing to supply them, because they discount. With an impending retail trade depression it seems certain that big battles lie ahead in the High Street and of course Mr. Consumer is smiling all the way to the Bank.

The loss of small local dealers for consumer electronic goods is obviously not to be welcomed, since their small size and flexibility usually provides an efficient after-sales service. In the case of jewellers selling quartz watches I think they have already shown that these are not suitable places from which to buy. Their profit margins are much too high for a product which thrives on low profit margin and a fast turnover. The servicing is minimum and a central service centre can service a large group of stores very efficiently and batteries, etc. can always be fitted at local level.

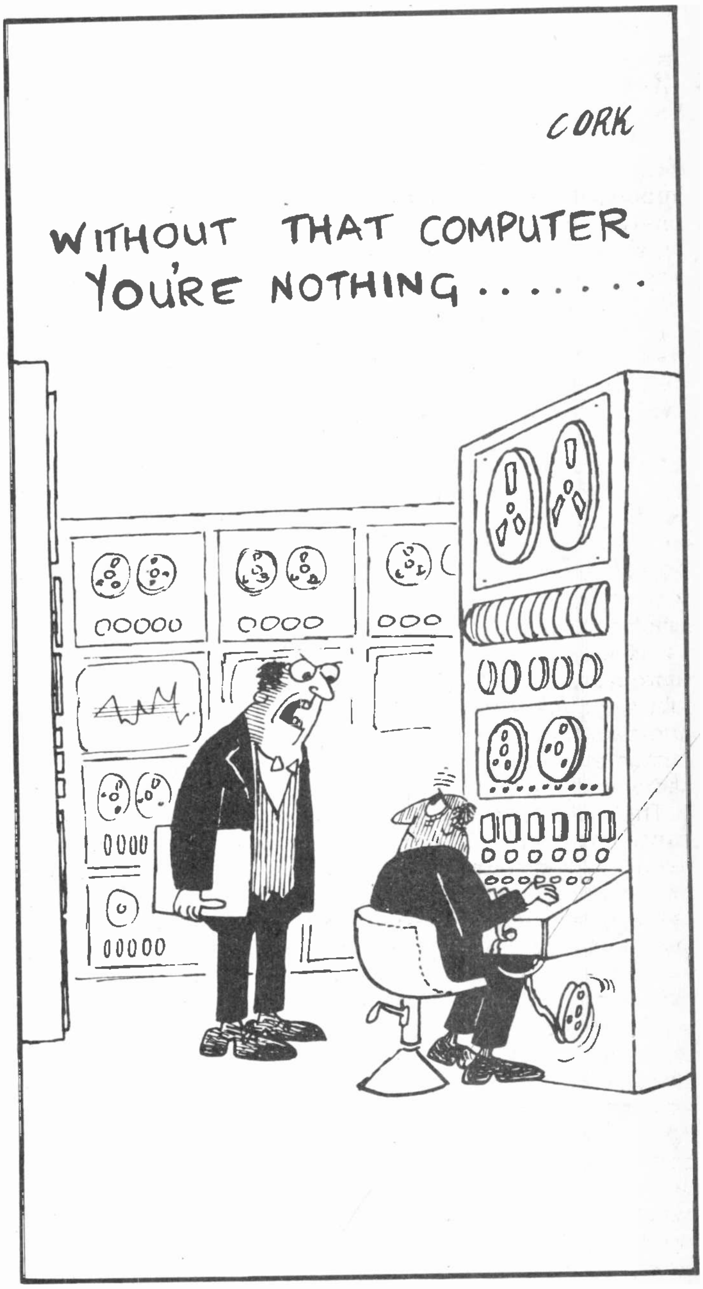
To try and forecast the future for the retail trade in consumer electronics is not easy, but it looks certain that the large multple stores will have to look closely at their buying methods and probably work closer with the very companies that are setting the price structure for microchip goods in the UK.

One company I know, whose name I would not divulge even if you inserted hot watch batteries up my nails, has increased its turnover by 20 times in three years and is all set to start discounting on the discount, so watch out Woolies.

Slimming Time

If you are not worried by the news that the Japanese are predicted to be big in making aero engines then you should be, since that is about the last major piece of technology we are still any good at. In addition to this, the sight of the latest Seiko version of an electronic watch is enough to make you give up and go home if you happen to be a watch designer. Styled in their usual superb way, these latest slimline models are as thin as some watch bracelets, which makes them look almost tasty enough to eat, let alone wear on your wrist. The 18 carat gold digital man's watch measures a total of 1.79mm in thickness overall. The watch module is a mere 1.38mm thick including battery.

The analogue version is 18 carat gold and also only 1.79mm thick overall. The price for both models is slightly thicker than average, a real snip at £2500 each. Accuracy of Seiko watches has been improved using a traditional electronic technique of twin quartz oscillators for a temperature compensating circuit. The pair of crystal oscillators have different temperature characteristics and each of the crystal oscillators are oscillating independently. The temperature change is detected and this is then compensated for using a microprocessor which in turn corrects the watch accuracy, thus achieving an approximate accuracy of plus or minus 10 seconds a year. ETI



Next Month

Hobby Electronics

MOBILE MICROELECTRONICS

We have managed to "persuade" one of the country's leading motoring journalists into writing a feature for us. He will be taking a look at the impact electronics has been making on the world of automotive engineering and some of the advances we can expect in the next few years.

Already we have cars (if you can afford them) like the Aston Martin Lagonda that are almost completely computer controlled, is this the shape of cars to come? We think so, find out all about it next month.

SHORT WAVE RADIO

Have you ever wondered why there are so few designs around for really simple SW radios? We think it's because most designers are a bit afraid of RF circuitry. After all digital equipment is so easy to design, most of the hard work has already been done by the IC designer.

So, we at HE have girded the loins, put our noses to the grindstone and come up with a really first-class design for a SW radio. We won't promise it'll cover 27 MHz (after all, there's not much to listen to, is there?) on the other hand it just might. Miss next month's copy and you will never know.

PETTING IT TOGETHER

Rick Maybury's latest report from the west coast of America comes from the Commodore factory in Silicon Valley California where the famous PET computer is assembled. The PET is probably the best known of all the minicomputer systems and Commodore have lost no time in carving out for themselves a very large slice of the market, find out why next month.

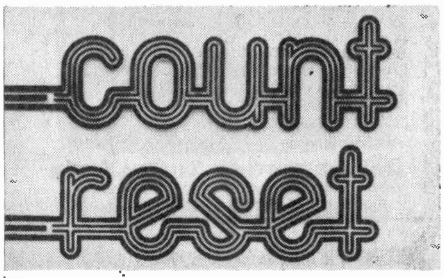
25 WATT MODULE

Here we have Keith Brindley putting the finishing touches to the prototype of the 25 Watt modular Amplifier for next month's HE. The final design will be built on a PCB and should set a new standard in medium power amplifiers. This project should be ideal for use in a home-built stereo system. Although we haven't published a purpose-built pre-amp it will happily work alongside the Tantrum pre-amp and virtually any other design, depending of course how far you want to go.

By using readily available components it should cost appreciably less than the commercial modules on the market.

To save you the trouble of finding a suitable PSU design we are publishing one designed for the job.

TOUCH SWITCH

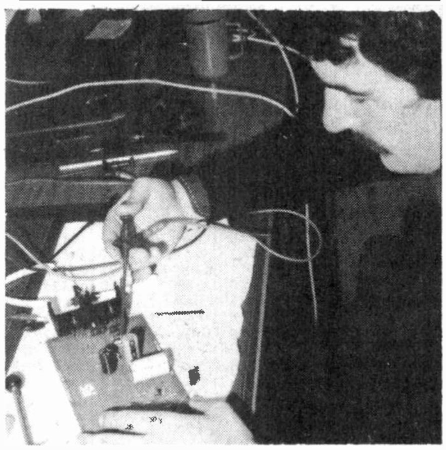


How would the world of amateur electronics exist without the ubiquitous touch switch? How have we got the nerve to publish another? Simple, they are easy to build and are a really great introduction to electronics.

Add a touch of class to your projects with next month's super design. Featuring novel circuitry and using only two inexpensive ICs with genuine capacitative operation we feel sure this one is going to be a winner. Ten channels are available and any one may be selected under fingertip control. Full constructional details next month. We know that you won't want to miss it.

PSU MODULE

To complement the 25 watt power amplifier module we have designed a purpose-built PSU. The power supply to be described next month will happily drive two 25 watt modules (with some to spare) and will still be relatively cheap and easy to build.



The March issue will be on sale February 8th

The items mentioned here are those planned but circumstances may affect the actual contents

AUDIOPHILE

Ron Harris brandishes his safety raiser at a dust bug and has news for Audiophile Amp fiddlers

It is a strange thing but the higher quality record deck you have, the more attention needs to be lavished upon it to keep it happy and operating. Not for the *real* hi-fi enthusiast the arm that raises itself from the groove after a hard side's tracking, thus liberating the ear from the repetitive click with which all composers, modern or baroque, somehow seemed to end every recorded piece. Oh no, it's not that easy.

It is only, apparently, upon the semi or totally automatic machines which populate the foothills surrounding peak-fi that such cantilever bending mechanisms are to be found. To be sure in the past couple of years' operation has moved ever more toward a gentleness suitable for the most compliant of stylus carriers.

Alas, though, noses still head rapidly skyward at a sniff of automation.

Not that there have not been devices marketed to add a refined touch of convenience to the first division decks before. There have. Never successfully enough, though. Anyway, wanting both my cake and digestion of it, I purchased myself the latest of this line, the Audio Technica "Safety Raiser".

Before we go ANY further, I absolutely refuse to make so much as a single pun around that name. Whatever blade at AT thought it up can keep his giggles to himself! I will simply applaud the sharp edge of his wit.

With anything resembling justice this beautifully engineered little device would sell a million. It looks superb and the action is so smooth and gentle that even the most hidebound purist must begin to question the value of listening to the run-out groove.

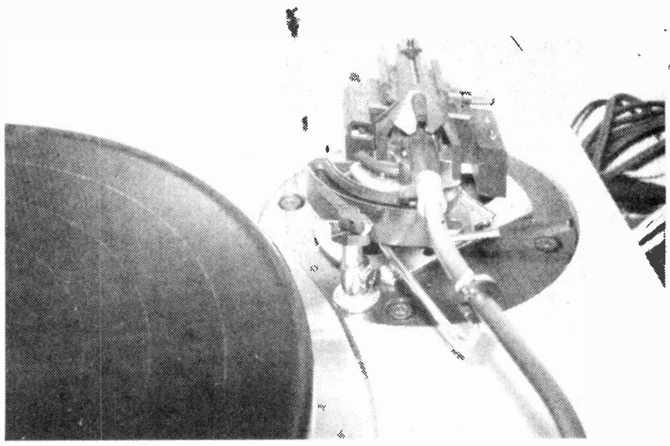
Lift-off

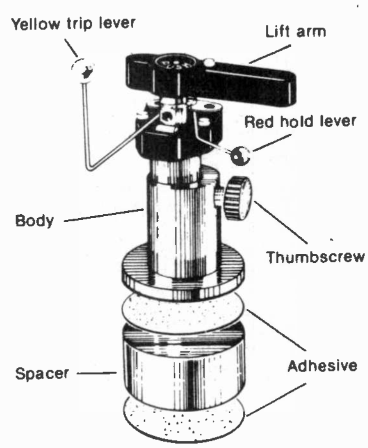
The trip lever is positioned so that it lies in the path of the pickup arm as it swings across at the end of the side. Once touched it leaps back out of the way, magnetically releasing the damped action platform to rise up and take the stylus away from all this, so to speak.

The required force on the trip lever to achieve this is so minute that it could not possibly be said to interfere with the arm anymore than would a passing butterfly breathing on it. Before fitting it I spent a good half-hour with the thing in the middle of my desk trying to touch the trip lever, without triggering the arm lift.

One thing's for sure — I ain't no butterfly, passing or otherwise. A big kid maybe, but butterfly no. Ah well, mine is not to do and fly . . .

In use the Raiser is a delight, although positioning it could prove a problem in some cases. I had a devil of a time persuading it to sit under an SME I I I such that it avoided the edge of the turntable, but reached the arm when it went for it.



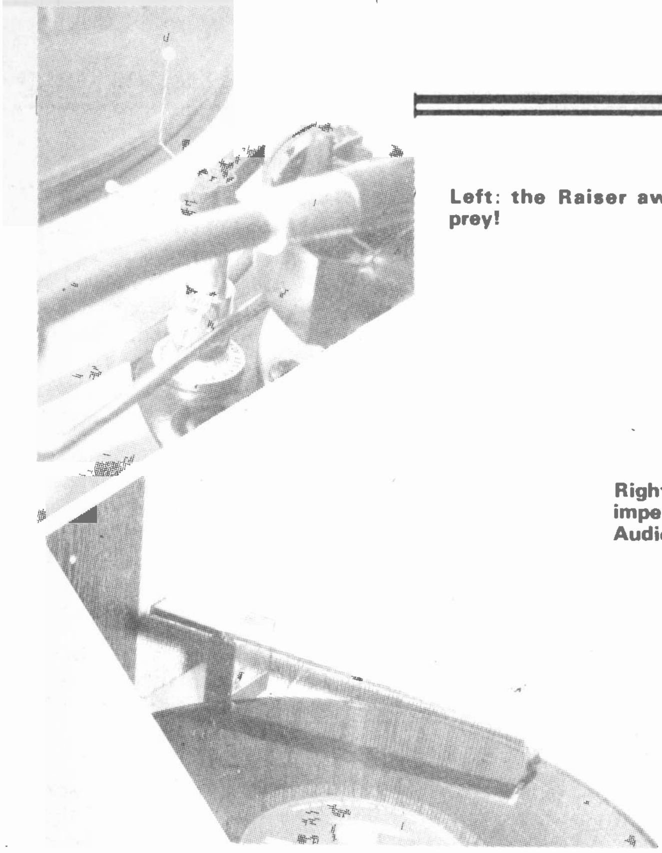


The little safety raiser in situ, i.e. stuck under the SME III, and what all the bits are for! The yellow lever is the one which the arm contacts on its way across the LP, thus triggering the action.

The height adjustment must be tightened up solidly, since you have to push the platform down after every operation and if you haven't tightened the screw enough . . .

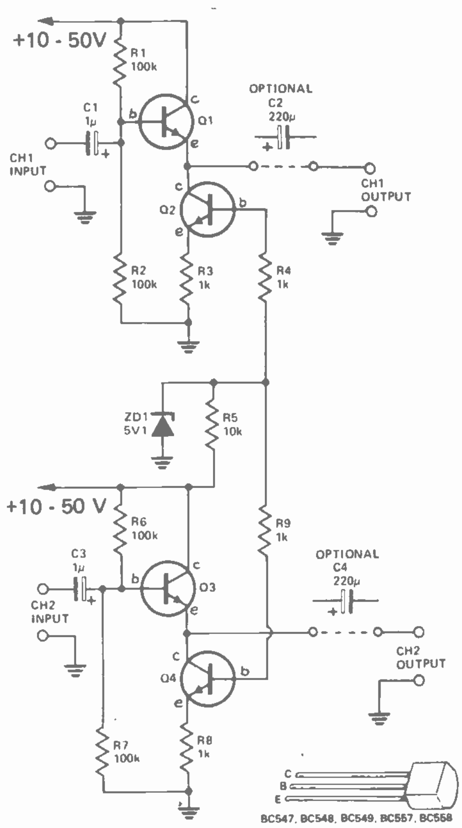
Anyway, it's not often you can spend as little (circa £11) on the hi-fi and get such a welcome return. After all — admit it, oh ye followers of the holy musicality, there are times when you simply *cannot* get to the deck at once — aren't there?

No? Hmm . . . you're more dedicated to this hobby than I thought. Didn't Daddy ever take you aside for a little talk . . .? ▶



Left: the Raiser awaiting its prey!

Above: the Decca record brush in action. Note the earthing wire snaking away in the background.



Right: circuit diagram of the low impedance driver circuit for the Audiophile Amp.

Brush Up On Carbon

While I was meandering around the local audio emporium in search of the Raiser, I promised myself I'd finally replace my ageing Dust Bug — which is now so old it has a good claim to have kept the Magna Carta records clean.

After a deal of bewilderment in the face of the veritable horde of appliances vended to trail a brush across an LP, I settled on the Decca version as potentially the most useful.

Despite the varying claims for all these contraptions, their aim is usually identical. The purpose *should* be to sweep the grooves just ahead of the stylus, picking out any debris lurking therein to prevent it gathering around the diamond and suffocating its tracking ability.

Decca claim a static removal ability too, as do droves of the others. The bristles of the brush are conductive carbon fibre and an earth return lead is provided to attach to the deck earth. The scheme is that any local static charge will be grounded by the passage of the brush before the pickup reaches it.

Besides all this I simply thought the Decca was a nice looking little device and a bit more individual than most.

Since I've been using it I can report a definite drop in perceived surface noise, quite dramatic at times in fact. It seems that earth path *does* lead somewhere after all.

The device has been around a while I know, but has probably been buried under a mound of similar offerings from beyond the edge of the Empire in a lot of shops.

It deserves better! It works very well indeed — at least give it a look over next time you're browsing around, the brush-off would be un-just!

Audiophile Amp

Amongst the many bits of paper with stamps on that that funny little man with the flat cap (and head?) keeps dropping all over our floor every morning has been some correspondence on the Audiophile amp.

It seems that some fickle fiddlers out there are using the power amps of this superb design, but not the pre-amp. Tsk, Tsk terrible people. Anyhow this may just cause problems. Our pre-amp was designed as a low impedance driving source for the power amps, the input impedance of which varies with frequency from a few kilo-ohms at extreme LF to hundreds of ohms at the top end.

If you go driving this with a high impedance output, the amplifier will load down the driving current at HF, causing distortion. With a low output impedance pre-amp (50R) no symptoms need be expected. However it is for the rest I speak these words of doom.

As there is no chance of anyone out there abandoning the idea of separating the Audiophile system, it falls to us to do the decent thing and provide a low impedance driver which will allow greater compatibility with the universe in general. The circuit given here will do just that.

PARTS LIST

Resistors — All ½W, 5%

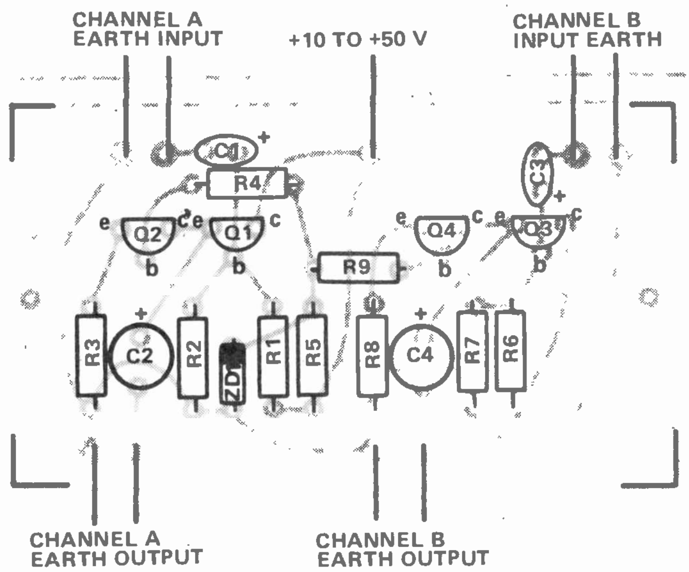
R1,2,6,7	100k
R3,4,8,9	1k0
R5	10k

Capacitors

C1,3	1u0 35V tantalum
C2,4	200u 35V electrolytic

Semiconductors

ZD1	5V1 400mW zener
Q1—Q4	BC547, BC107 etc.



Above: component overlay for the low impedance driver circuit. The PCB is to be found hiding with the rest of its kind.

It consists of two emitter followers, Q1 and Q3 with constant current generators in their emitters. Both the latter share a common reference, ZD1, which feeds the bases of Q2 and Q4, setting their emitter voltages at 4V4.

These transistors will always pass the exact amount of current required to maintain that emitter voltage, regardless of supply voltage. The constant current generators are to limit supply current and dissipation of the emitter followers when used with a high supply rail. It also lowers output resistance.

Output is derived via the optional blocking capacitors C2 and C4, which can be omitted if our modules are ALL you're driving with this buffer, but as we don't trust you ..... Fit them if any other equipment at all is to be linked to the circuit. Replace the C1 capacitor in the power amp with a 220u (35V), with positive lead towards the input, if you leave out the blockers.

We've provided a PCB layout which we would advise using, and be careful with earthing arrangements — use the signal earths wherever possible.

●

Trailing Trailers

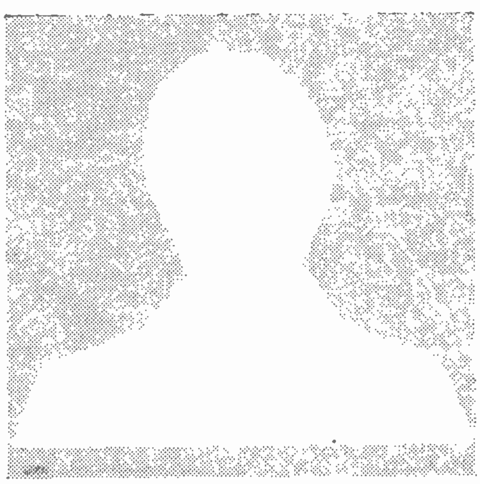
Next month I'm taking a look at some of the best of budget hi-fi. A heated conversation arose here some little while ago about just what level of fidelity could be obtained for £300 or less.

Everyone had their own ideas and tastes. Trouble is some of the combatants showed a deplorable *lack* of taste — would you believe not all of them had the sense to see that Felicity Kendal is the most beautiful woman in creation. Given that obvious blind spot in their make-up how can one possibly listen further?

I went ahead and assembled *my* £300 system despite the heathen howling hereabouts, and am presenting the results next issue.

I must confess there is one component I am not entirely happy about, but the amp and cartridge are real gems and together barely cost £100. ETI

ETI NEEDS YOU!



ETI is seeking to expand its staff once more and we are looking for a Project Engineer to join our ranks. In order to complement existing staff skills within our organisation we expect that the successful candidate will have had some experience with MPU based designs. He need not have been a specialist.

Our Engineer will be designing and testing projects for the magazine — and writing them up! This is the easiest part of the job and has caused no-one any problems yet, even though none of our existing staff were journalists prior to joining us.

We are flexible as to age and salary, but imagine that the successful applicant will be paid around £5000 p.a. — more for someone exceptionally qualified for the job.

Applications, including a C.V., should be addressed to :

**The Editor,
ETI Magazine,
145 Charing Cross Road,
London WC2H 0EE.**

Please mark your envelop "Project Engineer".

Metac ELECTRONICS & TIME CENTRES

QUARTZ LCD 11 Function

Slim chronograph

12:30 pm 45
Hours mins secs

8 14TH
Month date day

0:00 00
Min secs 1/10 1/100

6 digit, 11 functions. Hours, mins., secs., day, date, day of week, 1/100th, 1/10th, secs., 10X secs, mins., Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet.

Same day despatch

Price only £9.95

Also available SOLAR CHRONOGRAPH M9 — Price £11.95

M3 Price includes POST & PACKING

QUARTZ LCD ALARM

With snooze alarm

12:30 pm 45
Hours mins secs

8 14TH
Month date day

7:30A
Alarm

6 Functions plus Alarm: Conference signal, 5 minute snooze alarm, Conference signal sounds 4 secs., before main alarm to give advance warning and an option to cancel. Snooze sounds 5 mins., after main alarm and is always preceded by the conference signal.

Same day despatch

Price only £9.95

M4 Price includes POST & PACKING

QUARTZ LCD ALARM CHRONOGRAPH

With 12/24 display

12:30 pm 45
Hours mins secs

8 14TH
Month date day

0:00 0
Min sec 1/10th

7:30A
Alarm

Hours, mins, secs, day of week. Month, date, day of week, alarm, hour, mins, a.m./p.m. 24 or 12 hour display mode. Alarm test. Chronograph, lap time, stop watch 1/10th secs.

Price only £13.95

Same day despatch

Also available SOLAR ALARM CHRONO M7 — Price £17.95

M16 Price includes POST & PACKING

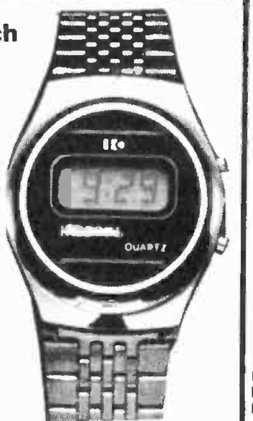
QUARTZ LCD Lady's Day Watch

Hours, mins, secs, day, date, back light, auto calendar.

12:30
Hours mins

8 14
Month date

:45
Secs



Fully adjustable bracelet only 25x20mm and 6mm thick. Silver or gold.

Price only £7.95 P&P included

M15 Same day despatch

QUARTZ LCD Lady's Cocktail Watch

Beautifully designed with a very thin bracelet

12:30
Hours mins

8 14
Month date

:45
Secs

Hours, mins, secs, day, date, backlight and autocalendar. Bracelet fully adjustable to suit all wrists. State gold or silver finish. Only 25x20x6mm

Price only £14.95 P&P included

M18 Same day despatch

Metac Guarantee

All Metac products carry 12 months guarantee and we also refund your money if not satisfied with our goods or service in the first 10 days. Metac's well-equipped service centre minimises service delays. Please note we do not delay your order to clear cheques.

HANIMEX Electronic LED Alarm Clock

Features and Specification:
Hour minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on/off control. Display flashing for power loss indication. Repeatable 9-minute snooze. Display bright dim modes control. Size: 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm). Weight 1.43lbs (0.65 kg).

M13 **£10.20** Thousands sold!
Mains operated. POST & PACKING incl.
Same day despatch.

QUARTZ LCD 5 Function

Hours, mins, secs., month, date, auto calendar, back light, quality metal bracelet. 6mm thick

12:30
Hours mins

8 14
Month date

:45
Secs

Price only £6.95
POST & PACK incl.

M1 Same day despatch

Telephone your order using Barclaycard/Access Number on

03272-76545

24-hour answering service

OR COMPLETE THE COUPON

WHOLESALE MAIL ORDER

Send for our trade price list and minimum order details. Sell our products to your friends and earn £££s for yourself.

ELECTROMYOGRAM

ETI's latest biofeedback box converts the electrical impulses associated with moving a muscle - any muscle - into observable outputs. Either audio output or a meter reading can be obtained and if you can't relax with this, try reading ETI again!

The design and construction of an electromyogram presents some unique problems. The object is to detect the minute electrical signals produced by the 'firing' of muscle fibres in a particular muscle. For our purpose metal electrodes of some sort are attached to the skin over the muscle(s) of interest. For a relaxed muscle, these signals are fractions of a microvolt in amplitude. That's a small enough signal to detect on its own without having to find it amongst *volts* of 50 Hz hum that will be present in the body — induced from power and light wiring.

When the body is grounded, this hum will drop to typically one volt peak-to-peak, but trying to see one microvolt in one volt of unwanted noise (50 Hz hum here) isn't easy.

The overall block diagram of the unit is shown in the drawing.

Battery operation is essential as, with any device connected directly to the body, the possibility of accidental contact with mains potential from a mains-operated unit is very real — with lethal results.

The instrument is called upon to detect quite small signals in the presence of large amounts of noise. It should have variable gain control — adjustable by the user, a threshold control so that small variations of a large signal may be readily detected, a visual indication (a meter) and an audible output that follows the convention of rising pitch or pulse rate for increasing muscle activity, and vice versa. Also some form of band-pass filtering to sort out the predominant muscle signal which is in the 100 Hz to 500 Hz range, and selectable integration of the feedback response was considered desirable.

Biasing the differential input stage is important and this is discussed in the "How it Works" section. One trimpot is used to set up the input stage for correct operation. Once set up, any of the component values may be varied by +/— 10% without affecting the CMRR.

The choice of this type of first stage has resulted in a very low noise figure. The prototypes (we built two) had measured noise figures close to 150 nV at the input. This equals the performance of the best commercial units we have seen.

To provide some integration of the muscle activity level, so that the meter and audible responses are not too rapid (as researchers have found undesirable in some instances), switched capacitors are provided to provide integration times of about 0.5 second and 4 seconds — selected by a front panel switch. ▶

PARTS LIST

Resistors All ¼W, 5%

R1,2,18, 31	220k
R3,7,9	4k7
R4,25,26	100R
R5,6	2M2
R8,10,11, 22,23,40,41	1M0
R12,45	1k0
R13	8k2
R14-17, 27-30	47k
R19,32	270k
R20,24,33, 38,39,42,47	10k
R34	330k
R35	560k
R36	5M6
R37	3M3
R43	390k
R44	470k
R46	680R
R48	2k7
R49	18k
R50	27R

Potentiometers

RV1	1M0 linear
RV2	5k0 linear
RV3	1k0 linear
RV4	1k0 trimmer

Capacitors

C1-C6	1u0 polyester
C7,8,29,30	1n0 polyester
C9,10,12, 19,20,23,35, 41	33u 16V tantalum
C13,31,34, 21	100n polyester
C14-17, 24-17	68n polyester
C11,36	100u 25V
C18	22n polyester
C22,39,40	1000u 25V
C28	47n polyester
C32	220n polyester
C33	150n polyester
C37	470u 25V
C38	47u 25V

Semiconductors

D1,2	1N914
D3,4	1N4004
Q1,2	BC559
Q3,4	BD140
Q5-7	BC549
IC1	LM3900
IC2,3	741
IC4	555

Switches

SW1,2	SPST
SW3,4	DPDT

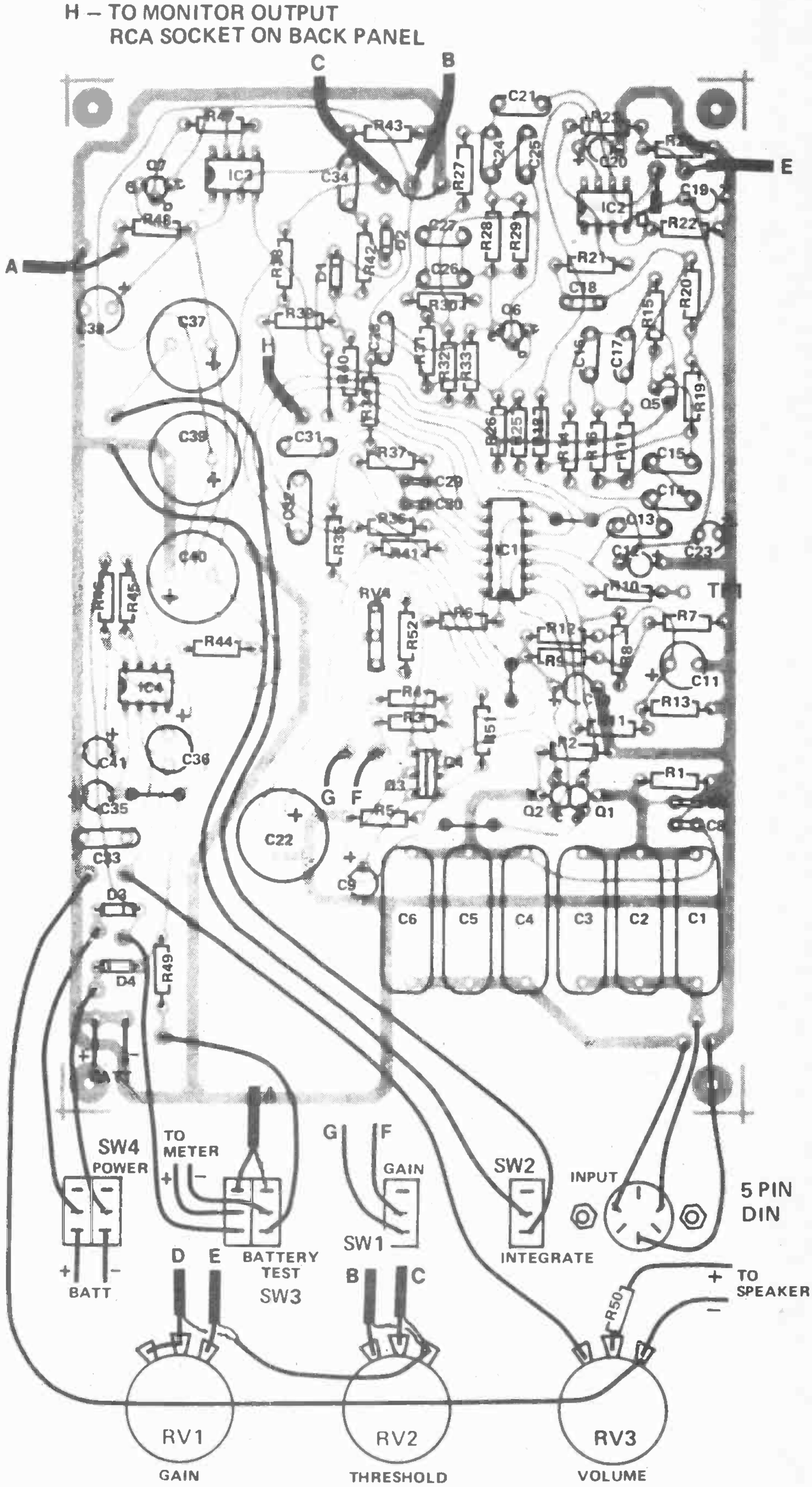


Fig.1. (Above) Component overlay for the electromyogram board.

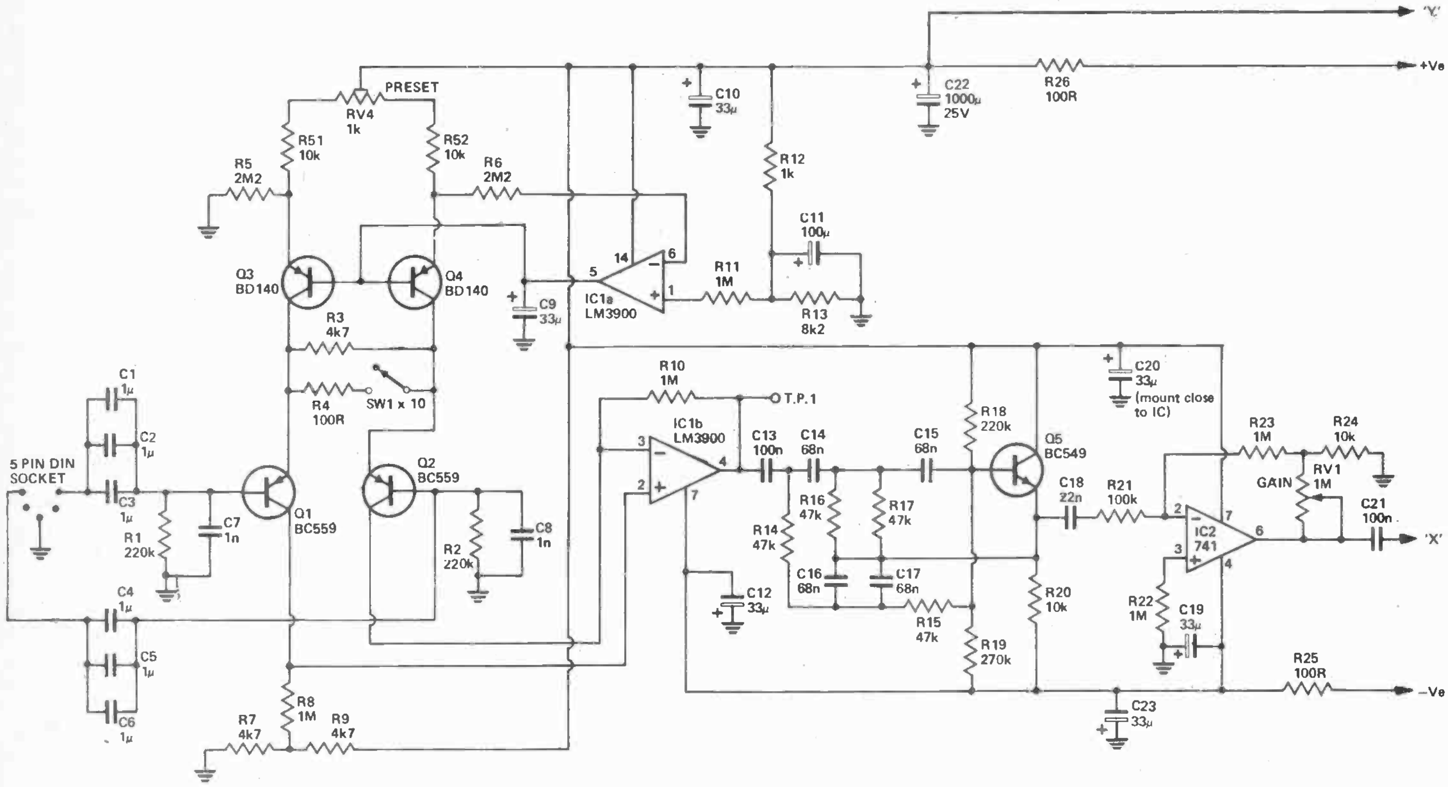


Fig.2. (Above) Circuit diagram of the unit. Note the battery connections carefully.

Since the circuit is fairly complex, a detailed analysis of its operation is best tackled by looking at the individual stages in turn, from input to output.

Input signals from sensors on the body drive Q2 and Q1 which are arranged as a differential pair. Emitter current, and thus collector current, for Q1 and Q2 is derived from a precision constant-current source comprised of Q3, Q4 and IC1a. Transistors Q1 and Q2 share the current supplied by the constant-current source. If Q1 (for example) is driven harder, by an input signal, than Q2 then, while the collector current of Q1 increases, there will be a corresponding decrease in the collector current of Q2.

Now, the collectors of Q1 and Q2 are each connected to the input of IC1b, one amplifier in an LM3900 (a quad op-amp package). The amplifiers in the LM3900 package have the special feature that they amplify current differences applied to the inputs.

To ensure a high common-mode rejection ratio, the quiescent (no signal) collector currents of Q1 and Q2 must be held very close to a fixed amount. Hence, the precision constant-current source.

To derive this constant current source for Q1 and Q2 the two bases of Q3 and Q4 are driven by the output of IC1a. The non-inverting input (marked +) of IC1a is driven by a fixed voltage derived from a voltage divider (R12, R13) from the positive supply rail. C11 is a bypass capacitor to prevent supply rail variations modulating this reference voltage.

The inverting input (–) of IC1a is coupled to the emitter of Q4 placing this transistor in the feedback loop of IC1. The op-amp (IC1a) will attempt to maintain the current flowing through its inputs at a constant level, thus maintaining the base-emitter current through Q4, and therefore the collector current, constant at nominally, 100 mA. Assuming Q3 has similar gain to Q4, its collector current will be the same. The 1k preset, RV4, allows adjustment of the two collector currents to offset any slight differences in gain.

The input stage gain is determined by the value of the resistance between the emitters of Q1 and Q2. The lower this resistance, the higher the gain. The 'x 10' switch simply connects a 100 ohm resistor in parallel with R3, increasing the gain.

Capacitors C7 and C8 ensure high frequency stability through bypassing the bases of Q1 and Q2 at frequencies above the range of interest.

To ensure good common-mode rejection ratio, it is essential that the bases of Q1 and Q2 each receive the *same* level of input signal. As the input is AC-coupled the characteristics of the input coupling capacitors must closely match each other. If stranded 10% capacitors are used the slightly different impedances of each will limit the common mode rejection. The solution we adopted was to use several capacitors in parallel so that the slight capacitance variations, and corresponding impedance variations, average out. It is important therefore that these six capacitors, C1-C6, are all the same type.

Supply rail decoupling for the input stages is provided by R25, R26 and C22, C23.

Two 50 Hz hum filters are employed, as can be seen in the block diagram, one immediately following the differential input stage, the other between the variable gain stage and the band-pass filter.

Both 50 Hz filters employ a 'twin-T' circuit – as used in our Hum Filter project, ETI 451.

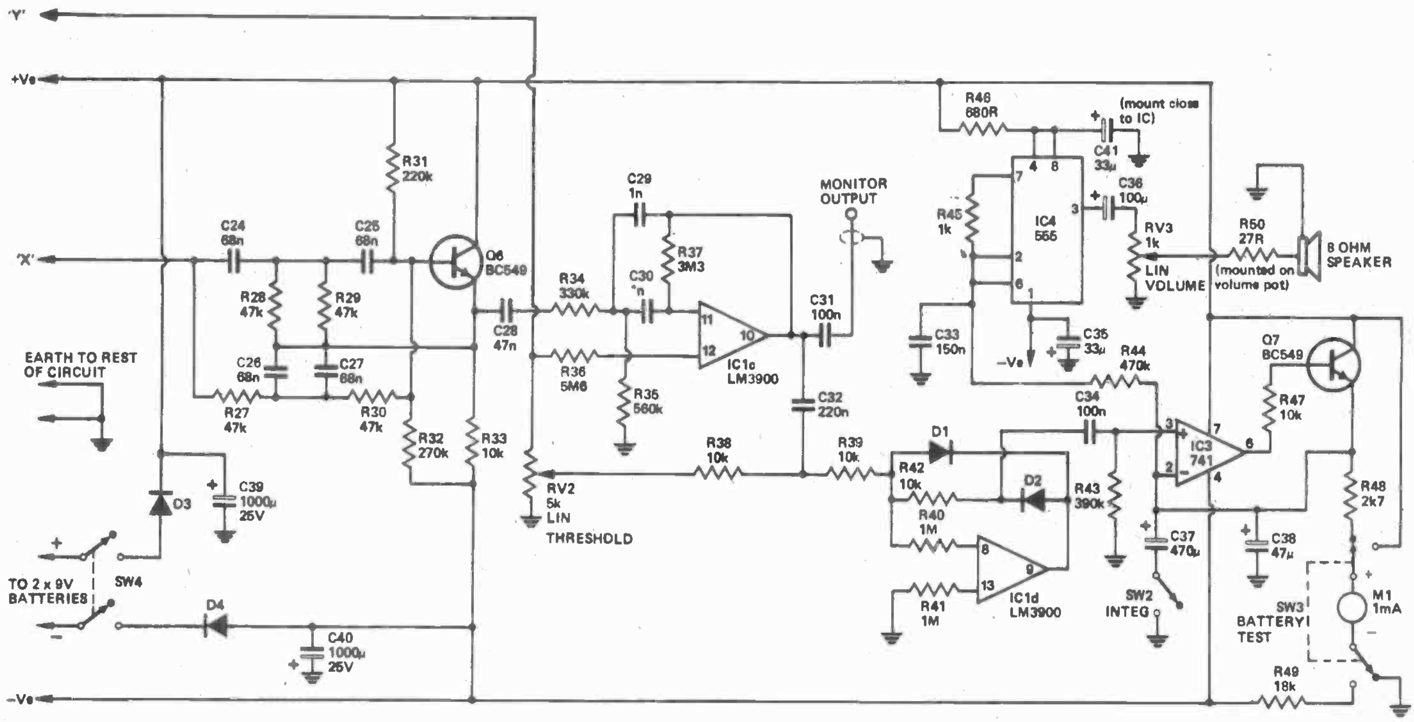
In the first hum filter, Q5 is connected as an emitter follower, the twin-T components connected to provide feedback at 50 Hz. In order to obtain a high circuit Q and thus good rejection at 50 Hz, the value of the resistance formed by R16 and R17 (parallelled) must be as close as possible to half the value of R14 and R15. As the latter are 47k resistors, the best way to obtain a value of half that is to connect two 47k resistors in parallel.

Similarly, for the second hum filter, Q6 is the active component and the filter consists of C24, 25, 26, 27 and R27, 28, 29 and 30. Resistors R28 and 29 form a resistance half that of R27 and 30 to provide good rejection at the notch frequency.

These stages provide a total of 20 dB rejection at 50 Hz.

Following the first hum filter is a variable gain stage employing a 741 op-amp. This is quite a conventional amplifier, gain variation being provided by RV1, a 1M potentiometer connected in the feedback path of the 741. RV1 is a front panel control. Gain is variable between 10 and 1000.

To avoid problems arising from large output offset voltages and unstable gain settings, the feedback for the 741 has been arranged via a voltage divider consisting of R23 and R24, the gain potentiometer being connected between the op-amp output and the junction of these two resistors.



HOW IT WORKS

The gain of the circuits is given by the equation :

$$\text{GAIN} = \frac{R_{23} + \dfrac{R_{23}\,RV1}{R_{24}} + RV1}{R_{21}}$$

Signal levels at the output of the variable gain stage are around 1 V. Any hum exceeding this level could easily cause clipping in succeeding stages and the purpose of the second hum filter is to prevent this.

The bandpass filter employs one op-amp from the LM3900 package, IC1c. A filter network, consisting of R34, R35 and R37 and C29 and C30, is connected around a feedback path between the op-amp output and its inverting input. This provides a bandpass extending from 100 Hz to 500 Hz which encompasses the range of interest for the muscle fibre signals. At midband (250 Hz), the gain of this stage is roughly four.

A monitor output is taken from the output of IC1c so that the muscle activity waveforms (filtered) may be viewed on an oscilloscope if desired.

This consists of a precision rectifier that passes only the positive peaks of the signal that are greater than a presect DC voltage – determined by potentiometer, the theshold control on the front panel.

The output of the bandpass filter is mixed with a DC voltage derived via the positive supply rail by the potentiometer RV2. The resultant signal – the AC muscle activity signal superimposed on a DC voltage – is then applied to the input of the precision rectifier. This involves IC1d, D1 and D2 and resistors R39, 40, 41 and R42. The latter two resistors convert the current-differencing input of the LM3900 into a conventional voltage-input op-amp.

Positive-going signals of less than 0.6 V above the voltage present on the junction of R39 and R40 will be amplified by the full open-loop gain of IC1d. The output of this stage increases rapidly until D2 conducts, the stage then has only unity gain (x 1), determined by the ratio of R42 and R39.

Output from the precision rectifier is taken from the cathode of D2 and will consist of the amplified, positive-going part of the muscle fibre signals that are above the positive voltage set by the threshold potentiometer, RV2.

Diode D1 ensures that the gain of the stage remains at unity gain for the negative-going portions of the muscle fibre signals from the output of IC1c.

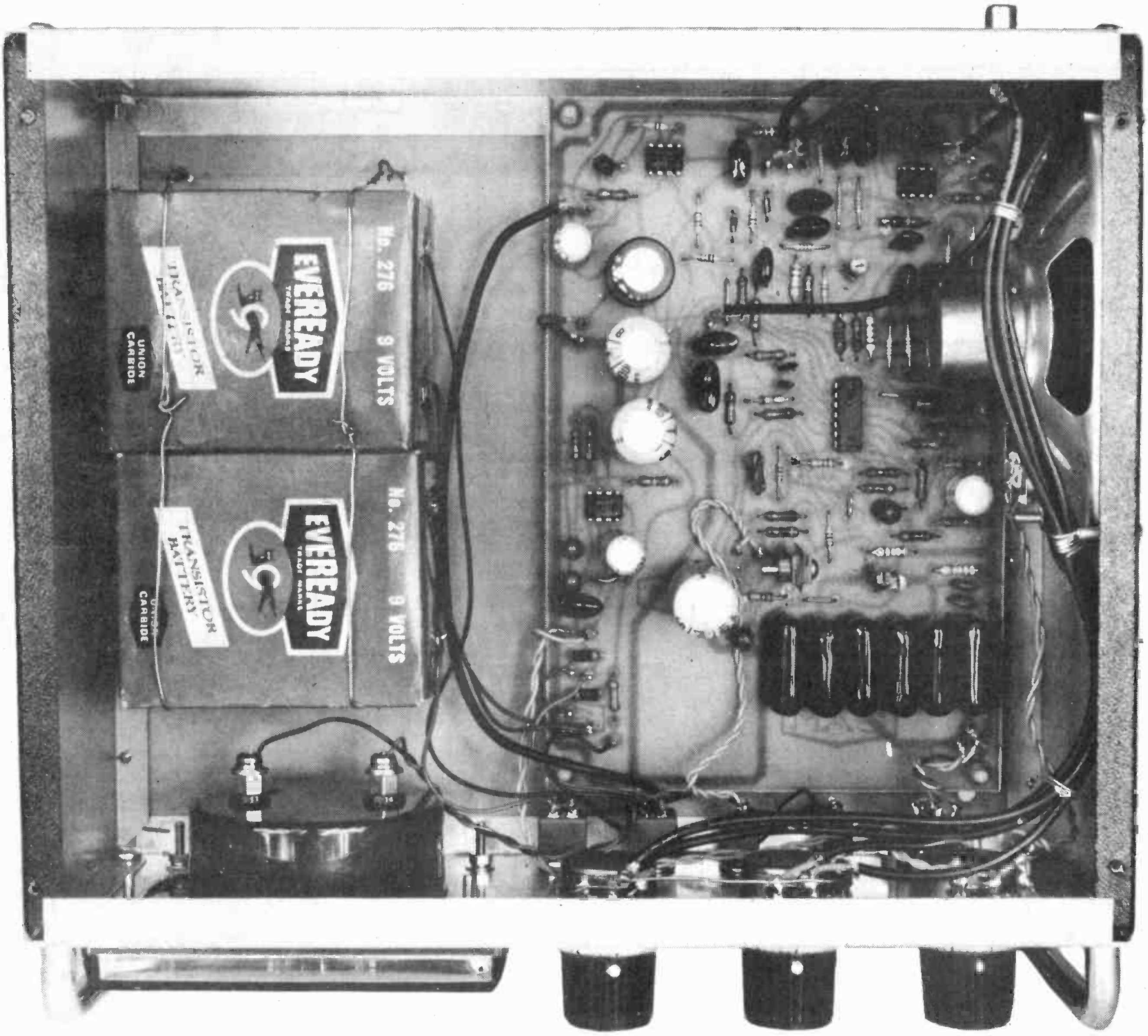
This consists of an op-amp (IC3) with an emitter-follower stage (Q7) connected in the negative feedback path. The emitter of Q7 drives the meter.

The threshold stage output is coupled to the input of IC3, a 741, via a 100n capacitor, C34. Resistor R47 limits the base current of Q7 to a safe value as the 741 will provide much more current than the transistor will stand! A signal from the output of the threshold circuit will be amplified by IC3, causing Q7 to turn on, charging C38. The meter is connected to 'read' the charge on C38, via R48. The more signal that appears above the threshold, the longer Q7 will be turned on, increasing the charge in C38, thus increasing the meter reading. The circuit will respond quickly to increasing input signals, showing a corresponding increase in the meter reading. As the signal decreases, with decreasing muscle activity, the meter reading decays at a rate depending on the capacitance between the emitter of Q7 and ground. This provides for some integration of the signal level variations.

The integrate switch, SW2, connects a 470 u capacitor C37) in parallel with C38 (47 u). With this in circuit (integrate switch 'on'), the meter takes some four seconds to drop from full scale to zero.

This provides an audio output, consisting of a series of pulses, the repetition rate being an indication of muscle activity.

The emitter of Q7 is coupled to IC4, a 555 timer, via R44. Current through this resistor charges C33 until the voltage on pin 6 of IC4 reaches 2/3 of the voltage on pins 4 and 8. At this point, pin 7 of the 555, previously appearing as an open circuit, will conduct discharging C33 via R45. Once the voltage on pin 2 drops below 1/3 of that on pins 4 and 8, pin 7 returns to an open circuit condition, allowing C33 to charge again. In this manner, the 555 oscillates providing pulses on pin 3 to the speaker, via RV1 which serve as a volume control. As the voltage at the emitter of Q7 varies according to the variation in muscle activity signals, the rate at which C33 charges will vary. This varies the pulse repetition rate of the 555 oscillator in sympathy with the variations in muscle activity.



The case will hold the PCB, batteries and the loudspeaker. Note the positions of the front panel controls.

The audible output is derived from the meter drive so that it corresponds with the visual feedback response provided by the meter. This consists of a voltage-controlled oscillator (VCO) that provides a series of pulses to drive a speaker. The VCO employs a 555 timer IC.

Originally, it was intended to use a tone for the audio output. However, battery consumption on the prototype was almost 150 mA — at best! Battery life would be very limited at this consumption. A class A audio output stage is necessary to provide a tone output, and these are quite inefficient. Using a pulse output enables us to reduce the total current consumption to 20 mA.

Muscle Building

Construction is best commenced with the board. This method of construction is recommended as layout of the various stages is critical to avoid feedback or interaction between stages as one LM3900 package does sterling service in several parts of the circuit!

Assembly of the board should start with the resistors and capacitors. We found it easier to leave the six 1u input capacitors until the input transistors (Q1-Q4) were mounted. Be sure to check the polarity of the electrolytic and tantalum capacitors.

Finish loading the baord by inserting the diodes, transistors and ICs. The input transistor pair, Q1 and Q2, must be mounted so that their flat faces are touching to provide thermal coupling. The best way to do this, to avoid straining anything, is to solder only the collectors and emitters of Q1 and Q2 at first. Smear some thermal paste on the two flats and then tie the two transistors together using a link of enamelled (coil) wire — this prevents the possibility of shorts to the transistor leads should the loop slip off at some time. Tighten the loop by taking the ends in a pair of pliers and twisting until the transistors are held tightly together. Once this is done, solder the base leads.

The two BD140s, Q3 and Q4, also need to be mounted together. As they are in TO-126 packages they may be bolted together. It is necessary to use an insulating washer between them to prevent the collector contacts touching. Use thermal paste to improve the thermal coupling.

Once these devices are mounted, six 1u input capacitors may be soldered into place.

If you use board pins, the external connections to the board may be made after it is mounted in the case, otherwise, now is the time to attach all the leads going to the externally-mounted components.

Pinned Down

As high gain stages are used in several places, the circuit is sensitive to noise or signals radiated from other parts of the board. The 555 VCO output can be especially troublesome, so use shielded cable to connect the output of the 555 to the volume control. The only resistor not mounted on the board (R50) is mounted between the wiper terminal of the volume control and one of the loudspeaker terminals.

There are a number of other connections that should be made with shielded cable and these are shown in the wiring diagram.

There is sufficient room inside the cabinet to accommodate a variety of 9 V batteries. The type of connection to the battery will depend on the particular style of battery used.

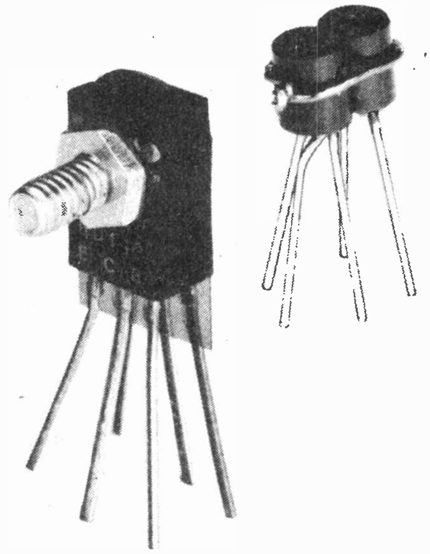
The speaker is mounted on one side of the cabinet and the monitor output (and RCA coax socket) is mounted on the back.

On the front panel, the switches should be mounted first, followed by the pots and the meter.

Although the common mode rejection of the input is better than 100 dB this will be degraded drastically if the contact to the skin is not good enough. To enable the input stage CMRR to effectively reduce 50 Hz hum it is necessary to ensure that the hum is exactly the same level on both inputs. For this reason the construction of the electrodes is very important.

The two input leads are made by soldering the centre conductor of the shielded cable to small metal discs about the size of 5p pieces. Cut the earth braid back enough so that it cannot touch the electrode. The braids of the two input cables are connected to pin 2 of the five-pin DIN plug (the grounded pin). This pin is also connected to the shield of the third cable which becomes the ground electrode. The centre conductor of this cable is not used and the other end of the braid is soldered to another metal disc. Use a slightly larger disc (about the size of a 10p piece) as this helps to ensure a good ground connection to he body.

Before powering up, check the board. Check the orientation of all the polarised components – electrolytic and tantalum capacitors, transistors, ICs and diodes. If everything is all right, switch the unit on with the battery switch in the test position. With 9 V batteries the meter should read about 9. If the battery switch is now switched off the meter should immediately fall to zero provided the gain control is turned fully down. If the volume control is turned to full on a slow clicking should be heard.



Thermal stabilisation is achieved by mounting the input transistors together as shown and described in the text. Note the insulating piece between the BD140s.

BUYLINES

The design uses no unusual components, despite its complexity. The electrodes can be made at home easily enough, although commercial units, we believe, are available. Any of the bio-feedback firms, Aleph One etc will be able to supply.

Now, measure the voltage (with respect to earth) at the test point (TP1) at the output IC1a (pin 4). With the x10 switch in the x1 position adjust the preset pot to obtain zero volts.

If the gain control is now increased, the meter reading will move along with the frequency of the clicks.

Threshold Advances

Now, advance the threshold control and the meter reading and click frequency should decrease. This threshold control works by varying the minimum signal required to cause a meter response. The higher the threshold control is set, the higher the input signal must be to cause a meter response. The threshold can be set just above the noise level so that even a very small input signal can be detected.

The electrodes can now be connected to the body and plugged in. The ideal way to secure the electrodes to your skin is to use a band of Velco tape, although we found Bandaids okay. If all three electrodes are placed reasonably close to each other along the inside of the arm (earth between the others) they can be secured in place all at once with a single wide band of Velco wrapped right around the arm. Some electrode paste may be used between the electrodes and the skin to improve the contact. This is available from some distributing chemists and medical suppliers, although it is relatively expensive. We found moistening the electrode to be a good alternative.

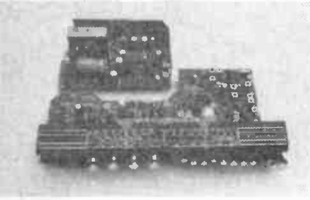
Once the electrodes are attached to the arm and plugged into the EMG monitor a reading should be easily obtained. Start with the gain and threshold controls set fully anti-clockwise, the gain switch in the X1 position and the integrate switch off.

If the arm is tensed the meter should indicate muscle activity readily. With these settings the EMG is really acting as a strength meter. Relaxing the arm, the gain switch can be switched to the x10 position and the gain control slowly increased. With each gain increase, the threshold can be increased slightly to cancel any increase in noise that may have occured, although don't overdo the use of the threshold control until you are familiar with the unit as it is easy to cover up muscle activity as well as noise.

Eventually you should reach a stage such that the gain control can be set at maximum but with muscle activity held so low that the meter reads about 2 to 3. This isn't easy!

Some experimentation with electrode placement will indicate how to get good results on particular muscles.

B.K. ELECTRONICS



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Disc Sensitivity: 100 mv (ceramic cartridge)
Radio: FM (VHF) 87.5MHz-108MHz. Stereo beacon lamp. Long Wave 145KHz-265KHz. Medium Wave 520KHz-1620KHz. Short Wave 5.8MHz-16MHz.
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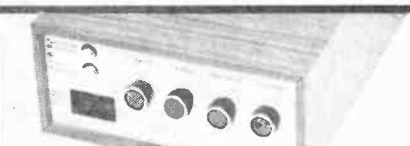

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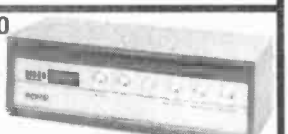

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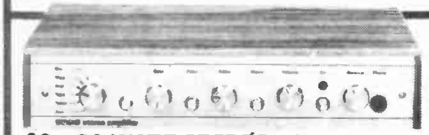

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ELECTRONIC TRANSLATOR

Ian Graham reports on his adventures with the Brainbank electronic information centre.

Whilst phrase books are valuable little tomes for those of us with the 'why can't foreigners speak English?' syndrome, it can be infurating to have to thumb through the food, health and shopping sections to find out how to ask an impatient Parisian police person where their copy of Blackpool Tower is.

As I see it you have two alternatives. You could follow Jonathan Miller's observation of the British abroad. If you speak to a foreigner loud enough and sufficiently slowly, clearly enunciating every word, he's bound to understand you . . . eventually. The assumption is that all foreigners can speak English perfectly well, but are too bloody-minded to use it.

However, if you don't suffer from galloping xenophobia, you will accept that some of the onus of being understood abroad lies with you. Wouldn't it be simpler if you could select the word you want from hundreds of others without going through the others first? The Ami Memory System allows you to do that *and* a lot more.

Multi-Access

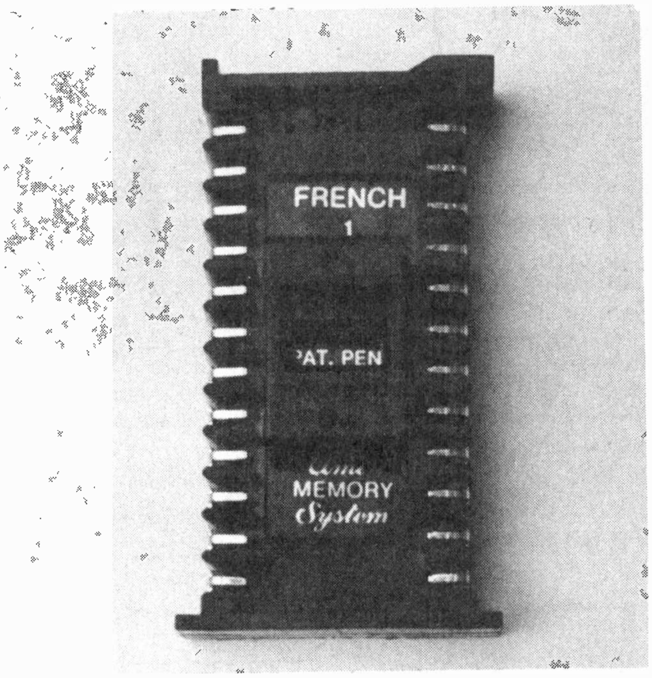
Although it can be used as a calculator and a desk diary, its chief use (and the reason why it's likely to be bought) is as an electronic translator. It can cope with single words and short phrases. You can also get at the words in a number of ways.

Four stores are accessible through the keyboard. Buttons L1, L2 and L3 permit access to plug-in memory cells. L4 is a general-purpose on-board memory. It contains common imperial/metric conversions, gallons to litres, etc and over twenty common words and phrases, available in French, Spanish and German.

Button-Pushing

On receiving the 'Brainbank', the first thing you must do is turn it upside down. Some of its capabilities are inscribed on its botty.

If you know the word you want to translate, you can punch in the English word. On the model I had, L1 was in English, L2 French and L3 German. So, to translate your word into French, just press L2, the screen blanks for a moment, then up comes your translation. It couldn't be simpler.

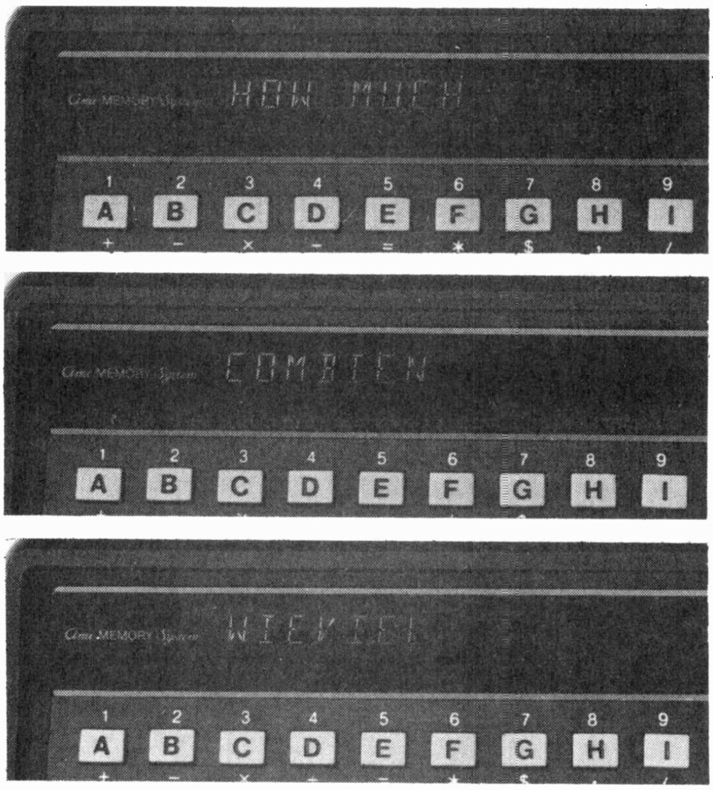


Schooldays might be a bit more fun, if you could plug in one of these to learn French. It's one of Brainbank's memory cells.

Re-Search

But what happens if the Box of tricks doesn't know your word? Let's take an example. Translate ABILITY into German. When you punch in ABILITY and press L3 for German, each letter is miraculously transformed into a dotless question mark. The Brainbank doesn't understand you. You can now press the SCH (search) key. The machine will then start taking letters off the end of your word until it recognises what is left and can compare it with words it knows. ABILITY is cut down to AB. Brainbank (or BB to its friends) will then go through its store of English words beginning AB. The first one is ABLE. So, you can now have a bash at forming your sentence a slightly different way.

If you're not a superb speller of the Queen's lingo, the search facility eliminates any difficulties arising from your own bad spelling. You can see the memory cycling through all the possible words on the display.



At the touch of a button you can translate straight from English to French or German and vice versa.

Although L1 is programmed in English, you don't have to swap the chips round in order to translate, say, from French into English. As you're strolling down the rue and you see an arrow directing you to the gare, switch BB on, press L2 (for French), punch in GARE and press L1 (for English) — Up flashes TRAIN STATION.

Phrases

If you want a well known phrase, the chances are that you won't have to enter the whole thing, letter by letter. Have a look at BB's botty again. You can press PHR (phrase) plus any one of 26 letters, each of which represents a word or a complete phrase. For instance, pressing PHR plus V will enter 'Do you change traveller's cheques?' Pressing PHR twice plus a letter will enter partial phrases eg PHR PHR D will flash 'I am looking for . . .' on the display.

You can also access words by category eg pressing HOTEL plus LRN will make BB cycle through words relating to hotels. Pressing LRN again stops the cycling process and you can translate the word you want.

Summing Up

BB can also be used as a calculator, albeit a rather slow one. The calculation of two times four takes around three seconds, so BB is unlikely to be bought as a pocket calculator alone. However, it is convenient to have the simple four function calculation facility built in. It saves carrying an extra box around.

Extras

BB has one or two luxury extras. If you would prefer to see the words moving from right to left across the display instead of flashing up at the same end everytime, you can do just that with the ROT (rotate) key.

If you can soak up the words faster than BB's standard rate you can speed things up with the F/S key.

Hardware

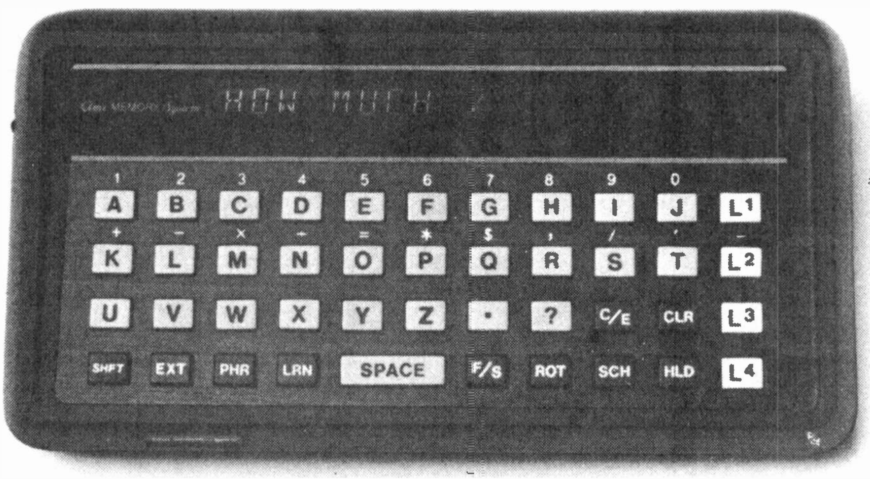
Six plug-in language cells were available when we first heard about BB (English, French, German, Spanish, Italian and Portuguese) with Japanese and Arabic due in the following weeks. Each cell holds 1200 of the most common words, together with 25 complete and 25 partial phrases. Uprated cells containing 9,600 words should soon be available. That's good news, as even 1200 words is rather restricted.

Cells covering pronunciation, diet and nutrition, first aid, taxation and a thesaurus are already complete. A cocktail mixer guide, a spelling guide and word games and puzzles are on the way. Blank cells which the user can program through the keyboard are also imminent.

The Brainbank is powered by four HP7-size cells (giving ten hours of continuous operation) or by rechargeable nickel cadmium batteries.

Your cheque for £150 or thereabouts will buy you one Brainbank, complete with mains adaptor, battery charger and one free cell. Extra cells will cost less than £20. Brainbank is marketed in the UK by Ring Electric.

If you want to see Brainbank 'in the flesh', it is on display at the 'Challenge of the Chip' exhibition at the Science Museum in London until June. ETI



One criticism of Brainbank is the keyboard layout. A QWERTY board would be much quicker to operate. You can use the superior symbols and numerals by using the shift button just as on a normal typewriter OR by pressing the EXT button, you can use Brainbank as a calculator until the next time you press the CLR button.

Greenbank

Greenbank Electronics
(Dept T3E) 92 New Chester Road, New Ferry
Wirral, Merseyside L62 5AG
(Tel: 051-645 3391)

TERMS, VAT, CWO. Cheques etc payable to Greenbank Electronics. Add VAT to all prices at 15% except where stated otherwise. Post etc: UK 30p (+5p VAT = 35p) per order. Export: NO VAT but add 30p (Eire), 75p (Europe) and £2.50 elsewhere.
(Polys, universities, govt depts, etc can telephone their orders for immediate despatch on account.)

BARCLAYCARD

UV EPROM ERASERS

Two easy to use units designed for both the professional and amateur UV-prom user.

Features:

- Can erase up to 14 proms.
- Special short wave ultraviolet tube.
- Erase time variable between 5 and 50 minutes in 5 minute steps (preventing pver exposure which may shorten prom life).
- Sliding tray carries proms on conductive foam.
- Safety interlock switch prevents the timing circuit from operating and switching on the tube with the tray open.
- "Mains on" and "Tube On" indicators.
- Smart textured case.
- Complete instructions supplied.

Supplied complete with mains plug and flex.

Model UV141. Price £77.70

Also available without timer as

Model UV140: Price £61.20

PROM WASHING: 50p each prom

CMOS

These cut prices for Amateur Users and Export. Note: industrial users — quantity prices available. Mostly Motorola. RCA

4000	15p	4042	75p	4089	£1.50	4419	£2.88	4531	£1.45
4001	17p	4043	94p	4093	63p	4422	£5.00	4532	£1.27
4002	17p	4044	90p	4094	£1.90	4431	TBA	4534	£5.13
4006	£1.05	4045	£1.45	4095	£1.05	4433	£11.32	4536	£3.69
4007	18p	4046	£1.28	4096	£1.05	4435	£7.93	4537L	£13.23
4008	87p	4047	87p	4097	£3.72	4440L	£11.50	4538	£1.25
4009	50p	4048	58p	4098	£1.10	4450	£2.67	4539	91p
4010	50p	4049	48p	4099	£1.45	4451	£2.67	4541	£1.14
4011	18p	4050	48p	40061	N/S	4452	TBA	4543	£1.59
4012	18p	4051	72p	40100	£2.50	4461	£2.18	4549	£3.69
4013	42p	4052	72p	40101	£1.61	4462	£2.42	4552	£10.55
4014	86p	4053	72p	40102	£2.12	4490FP	£6.54	4553	£3.87
4015	89p	4054	£1.10	40103	£2.12	4490VP	£3.48	4554	£1.19
4016	45p	4055	£1.28	40104	£1.09	4500	£6.95	4555	78p
4017	89p	4056	£1.34	40105	£1.06	4501	17p	4556	78p
4018	89p	4057	£25.70	40106	81p	4502	91p	4557	£3.86
4019	48p	4059	£4.80	40107	68p	4503	69p	4558	£1.14
4020	99p	4060	£1.15	40108	£5.36	4505	£5.71	4559	£3.69
4021	91p	4061	£15.67	40109	£1.02	4506	51p	4560	£1.84
4022	86p	4062T	£10.00	40181	£3.39	4507	55p	4561	85p
4023	20p	4063	£1.09	40182	£1.40	4508	£2.48	4562	£5.33
4024	66p	4064	N/S	40192	£1.40	4510	99p	4566	£1.59
4025	19p	4065	N/S	40193	£1.40	4511	£1.38	4568	£2.38
4026	£1.80	4066	57p	40194	£1.18	4512	81p	4569	£2.57
4027	45p	4067	£3.80	40257	£1.48	4514	£2.85	4572	25p
4028	81p	4068	22p	4160	£1.08	4515	£2.99	4580	£5.74
4029	99p	4069	20p	4161	£1.08	4516	£1.09	4581	£2.82
4030	58p	4070	23p	4162	£1.08	4517	£3.82	4582	98p
4031	£2.05	4071	21p	4163	£1.08	4518	£1.02	4583	76p
4032	£1.00	4072	21p	4174	£1.08	4519	51p	4584	43p
4033	£1.45	4073	21p	4175	99p	4520	£1.08	4585	£1.01
4034	£1.96	4075	23p	4194	£1.08	4521	£1.88	4595	£1.20
4035	£1.11	4076	85p	4408	£6.59	4522	£1.08	4597	£2.32
4036	£2.45	4077	23p	4409	£6.59	4524	N/S	4598	£2.65
4037	£1.00	4078	21p	4410	£5.73	4526	£1.08	4599	£6.95
4038	£1.08	4081	20p	4411	£9.50	4527	£1.52	4700	£1.75
4039	£2.45	4082	21p	4412VP	£9.43	4528	99p		
4040	£1.05	4085	74p	4415V	£7.50	4529	£1.14		
4041	80p	4086	73p	4415F	N/S	4530	85p		

74C

74C00	24p	74C83	£1.29	74C164	£1.04	74C905	£7.26	74C92L	£4.84
74C02	24p	74C85	£1.29	74C165	£1.04	74C906	54p	74C927	£4.84
74C04	24p	74C86	64p	74C173	90p	74C907	54p	74C928	£4.84
74C08	24p	74C89	£4.38	74C174	£1.51	74C908	96p	74C929	£11.93
74C10	24p	74C90	85p	74C175	90p	74C909	£1.63	74C948	TBA
74C14	£1.41	74C93	85p	74C192	£1.10	74C910	£6.78	80C95	54p
74C20	24p	74C95	£1.84	74C193	£1.10	74C911	£7.13	80C96	61p
74C30	24p	74C107	£1.22	74C195	£1.04	74C912	£7.13	80C97	54p
74C32	24p	74C150	£4.12	74C200	£6.78	74C914	£1.41	80C98	61p
74C42	92p	74C151	£2.46	74C221	£1.36	74C915	£1.10	82C19	£4.13
74C48	£1.38	74C154	£3.67	74C373	£1.73	74C918	£1.06	88C29	£1.93
74C73	54p	74C157	£2.20	74C374	£1.73	74C921	£11.83	88C30	£1.93
74C74	56p	74C160	£1.10	74C901	54p	74C922	£3.66		
74C76	54p	74C161	£1.10	74C902	54p	74C923	£3.73		
		74C162	£1.10	74C903	54p	74C924	TBA		
		74C163	£1.10	74C904	54p	74C925	£4.84		

QUARTZ

32.768KHz (Watch)	£3.23
60 KHz	£9.95
100.0 KHz	£3.62
200.0 KHz	£3.92
204.8 KHz	£3.92
282.144 KHz	£3.92
307.2 KHz	£3.92
312.5 KHz	£3.92
455.0 KHz	£4.95
1.000 MHz	£3.62
1.008 MHz	£3.92
1.280 MHz	£3.92
1.8432 MHz	£3.62
2.000 MHz	£3.62
2.097152 MHz	£3.23
2.4576 MHz	£3.62
2.500 MHz	£3.92
2.56250 MHz	£3.62
3.000 MHz	£3.62
3.2768 MHz	£3.23
3.579545 MHz	£1.85
4.000 MHz	£2.90
4.032 MHz	£3.23
4.096 MHz	£3.23
4.194304 MHz	£3.23
4.433619 MHz	£1.25
4.608 MHz	£3.23
4.800 MHz	£3.23
4.915 MHz	£3.23
5.000 MHz	£3.23
5.0688 MHz	£3.23
5.120 MHz	£3.23
5.185 MHz	£3.23
6.000 MHz	£3.23
6.144 MHz	£3.23
6.400 MHz	£3.23
6.55360 MHz	£3.23
7.000 MHz	£3.23
7.168 MHz	£3.23
7.680 MHz	£3.23
7.86432 MHz	£3.23
8.000 MHz	£3.23
8.388608 MHz	£3.23
8.867237 MHz	£3.23
9.375 MHz	£3.92
9.800 MHz	£3.92
10.000 MHz	£3.23
10.245 MHz	£3.23
10.700 MHz	£3.23
10.92 MHz	£3.92
11.000 MHz	£3.92
12.000 MHz	£3.92
14.0 MHz	£3.92
14.31818 MHz	£3.23
16.000 MHz	£3.92
18.000 MHz	£3.23
18.432 MHz	£3.23
20.000 MHz	£3.62
20.1134 MHz	£3.23
27.0MHz	£3.92
27.648 MHz	£3.92
38.6666 MHz	£3.23
48.000 MHz	£3.23
100.000 MHz	£3.23
116.000 MHz	£3.23

VEROBOARD
0.1" Pitch with copper strips

2½"×1" (pack of 5)	74p
2½"×3¾"	53p
2½"×5"	62p
2½"×17"	£1.86
3¾"×3¾"	62p
3¾"×5"	69p
3¾"×17"	£2.40
4.7"×17.9"	£3.14

0.1" Plainboard (no strips)

3¾"×2½"	38p
3¾"×5"	59p
3¾"×17.0"	£1.56
Terminal pins	£1.50/500
V-Q DIP board	£1.17
DIP breadboard	£2.81
Spot face cutter	93p
Pin insertion tool	£1.28

SOLDERCON PINS
100 50p 1000 £3.95

DIL SOCKETS
8/14/16 pin 10p/12p/13p
18/20/22 pin 18p/20p/25p
24/28/40 pin 30p/40p/50p
24 pin Zero insertion force £8.50

TIMER ICs
NE555/556 29p/49p

OP-AMPS
(All Mini dips)
CA 3130E 84p
CA 3140E 35p
UA 741 (Texas) 22p

4 DIGIT LED DISPLAY
Multiplexed, common cathode, prime quality.
NSB 3881 (0.3") £4.25
NSB 5881 (0.5) £5.75

LED DISPLAYS
DL-704E/707E 85p
DL-727E/728E £2.00
DL-747E/750E £1.80
FND 500/560 £1.20

LIQUID CRYSTAL DISPLAY
4×0.5" Digits 40 pin DIL £9.95

CLOCK CHIPS
AY-5-1224A £2.60
MK 50253 £5.50
MK 50362/50366 £6.50
MC 14440/(LCD) £11.58

SIX DECADE COUNTERS
MK 50395/6/7 £8.75
MK 50398/9 £6.20

MODULATORS

UM111: E36 UHF Ch.36 Vision Modulator £2.50
UM1231 UHF Ch.36 Vision Modulator wide bandwidth (for computers etc.) £4.70
UM1263 FM Sound Subcarrier Modulator £2.50

SWITCH MODE PSUs

AC 5221S 5v/10A, remote sense £63.25
AC 8221S 5v/5A, +12v/1A, −12v/1A £78.90
AC 9221S as 8221 but also −5v/0.1A £84.30
Typically 70% efficient. Dims. 2" x 4" x 8½"

DATA

Note: in this section all data books are subject to 0% VAT. For postage see 'Terms' at top of page.

113 page Electronic Projects Index 72-77 (North Tyneside Libraries)	£1.50
c650 page COSMOS Databook (RCA)	£4.95
c31 page 'A Guide to SC/MP Programming' by Dr. Drury (Kemitron)	£3.75
c20 page 'A Guide to Kitbug' (Kemitron)	75p
c24 page NBL Reference Guide (National)	£3.45
Data for 4116 (Mostek)	50p
c6 page data for Mk 4118	25p
16-page data for INS 8154 RSP-8A/650 (National)	50p
20-page data for SC/MP II (National)	50p
c100 page CDP 1802 MPU User Manual (RCA)	£4.50
c45 page Fixed Point Binary Arithmetic Routines for COSMAC	£4.50
c31 page Floating Point Arithmetic Routines for COSMAC (listings excluded)	£4.50
c43 page COSMAC MPU Product Guide (RCA)	75p
c15 page CDP 1802 Instruction Summary	25p
c70 page Understanding CMOS (RCA)	£1.50
1 page COSMOS Pocket Selection Guide (RCA)	25p
c21 page COSMOS Digital Integrated Circuits (RCA)	75p

REVISED Z80 DATA PACK £14.95
The contents of this data pack have changed. It now includes data in bound volumes, and also covers some other microprocessors as well. Regrettably the books cannot be supplied separately, as we are forced to buy the packs complete. Contents:
c275-page Z80 Programming Manual
c525-page Microcomputer Component Data Book
c25-page Z80 Micro Reference Manual (pocket size)
c130-page Microcomputer Systems Data Book
c450-page Memory and Designers Guide

c50-page Finite State Fantasies (Cartoons putting programming on human level) (Matrix Press)	£2.00
c225-page Home Computers: 2[10] Questions and Answers. Vol. 1: Hardware by Rich Didday (Dilithium)	£5.70
c175 page Home Computers: 2[10] Questions and Answers. Vol. 2: Software by Rich Didday (Dilithium)	£4.95
c175 page Home Computers: Beginners Glossary and Guide by Miller and Sippl (Dilithium)	£4.95
c104 page 8080 Machine Language Programming for beginners, by Ron Santore (Dilithium)	£4.95
c225 page Understanding Computers by Paul Chirlian (Dilithium)	£6.50

COMPUTER BOARDS

The following is an extract from our leaflet ref. 'MP4', which is available free on request (a 9" x 6" SAE helps, but is not essential). See Microprocessor section to the right for board prices.

For many people the wide choice of micro-processors now available presents a difficult choice. To understand any particular microprocessor in depth a development system is almost essential, however in the past to understand more than one several separate development systems have had to be purchased.

The reason that separate systems, one for each processor, have been necessary is due to the fact that individual microprocessors have their own individual features: in one case to access memory a separate read strobe and write strobe is required, in another a 'read/write' line is used in combination with a combined strobe called 'valid memory address and phi-2'. With some processors, the same address bus can be used for both memory and 'input/output ports', under the control of a 'memory request' or an 'input/output request' control line.

Naturally, if a development system takes advantage of any of the particular unique features of any particular microprocessor, this makes it more difficult to graft some other unrelated microprocessor onto the same bus at a later date.

A Universal Micro System provides a basic bus structure on which any one micro-processor can be connected. The system uses a CPU (Central Processor Unit) card which is separate from the rest of the system, and this allows the same memory and interfaces to be retained when a different MPU is used.

The basic system bus consists of data and address buses together with read and write strobes. By locating the data input (Keyboard) and output (VDU) in the memory space then such chips as the 8080/Z80 family, which normally use input/output ports, can now be used without any fundamental change to the bus (and as a bonus, users of these MPU's have all the ports entirely free for their own purposes).

The range of p.c.b.'s includes boards to implement a memory-mapped VDU, cassette interface, keyboard interface, PROM programmer, and a number of RAM and ROM cards. All the cards are of International Size 114 x 203 mm (4½" x 8") except for the larger power PSU A power supply card. This latter card is sized so that it can be bolted to the side of a standard 4" chassis module which is then compatible with the other cards. The cards have a standard 43-way edge connector, with one position used for polarisation.

We do not propose to defend the (relatively) small number of bus connexions (42), against such standards as the 'S100' 100-position bus. The S-100 bus, as it originated in America, is bigger and better. It [illegible] more expensive. In the same way, a Ford 'Granada' is bigger and [illegible] Ford 'Cortina', but it doesn't mean a Cortina isn't good val[illegible] [illegible]lows — it may even be better value!

The International Size [illegible] [illegible]ist '3U' 19" rack systems. These [illegible] [illegible]and a variety of modules [illegible] [illegible]ustomising their own [illegible] [illegible]s the firm 'R.S. [illegible] [illegible]culty.) [illegible] [illegible]t to compete [illegible] [illegible]he purchaser [illegible] [illegible]d) assembly [illegible] [illegible]e computer [illegible] [illegible]s virtually [illegible]

[illegible] [illegible]ent. You [illegible] [illegible]s will be [illegible] [illegible]e's, or [illegible] [illegible]es not [illegible] [illegible]ere to [illegible] [illegible]your [illegible] [illegible] As menti[illegible] [illegible]the design o[illegible] [illegible]ble arrangeme[illegible] [illegible]le obsolete ov[illegible] have been pr[illegible] pattern which [illegible] Often these ca[illegible] decoding. An e[illegible] regulator, or ga[illegible] [illegible]east' and 'Input/Output R[illegible] [illegible]ues not already have this facility.

Of course we know [illegible] [illegible]o would faint clean away at the thought of cutt[illegible] [illegible]s, adding extra integrated circuits and bits of wire in th[illegible] [illegible] above, but it is not for these people that this sort of system ha[illegible] [illegible]signed. We would like to think of this system as basis on which you can build your own personal design, perhaps as an alternative to the use of 'Veroboard' or etching your own pcb's.

(Further sections give an outline of each card in turn. Although we have in mind all sorts of exotic future developments (e.g. high resolution graphics, floppy disc controllers, dynamic high-density RAM cards, programmable VDU formats, colour displays, Light pens, sound generators etc.) we prefer to keep quiet about them until they actually exist. All of the cards described actually exist, and at the time of writing (September 1979) most are in stock. (We plan it so they are all in stock, but people will insist on buying them, without caring what havoc they wreak in our stock control!)

NEW! 'ISBUS-1.1'

Low-cost commercial quality computer back board, 13" x 4 3/8" approx, for the International Standard (114×203mm) cards. Although intended for the 86-way double sided connector, it can be used with the 43-way connector specified for the computer boards we advertise. (Pin 37 is used for polarisation.) Takes up to 13 cards on 1" centres, and provides for 4 power rails, 58 parallel address/data etc. bus lines and 3 'daisy chains'. Epoxy glass, tinned, price £11.50 More details in our free leaflet 'ISB-1/1'.

MICROPROCESSORS

COMPUTER BOARDS
114 x 203 mm fibreglass, with gold plated edge connector.

Buffered SC/MP CPU	£7.95
SC/MP Protoboard	£5.95
Z80 CPU card	£7.50
VDU 'A' (set of three)	£7.50
VDU 'B' (set of three)	£7.50
VDU 'G' (set of three)	£7.95
EPROM Programmer (2708s)	£7.95
4k PROM board (5204s)	£5.95
8k PROM board (2708s)	£7.95
2k RAM board (2102s) 1K-2K	£7.95
8k RAM board (2114s) 1K-8K	£7.95
TAPE interface	£7.50
Keyboard interface	£7.50
PSU 5v, +12v, −12v board	£7.50
PSU 5v, −12v board	£4.95

Further details on request

Z80

Z80 CPU (2½MHz)	£9.00
Z80-CTC (2½MHz)	£5.95
Z80-PIO (2½MHz)	£6.00

(Add £1 for the 4MHz version of any of the above 3 chips.)

SC/MP II RAM I/O

SC/MP II (4MHz)	£8.82
INS 8154 RAM I/O	£8.10

6800

6800 MPU	£6.96
6802 MPU	£9.86
6810 (128 × 8 RAM)	£2.97
68A10 (128 × 8 RAM)	£3.75
6820, 6821 PIA	£3.96
6850 ACIA	£3.00
MC6880	£2.64

6502

6502	£12.00
6520 PIA	£6.22

CMOS

COSMAC 1802CE	£9.85
COSMAC CDP 1802E	£10.85
CDP 1864	£7.25

STATICS (Mostly 450nS)

2101—256 x 4	£2.25
21L02—1K x 1	£1.20
2111—256 x 4	£1.75
2112—256 x 4	£2.25
2114—1K x 4	£4.38
21L14—1K x 4	£5.50
4118—1K x 8 (2708 Compatible)	£18.50

DYNAMICS

MK 4027 4K 250nS	£3.50
MK 4116 16K 250nS	£6.95
MK 4816 2K x 8	£30.52

UV ERASABLES

5204 ½K x 8	£10.50
2708 1K x 8	£6.75
L716/2516 2K x 8 single 5v	£23.50
2532 4K x 8 (5v)	£47.00

PROMWASHING each Prom 50p (+30p +VAT)

UV PROM ERASER

UV140	£61.20
UV141	£77.70

INTERFACE

81LS95/6/7/8	£1.25
75491 LED driver	50p
75492	82p
ZN425	£3.95
8T26	£2.64

MOSTEK VDU BOARD

VAB-2	£125.00

CRT Controller: Uarts

Thompson CSF SF.F96364E	£11.50
AY-5-1013 UART TR 1602	£4.00
AY-5-1013A	£4.70
AY-3-1014A	£5.00
AY-3-1015	£5.00

CHAR. GEN. KEYBOARD ENCODER

MCM 6571/4/5/6	£9.50
MCM 66760	£9.75
MK 5302	£15.29
RO-3-2513 (5v Uppercase)	£6.95
DM 8678 CAB/BWF	£14.27
AY-5-2376	£9.75

FIRMWARE

2K Tiny Basic for Z80 (2 x 2708)	£25
4K NIBL in 4 x 2708	£55
NIBL-MM in 4 x 2708	£55
ETIBUG 1 in 5204	£14.95
ETIBUG 2 in 5204	£14.95
KITBUG (1 x 5204)	£14.95
MIKBUG 60-7	£13.70
KITBUG MM (1 x 2708)	£19.95
SC/MP Utilities (1 x 2708)	£19.00

VOLTAGE REGULATORS

7805	75p
7905	£1.00
7812	97p
7912	£1.00
LM 323K	£5.61

74LS

74LS00	14p	74LS27	28p	74LS76	40p	74LS125	60p	74LS163	£1.18	74LS240	£2.36	74LS283	£1.92	74LS375	£1.60
74LS01	14p	74LS28	48p	74LS78	40p	74LS126	60p	74LS164	£1.14	74LS241	£2.32	74LS290	£1.28	74LS377	£2.12
74LS02	16p	74LS30	22p	74LS83	£1.15	74LS132	95p	74LS165	75p	74LS242	£2.32	74LS293	£1.28	74LS378	£1.84
74LS03	16p	74LS32	27p	74LS85	£1.18	74LS136	55p	74LS166	£2.26	74LS243	£2.32	74LS295	£1.85	74LS379	£2.15
74LS04	16p	74LS33	39p	74LS86	43p	74LS138	85p	74LS170	£2.88	74LS244	£1.70	74LS298	£1.68	74LS384	86p
74LS05	20p	74LS37	39p	74LS90	60p	74LS139	85p	74LS173	£1.05	74LS245	£2.70	74LS324	£2.40	74LS386	86p
74LS08	22p	74LS38	39p	74LS91	£1.04	74LS145	£1.08	74LS174	£1.06	74LS247	£1.90	74LS325	£2.90	74LS390	£2.30
74LS09	22p	74LS40	28p	74LS92	89p	74LS147	£1.70	74LS175	£1.10	74LS248	£1.90	74LS326	£2.94	74LS393	£2.30
74LS10	20p	74LS42	98p	74LS93	89p	74LS148	£1.73	74LS181	£3.98	74LS249	£1.90	74LS327	£2.86	74LS395	£2.18
74LS11	22p	74LS47	90p	74LS95	£1.16	74LS151	96p	74LS183	£2.98	74LS251	£1.34	74LS347	£1.48	74LS396	£2.15
74LS12	23p	74LS48	£1.20	74LS96	£1.16	74LS153	76p	74LS190	£1.40	74LS253	£1.42	74LS348	£1.86	74LS398	£2.76
74LS13	38p	74LS49	£1.20	74LS107	44p	74LS154	£1.70	74LS191	£1.40	74LS257	£1.10	74LS352	£2.28	74LS399	£2.30
74LS14	75p	74LS51	24p	74LS109	55p	74LS155	96p	74LS192	£1.30	74LS258	£1.46	74LS353	£2.28	74LS445	£1.50
74LS15	30p	74LS54	28p	74LS112	55p	74LS156	96p	74LS193	£1.30	74LS259	£1.60	74LS365	65p	74LS447	£1.44
74LS20	20p	74LS55	30p	74LS113	50p	74LS157	76p	74LS194	£1.66	74LS261	£4.50	74LS366	65p	74LS490	£1.80
74LS21	22p	74LS63	£1.50	74LS114	50p	74LS158	96p	74LS195	£1.36	74LS266	52p	74LS367	65p	74LS668	£1.82
74LS26	48p	74LS73	46p	74LS122	70p	74LS160	£1.28	74LS196	£1.00	74LS273	£2.44	74LS368	66p	74LS669	£1.82
		74LS74	41p	74LS123	70p	74LS161	98p	74LS197	£1.00	74LS275	£2.50	74LS373	£1.80	74LS670	£2.48
		74LS75	48p	74LS124	£1.80	74LS162	£1.33	74LS221	96p	74LS279	66p	74LS374	£1.95		

HEATER CONTROL

A hyper-efficient circuit that can be used to give automatic precision control of any electric heater unit with a power rating not exceeding 3 kW. The unit can maintain room temperatures to within 0.5 C of a pre-set value

This unusual project is designed to impart automatic precision electronic control or regulation to virtually any electric convector or radiant bar heater with a power rating not exceeding 3kW. The heater is simply plugged into the electronic controller, which uses a remotely-mounted sensor/control unit to sense room temperature. The circuit can maintain the room temperature within 0.5° C of a pre-set value. Desired temperatures can be pre-set via the sensor/control unit.

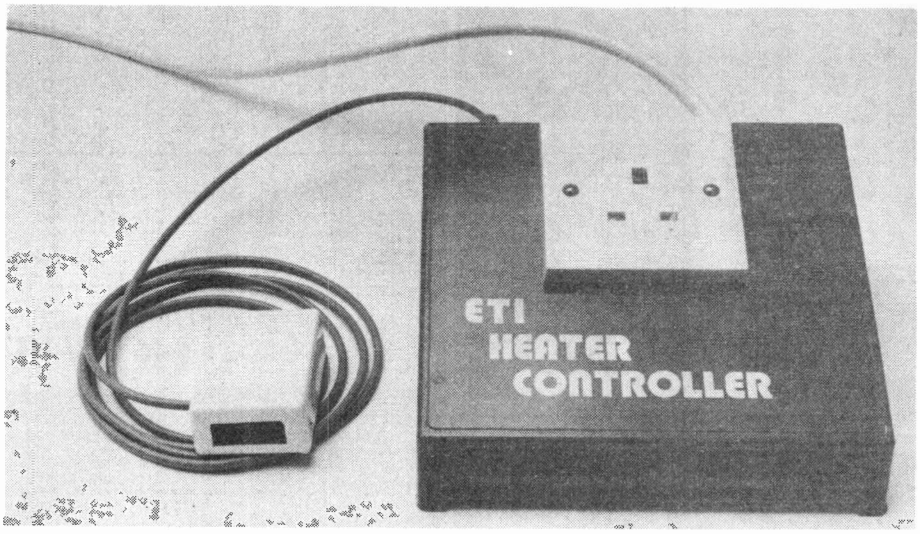
The action of the ETI controller is such that, when first activated, it turns the heater on at full power until the room temperature rises to within a degree or two of the desired temperature and then progessively reduces the heater power output until the precise desired temperature is attained. From that point on, the controller maintains the room temperature within 0.5°C or so of the desired value and automatically adjusts the heater power output so that it exactly balances the thermal losses of the room: if an additional person enters the room, the controller reduces the heater output by an amount equal to that person's radiant body heat, thereby maintaining a thermal balance.

Zero RFI

Conventional thermostat-controlled electric heaters suffer from two major defects. First, their crude on/off electro-mechanical switching action gives poor thermal regulation and causes room temperatures to vary in a repeating series of thermal over-shoots and under-shoots. Secondly, because the thermostat switching action is not synchronised to the mains frequency, the thermostat causes high switch-surge currents to be generated and generates a high level of RFI (radio-frequency interference).

The ETI controller, by contrast, uses a solid-state mains-synchronised triac to switch up to 2kW of mains power to the heater. The switching action is synchronised to the 'zero crossover' points of the mains cycles and consequently causes virtually zero RFI generation. The triac is controlled via a thermistor proportional or 'burst fire' control circuit which enables the mean power output of the heater to be infinitely varied between zero and maximum and thereby enables the temperature to be regulated with negligible over-shoot or under-shoot.

The complete control unit uses only a handful of components, including two ICs and the triac. It can be built in an evening, at a total cost of about £15, including the case and 13A output socket.



Construction

Construction should present few problems. The unit uses two PCBs. The small board holds the remotely-located RV1-TH1 sensor/control components. All remaining components are mounted on the larger board, which is housed in the main units case. The 2N5574 triac is fixed to a large (64mm x 100mm) heat sink which is bolted directly to the PCB. The two ICs are mounted in suitable holders. The completed PCB is bolted to the case base-plate via stand-off insulators.

The remotely-located sensor/control board is mounted in a small (25mm x 50mm x 72mm) plastic Vero 'potting' box, which can be fixed in a suitable location via sticky-pads. The lower end of the box must be cut away to allow air to reach the temperature-sensing thermistor. A small hole should be drilled in the front of the case to allow screwdriver access to the RV1 'set temperature' pot.

On our prototype, we used a 3-pin DIN socket to connect the sensor unit to the main unit. You can use direct wiring if you prefer. When you complete the interwiring of the unit, remember to use adequately rated cables and plugs and sockets: the unit is intended to carry up to 13 amps of mains current!

Note that there is no need to fit the unit with fuses or on/off switches, as these should already be provided via your mains plug and socket. If the triac does short-circuit, the heater will simply lock on and no sigificant damage will be done.

Using the Unit

When construction is complete, plug ▶

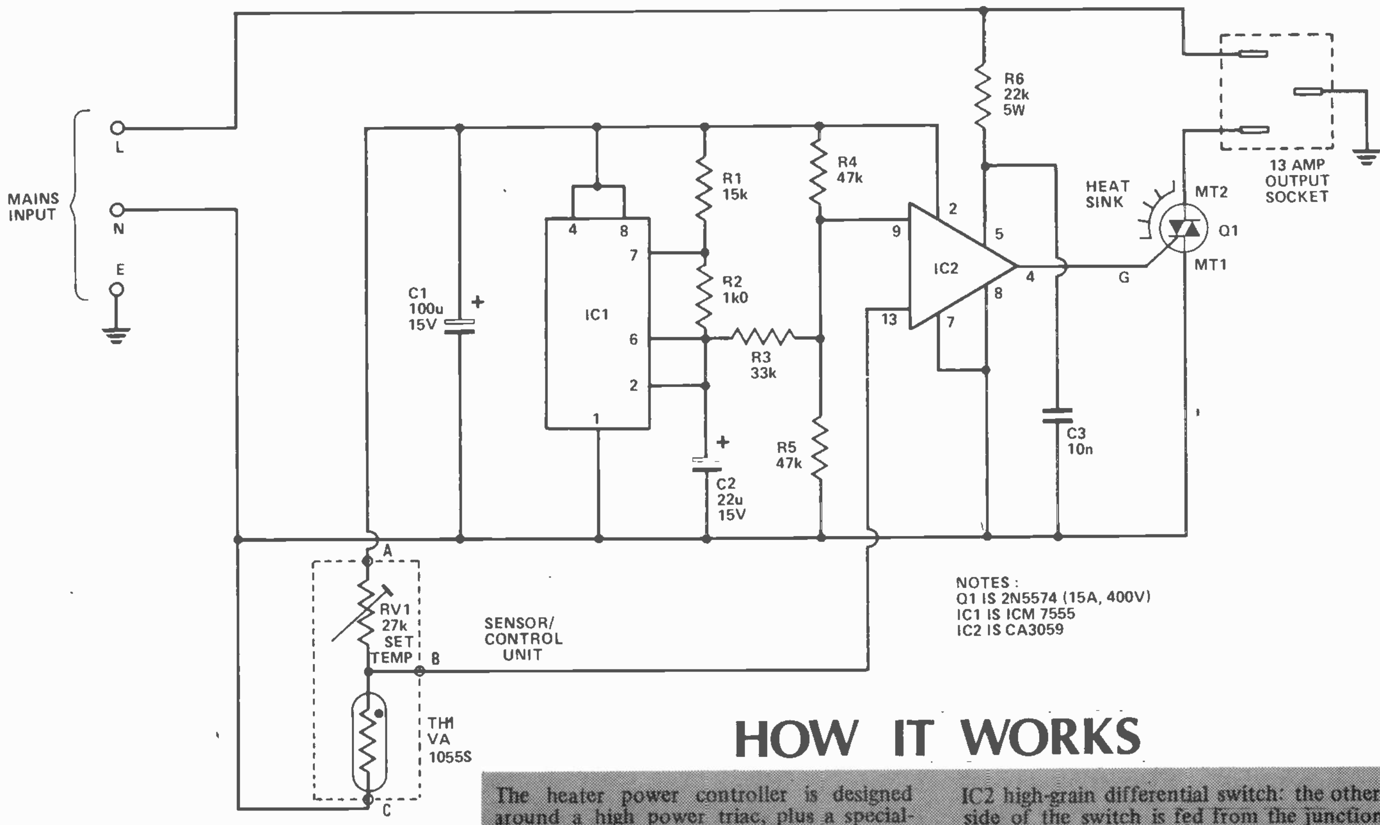


Fig. 1. Circuit diagram of the heater controller and remote sensor unit.

a heater into the unit, plug the unit into the mains and give the unit a functional check: if possible, temporarily wire a lamp in parallel with the heater, as this will give you a visual indication of the functional operation. Adjust RV1 and check that the heater/lamp load can be turned on and off via the preset pot. When RV1 is set to a value corresponding with the prevailing ambient temperature, power should pulse to the load at the timebase rate and the heater output should set to some value below maximum. If this action is obtained, the circuit is functioning correctly and you can complete the installation of the system.

When you install the system, be sure to fit the sensor/control unit in a position away from draughts and local sources of heat. Set RV1 by trial and error so that the heater produces a reduced output at the desired room temperature. If your heater is provided with its own thermostat, set the thermostat to maximum.

If your heater is fitted with a built-in lamp, you'll find that an annoying 'pulsing' action occurs as the heater power is regulated. You can overcome this problem by either disconnecting the lamp or providing it with an independent connection to the mains input terminal of the controller unit. ETI

HOW IT WORKS

The heater power controller is designed around a high power triac, plus a special-purpose IC known as a 'zero-voltage switch' and a CMOS version of the well known 555 timer IC.

The electric heater is wired in series with a high power triac, which acts as a solid-state high-speed bidirectional power switch which can be turned on via it's gate terminal: the triac turns off automatically at the end of each mains half-cycle. When the triac is turned on it self-latches for the remaining duration of the half cycle: the triac can thus be turned on via a very brief gate pulse. In our circuit, the triac is either not turned on at all or is turned on only at the very beginning of a mains half cycle (when the instantaneous mains current is near-zero), thus ensuring that very low switching (transient) currents are drawn from the mains, with consequently negligible switching RFI.

This switching action is obtained via IC2, which incorporates a mains zero-crossing detector which drives the triac via a 2-input AND gate/driver network which ensures that the triac is gated on only when the instantaneous mains voltage is close to zero and a GO signal is present on the other terminal of the AND gate. The GO signal is derived from a high-gain differential switch, which is also built into IC2. This IC also contains a DC voltage regulator that draws power from the mains and generates a stable 6 volt DC output that can be used to power internal and external circuitry.

We use the 6 volt DC supply of IC2 to power a ramp (timebase) generator, designed around a CMOS 555 timer (IC1), which has it's output fed to one side of the IC2 high-grain differential switch: the other side of the switch is fed from the junction of potential divider RV1-TH1. TH1 is a carbon rod thermistor and is used to sense the room temperature.

When the room temperature is more than a degree or so below the pre-set value, the DC bias level (level 1) from RV1-TH1 is permanently above the ramp level. Under this condition the output of the differential switch is permanently high and a gate signal is fed to the triac at the start of each mains half cycle, thus causing the triac at the start of each mains half cycle, thus causing the triac and heater to be switched on for the duration of each ramp or timebase cycle.

As the room temperature rises, the DC bias level from RV1–TH1 interrupts the ramp waveform and the differential switch output goes low and cuts off the triac for part of each timebase cycle. Since the timebase period is short (a few hundred milliseconds) compared to the thermal time constant of the heater (several seconds), this action causes the mean output power (integrated over several seconds) of the heater to decrease linearly as the room temperature rises. In practice, a thermal negative feedback loop is set up by the circuit and eventually causes the heater output to adjust to a level that exactly balances the thermal losses of the room, thereby maintaining the room temperature within a typical accuracy of 0.5°C.

If the room temperature does rise above the pre-set level, the DC bias level falls permanently below the ramp level and under this condition the triac and heater are cut off for the full duration of each timebase cycle.

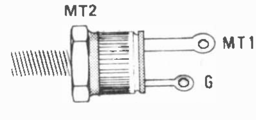


Fig. 2. Q1 outline

PARTS LIST

Resistors

R1	15k
R2	1k0
R3	33k
R4,5	47k
R6	22k 5W

Potentiometers

RV1	22k 0.25W horizontal preset
TH1	VA1055s

Capacitors

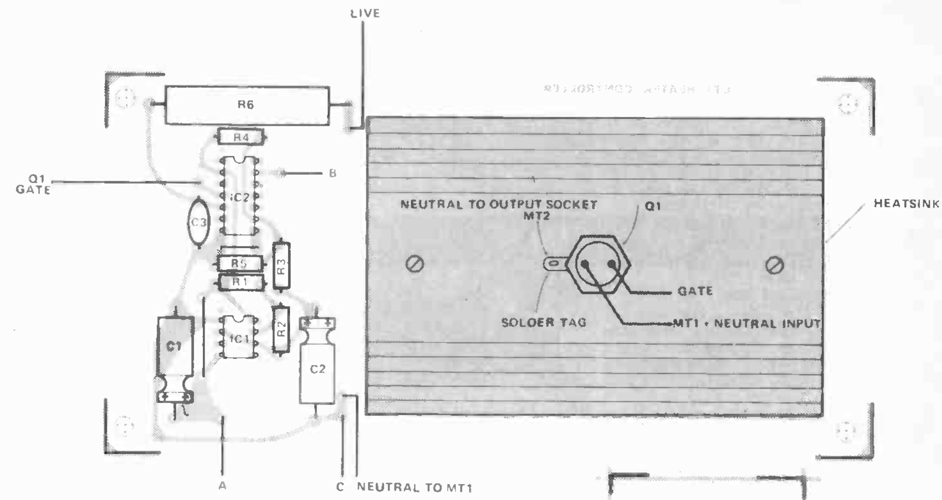
C1	100u 25V electrolytic
C2	22u 25V electrolytic
C3	10n polyester C280

Semiconductors

IC1	ICM7555
IC2	CA3059
Q1	2N5574 (15A 400V)

Miscellaneous

13A MK socket, 3pin plug + socket, ½" grommet, ¼" grommet, Vero potting box order code 202-21025K heatsink 100mm x 65mm.



BUYLINES

The case chosen for the Heater Power Controller was obtained from CSC Ltd (see below for address), order as DMC–1.

The CA3059 IC can be purchased from Marshall's, all other components used are readily available from major stockists that advertise in this issue.

CSC (UK) Limited,
Shire Hill Industrial Estate,
Saffron Walden, Essex CB11 3AQ
Phone (0799) 21682.

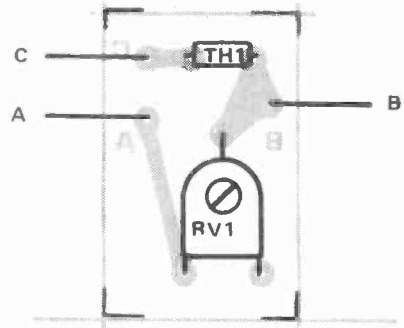
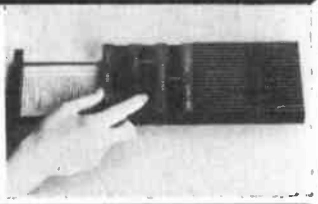


Fig. 3a (top) Component overlay of main control unit.
Fig. 3b (above) Component overlay of remote sensor.

24 TUNE DOOR CHIMES

DOOR TUNES £17.13 + VAT

Waddington's Videomaster announce a doorbell that doesn't go Brrringgg, Ding-Dong or Bzzzzz. Instead it plays 24 different classical and popular tunes. It will play the tune you select for your mood, the season or the visitor you are expecting to call. Door tunes is not only great fun and a wonderful ice breaker, but is also very functionally and beautifully designed to enhance your home. There is something for Christmas, something for your continental visitors or your relations from the states, and even something for the Queen. Door tunes is easy to install and has separate controls for volume, tone and tempo.



T.V. GAMES

PROGRAMMABLE £29.50 + VAT.
COLOUR CARTRIDGE T.V. GAME.

The TV game can be compared to an audio cassette deck and is programmed to play a multitude of different games in COLOUR, using various plug-in cartridges. At long last a TV game is available which will keep pace with improving technology by allowing you to extend your library of games with the purchase of additional cartridges as new games are developed. Each cartridge contains up to ten different action games and the first cartridge containing ten sports games is included free with the console. Other cartridges are currently available to enable you to play such games as Grand Prix Motor Racing, Super Wipeout end Stunt Rider. Further cartridges are to be released later this year, including Tank Battle, Hunt the Sub and Target. The console comes complete with two removable joystick player controls to enable you to move in all four directions (up/down/right/left) and built into these joystick controls are ball serve and target fire buttons. Other features include several difficulty option switches, automatic on screen digital scoring and colour coding on scores and balls. Lifelike sounds are transmitted through the TV's speaker, simulating the actual game being played.
Manufactured by Waddington's Videomaster and guaranteed for one year.

EXTRA CARTRIDGES:

ROAD RACE – £8.87 + VAT.
Grand Prix motor racing with gear changes, crash noises

SUPER WIPEOUT – £9.17 + VAT.
10 different games of blasting obstacles off the screen.

STUNT RIDER – £12.16 + VAT.
Motorcycle speed trials, jumping obstacles, leaping various rows of up to 24 buses etc.

NON-PROGRAMMABLE TV GAMES

6 Game – COLOURSCORE II – £13.50 + VAT.

10 Game COLOUR SPORTSWORLD £22.50 + VAT.

CHESS COMPUTERS

STAR CHESS – £56.09 + VAT.
PLAY CHESS AGAINST YOUR PARTNER.

using your own TV to display the board and pieces. Star Chess is a new absorbing game for two players, which will interest and excite all ages. The unit plugs into the aerial socket of your TV set and displays the board and pieces in full colour (or black and white) on your TV screen. Based on the moves of chess. It adds even more excitement and interest to the game. For those who have never played, Star Chess is a novel introduction to the classic game of chess. For the experienced chess player, there are whole new dimensions of unpredictability and chance added to the strategy of the game. Not only can pieces be taken in conventional chess type moves, but each piece can also exchange rocket fire with its opponents. The unit comes complete with a free 18V mains adaptor, full instructions and twelve months guarantee.

CHESS CHALLENGER 7 – £85.65 + VAT. →
PLAY CHESS AGAINST THE COMPUTER.

The stylish, compact, portable console can be set to play at seven different levels of ability from beginner to expert including "Mate in two" and "Chess by mail". The computer will only make responses which obey international chess rules. Castling, on passant, and promoting a pawn are all included as part of the computer's programme. It is possible to enter any given problem from magazines or newspapers or alternatively establish your own board position and watch the computer react. The positions of all pieces can be verified by using the computor memory recall button.
Price includes unit with wood grained housing, and Staunton design chess pieces. Computer plays black or white and against itself and comes complete with a mains adaptor and 12 months guarantee.

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ELECTRONIC CHESS BOARD TUTOR
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A special bulk purchase of these amazing chess teaching machines enables us to offer them at only £19.75 less than half recommended retail price. The electronic chess tutor is a simple battery operated machine that can actually teach anyone to play chess and improve their game right up to championship level. This machine is not only for total beginners but also for established players wanting to play better chess. Unit contains the electronic chessboard with 32 chess pieces, a 64 page explanatory booklet and a set of 32 progressive programme cards including 6 beginners cards, 16 check mate positions, 9 miniature games, 5 openings, 3 end games, 28 chess problems and 2 master games.

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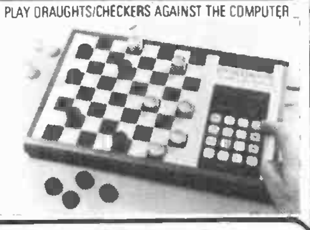
CHECKER CHALLENGER 2 LEVELS £43.00 + VAT
4 LEVELS £78.00 + VAT

The draughts computer enables you to sharpen your skills, improve your game, and play whenever you want. The computer incorporates a sophisticated, reliable, decision-making microprocessor as its brain. Its high level of thinking ability enables it to respond with its best counter moves like a skilled human opponent. You can select offence or defence and change playing difficulty levels at any time. Positions can be verified by computer memory recall. Machine does not permit illegal moves and can solve set problems. Computer comes complete with instructions, mains adapator and twelve months guarantee.

PLAY DRAUGHTS/CHECKERS AGAINST THE COMPUTER



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TELEVISION SOUND

Rick Maybury takes the back off his telly (and his life in his hands) for ETI to give a few hints on improving TV sound

There was a rumour some years ago that one of America's top Hi-Fi manufacturers was using old television loudspeakers instead of fancy new ones in their systems. That actually makes some sense when you consider the amount of use the average telly speaker gets. The cone tends to lose its stiffness and enables it to cover a greater range of frequencies. Whether you believe this or not, one fact is beyond dispute. The TV speaker is probably the most 'used' speaker in any piece of household audio.

It is, therefore, surprising to consider that the circuitry devoted to handling audio frequencies within a TV set and the speaker that produces the sound was up to only a few years ago (and still is with some manufacturers) actually considered a nuisance. In the ideal world of the TV set designer there would be no sound. This is perhaps best illustrated by the speakers used. They are deliberately shaped to take up the minimum space. Elliptical speakers on their own may not seem too bad but just consider where they are sited. One manufacturer (who shall remain nameless) actually put it at the back, unable to find anywhere it could be usefully placed. Side facing speakers are not uncommon (even one on the bottom of the cabinet). Within the last five years something of a revolution has been taking place. Tone controls have been spotted on some sets. The growing awareness of the set-maker to the interest in audio have stirred the advertising men, looking for new features to sell their boxes. This has led to some rather dubious claims for quality, so it is perhaps a good time to look at the transmitted signal which, unless someone has managed to do without it, remains the be-all and end-all of the sound that eminates from your telly.

The quality of the transmitted sound is relatively high. The main factor from the broadcaster's point of view is source. The video tape recorder is probably the worst in that respect. The tape used for VTRs is designed for just that. The oxide particles that make up the catering are aligned to optimise the helical scanning of the VTRs recording/playback head. The audio track is usually arranged on the bottom edge of the tape and nearly always recorded in a linear fashion. Because of this the best bandwidth that can be expected will be around 10 kHz.

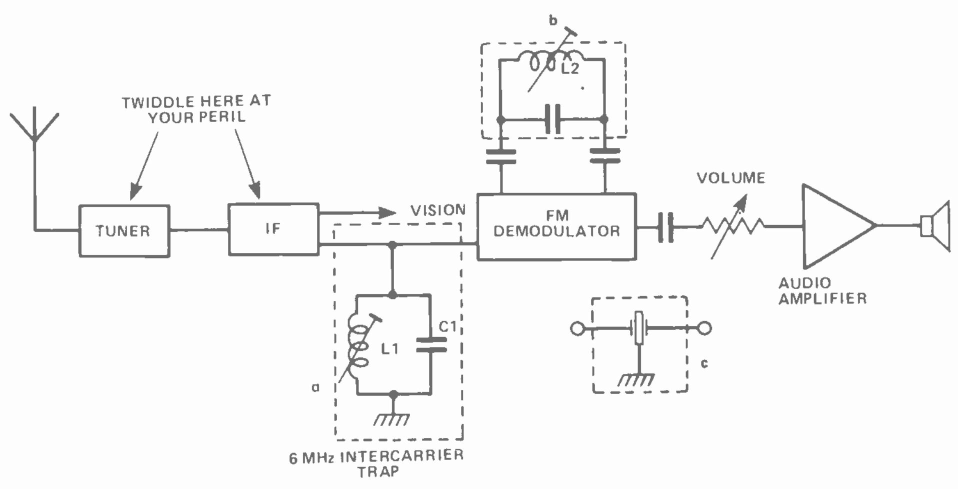
Live broadcasts and telecine material will do a little better, provided that the audio material is carefully handled something like 12 kHz can be expected.

The best quality undoubtedly comes from the 'simulcast' and separate synchronised audio recording. The audio material is recorded quite apart from the video on high quality studio tape recorders. At no time is this material ever allowed to come in contact with lesser machines and in theory at least, will have a bandwidth of something like 18 kHz. What it will be like by the time it comes out of your loudspeaker is another story.

At present there are two methods of transmitting a composite sound and vision signal used in the UK TV system.

The first and most obvious is to send the audio on a slightly different frequency or carrier to that of the video signal. This is the method used for domestic TV broadcasting at the moment. It has the rather glamorous sounding title of Intercarrier Sound. It involves transmitting the FM encoded audio on a carrier 6 MHz above the vision carrier. For instance, channel 21 on band IV — the video is

Fig. 1. Twiddling points within the sound signal path. (a) 6 MHz intercarrier sound trap coil, L1. (b) Balance circuitry for setting up coincidence detector demodulator now widely found on sets using TBA120 sound and IF detector ICs. (c) Ceramic filter sometimes used in place of circuitry around trap L1, C1 — no twiddling possible! Please DO NOT attempt to twiddle anything before the intercarrier trap you will only regret it and that's a promise.



transmitted on a frequency of 471.25 MHz whilst the accompanying audio is to be found on 477.25 MHz. We will deal with Intercarrier Sound demodulation in more detail later on.

The second, less obvious method rejoices under the name of Sound in Sync or SIS. This is not used for normal broadcast transmissions but for transmission of audio between studio and transmitter or relay stations. This is a rather cunning technique utilising the space 'inside' the line synchronisation pulse that occurs at the beginning of every TV line. This pulse is sited at a point on the TV waveform 'below black level'. This means it occurs below a pre-determined voltage at which the TV receiver will recognise it as picture information. The sync pulse lasts for approximately 4.7 microseconds and occurs at a repetition rate of 15.625 kHz (line timebase frequency).

Because SIS occurs in a synchronisation pulse it has to be removed if the signal is to be displayed. Within the studio environment a filter is used to remove SIS for insertion in studio monitors. It is removed at the transmitter prior to encoding into intercarrier sound for normal broadcast.

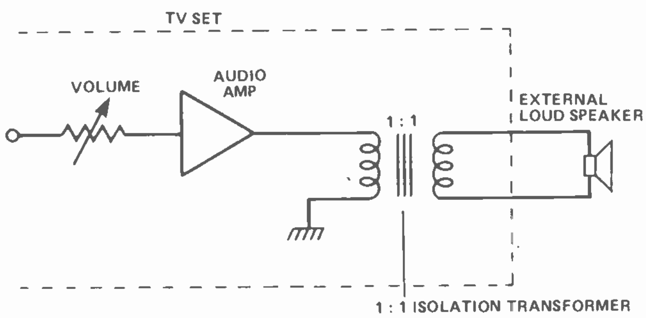


Fig. 2. Connecting an external speaker to a set with a live chassis (see fig. 4). Of course, if the set has an isolated chassis, the transformer is unnecessary and a direct connection may be made. Ensure the replacement speaker matches the impedance and power handling of the original.

Inter Sound

The broadcast sound is FM modulated onto a carrier with an impressive 8 MHz bandwidth. The peak FM deviation, ie the amount by which the signal deviates around the centre frequencies, is 50 kHz. This compares with a 75 kHz deviation on FM sound radio. The sound and vision signals make uneasy bedfellows, even being 6 MHz apart. A variety of problems can arise with these two signals, sharing as they do a great deal of common circuitry within the TV receiver — not the least being intermodulation resulting in a loud irritating buzz, aptly called Intercarrier Buzz.

Those are the bare bones of TV sound. From a critical standpoint the signal that leaves the TV transmitter is rarely the same one as the one coming from the set's loudspeaker.

If it is your wish to improve upon what greets your ears every night you have a problem. Basically you are limited by the original design. You have two courses of action open to you. Firstly you can take it upon yourself to build a complete tuner/IF/demodulator. This is not recommended for the faint of heart. To get round this a couple of enterprising manufacturers have got TV sound tuners on the market. You would be hard pressed to improve upon them, let alone do it as cheaply.

The second, more practical route is to make the best of a bad job and improve upon what you already have.

The first and most obvious problem is perhaps the hardest to cure. That is the initial design. Modern receivers of the last few years have at least made some attempt to demodulate the sound responsibly. If your set is more than five years old — forget it. Proceed to step 2.

Step one. The aerial, the first link between the speaker and the incoming signal must be OK. As a general rule of thumb if the picture looks OK the sound will be. The colour TV is a very good indicator of signal quality being far less forgiving than a monochrome set. Look for noise or snow on the picture. If there is any, get a better aerial/move to an area with better reception/give up and proceed to step two.

The second principle of step one (confusing isn't it?) comes under the heading of alignment. Two symptoms to look for. Number one is intercarrier buzz. No big prizes for guessing how to recognise it. The second symptom of the second principle of step one (Prize for understanding that bit now available from the ETI offices) is called sound on vision. This is not necessarily detrimental to the sound quality but you might as well sort it out whilst you're at it.

Both these maladies point to one thing; poor alignment. The obvious remedy consists of whipping the back off your telly and twiddling the appropriate components. But hold on, which one. Most tellies have forty or fifty presets, coils, trimmers, etc just waiting for the eager, would-be twiddler. The answer here is arm yourself with a manufacturers' service sheet. You will be able to locate the audio section on the diagram quite easily. Just look for the loud speaker, amplifier section and decoder. On a modern colour TV just before the demodulator there will be a trap circuit. This usually consists of an LC network or a ceramic filter. For the sake of sanity DO NOT twiddle anything before this section. You will be entering the realms of IF alignment where only bold men tread, especially if you haven't got a wobbulator. If you have, then you have our deepest sympathy (and why are you reading this anyway because your set should be perfectly aligned?)

Now having located the demodulator/audio section take a deep breath. **First thing to do is check up on your life insurance. Many thousands of volts run around the innards of tellies. Let them run up an errant finger and down your other arm, (the one clutching the gas pipe) and it won't really matter how bad your sound is on your TV set. The only noises you'll be hearing will be the strumming of heavenly harps (If you're lucky).**

Start again, are you sound of wind, limb and brain. Yes? Then look for the vision signal trap. Does it consist of a LC network. If it does, mark the position of the slug relative to the coil, with one eye on a reflected image of the screen (use a mirror in front of the set) and the other on your shaking hand. Twiddle, no more than half a turn either way. Look for any striation on the screen (that's wavy lines). If they disappear back off and try the other way. If on the other hand the picture contorts with the sound coming from the set then go back to the starting point.

To make matters clear, if there is sound on vision this may cure it, it may also cure intercarrier buzz. If nothing changes or gets worse then return the slug to its original position.

Our next twiddle, or first, if you didn't have the first, ▶

should be found around the demodulator circuit. As the sound is FM modulated you may be lucky and have a ratio-detector type decoder. If you have, chances are that there is another twiddle in store.

This time we will be setting up the decoder by ear. There is no practical way round it. Just twiddle and listen, keep looking at the screen, though nothing really terrible should happen. As always, make sure you know the starting point and NEVER twiddle more than half a turn either way. That way at least you should be able to get back to where you started without too much bother.

If neither of these exercises did anything for you, now is the chance for you to proceed to step two. It must be said however that if the sound is still really dreadful your IF stage is probably in need of attention. The only really capable people are the manufacturers themselves. Have a word with your local (friendly) TV serviceman about doing a swap. Most sets in the last few years use modular construction so the IF strip and/or tuner might just unplug and easily substitute for another.

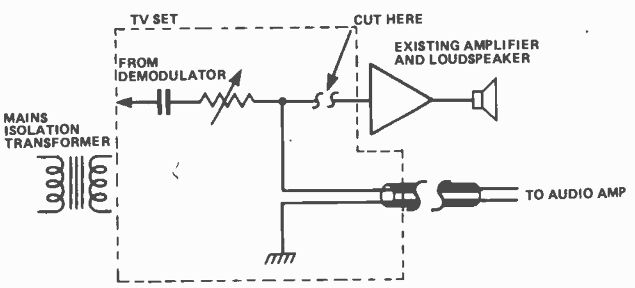


Fig. 3a. By isolating the set with a 1:1 mains isolation transformer, connections to the outside world should be safe. If your set has an isolated chassis, you should be OK.

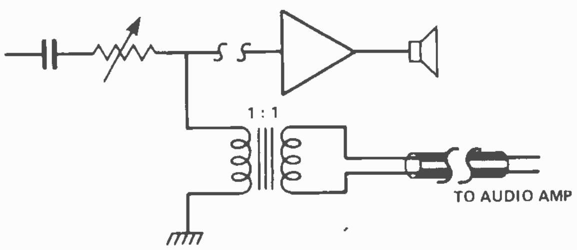


Fig. 3b. Using a 1:1 isolation transformer to prevent nasty shocks. The isolation transformer shown in fig. 4 is, however, the best solution for safe connection.

The Famous Step Two

Step two exists for those of you who are either scared of rooting about in the backof 'live' TV sets or have tried step one without success.

This involves modifications to your set. Two things must be ascertained before you pick up that soldering iron. Firstly, the set must be your own. It's no good trying to tell the man from Radio Rentals that you were trying to improve his set. Be assured something nasty will happen if you do. The second thing to consider is, will I mind if the modifications I am about to make blow my set/house/self/cat up. If you can hold your hand on your heart and still pick up that soldering iron with an easy conscience, then proceed.

As we said earlier, the loudspeakers used in TVs can be particularly nasty items. Why not replace your one with a nice big 12in woofer? It won't fit in the case. Solution, disconnect the existing speaker making notes of impedance, power rating, etc and replace. Problem number one is likely to be the high voltages running around the speaker. Most modern colour sets have a metal chassis at around half mains potential. This is because of the types of power supply used do not employ mains transformers, or, if they do, they are of the auto type with no separate primary and secondary. You have been warned. Let not your fingers touch these wires or you will know all about it. Problem number two with this procedure is called visual/audio image separation. Be sure not to site the speaker too far away from the screen. You will have the disturbing effect of seeing the picture in front of you and the sound coming from one side or another. This is especially irritating when watching Crossroads, as it can appear that Meg Richardson is at the same time on telly and somewhere in your living room. To be avoided at all costs.

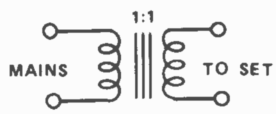


Fig. 4. Recommended method of isolating a TV set with a live chassis. Please note that the transformer should be rated at a minimum of 500 watts for a colour set.

The Step Three Bit

Step three is for the intrepid only. Going back to your trusty manufacturers' diagram, try to locate the point of entry of the audio signal into the audio output stage. Most manufacturers do this around the volume control area. The trick we are about to play here is to take this point, sever the connection between the volume control and the audio stage and introduce it to your expensive hi-fi equipment. The proviso in step two still holds good, but this time add expensive Hi-Fi to the list of things that could be blown up.

Because we still have the live chassis situation, you must first rid the wires coming from your set of any high voltages. A1:1 mains isolation transformer is the only practical answer. Now you have to determine the impedance and level of the signal coming out of the demodulater. There is only one reliable way to do this. Measure the level on a 'scope. Use your judgement for the impedance. Safest bet (though don't blame us if it's not) is to assume it will be a fairly hefty signal and treat accordingly. All being well and nothing nasty happening, place your speakers either side of the telly and switch to Mono. You may be rewarded with a really rich sound, complete with a full set of tone controls. On the other hand you may be left with a smouldering mass of high technology that was the telly and the Hi-Fi. Seriously though, any of these methods outlined here should only be attempted if you have a very good grounding in electronics. **Do not on any account muck around with your set unless you know what you are doing.** If you don't then save up and buy yourself a TV sound tuner and you'll live to read all the complaints about this article next month from irate TV manufacturers. ETI

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ETIPRINTS are a fast new aid for producing high quality printed circuit boards. Each ETIPRINTS sheet contains a set of etch resistant rub down transfers of the printed circuit board designs for several of our projects.

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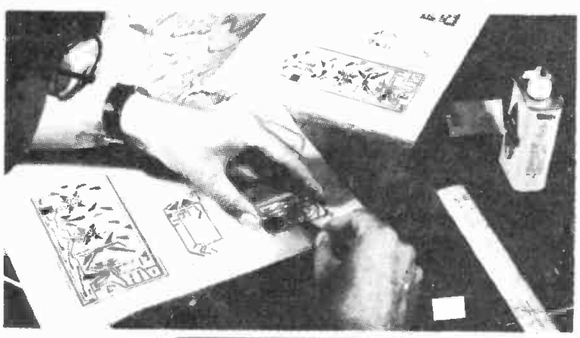
HOW IT WORKS



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METAL LOCATOR

For discriminating treasure hunters, we present the Shadow metal locator from Altek, featuring deep-seeking VLF and discriminating operation.

The design of professional quality metal detectors is a specialist field which up until now the commercial manufacturers have kept very much to themselves. This design incorporates many of the latest techniques in push button VLF discriminators which have hitherto been the subject of well guarded trade secrets. The detector performs as well as commercial models costing over £200.

It uses a ready made search head, as a home-made one would have no hope of giving the results needed for a design of this nature (would you use a home-made speaker with your hi-fi?). The search head from Altek enables depths of over 12" for a single coin to be achieved.

Construction

The use of sockets for IC1 and IC5 is not recommended due to the increased risk of leakage currents in the push button circuitry. C12 is a very critical component. Its value is not too important but it must be of the highest quality, have low dielectric absorption and high resistance. Polycarbonate types were used, but polystyrene would be equally suitable.

To keep the design as tidy as possible 20 way ribbon cable is used to connect the board to the controls. As each colour appears twice they are differentiated by indicating from which side of the ribbon they come — either white or black (the colour of the wire at the edge of the ribbon). Circuit pins are used at all other connection points so that wires can be attached after the board is installed in the case.

Setting Up

When construction is complete and the detector appears to function it is necessary to make sure that the Rx

coil has been properly connected. Due to the way the head is aligned it is not possible to check it until this stage.

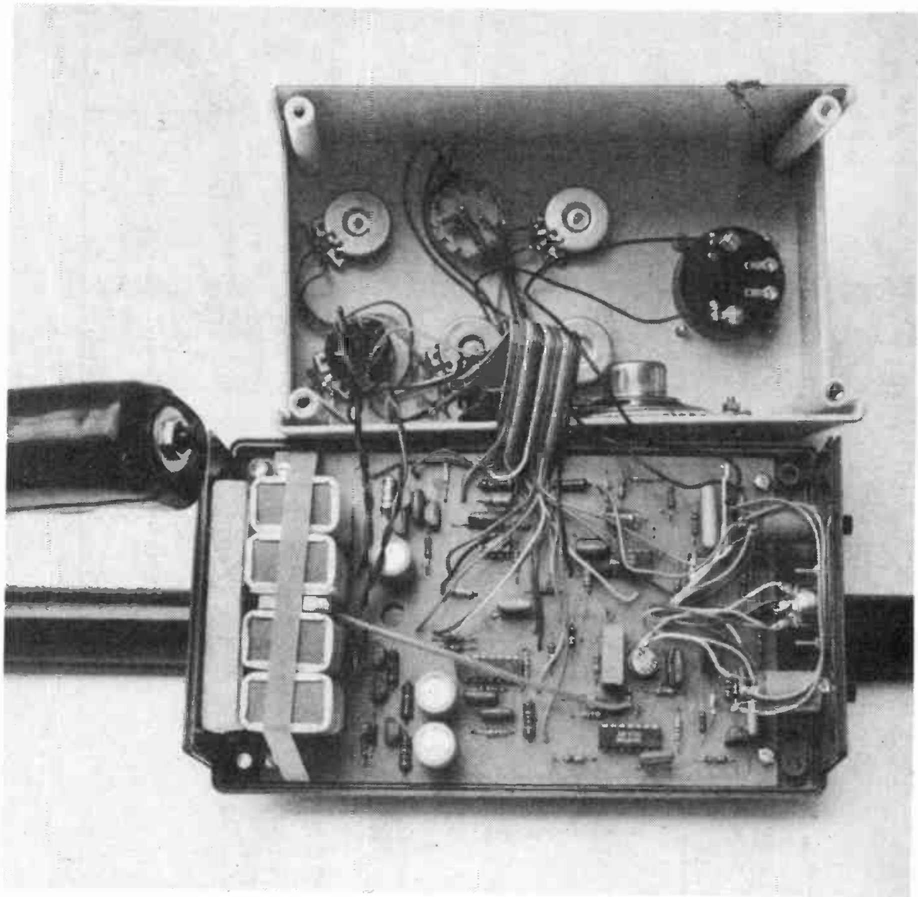
Hold the head away from all metal and set the controls as follows: MODE and GROUND fully anticlockwise. ALL OTHERS at mid-rotation. Depress the tuning button and hold it in, rotate the TUNE control until the meter needle is approx mid scale. Release the button and bring the head close to a metal object — the meter should be deflected to the right. If it goes left, reverse the wires from the Rx coil (see diagram).

Use

Using the detector and interpreting the results is very much a matter of experience but the following notes will help.

Tuning

To adjust, the push button must be depressed. When tuned to your satisfaction release the button. If the tuning point drifts then it can be brought back simply by pushing the button for a second or two. When first switched on the memory retune button will be needed every few seconds but as thermal equalibrium is established it will be needed less often.



Connections from the PCB are taken to the top panel controls by 20 way ribbon cable.

Sensitivity

It is not necessary to set the sensitivity to maximum to achieve the greatest depth. Amplification is so great that a maximum setting may bring on instability. Experiment intelligently with it — mid-rotation is about right.

Ground

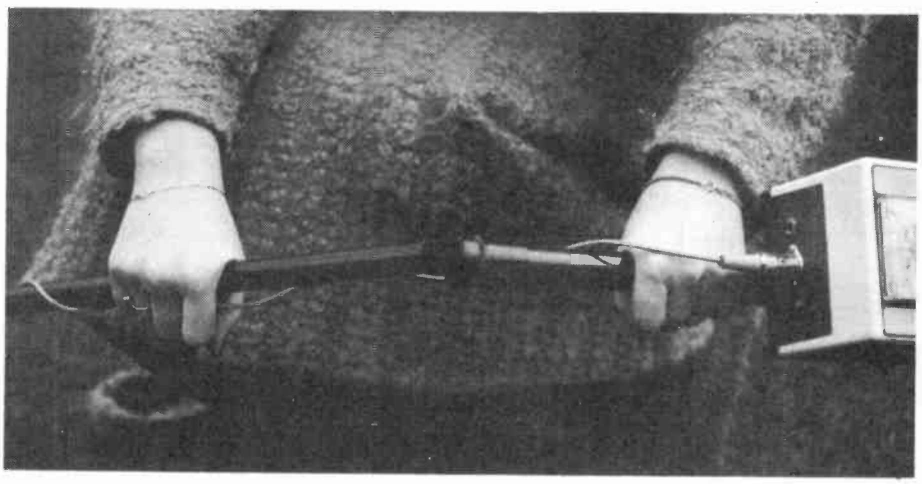
This only works in the VLF mode. Its setting is quite critical. First set the tuning with the head away from the ground. Move the head down to the ground and observe the meter. If it swings left — rotate GROUND clockwise, if it swings right — turn anticlockwise. Hold the head away from the ground and depress the button to reset the tuning. Repeat this procedure until the meter does not deviate when the head is lowered. A slight misadjustment is tolerable but if it is turned too far clockwise the detector will work in "reverse". When VLF is selected the detector is in its most sensitive mode.

Discrimination

It only functions when a TR mode is selected. The degree of discrimination is controlled jointly by the MODE (coarse setting) and the DISCRIMINATION (fine setting) controls. Together they set the point at which the resistance of the target causes a left or right deflection on the meter. The circuit in this design is very good indeed. It is possible to differentiate between a can ring pull and a gold ring, for example. However, the discrimination control reduces sensitivity slightly. It is best to use a detector of this type in VLF mode until a target has been found and then use discrimination to determine its likely value!

Finally we ought to point out that in the UK it is necessary to obtain a licence before using a metal detector. this is not necessary elsewhere. Application forms can be obtained from: Home Office, Radio Regulatory Dept., Waterloo Bridge House, London S.E.1.

▶



No, we haven't broken it. The two-piece shaft is telescopic, accommodating varying altitudes of treasure hunter.

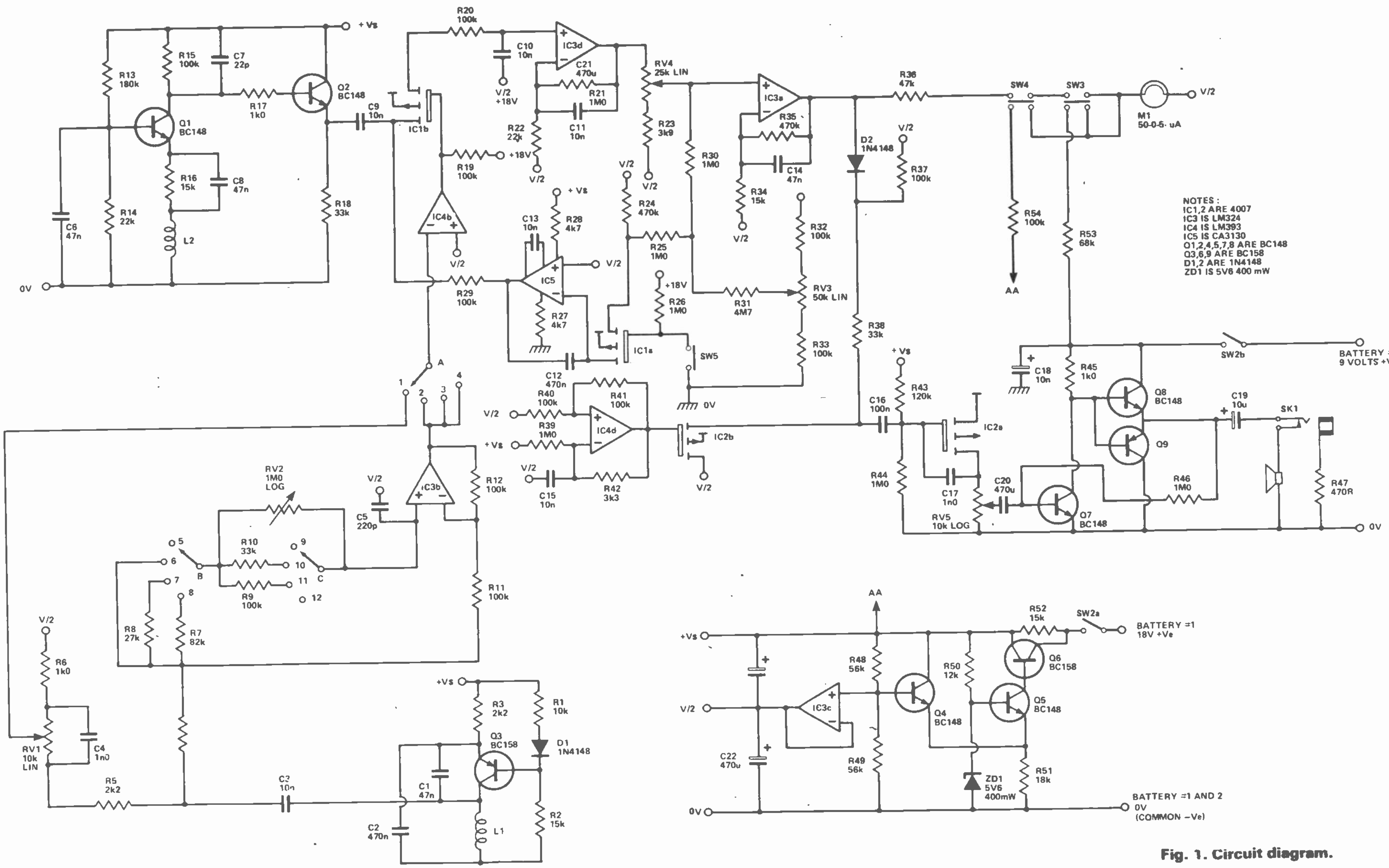


Fig. 1. Circuit diagram.

HOW IT WORKS

L1 and L2 are the Tx and Rx coils in the search head. The signal to drive L1 is produced by Q3 and associated components which generate a sine wave of approx. 16 kHz. Part of this signal passes via C3 to the phase shift section which produces a reference signal for the phase comparator. When the VLF mode is selected, RV1 (ground control) and C4 provide a variable phase advance of 0 - 180.

The suitably modified signal is squared up by the precision voltage comparator IC4b and applied to the gate of the phase comparator IC1b. Meanwhile, the signal picked up by L2 passes through Q1 and Q2 which amplify, but do not distort or shift the phase, and meet the reference signal at IC1b.

The signal emerging from IC1b is a DC signal upon which is superimposed an AC component corresponding to the phase coincidence of the reference and received signals. This is integrated by IC3d and a portion of the emerging DC signal is tapped off by the sensitivity control RV4. This is further amplified by IC3a and applied to the meter and, via D2, to the audio gate IC2b.

Audio is generated by an astable formed from the remaining half of the voltage comparator IC4a and, after being gated by IC2b, is amplified by IC2a, Q7, Q8 and Q9. RV5 is the volume control.

IC5 and IC1a form the heart of the push button tuning system. Part of the voltage from RV4 is added to a voltage determined by the position of the slider of RV3 and applied to the source of IC1a. When the tuning button is depressed, the normally high source to drain resistance falls and allows current to flow through the FET and build up as a voltage across C12. IC5 inverts and buffers the voltage to provide a DC bias for the phase comparator. The change of bias at IC1b in turn affects the DC conditions at IC1a (via IC3d and RV4). In other words a negative feedback loop is established whenever the tuning button is pressed. Within a second or two the new DC levels settle down and the button is released. The system is then maintained by the charge held on C12.

The power supply to the audio section is unstabilised, but due to the sensitive nature of the DC levels in the control section, stabilisation is required there. ZD1 provides a voltage reference for the differential amplifier formed by Q4 and Q5, which control the series pass element Q6. R52 allows a small current to Q4 and Q5 at switch on to ensure that Q6 starts conducting. The base of Q4 must always be at 50% of the stabilised supply (R48 =R49). This point is buffered by IC3c used in the voltage follower mode to source the V/2 supply. C21, C22 and C20 are decoupling components. Special attention has been given to cutting down the current consumption. The control section only takes 5.5 mA and the sudio section less than 2 mA when silent or when using headphones.

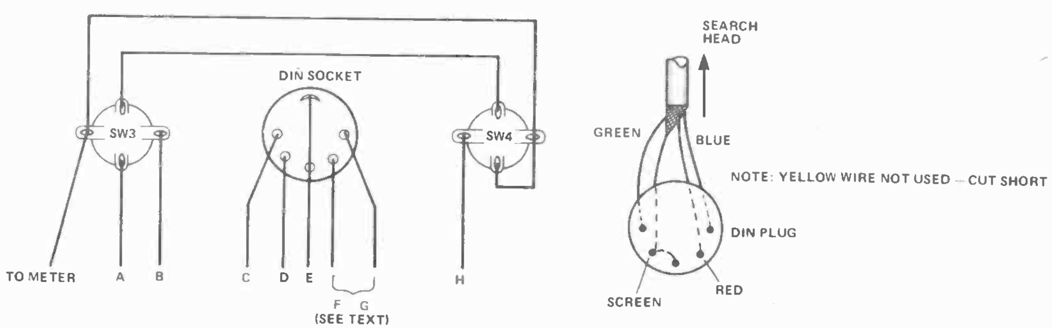
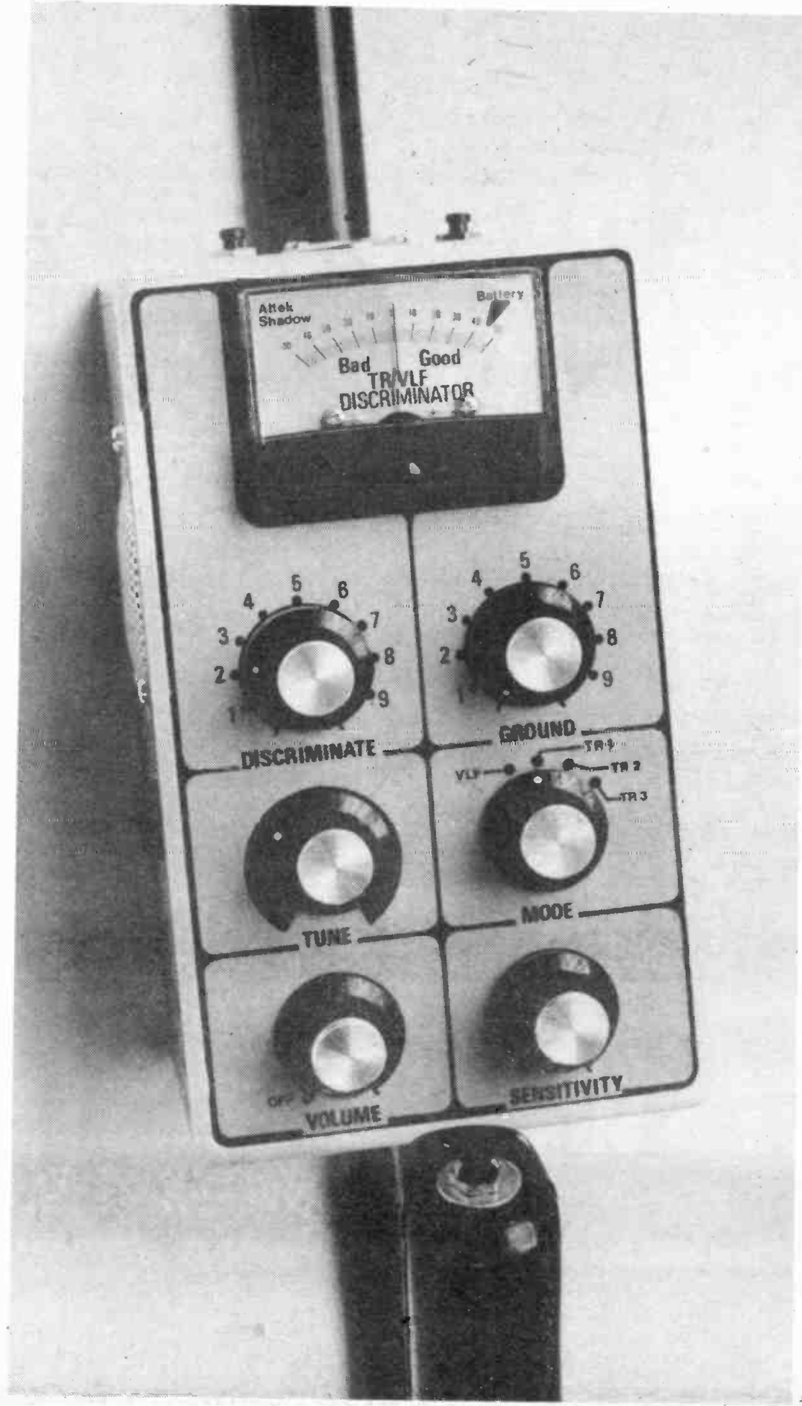


Fig. 2. Connection details for DIN plug and socket and SW3, 4. Note the tag lengths on SW3, 4.



You'll need a driving lesson before you commence twiddling with this control panel.

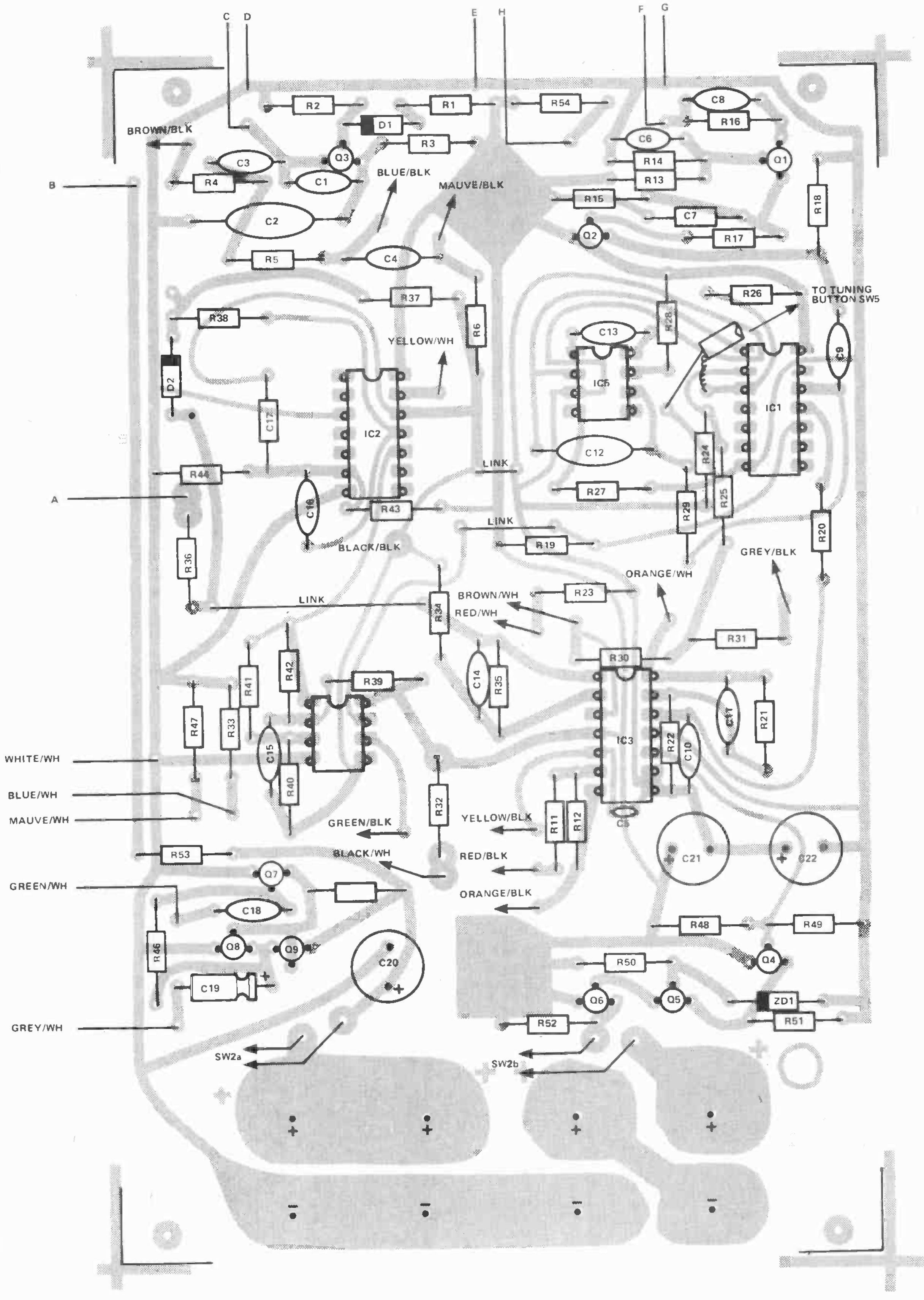
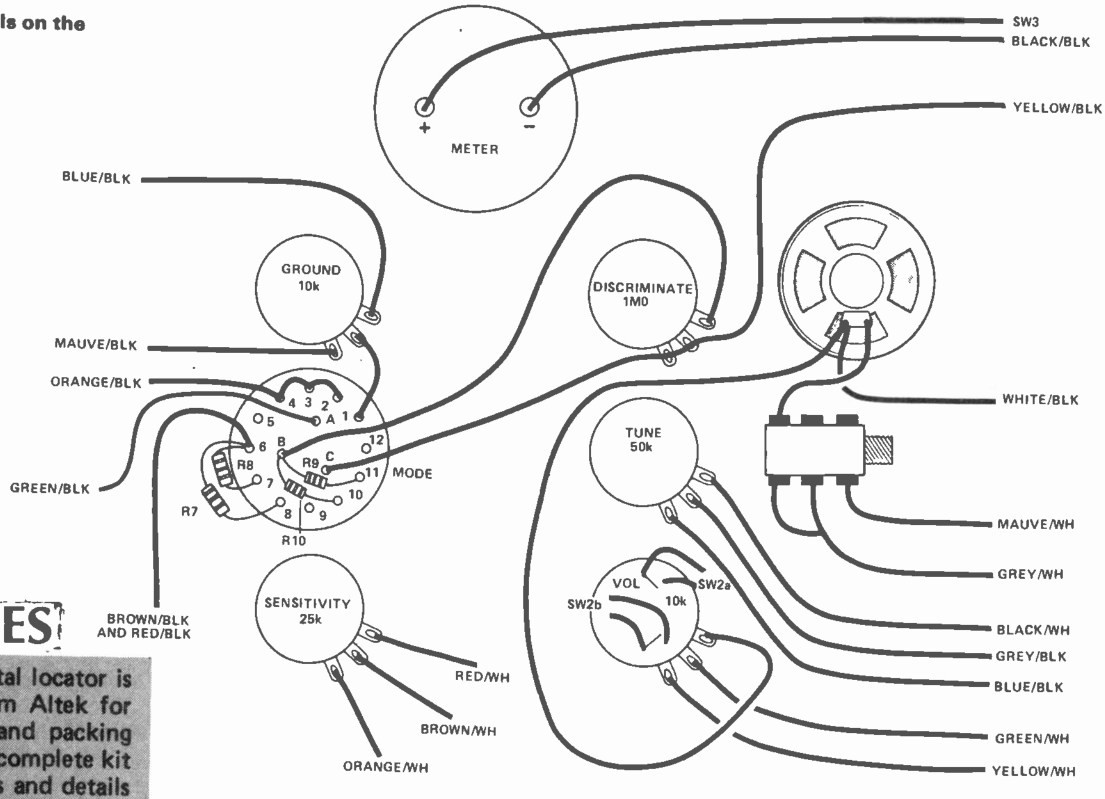


Fig. 3. Component overlay.

Fig. 4. Connections to controls on the front panel.



CONNECTION DETAILS FOR CONTROLS, METER, SPEAKER AND JACK SOCKET

BUYLINES

The Shadow VLF/TR metal locator is available in kit form from Altek for £85 plus VAT (Postage and packing £1.50). Purchasers of the complete kit will also receive free parts and details of an extra switched function to sound a tone for 'good' and 'bad' or just 'good' finds when in discriminate mode.

A hardware kit is also available. It includes shell, search head, PCB and case and costs £44 plus VAT (P and P £1.50) from Altek.

Altek (ETI),
1 Green Lane,
Walton-on-Thames,
Surrey.

PARTS LIST

RESISTORS All ¼W, 5%

R1	10k
R2,16,34, 52	15k
R3,5	2k2
R4,51	18k
R6,17,45	1k0
R7	82k
R8	27k
R9,11,12, 15,19,20,29, 32,33,37,40, 41,54	100k
R10,18,38	33k
R13	180k
R14,22	22k
R21,25,26, 30,39,44,46	1M0
R23	3k9
R24,35	470k
R27,28	4k7
R31	4M7
R36	47k
R42	3k3
R43	120k
R47	470R
R48,49	56k
R50	12k
R51	18k
R53	68k

POTENTIOMETERS

RV1	10k lin
RV2	1M0 log
RV3	50k lin
RV4	25k lin
RV5	10k log

CAPACITORS

C1,6,8,14	47n polyester
C2	470n polyester
C3,9,10,11, 13,15,18	10n polyester
C4,17	1n0 polystyrene
C5	220p ceramic
C7	22p polystyrene
C12	470n polycarbonate
C16	100n polyester
C19	10u 25V electrolytic
C20,21,22	470u 16V electrolytic

SEMICONDUCTORS

IC1,2	4007
IC3	LM324
IC4	LM393
IC5	CA3130
Q1,2,4,5, 7,8	BC148
Q3,6,9	BC158
D1,2	1N4148
ZD1	5V6 400mW

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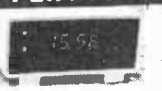

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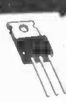

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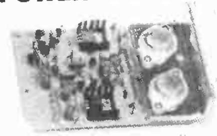

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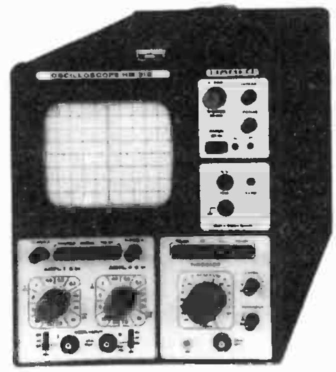

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VOLTAGE CONTROLLED MIXER
—A PROJECT 80 MODULE

This month we continue ETI's Project 80 with constructional details of the Voltage Controlled Mixer and Processor modules

Within a synthesiser there are a variety of sound sources, for example, the waveforms from the voltage controlled oscillators and the outputs from the noise generator. In addition there are treated sounds obtained by filtering, modulation and so on. Incorporating mixers greatly increases the scope for generating complex wave-shapes by additive or subtractive synthesis as well as providing the normal mixer function of proportioning the various inputs. Furthermore, mixing within the synthesiser maintains a compatible signal level and a high signal to noise ratio. The synthesiser this month is a four-channel mixer with pan control of the outputs. The unusual feature is that the input levels and pan have both manual and voltage control facility and some of their applications will be described.

Voltage Controlled Mixer

The design is based on a custom IC, namely, the CEM 3330 Dual Voltage Controlled Amplifier produced by Curtis Electromusic Specialties. At first sight this may seem an expensive approach, but the device has the essential features required for a good mixer — namely, low distortion, low noise and wide bandwidth. Furthermore, it is directly compatible with the signal and control voltages employed and has a summing node control input. These features eliminate the need for additional op amps for buffering and control purposes. Additionally, the performance of the CEM 3330 is satisfactory for the present application without employing trimmers and this is particularly useful to constructors having a limited amount of test equipment.

For synthesiser use, proportional (linear) mixing has been found simpler to use since the dial reading or control voltage is directly related to the proportion of each input being mixed. The input signal has been attenuated by a factor of four on each channel and maximum output is obtained with a 10V control signal derived from a rotary potentiometer, or from external sources. A manual master gain control has been provided for attenuating the output when required, or more commonly for maintaining signal level near to the standard 10V P-P. The output may be adjusted by a factor of ± 5. A visual peak level indicator has been included. After mixing, the output passes to another dual VCA operated at unity gain and with a pan facility such that a 10V control voltage results in a full swing from left to right outputs. This arrangement gives a constant total voltage output, but its distribution may be varied between two speakers with the aid of a stereo amplifier. If only one output is used then the pan control facility will function as a fade control. Panel space has dictated the number of controls incorporated in the mixer and the pan system is considered to be the most versatile especially if the outputs are being subjected to further treatment.

The design is fairly flexible insofar as component values may be changed to suit other control voltages and so on. Nevertheless it is designed to operate with signal levels commonly found within synthesisers. ▶

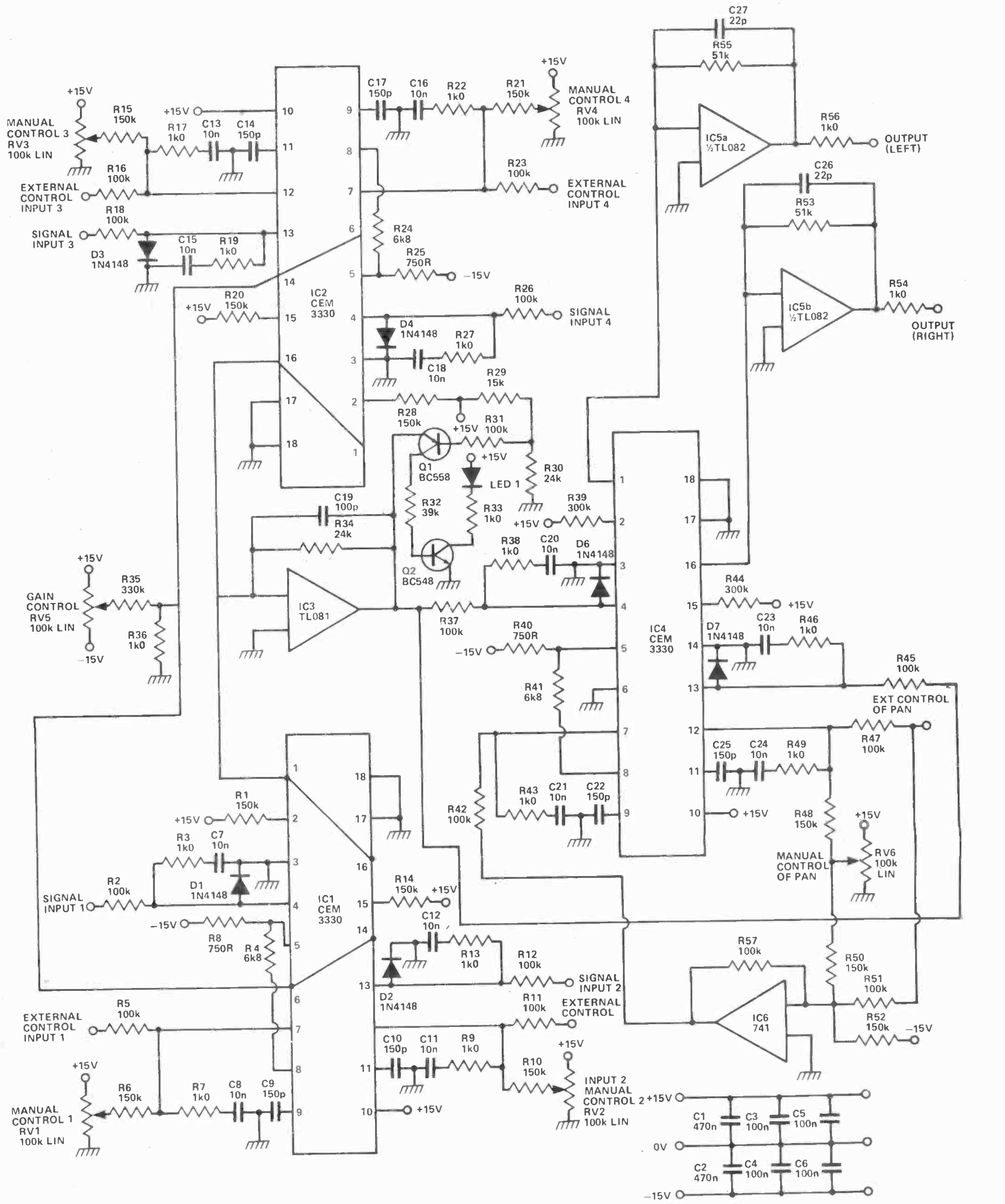


Fig.1. Circuit diagram of the voltage controlled mixer.

HOW IT WORKS

The CEM 3330, from Curtis Electromusic Specialties, contains two voltage controlled amplifiers each of which consists of a variable gain cell and a log converter. The gain cell is the curren-in, current-out type and has simultaneous linear and exponential controls. The log converter generates the logarithm of the linear control input current while transmitting the exponential control input unchanged to its output.

Reference to the circuit diagram and Pins 1 to 9 of IC1 illustrate the basic principle of the design and some of the features of the CEM 3330. The signal input (Pin 4) is a summing node and can, therefore, accept multiple inputs. In this application where we require independent control over each input only one input has been provided and with R2 = 100k the signal level should be kept to ±10V. R3 and C7 are compensation components and the diode, D1, is to prevent latch-up problems. R1 connected to +15V provides a reference current to the gain cell and this current should be limited to 100 uA for best linearity. The design is based on proportional mixing of up to four signals and thus the linear control input is used to independently control the gain of each signal input. Again this is a summing node input at Pin 7 which allows manual control of gain via RV1 and R6 or external control via R5 without additional op amps. By using a 150k resistor for R6 the control pot can make use of the standard +15V supply and provide the same gain as a 10V external control signal applied to the 100k resistor, R5. R7 and C8 compensation network stabilise the log converter. C9 is for compensation of the gain cell. A master gain control is obtained by injecting a small voltage into the exponential control input (Pin 6). This voltage is derived from RV5, R35 and R36 and is common to the four input stages.

The overall gain of the VCA is given by

$$A_V = \frac{R_F}{R_I} \times \frac{I_{CL}}{I_{REF}} e^{-V_{CE}/V_T}$$

where R_F is the value of the output resistor (R34); R_I the signal input resistor (R2); I_{CL} the linear control current developed across R5 (or R6); I_{REF} the current input to Pin 2 via R1; and V_{CE} the exponential control voltage. This equation indicates how the mixer may be altered to suit other signal and control levels.

One of the unique features of the CEM 3330 is that the operating point of the amplifiers may be set anywhere from Class B to Class A according to which parameters are most important in a particular application. The quiescent standby current of the signal-carrying transistors is varied by placing a resistor between the I_{EE} pin (Pin 5) and the idle current adjust pin (Pin 8). In this application the amplifiers are run Class AB with the 6k8 resistor (R4) providing a standby current of about 7 uA.

The four signal input and control stages are identical and their output currents are summed at IC3 and converted to a voltage across R34. This voltage is applied to Q1 which is turned on when the peak output voltage is about 9V5 (normal signal level for the synthesiser), which is set by the voltage divider R29, R30. Q2 is also turned on when this peak voltage is reached and the LED (D5) will then light up. At constant amplitude high frequency the LED will tend to glow dimly but intermittent peak voltages are clearly indicated.

The output voltage from IC3 also goes to both VCAs in IC4 which is configured in a similar manner to ICs 1 and 2 except that the exponential output is grounded. The amplifiers and associated op amps (IC5a) and IC5b) are set to unity gain when a 10V control voltage is applied to R42 or R47. The panning effect is obtained through IC6 and associated components which provides a 10V output with zero volts at R47, or RV6, and 0V when there is 10V at R47, or when RV6 is fully clockwise. The left and right outputs are obtained by converting the current to a voltage across resistors R55 and R53 respectively. The use of op amp, IC5, provides low impedance outputs.

The CEM 3330 may be trimmed for precision control of gain and for use in high quality audio applications. The arrangement used in this design is entirely satisfactory for its intended use with high signal levels.

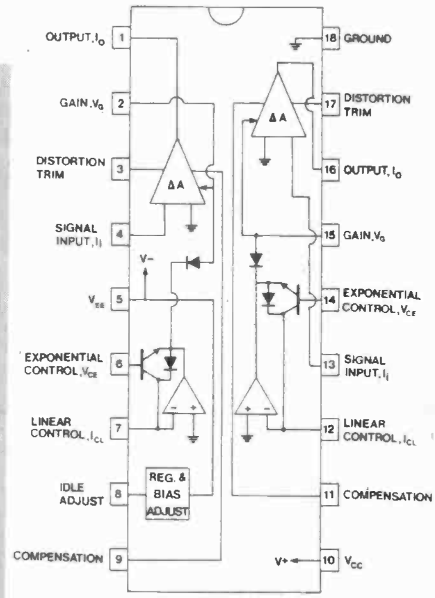
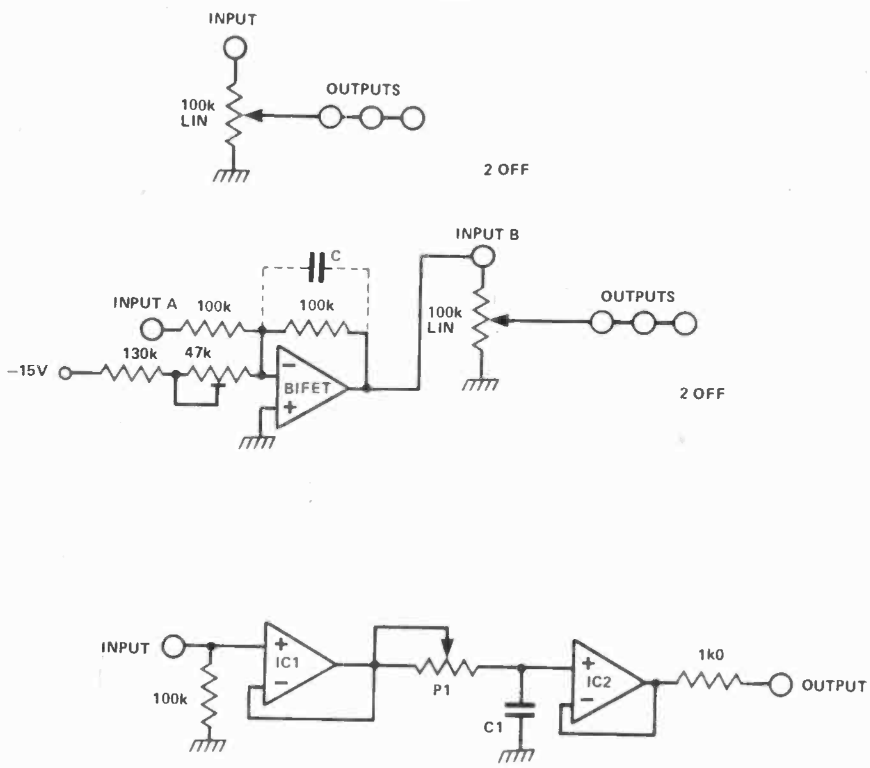


Fig.2. The internal structure of the CEM 3330 dual VCA.



○ = JACK SOCKET

Fig.3. Circuit diagram of the simple processor.

▶

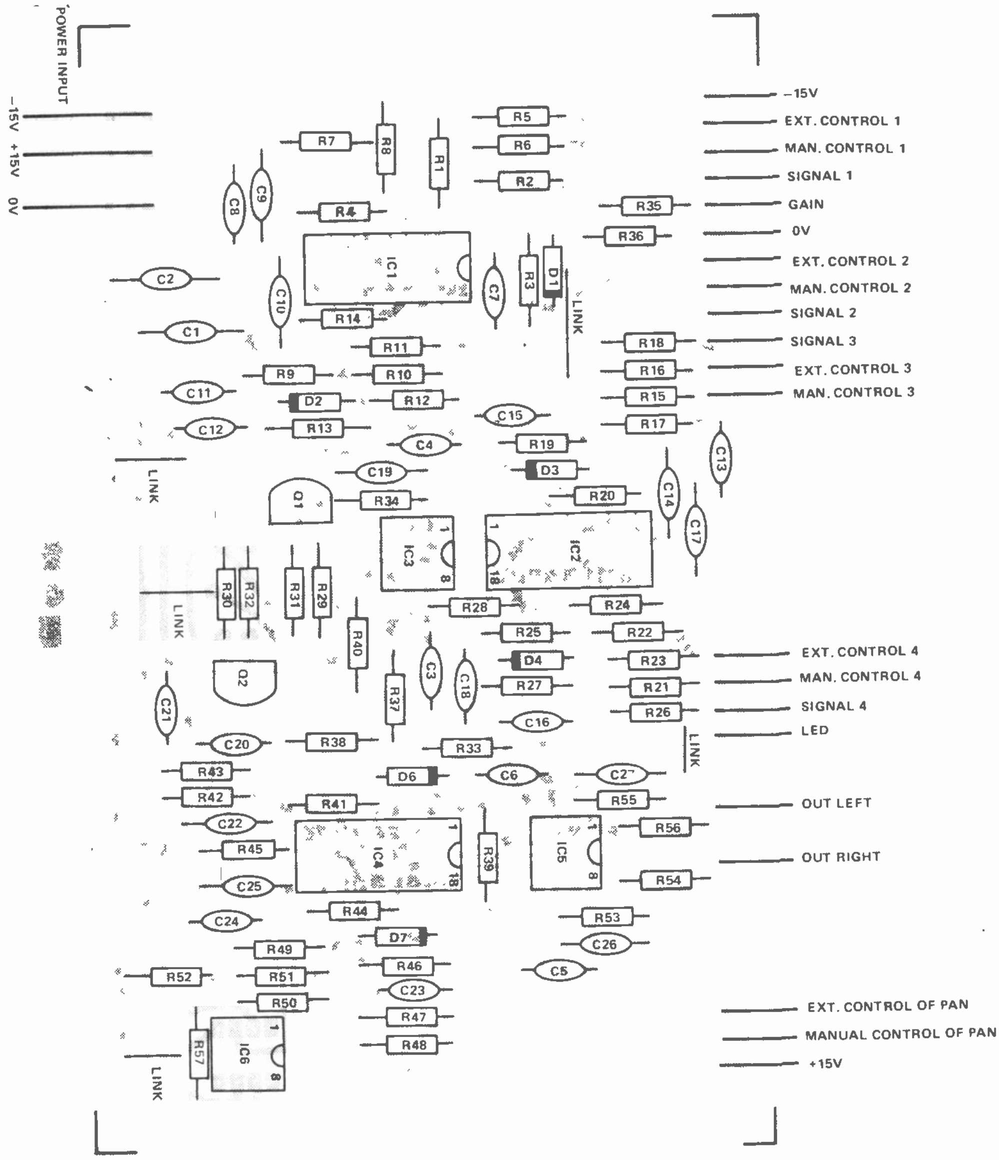


Fig.4. Component overlay of the VCM.

PARTS LIST

RESISTORS	
R1,14,20, 28,50,52	150k 1% metal film
R2,5,11, 12,16,18,23, 26,31,37,42, 45,47	100k
R3,7,9,13, 17,19,22,27, 33,36,38,43, 46,49,54,56	1k0
R4,24,41	6k8
R6,10,15, 21,48	150k
R8,25,40	750R
R29	15k
R30,34	24k
R32	39k
R35	330k
R39,44	300k 1% metal film
R51,57	100k 1% metal film
R53,55	51k
POTENTIOMETERS	
RV1–6	100k lin
CAPACITORS	
C1,2	470n polyester
C3,4,5,6	100n polyester
C7,8,11,12, 13,15,16,18, 20,21,23,24	10n polyester
C9,10,14, 17,22,25	150p polystyrene
C19	100p polystyrene
C26,27	22p polystyrene
SEMICONDUCTORS	
IC1,2,4	CEM3330
IC3	TL081CP or equivalent
IC5	TL082CP or equivalent
Q1	BC558
Q2	BC548
D1,2,3,4,6, 7	1N4148 (1N914)
D5	Red LED

Using The Mixer

A few guidelines on use are given to demonstrate the versatility achieved by incorporating voltage control.

1. A simplistic view would be to consider the mixer as four voltage controlled amplifiers with a common output. One technique often applied to a VCA is amplitude modulation (tremolo). Usually, however, the VCA is one of the last stages and, if a number of signals have been combined in a conventional mixer prior to the VCA, then the total signal has to be amplitude modulated. Using the voltage controlled mixer only parts of the signal need be modulated and the resultant effect can be more pleasing.

2. One of the early works with a synthesiser was Morton Subotnick's "The Wild Bull," recorded in 1968. In this work extensive use is made of a sawtooth waveform (high harmonic content) which is separated into four octave bands to provide the signals for a four-channel voltage controlled mixer. Each channel was controlled by an ASDR envelope shaper gated from a sequencer. This arrangement allows the separate timbral characteristics of any sound to be independently treated. Furthermore, by varying the speed of the sequencer the characteristics of the sound can be made to vary widely, for example, as the rate is increased the four bands begin to sound simultaneously. Only a simple digital sequencer is required for the above and the voltage controlled mixer becomes the heart of a useful music making instrument within the body of the synthesiser. This type of approach is particularly useful for those without access to multi-track recording equipment.

3. Adding and subtracting waveforms from two or more oscillators set to different pitches has not been widely used with synthesisers due to the tendency for the voltage controlled oscillators to track at different rates. The latter makes it impossible to maintain the same tone quality over several octaves. With the incorporation of synchronising facilities in modern VCOs this problem is overcome and additive and subtractive synthesis is a worthwhile field of exploration. Of course, subtractive synthesis is already widely employed by filtering techniques but more subtle tones can be obtained by mixing techniques.

BUYLINES

4. A major application of the voltage controlled mixer is the ability to alter loudness and harmonic content with pitch. One of the criticisms of 'live' electronic music is the precise nature of its sounds and the initial excitement of a new sound turns to boredom as the brain adversely reacts to its repetitive nature. By applying the keyboard control voltage (or its inverse, or a proportion of either) to one or more of the mixer control inputs then the amplitude or harmonic content (often both) will vary with pitch and so provide a useful means of dynamically altering the timbral characteristics of the sound.

5. Applying a low frequency waveform to the pan control input can produce some interesting spatial and rotational effects, but for greatest impact this technique should be used sparingly.

6. Mention has been made of waveforms, envelope shapers and keyboard voltage for control of the mixer and in common with other voltage controlled modules any variable voltage source may be used. A foot pedal control adapted to provide a 10V output is particularly useful in conjunction with a mixer.

Processor Module

As discussed in Part 1, the low output impedance and high input impedance of the modules allows one output to drive several inputs without overloading or introducing appreciable errors. Thus attenuators should be on inputs rather than outputs so that their level can be independently adjusted. Likewise the modules should ideally have a number of commoned output sockets to facilitate distribution of the signal to other modules.

Additional attenuating potentiometers and jack sockets add to cost and also take up valuable panel space and so for situations where the controls are used infrequently a distribution panel was discussed last month.

A suggested configuration for the module (a 'processor') is two distribution blocks which allow one input to be distributed to three outputs with or without attenuation.

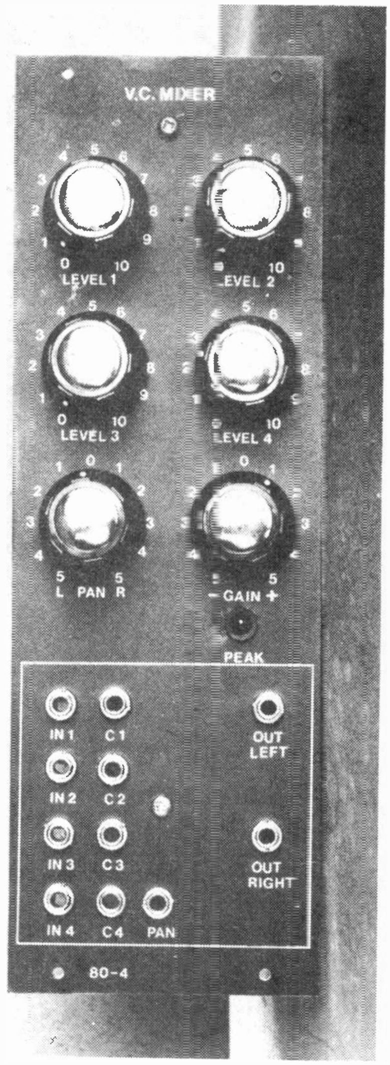
Secondly, there are a further two blocks which may be used as above, or the signal may be inverted via an op amp. In this instance inverting means subtracting the input voltage from 10 volts and not turning a positive input voltage into a negative one. This is achieved by adding components R3 and TP1 to a conventional unity gain inverter.

Another addition is the so-called 'lag processor' which is simply a low pass filter and akin to the usual portamento circuit. This is useful for slowing down fast control signals and also for delaying control signals.

Construction

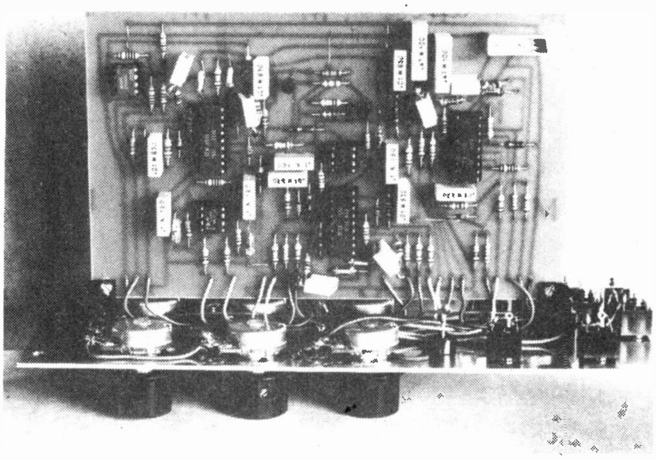
Because of the simple construction of the circuits no printed circuit board is shown but a few construction hints may be of value. For the inverter a BIFET type op amp (LF 351, TL 081, etc) should be used to prevent distortion of high frequency or fast signals. The main precaution is to keep the signal input resistor close to the inverting pin. A small capacitor (10 or 22p) across the op amp also reduces the likelihood of instability. Furthermore, if you decide to install more than two inverters on a board then 100n decoupling capacitors mounted close to the power supply pins of the IC will prevent the tendency of these devices to talk to one another. The circuit should be wired up so that the inverter stage is disabled when input jack socket 'B' is in use.

A LM1458 type op amp should be adequate for most applications of the lag processor. RV1 = 2M2 and C1 = 220n will provide sufficient delay and since short delays are the most useful a polyester capacitor may be employed. ETI

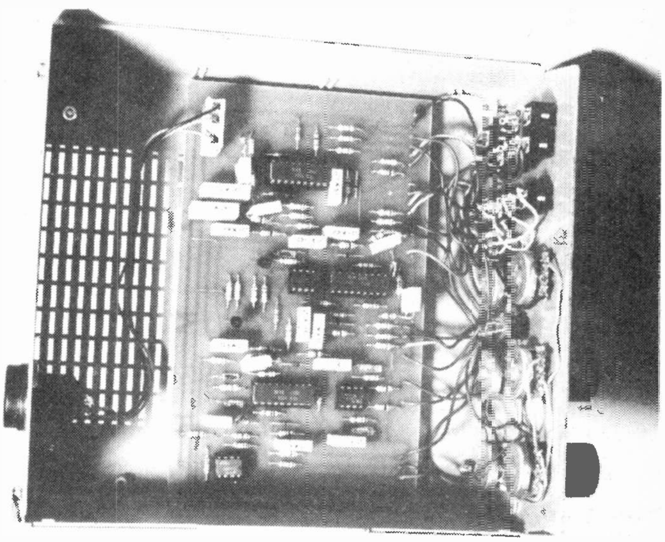


Panel layout of the mixer.

The mixer PCB attached to its front panel.



The mixer PCB installed in its case.



TECH TIPS

Grand Prix

M. R. Harrison

Grand Prix can be played on the following calculators — Casio fx-201p and Casio Profx-1.
The game is played by the calculator explaining the conditions of the road by means of a skill factor. The conditions are as below:
1.5+Excellent conditions and on a straight.
1.4+Very good.
1.3+Good.
1.2+Reasonable road surface but bends in road. Take care.
1.1+Greasy road surface due to water.
1.0+Oil !!!! DANGER.

The player whose turn it is, decides how fast he dare travel without crashing. The faster the speed the further the distance the player's car will travel. The winner is the first person to travel a chosen distance.
The game is played as follows:
1. Press start.
2. Skill factor is shown for player 1.
3. Player 1 enters his required speed.
4. Total distance player 1 has travelled will only be displayed if player 1 did not crash.
5. Skill factor is shown for player 2.
6. Player 2 enters his required speed.
7. Total distance player 2 has travelled will only be displayed if player 2 did not crash.
8. Go to stage 2.

The first part of the program is to obtain a random number between 0 and 1. This is done by multiplying another number between 0 and 1 again by —3.94. To the result, 1 is continually added until the result becomes positive. This result is used in obtaining the next random number in the same way and also in the next stage of the program, which is to obtain a skill factor. The skill factor is found by dividing the random number previously calculated by 2 and then adding on 1.021.

Example game of "Grand-Prix".

Winner is the first player to travel 1000 km. Pre-load store 3 with 0.25.

Player 1			Player 2		
Skill Factor	Speed (kmph)	Dist Travelled (km)	Skill Factor	Speed (kmph)	Dist Travelled (km)
1.03	10.00	0.15	1.49	100.00	80.81
1.17	20.00	5.92	1.44	90.00	crash!!
1.35	30.00	24.46	1.21	20.00	88.14
1.28	23.00	35.91	1.49	110.00	177.44
1.15	20.00	41.21	1.49	120.00	274.60
1.16	20.00	46.78	1.46	120.00	crash!!
1.27	30.00	61.15	1.03	15.00	275.08
1.45	110.00	crash!!	1.30	35.00	293.68
1.41	100.00	crash!!	1.46	100.00	crash!!
1.30	35.00	crash!!	1.45	80.00	354.48
1.32	35.00	80.86	1.34	37.50	376.95
1.25	25.00	92.16	1.09	20.00	crash!!
1.22	23.00	101.14	1.23	25.00	387.13
1.14	20.00	107.94	1.34	44.00	crash!!
1.27	25.00	119.92	1.04	10.00	387.43
1.46	90.00	189.52	1.28	33.00	403.72
1.50	150.00	crash!!	1.12	15.00	406.67
1.13	17.50	193.55	1.08	20.00	crash!!
1.26	25.00	204.90	1.07	12.00	407.96
1.30	35.00	223.93	1.38	50.00	441.47
1.07	10.00	225.01	1.31	45.00	crash!!
1.38	52.00	259.54	1.09	15.00	443.53
1.25	30.00	crash!!	1.13	17.50	447.14
1.11	15.00	262.25	1.16	20.00	452.72
1.46	90.00	crash!!	1.27	30.00	

ETC

By keeping a record of one's attempts, the player can soon realise how fast he may go with certain skill factors.
For a new game, stores 7 & 8 have to be cleared.

GRAND—PRIX	Steps:—
ST*0: GOTO9: I=9: GOTO8:	13
GOTO9: I=K2: GOTO8: GOTO0:	27
SUB*9: 3=3x6:	36
ST*4: 3=3+9:	45
IF3=K0:4:5:5:	57
SUB*8: IM=3÷K2+0:	69
ANS IM:	72
2=9 10^x x IM TAN:	80
I=I3K3:	87
ENT IM:	90
1=IM: IF IM=2:1:1:3:	105
ST*1: I=I+K3:	115
IM=3SINx1+IM:	124
ANS IM:	127

Pre-load memory stores as below:—

Store 9	1
Store 6	—3.94
Store 0	1.021
Store 3	any number between 0 and 1.

Rad-Deg-Grad switch *must* bet set on "Radians".
For a new game, stores 7 & 8 have to be cleared.

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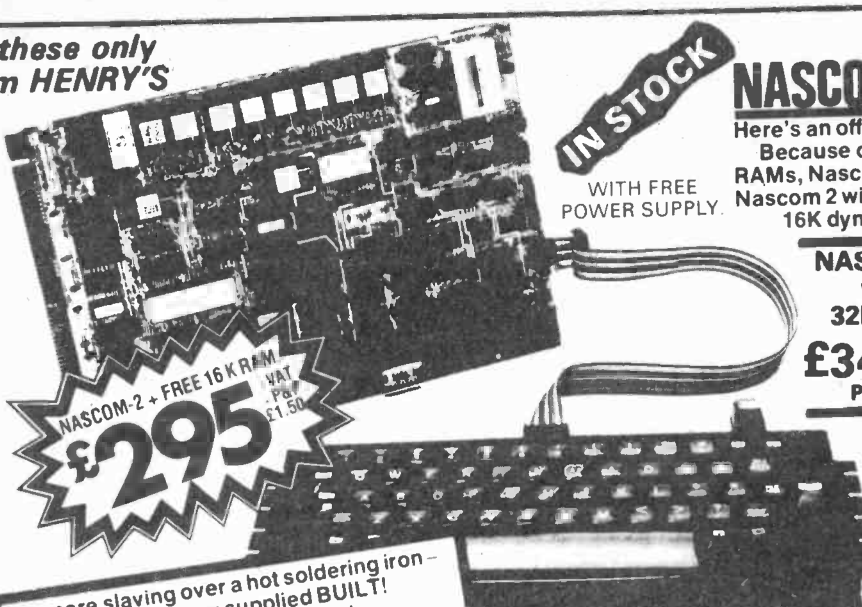

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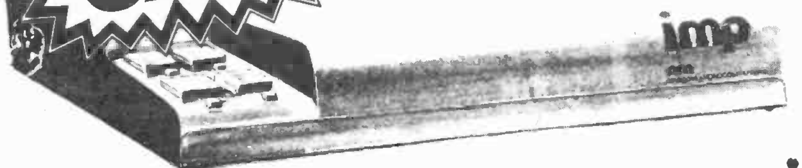

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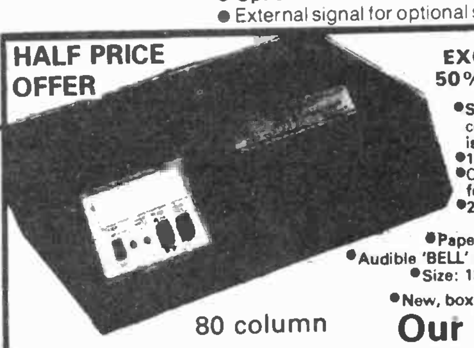

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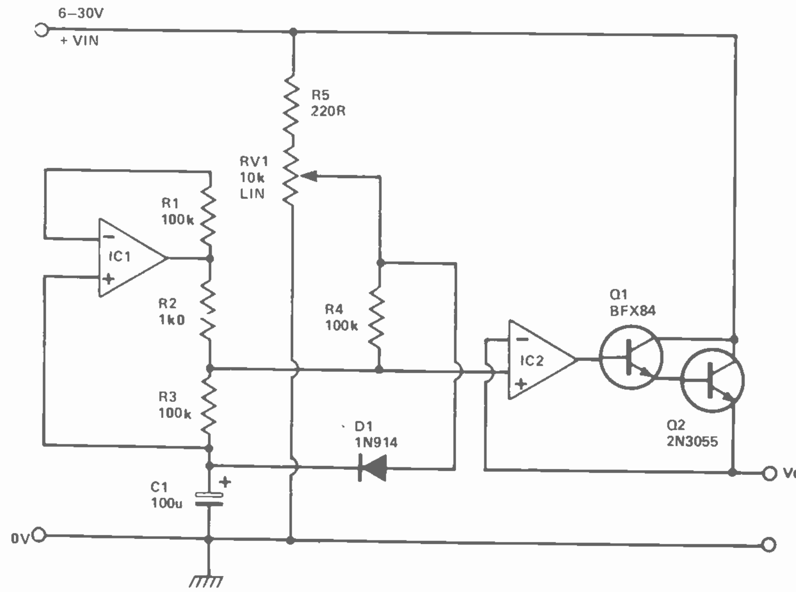
Gyrator Smoother

J. P. Macaulay

Although this circuit was developed to supply a well smoothed supply to a stereo class A amplifier it is well suited to many other applications. The circuit is based on the dual op amp LM358. A1 is used as an gyrator, C1 being amplified by the ratio of R3 to R4, ie 1000X. The simulated capacitor thus formed between the output of A1 and ground is 100n.

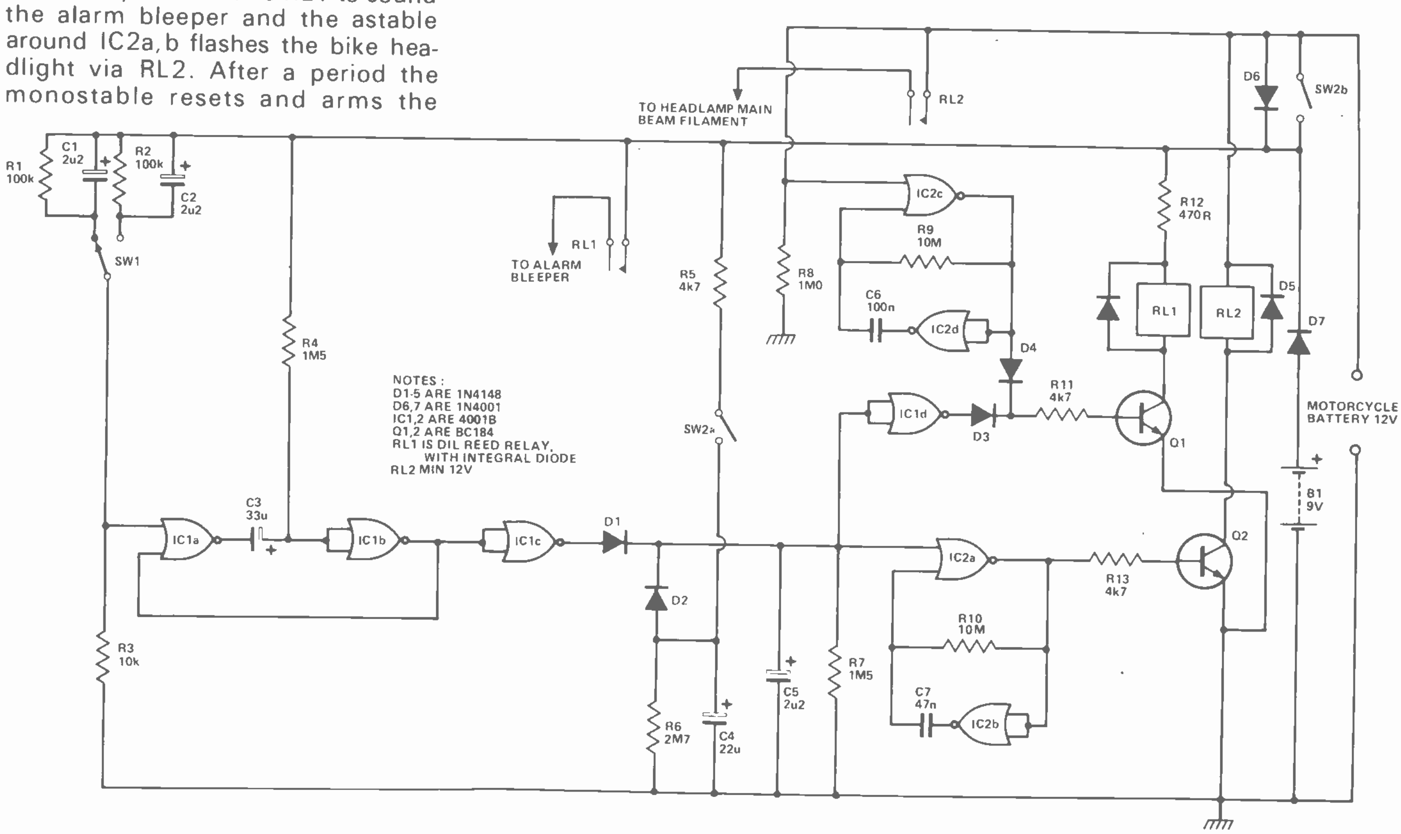
R5 and RV1 set the output voltage whilst R4 in series with the 'capacitor' forms a smoothing network with a time constant of 10,000 seconds! In order to avoid protracted turn on times the diode, D1, rapidly charges C1 to within 0V6 of the nominal output voltage within two seconds. Ripple is not measurable with the prototype when supplying 3A into a load. A2 and the Darlington output pair Q1 and Q2 form a voltage follower with an output current capacity in excess of 10A, if Q2 is mounted on a hefty heatsink.



Motorcycle Anti-Theft Alarm

C. R. Goble

IC1a,b form a monostable triggered by mercury switch S1.IC1c then provides a low output, allowing the charge on C5 to decay over a couple of seconds through R7. After this short delay IC1d allows RL1 to sound the alarm bleeper and the astable around IC2a,b flashes the bike headlight via RL2. After a period the monostable resets and arms the circuit once more. If the battery leads are cut then another astable around IC2c,d will switch the bleeper on and off continuously, via RL1, until disarmed by lockswitch S2.C4 discharging prevents the alarm from sounding for about 20 seconds after initial arming. RL2 contacts should be suitably rated and, ideally, RL1 should take only a low current to help conserve standby power. Current drain when untriggered amounts to that through S1.6V operation is possible with 6V relays although values may need altering to preserve timing. Mercury switch S1 can be formed either from one double switch or from two single switches, mounted across the 'bike and wired to give a changeover action.



Solder Sucking

A. D. Hextall

Here is a tip for those wealthy enough to possess a solder sucker. Those so fortunate will appreciate the cost of buying replacement nozzles. Great financial saving can be achieved by sliding a piece of rubber sleeving over the nozzle, extending it by about 4 mm. Not only is the sleeving heat-resistant, but when worn can be replaced at a miserly cost.

Car Alarm

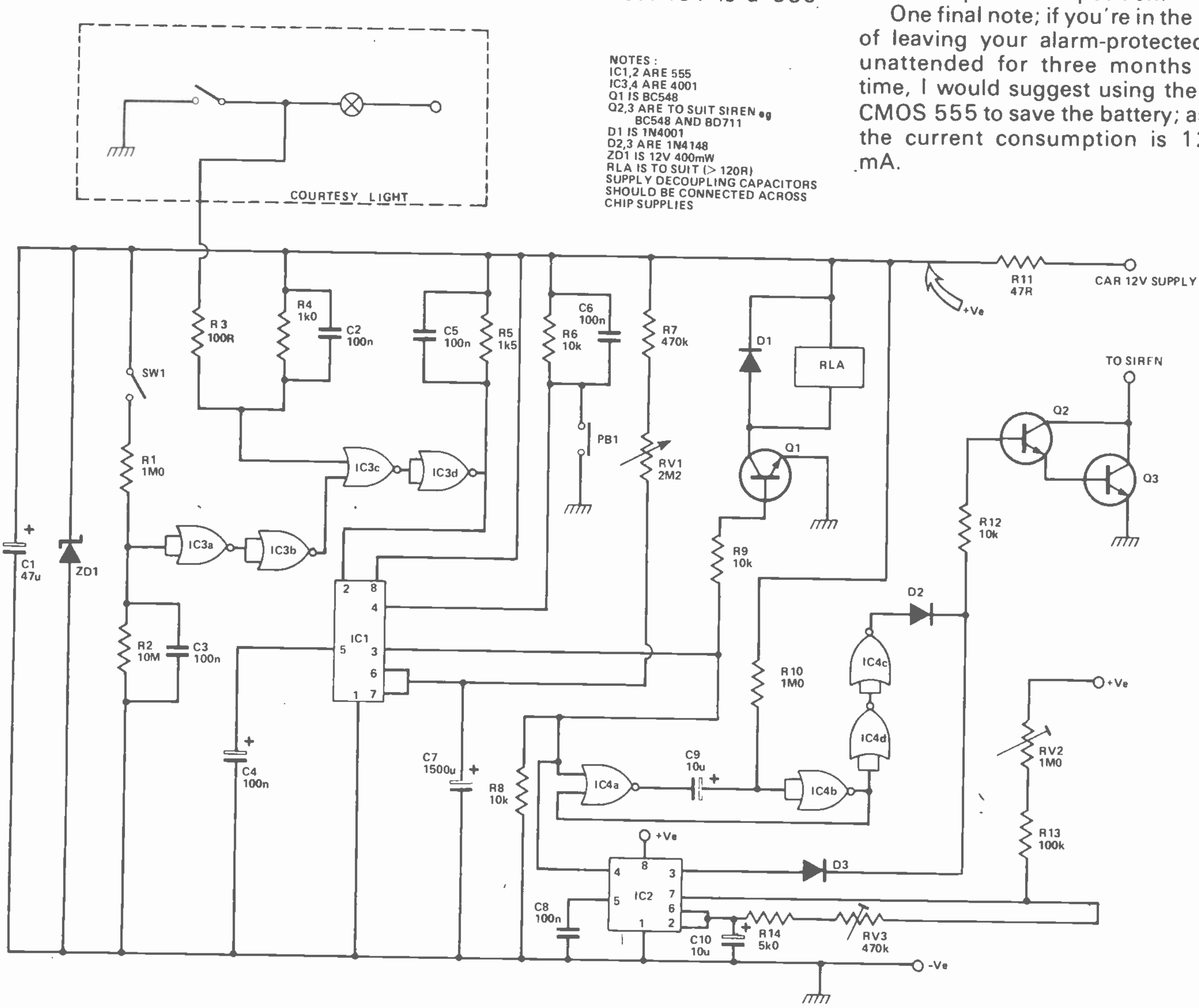
W. D. Solomon

This circuit offers a greater degree of security than many of the designs previously published, in that there is absolutely no way of controlling, or resetting the alarm from inside the car. When triggered, a relay flips over, to be used for immobilising the car by, say, shorting out the points or disconnecting the solenoid. A siren is also turned on, winding up for a few seconds before an astable turns it on and off, thus producing an effective alarm sound. After a pre-selected time the system resets itself, to avoid draining the battery, or annoying the neighbours.

IC3 provides the trigger logic, the gates being arranged so that if the wire to SW1 (the enable/disable switch) is cut or damaged, the system will still be enabled. IC1 is a 555 being used as a basic timer; the time period (before the system resets itself) is controlled by RV1. The output of IC1 turns on Q1 and thus the relay, while triggering the monostable (IC4a & b) and buffer (IC4c & d), which turns on the siren, via the Darlington pair (Q2 & 3). After a few seconds the astable 555 (IC2) takes over, bleeping the siren on and off. RV2, 3 are adjusted when the alarm is installed to vary the on and off times and produce the desired alarm sound. D2, 3 isolate the outputs of IC2, 4.

ZD1, C1 and R11 provide a stabilized 12V supply; C2, 3, 5, 6 and their associated resistors are a desperate attempt to protect the circuit from a noisy ignition! On the prototype, PB1 and RV1 were mounted on the alarm box, which was bolted inside the engine compartment; SW1 was hidden in the boot, although a key-switch could be used in a more prominent position.

One final note; if you're in the habit of leaving your alarm-protected car unattended for three months at a time, I would suggest using the new CMOS 555 to save the battery; as it is the current consumption is 12-15 mA.



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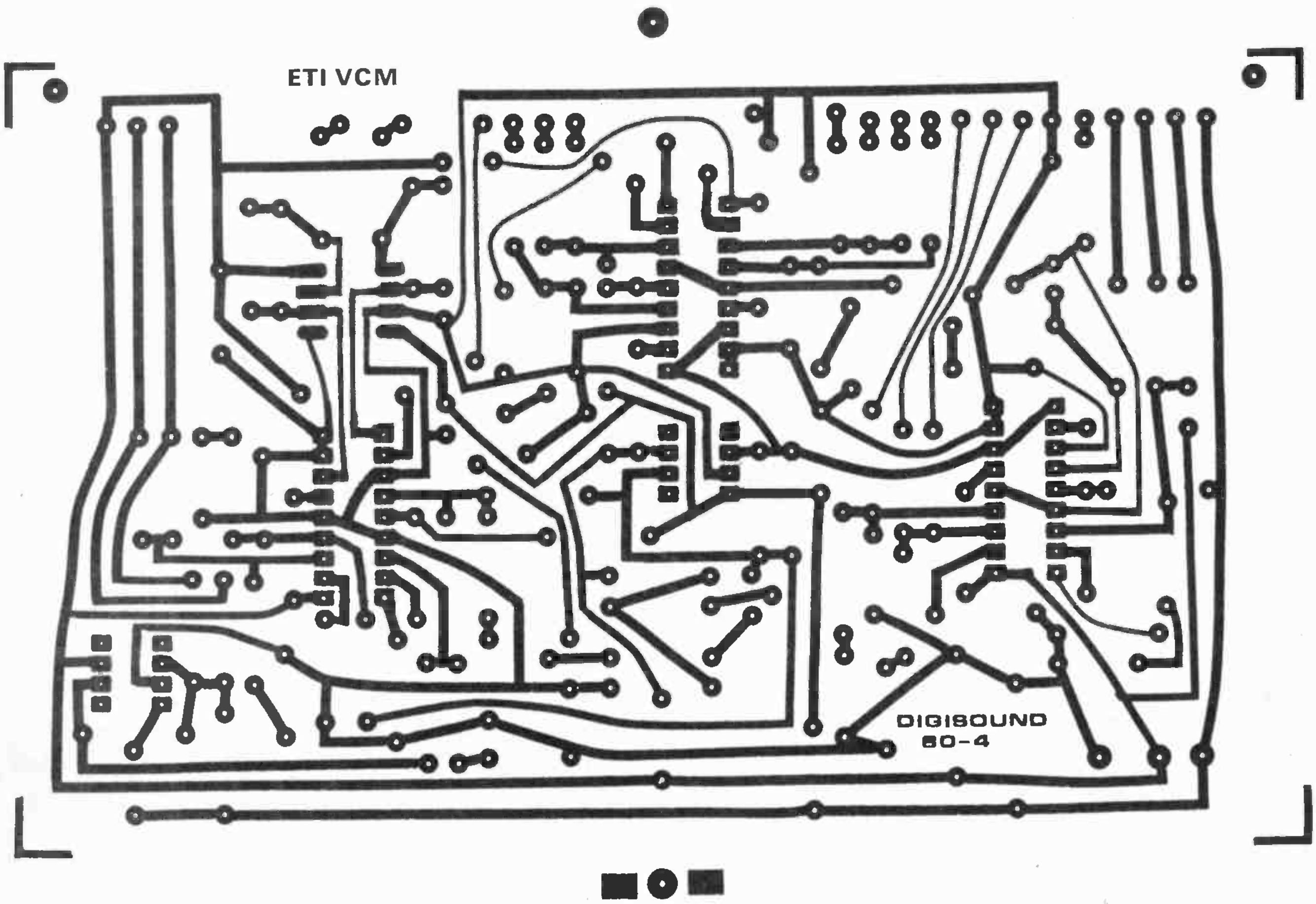

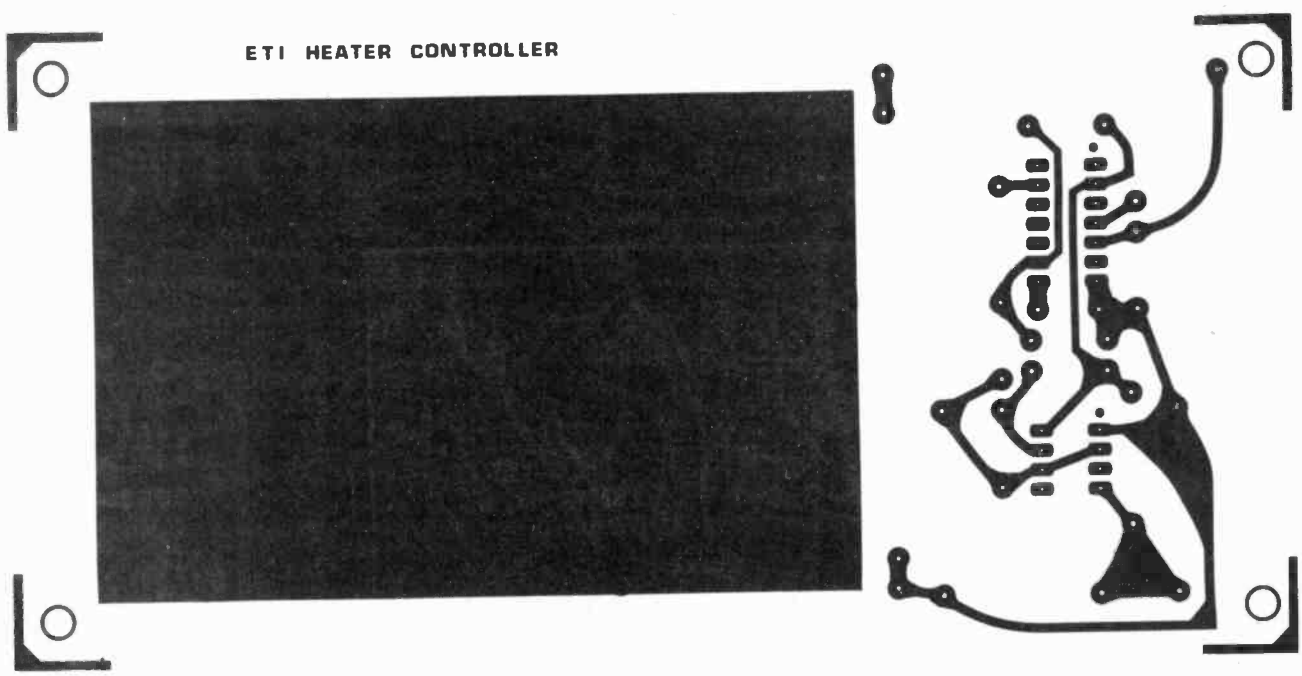

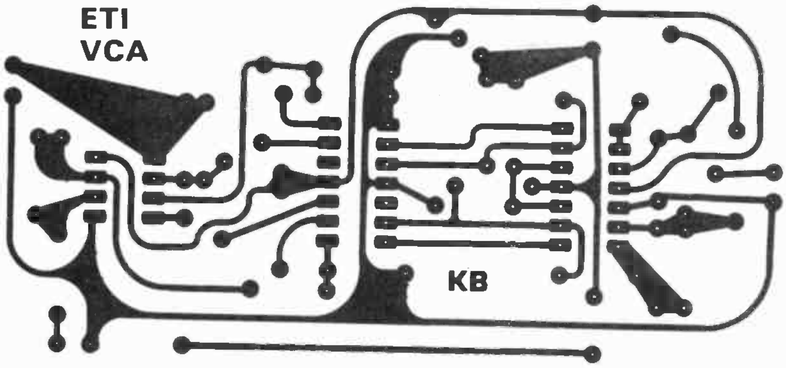
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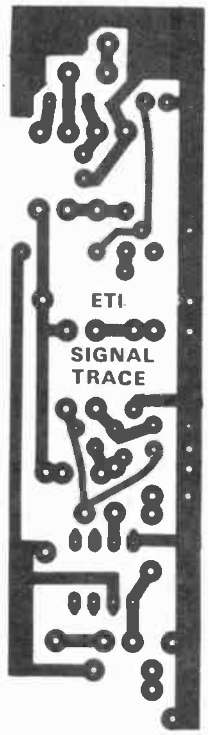
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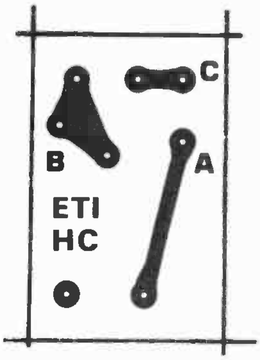
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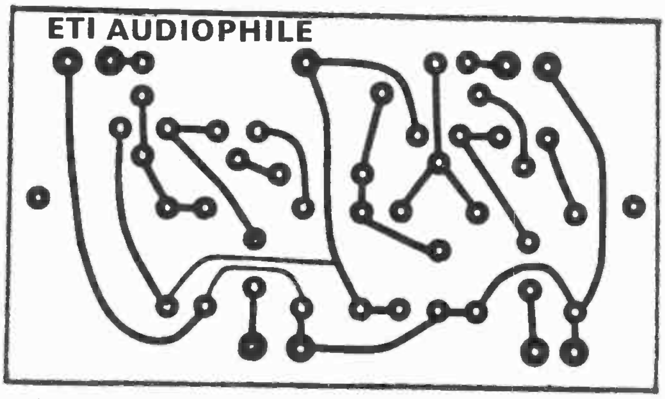
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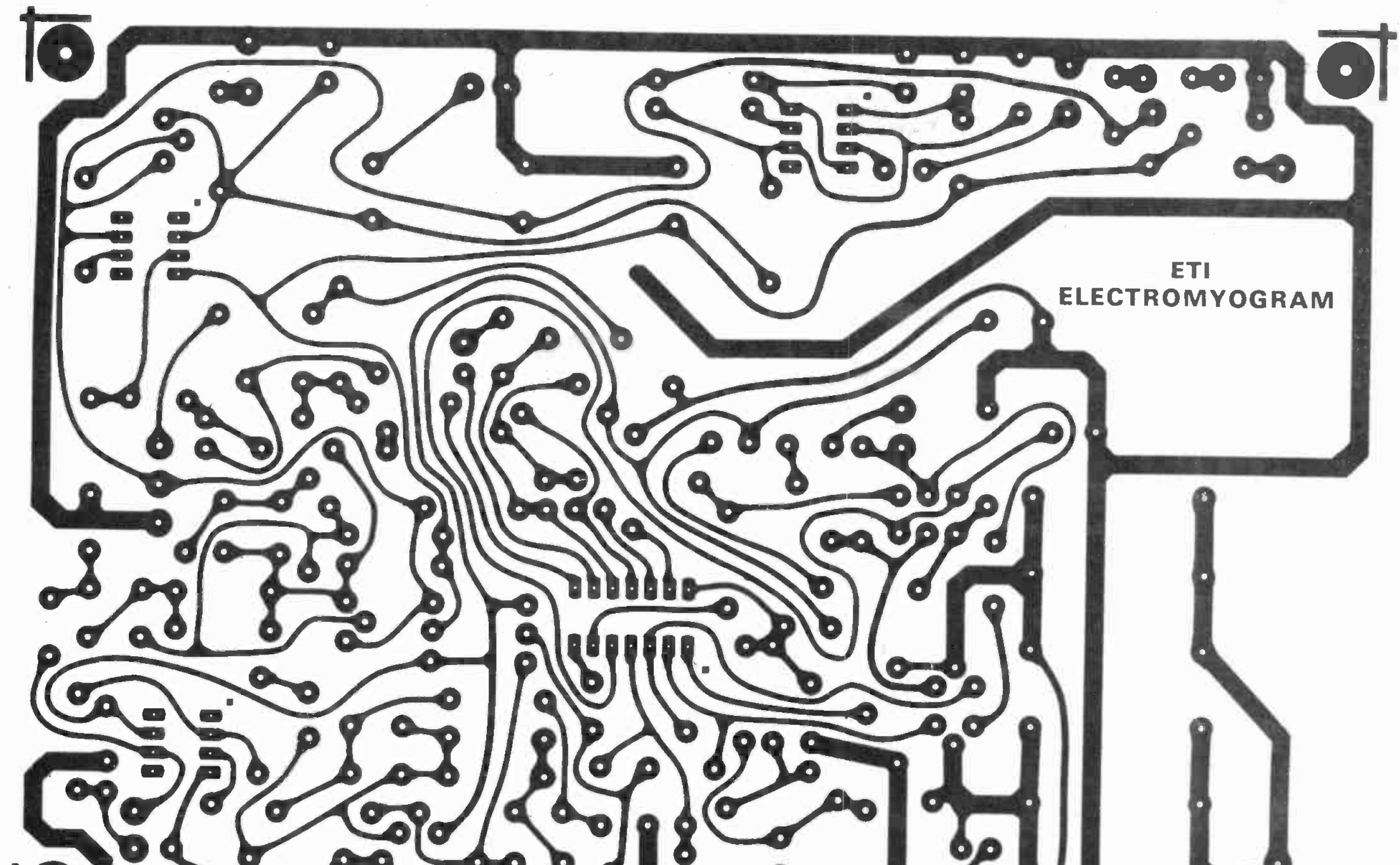
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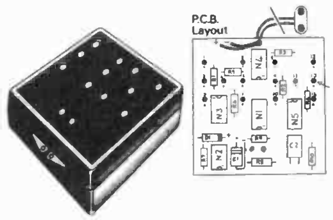

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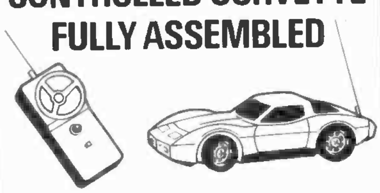

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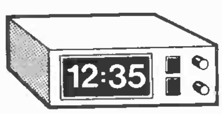

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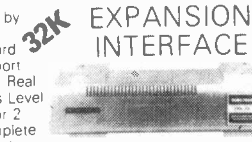

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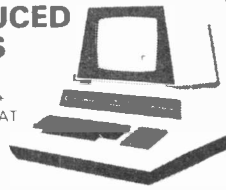

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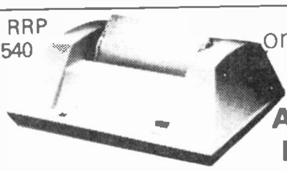

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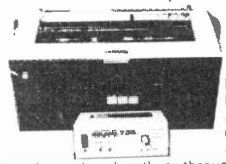

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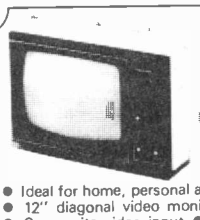
S100 EXPANSION — **£199**



video 100

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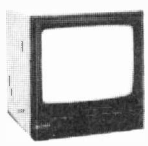
● Ideal for home, personal and business computer systems ● 12" diagonal video monitor ● Composite video input ● Composite video input ● Compatible with many computer systems ● Solid-state circuitry for a stable & sharp picture ● Video bandwidth - 12MHz + 3DB ● Input impedance -75 Ohms ● Resolution - 650 lines Minimum In Central 80% of CRT; 550 Lines Minimum beyond central 80%.



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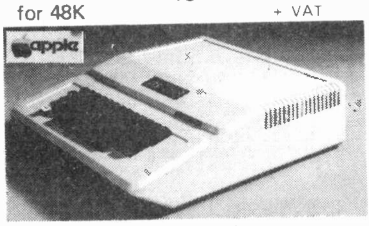

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NASCOM-2 MICRO-COMPUTER

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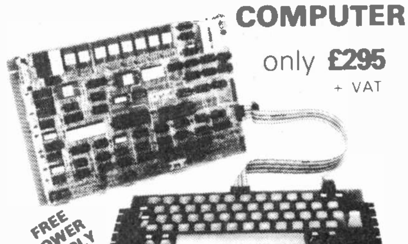

Microprocessors Z80A. 8 bit CPU. This will run at 4MHz but is selectable between 1/2/4 MHz. This CPU has now been generally accepted as the most powerful, 8 bit processor on the market.
INTERFACE
Keyboard New expanded 57 key Licon solid state keyboard especially built for Nascom Uses standard Nascom, monitor controlled, decoding
T.V. The Iv peak to peak video signal can drive a monitor directly and is also fed to the on-board modulator to drive the domestic T.V
I.O. On-board UART (Int.6402) which provides serial handling for the on-board cassette interface or the RS232/20mA teletype interface.
The cassette interface is Kansas City standard at either 300 or 1200 baud This is a link option on the NASCOM-2.
The RS232 and 20mA loop connector will interface directly into any standard teletype
The input and output sides of the UART are independently switchable between any of the options — i e it is possible to house input on the cassette and output on the printer
PIO There is also a totally uncommitted Parallel I/O (MK3881) giving 16, programmable, I/O lines These are addressable as 2 x 8 bit ports with complete handshake controls
Documentation Full construction article is provided for those who buy a kit and an extensive software manual is provided for the monitor and Basic.
Basic The Nascom 2 contains a full 8K Microsoft Basic in one ROM chip with additional features like DEEK, DOKE, SET, RESET for simple programming.
With free 16K RAM board

A PROFESSIONAL WORD PROCESSING SYSTEM AND IT'S A COMPUTER AS WELL.

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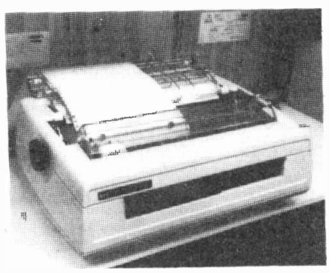


PET 32K — This is the standard 32K Pet from Commodore. Reverse video and graphics allow the WordPro Package to give simple clear and easy to read displays.

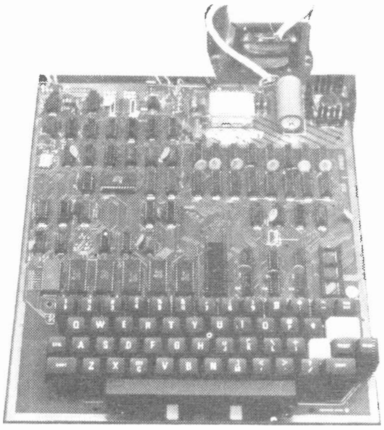
2040 Disk Drives Twin disk drives allow large high speed storage for your letters, or paragraphs. Plugs in the back of the PET.

NEC Spinwriter NEC's high quality printer uses a print "thimble" that has less diameter and inertia than a daisy wheel, giving a quieter, faster, more reliable printer that can cope with plotting and printing (128 ASCII characters) with up to five copies, friction or tractor fed. The ribbon and thimble can be changed in seconds.
55 characters per second bidirectional printing — with red/black, bold, subscript, superscript, proportional spacing, tabbing, and much, much more.

WordPro II The heart of the system — consists of a ROM and diskette. The ROM is inserted into a space socket inside the Pet. One of the most versatile Word Processing Packages around.

COMPUKIT UK101

EUROPE'S FASTEST SELLING ONE BOARD COMPUTER



★ 6502 based system — best value for money on the market. ★ Powerful 8K Basic — Fastest around ★ Full Qwerty Keyboard ★ 4K RAM Expandable to 8K on board. ★ Power supply and RF Modulator on board. ★ No Extras needed — Plug-in and go. ★ Kansas City Tape Interface on board. ★ Free Sampler Tape including powerful Dissampler and Monitor with each Kit. ★ If you want to learn about Micros, but did't know which machine to buy then **this is the machine for you.**

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The **Compukit UK101** comes in kit form with all the parts necessary to be up and working, supplied. No extras are needed. Ater plugging in just press the reset keys and the whole world of computing is at your fingertips. Should you wish to work in the machine code of the 6502 then just press the M key and the machine will be ready to execute your commands and programs. By pressing the C key the wor d of Basic is open to you

This machine is ideal to the computing student or Maths student, ideal to teach your children arithmetic, and is also great fun to use

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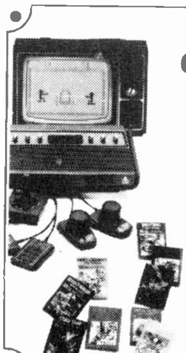

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