Australia 95c · New Zealand $1.10 · South Africa [illegible] · Malaysia $2.75

PRACTICAL ELECTRONICS

JANUARY 1980

55p

ULTRASONIC CLEANER

Also in this issue

SCRATCH & RUMBLE FILTER • SOFTY REVIEW

PRACTICAL
ELECTRONICS

VOLUME 16 No. 1 JANUARY 1980

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR FEBRUARY ISSUE WILL BE ON SALE FRIDAY, 11 JANUARY 1980
(for details of contents see page 33)

MORE BIG VALUE FROM YOUR TANDY STORE

1000 OHMS/VOLTS AC/DC 8 RANGES
Handy multitester for home and work-shop. Easy-to-read two colour 5cm meter, pin jacks for all 8 ranges. Reads AC and DC volts: 0-15-150-1000 DC current; 0-150 mA. Resistance: 0-100,000 ohms. Accuracy: ± 3% full scale on DC ranges, ± 4% on AC ranges. Complete battery. **22-027.** REG. PRICE **£6.95**

6-DIGIT FREQUENCY COUNTER
Counts frequencies from 100 Hz to over 45 MHz with 100 mS gate time. Accuracy is 3 ppm at 25°C or less then ± 30 Mkz on 10 MHz! Overload-protected 1-meg input. Sensitivity, 30 mV up to 30 MHz. Req. 9V battery. **22-351.** REG. PRICE **£79.95**

MULTITESTER
Dual FET imput for accuracy and minimum loading. 11.5cm mirrored scale. DC volts, 0-1-3-10-30-100-300-1000. DC current 0-100 a. 0-3-30-300 milliamp. Resistance 0-30-300-3k-30 1C-1 megaohm. 0-100-1k-10 1C-100K-3 megaohms. Req. 9V battery. **22-209.**
REG. PRICE **£29.95**

TRANSISTORIZED SIGNAL TRACER
Spot circuit troubles and check RF, IF and audio signals from aerial to speaker on al audio equipment. With 9V battery, instructions. **22-010.**
REG. PRICE **£9.95**

DIGITAL IC LOGIC PROBE

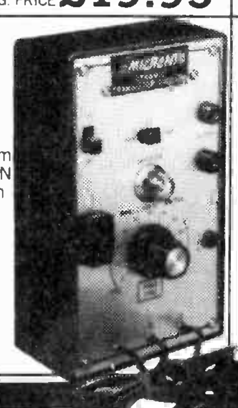
Unique circuitry makes it a combined level detector, pulse detector and pulse stretcher. Hi-LED indicates logic "1". Lo-LED is logic "0". Pulse LED displays pulse transitions to 300 nanoseconds, blinks at 3 Hz for high frequency signals (up to 1.5 MHz). Input impedence: 300K ohms. With 36" power cables. **22-300.**
REG. PRICE **£19.95**

SIGNAL INJECTOR
For RF, IF, AF circuits. Maximum accuracy. Easy pushbutton operation. Needs two "AA" batteries. **22-4033.**
REG. PRICE **£2.79**

AC/DC CIRCUIT TESTER
Accuracy in 1-300 volts ranges. Safe in live/dead circuits. Needs two "AA" batteries. **22-4034.**
REG. PRICE **£1.99**

REALISTIC DX 300
General coverage receiver. Quartz-synthesised tuning, digital frequency readout. 3-step RF Attenuator. 6-range preselector with LED indicators. SSb and CW demodulation. Speaker. Code oscillator. Batteries (not included) or 12V DC. **20-204.**
REG. PRICE **£229.95**

DYNAMIC TRANSISTOR CHECKER
Shows current gain and electrode open and short circuit. Tests low, medium or high power PNP or NPN types. Go/no-Go test from 5-50mA on power types. **22-024.**
REG. PRICE **£9.95**



VARIABLE POWER SUPPLY
Power project boards. IC's, other low-voltage DC equipment. Load regulation: less than 450mV at 1 amp at 24V DC. Ripple: less then 25mV. Maximum output current: 1.25 amps. Switchable colour-coded meter reads 0-25V. DC and 0-1.25 amps. Three-way binding posts take wires, banana plugs or dual banana plugs with 0.75" centres. For 220/240V AC. **22-9123**
REG. PRICE **£35.95**

You save because we design, manufacture, sell and service. Tandy have over 7,000 stores and dealerships worldwide. Over 2,500 products are made specifically for or by Tandy at 16 factories around the world. The quality of our products has been achieved by over 60 years of continuous technological advancement.

KNOWN AS RADIO SHACK IN THE U S A MAKERS OF THE WORLD'S BIGGEST SELLING MICROCOMPUTER TRS80

TANDY

The largest electronics retailer in the world.
Offers subject to availability. Instant credit available in most cases.
OVER 170 STORES AND DEALERSHIPS NATIONWIDE.

TANDY DEALER

Most items also available at Tandy Dealers. Look for this sign in your area.

Access, Barclaycard and Trustcard welcome.
Prices may vary at individual stores.

QUARTZ LCD 5 Function

Hours, mins, secs., month, date, auto calender, back-light, quality metal bracelet.

£6.65

Guaranteed same day despatch.
Very slim, only 6mm thick.

M1

SOLAR QUARTZ LCD 5 Function

Genuine solar panel with battery back-up. Hours, mins., secs., day, date. Fully adjustable bracelet. Back-light. Only 7mm thick.

£8.65

Guaranteed same day despatch.

M2

QUARTZ LCD 11 Function SLIM CHRONO

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.
Metac Price

£10.65 Thousands sold!
Guaranteed same day despatch.

M3

QUARTZ LCD ALARM 7 Function

Hours, mins., secs,. month, date, day.
6 digits, 3 flags plus continuous display of day and date or seconds. Back-light
Only 9mm thick.

£12.65

Guaranteed same day dispatch.

M4

MULTI ALARM 6 Digits 10 Functions

- Hours, mins., secs.
- Months, date, day.
- Basic alarm.
- Memory date alarm.
- Timer alarm with dual.
- Time and 10 country zone.
- Back-light.
- 8mm thick.

£18.65

M5

FRONT-BUTTON Alarm Chrono Dual Time

6 digits, 5 flags.
22 functions.
Constant display of hours and mins., plus optional seconds or date display.
AM/PM indication, month, date.
Continuous display of day.
Stop-watch to 12 hours 59·9 secs., in 1/10 second steps.
Split and lap timing modes.
Dual time zones.
Only 8mm thick.
Back-light. Fully adjustable open bracelet.

£22.65

Guaranteed same day dispatch

M6

SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

6 digits, 5 flags.
22 functions.
Solar panel with battery back-up.
6 basic functions.
Stop-watch to 12 hours 59·9 secs., in 1/10 sec., steps.
Split and lap timing modes.
Dual time zones.
Alarm. 9mm thick. Back-light.
Fully adjustable bracelet.

£27.95

M7

ALARM CHRONO with 9 world time zones

- 6 digits, 5 flags.
- 6 basic functions.
- 8 further time zones.
- Count-down alarm.
- Stop-watch to 12 hours 59·9 secs. in 1/10 sec. steps.
- Split and timing modes.
- Alarm.
- 9 mm thick.
- Back-light.
- Fully adjustable bracelet.

£29.65

M8

SOLAR QUARTZ LCD Chronograph

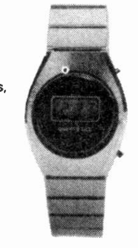
Powered from solar panel with battery back-up.
6 digit, 11 functions.
Hours, mins., secs., day, date, day of week.
1/100th, 1/10th, secs., 10X secs., mins.
Split and lap modes.
Back-light, auto calendar. Only 8mm thick.
Stainless steel bracelet and back.
Adjustable bracelet.
Metac Price

£13.65

Guaranteed same day despatch.

M9

QUARTZ LCD Ladies Day Watch



Only 25 × 20mm and 6mm thick.
Hours, minutes, seconds, day, date, backlight and auto calendar.
Elegant metal bracelet in silver or gold fully adjustable to suit very slim wrists.
State colour preference.

£9.95

Guaranteed same day despatch.

M15

QUARTZ LCD Ladies Fashion Watch

Elegant bracelet in bronze/gold finish or silver colour.
Hours, mins, secs, day, date, backlight and auto calendar. Adjustable for the slimmest of wrists.
State colour preference.

£14.95

Guaranteed same day despatch

M17

QUARTZ LCD Ladies Cocktail Watch

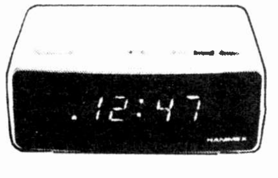
Highly functional watch which also suits those special occasions.
Beautifully designed with a very thin bracelet which retains strength as well as elegance.
Hours, mins, secs, day, date, backlight and autocalendar.
Bracelet fully adjustable to suit slim wrists.
State gold or silver finish.

£19.95

Guaranteed same day despatch

M18

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 1.43 lbs (0.65 kg)
AC power 220V.

£10.20 Thousands sold!
Mains operated.

Guaranteed same day despatch.

M13

EXECUTIVE ALARM WATCH

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 preceeded by the conference signal.

£14.95

M60

MACY QUARTZ ANALOGUE

Automatic Calendar
Day and Date
infinite bracelet.
This mans watch has elegance as well as the robust appearance provided by a watch with traditional features. Accuracy is provided by a quartz crystal powered by a long life miniature battery.

£24.95

M21

Metac price breakthrough for an Alarm Chronograph with Dual Time only

£18.95

OUTSTANDING FEATURES

- **DUAL TIME.** Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing.
- **CALENDAR FUNCTIONS** include the date and day in each time zone.
- **CHRONOGRAPH/STOPWATCH** displays up to 12 hours, 59 minutes, and 59.9 seconds.
- On command, stopwatch display freezes to show intermediate (split/lap) time while stopwatch continues to run. Can also switch to and from timekeeping and stopwatch modes without affecting either's operation.
- **ALARM** can be set to anytime within a 24 hour period. At the designated time, a pleasant, but effective buzzer sounds to remind or awaken you!

Guaranteed same day dispatch.

M16

HOW TO ORDER
Payment can be made by sending cheque, postal order, Barclay, Access or American Express card numbers. Write your name, address and order details clearly, enclose 40 pence per single item for post and packing or the amount stated in the advert. All products carry 1 year written guarantee and full money-back 10 day reassurance. Battery fitting and electronic calibration service is available to customers at any Metac shop. All prices include VAT currently at 15%.

Metac Wholesale:
Trade enquiries – send for a complete list of prices for all the goods advertised plus many more not shown also minimum order details.
Telephone orders: Credit card customers can telephone orders direct to Daventry (03272) 76545 or Edgware Rd. 01-723 4753 24 hours a day.

Service Enquiries 03272-77659
CALLERS WELCOME Shops open 9-30am-6.00

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Northamptonshire
Telephone: 03272 76545

South of England
327 Edgware Road
LONDON W.2
Telephone: (01) 723 4753

Send your orders to:-
DEPT. PE1, PO BOX 6, WARE, HERTS. Tel: 0920-3182
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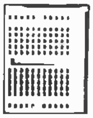
EXPERIMENTOR BREADBOARDS FROM CSC

CONTINENTAL SPECIALTIES CORPORATION

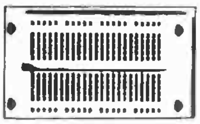
No soldering modular breadboards, simply plug components in and out of letter number identified nickel-silver contact holes. Start small and simply snap-lock boards together to build breadboard of any size.

All EXP Breadboards have two bus-bars as an integral part of the board, if you need more than 2 buses simply snap on 4 more bus-bars with the aid of an EXP.4B.

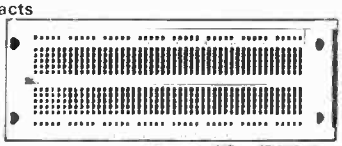
EXP.325. The ideal breadboard for 1 chip circuits.
Accepts 8, 14, 16 and up to 22 pin IC's.
ONLY £1·70



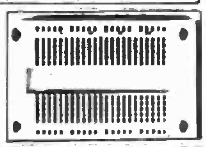
EXP.350. £3·73
270 contact points with two 20-point bus-bars.



EXP.300.
550 contacts with two 40-point bus-bars.
£6·13



EXP.650 for Micro-processors. **£3·83**



EXP.4B.
More bus-bars.
£2·45

ALL EXP.300 Breadboards mix and match with 600 series.

ANTEX IRONS

1943	15 watt quality soldering iron with 3/32″ bit	**£4·88**
1947	Replacement element for 1943	**£2·18**
1944	Iron coated bit 3/32″ for 1943	**£0·53**
1945	Iron coated bit 1/8″ for 1943	**£0·53**
1946	Iron coated bit 3/16″ for 1943	**£0·53**
1948	18 watt iron with iron coated bit	**£4·59**
1952	Replacement element for 1948	**£2·18**
1949	Iron coated bit 3/32″ for 1948	**£0·53**
1950	Iron coated bit 1/8″ for 1948	**£0·53**
1951	Iron coated bit 3/16″ for 1948	**£0·53**
1931	X25 25 watt iron, ceramic shaft and another shaft of stainless steel to ensure strength	**£4·88**
1935	Replacement element for 1931	**£1·84**
1932	Iron coated bit 1/8″ for 1931	**£0·57**
1933	Iron coated bit 2/16″ for 1931	**£0·57**
1934	Iron coated bit 3/32″ for 1931	**£0·57**
1953	SK1 soldering Kit – contains 15 watt soldering iron with 3/16″ bit plus two spare bits, a reel of solder, heat-sink and a booklet 'How to Solder	**£6·38**
1939	ST3 iron stand made from high grade bakelite chrom plated steel spring, suit all models – includes accommodation for six bits and two sponges to keep the iron bits clean	**£1·86**
1724	Model MLX as X25 iron but 12 volts	**£5·29**

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA110	£0·09	BY100	£0·25	BYZ11	£0·52	OA90	£0·11
AA120	£0·09	BY101	£0·25	BYZ12	£0·46	OA91	£0·11
AA129	£0·09	BY105	£0·25	BYZ13	£	OA95	£0·11
AAY30	£0·10	BY114	£0·25	BYZ16	£0·47	OA182	£0·15
AAZ13	£0·17	BY124	£0·25	BYZ17	£0·41	OA200	£0·09
BA100	£0·11	BY126	£0·17	BYZ18	£0·41	OA202	£0·09
BA102	£0·37	BY127	£0·18	BYZ19	£0·41	SD10	£0·07
BA148	£0·17	BY128	£0·18	OA5	£0·69	SD19	£0·07
BA154	£0·14	BY130	£0·19	OA10	£0·40	IN34	£0·08
BA155	£0·16	BY133	£0.24	OA47	£0·09	IN34A	£0·08
BA173	£0·17	BY164	£0·58	OA70	£0·09	IN914	£0·07
BB104	£0·17	BY176	£0·86	OA79	£0·11	IN916	£0·07
BAX13	£0·08	BY206	£0·34	OA81	£0·11	IN4148	£0·07
BAX16	£0·09	BYZ10	£0.51	OA85	£0·11	IS44	£0·06
						IS920	£0·07

CASES AND BOXES

INSTRUMENT CASES in two sections vinyl covered top and sides, aluminium bottom, front and back.

No.	Length	Width	Height	Price
155	8in	5½in	2in	£1·72
156	11in	6in	3in	£2·92
157	6in	4¾in	1¾in	£1·79
158	9in	5¼in	2½in	£2·43

ALUMINIUM BOXES made from bright alli, folded construction each box complete with half inch deep lid and screws.

No.	Length	Width	Height	Price
159	5¼in	2¼in	1½in	£0·85
160	4in	4in	1½in	£0·85
161	4in	2¼in	1½in	£0·85
162	5¼in	4in	1½in	£0·97
163	4in	2½in	2in	£0·87
164	3in	2in	1in	£0·60
165	7in	5in	2½in	£1·43
166	8in	6in	3in	£1·82
167	6in	4in	2in	£1·18

SLOPE front aluminium boxes with black vinyl base and sides & aluminium back, top & front – strong construction easily accessable.

169	2⅛in	5⅜in	2¾in	12in	3½in	8in	£5·45
168	2⅝in	7¼in	4in	16in	4½in	11in	£8·21

VERO plastic case box. These boxes consist of top and bottom sections which include fixings points for horizontal mounting PC boards/chassis plates, the two sections are held together by four screws which enter through the base and are concealed by plastic feet.

No.	Length	Width	Height	Price
170	140mm	40mm	205mm	£4·14
171	140mm	75mm	205mm	£4·62
172	140mm	110mm	205mm	£6·00

SPECIAL OFFERS

MINIDRILL 12v hand held battery-operated mini drill. 7,500 r.p.m. Collet chuck. Ideal for drilling printed circuits or model making. No.1402. **£7·79**

TRANSFORMER 240v Primary 0-20v @ 2A Secondary. By removing 5 turns for each volt from the secondary winding, any voltage up to 20v @ 2A is obtainable. Ideal for the experimenter. No.2042 **£1·50** + 86p P & P

ANTEX MLX Soldering Iron. Sturdy 25 watt iron complete with: 4½ metres of 2-core cable. Works off a 12 volt battery. Ideal for Car, Boat, Caravan. No.1724. **£5·29**

CARBON RESISTOR PAKS

These paks contain a range of Carbon Resistors assorted into the following groups.

16213	60 mixed 1/8w 100ohms-920ohms	£0·69
16214	60 mixed 1/8w 1Kohms-82Kohms	£0·69
16215	60 mixed 1/8w 10Kohms-83Kohms	£0·69
16216	60 mixed 1/8w 100Kohms-820Kohms	£0·69
16217	40 mixed 1/2w 100ohms-820ohms	£0·69
16218	40 mixed 1/2w 1Kohms-82Kohms	£0·69
16219	40 mixed 1/2w 10Kohms-82Kohms	£0·69
16220	40 mixed 1/2w 100Kohms-820Kohms	£0·69

CERAMIC PAKS

16160	24-3 or each value 22pf 27pf 33pf 39pf 47pf 68pf	£0·69
16161	24-3 of each value 100pf 120pf 150pf 180pf 220pf 270pf 330pf	£0·69
16162	24-3 of each value 470pf 560pf 680pf 1000pf 1500pf 2200pf 3300pf	£0·69
16163	24-3 of each value 4700pf 6800pf 01uf 015uf 022uf 033uf 047uf	£0·69

ELECTROLYTIC PAKS

16201	values from 47mfd – 10mfd	£0·69
16202	values from 10mfd – 100mfd	£0·69
16203	values from 100mfd – 680mfd	£0·69

COMPONENT PAKS

16164	200 resistors mixed value approx (count by weight)	£0·69
16165	150 capacitors mixed value approx (count by weight)	£0·69
16167	80 1/2w resistors mixed values	£0·69
16168	5 pieces assorted ferrite rods	£0·69
16169	2 tuning gangs MW LW VHF	£0·69
16170	1 pack wire 50 metres asssorted colours single strand	£0·69
16171	10 reed switches	£0·69
16172	3 micro switches	£0·69
16173	15 assorted pots	£0·69
16175	30 paper condensers – mixed values	£0·69
16176	20 electrolytics trans. types	£0·69
16177	1 pack assorted hardware – nuts, bolts gromets etc	£0·69

BOOKS BY BABANI

BP6	Engineers & Machinists Ref. Tables	40p†
BP14	2nd book Transistor Equivs & Subs	£1·10†
BP22	79 Electronic Novelty Circuits	75p†
BP24	52 Projects Using IC741 (or Equiv)	75p†
BP26	Radio Antenna Book Long Distance Reception & Transmission	85p†
BP27	Giant Chart of Radio Electronic Semiconductor & Logic Symbols	60p†
BP32	Build Metal & Treasure Locatore	85p†
BP34	Practical Repair/Renovation C/TV	95p†
BP35	Handbook of IC Audio Preamplifier & Power Amplifier Construction	95p†
BP36	50 Cicts use Germ/Sil/Zener Diodes	75p†
BP37	50 Projects Using Relays/SCR/Triacs	£1·10†
BP38	50 Field Effect Trans Projects	£1·25†
BP39	Digital IC Equivs & Pin Connection	£2·50†
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BP47	Electronics Projects for Beginners	£1·35†
BP48	Popular Electronic Projects	£1·45†
BP49	IC LM3900 Projects	£1·35†
BP50	Radio Stations Guide	£1·45†
BP55	Coil Design & Construction Manual	85p†
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BP226	Beginners Guide to Building Electronic Projects	£1·25†
BP227		

REGULATORS

Positive	Price
uA7805 TO220	£0·85
uA7812 TO220	£0·85
uA7815 TO220	£0·85
uA7824 TO220	£0·85
uA7818 TO220	£0·85
Negative	
uA7905 TO220	£0·92
uA7912 TO220	£0·92
uA7915 TO220	£0·92
uA7924 TO220	£0·92
uA7818 TO220	£0·92
72723 14 pin DN	£0·52
uA723C TO99	£0·52
LM309K TO3	£1·72

CASSETTES

o/no.3193	30 min lettertape	£0·38
o/no 301	Dindy C60 tape	£0·41
o/no, 302	Dindy C90 tape	£0·52
o/no. 303	Dindy C120 tape	£0·75

BRIDGE RECTIFIERS

SILICON 1 amp

Type	No.	Price
50v RMS	BR1/50	£0·23
100v RMS	BR1/100	£0·25
200v RMS	BR1/200	£0·29
400v RMS	BR1/400	£0·41

SILICON 2 amp

Type	No.	Price
50v RMS	BR2/50	£0·52
100v RMS	BR2/100	£0·55
200v RMS	BR2/200	£0·60
400v RMS	BR2/400	£0·67
1000v RMS	BR2/1000	£0·78

SILICON 10 amp

Type	No.	Price
50v RMS	BR10/50	£1·50
200v RMS	BR10/200	£1·70

SILICON 25 amp

Type	No.	Price
50v RMS	BR25/50	£1·90
200v RMS	BR25/200	£2·20

TRIACS

2 amp TO5 case

volts	No.	Price
100	TR12A/100	£0·36
200	TR12A/200	£0·59
400	TR12A/400	£0·82

6 amp

volts		
100	TR16A/100	£0·59
200	TR16A/200	£0·70
400	TR16A/400	£0·88

10 amp

volts		
100	TR110A/100	£0·88
200	TR110A/200	£1·06
400	TR110A/400	£1·29

10 amp

volts		
400	TR110A/400P	£1·29

DIACS
BR100 **£0·23** D32 **£0·23**

ZENER DIODES

400 mw (Bzy88) D007. Glass encapsulated range of voltages available 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4 3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v. **No. Z4 10p**

1w-1·5w Plastic and metal encapsulated. Range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No. Z13 18p**

10w Metal stud type SO10 case. Range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No. Z10 44p**

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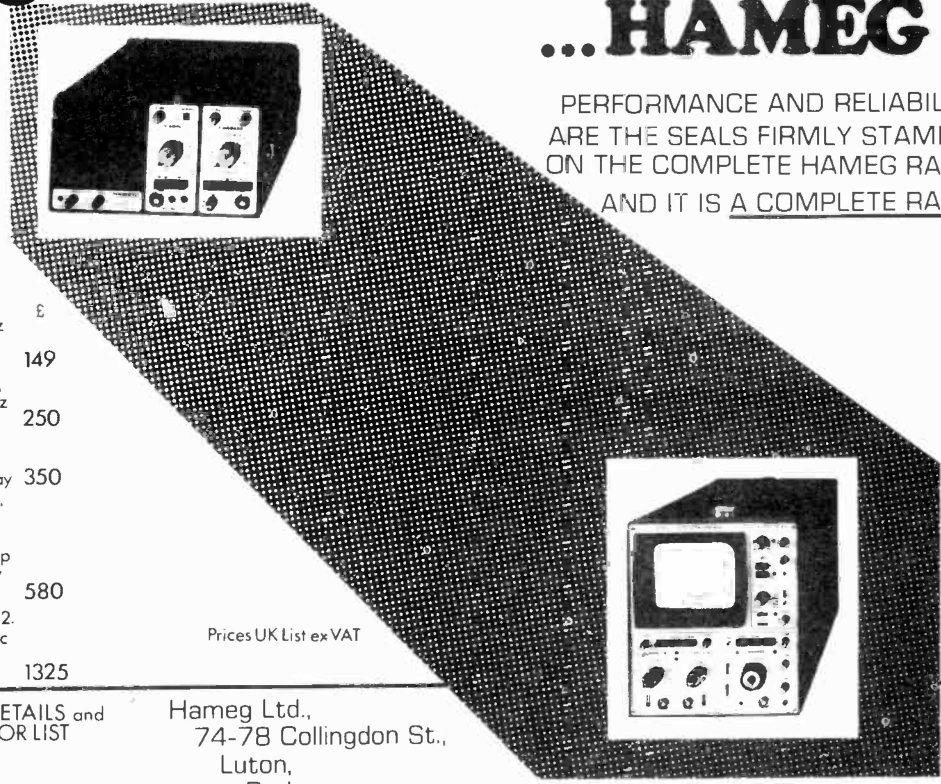

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PE VOLUME 16 No. 1 JANUARY 1980

REACTIVE TELLY

TO ANY that are hesitant at plunging into the depths of computer programming we would like to recommend them to it. The fascination of learning to think things through in a logical sequence and finding a TV to be a reactive medium after so many years of soap operas can be quite a revelation. Programming in itself probably accounts for hobby computing being such a fast growing pastime, it is most certainly addictive. Even if you find it difficult to dream up applications for the new toy don't be put off—they will probably take second place for a few months anyway.

The computer is, however, a hard task master, it does not tolerate sloppy work—even a journalist well used to checking copy can find the requirement for correctness in programming frustrating at first, no comma can be omitted. Once the basics (excuse the pun) are mastered, these previously passive punctuation marks take on new meanings, together with a few rather odd words, a range of numbers, letters and characters, they are capable of captivating the mind.

It is a new experience to spend hours gazing at a TV screen and feel achievement and satisfaction at the end of a productive session.

At first the hobby tends to be hermit like and stunts conversation and other interests to a far greater extent than the latest American repeats on the other channels—you don't get the news either! However, after a few weeks of late nights and bleary eyes, not to mention a wife who still thinks that peek and poke sound rather ominous, one comes out of it and starts to swap programs and even make the computer pay for itself. Our Modem to be published next month should assist the swopping of the latest program or chips full of data.

USEFUL?

Perhaps soon the step to becoming a useful tool will be taken by our office system—nicknamed Hal! At the present time Hal is rather a detraction, with a proliferation of new games being tried by all—apparently our Senior Illustrator is required in the Air Force, having excelled at Hectic; and we thought there was an age limit!

We hope that in due course all our indexing will be looked after by Hal. "He" will, we hope, help to lay out our issues, keep a check on the literary budget, write our standard letters, address hundreds of labels—even assist with project design and, most importantly, help us with our expenses. We could, of course, soon be receiving programs for *Microbus* from Hal via our Modem. It is just a start, but it is a start and we are all learning because of it.

Just don't expect any free time if you do invest!

Mike Kenward

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Technical Queries

We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to **one published project only**.

Components are usually available from advertisers; where we anticipate supply difficulties a source will be suggested.

Back Numbers

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 75p each including Inland/Overseas p&p.

Binders

Binders for PE are available from the same address as back numbers at £3·75 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £10·60 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

Market Place

Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

EXTRA EYE

Any constructors having problems seeing the new micro-technology will be interested in a highly efficient magnifier called the Handstand, it can be used as a hand-held magnifier or it may be inserted into a simple stand.

The lens, the wide rim protecting it and the flat handle are made as a single integral moulding from a high-grade acrylic material, which is shatter-resistant and has a better light transmittance than any glass lens. It has a diameter of 96mm (approx 4 inches), permitting both eyes to be used to view the work. Magnification is about 2 times.

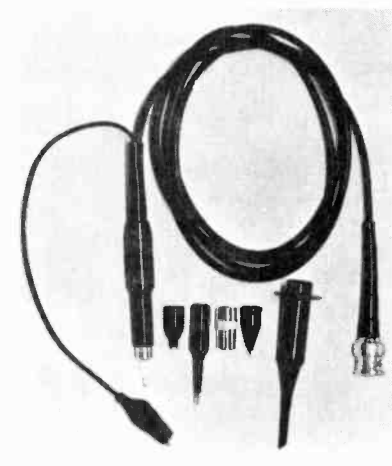
The unit is available from large stores, optical accessory outlets, stationers, hobby and craft shops at about £4·40 including VAT.

Combined Optical Industries Ltd., 200 Bath Road, Slough SL1 4DW.

SCOPE PROBES

A new range of scope probes designed for use with all popular makes of oscilloscopes is being launched by Electronic Brokers.

The probes are available in three different forms—model X1 or X10 and model X1X10



which is a switched probe. Each kit is supplied with a set of accessories, including a spring hook tip, i.c. tip, BNC adaptor and a trimmer tool. Model X10 has a bandwidth of 100MHz and the X1 a bandwidth of 20MHz. Maximum working voltage is 600V d.c., including peak a.c.

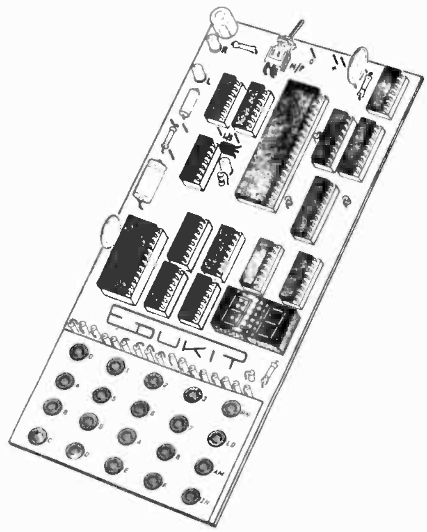
All three probes have a cable length of 1·5 metres and are supplied in a zip-up plastic wallet. Prices start from £9·00 a kit plus VAT and p&p.

For further information contact **Electronic Brokers Ltd., 49/53 Pancras Road, London NW1 2QB (01-837 7781).**

THE EDUKIT

A new MPU system aimed at teaching about micros from scratch is to be launched by Modus Systems. The EDUKIT is believed to be the first machine available for under £30. It is based around the COSMAC processor and comes with a carefully written manual produced by the designer Dr. A. A. Berk.

Rather than reading a book, those wishing to extend their knowledge to include the micro revolution can buy this complete package and practice on their own machine at very low cost.



The manual is suitable for technical and non-technical people of all ages. As well as describing construction, use of machine-code, hardware control etc., it guides the user to bigger machines once the basics have been learned on the EDUKIT.

The machine has hex keypad and hex display, 256 bytes of RAM, runs from a 6 volt dry battery or a 5 volt supply and has special command keys for loading and running programs and correcting mistakes. Plenty of I/O lines are included to form the basis of a simple but powerful control device. Indeed, the COSMAC MPU is very well set up for exactly this application.

As a special introductory offer, the EDUKIT is available from **Modus Systems., 29A, Eastcheap, Letchworth, Herts., at £29·99 inc. VAT. plus 80p p&p.**

BRAIN BANK

The Brainbank Electronic Information Centre represents a new generation of pocket companions following on from calculators and mini TVs. It is a learning aid, phrase book and translator for foreign languages; a library of general knowledge, education and entertainment topics; and a personal filing system combined.

The unit has a series of plug-in interchangeable memory cells, which provide this hand-held, machine with an infinitely variable store of information. This effective and novel learning laboratory for foreign languages has a powerful and immediate translation facility of up to three languages at a time.

Each language cell holds 1,200 of the most frequently used words which can be stored both in alphabetical order and by groups of up to 50 in categories such as Travelling, Clothing, and Food.

Operation is via an A to Z keyboard, which includes numerals and punctuation. The unit is also programmed with 25 complete and 25 partial phrases which can be added to give full sentences, for example "May I introduce . . .", "I'd like to say . . .". Spelling mistakes are automatically corrected and a "phonetic" cell aids pronounciation.

Currently six language cells are available—English, French, German, Spanish, Italian and Portuguese, with Japanese and Arabic due in

the next few weeks. All the remaining major languages will be available during the next four months.

As an Information Centre, the unit has a built-in metric conversion facility, while memory cells containing comprehensive details on diet and nutrition programs, First Aid, Taxation and a Thesaurus are already complete.

The unit is housed in a robust case which measures 7 × 3 × 1½in and weighs 14oz. It is powered by four standard alkaline penlight batteries which give ten hours continuous use, or by rechargeable nickel cadmium batteries. "Brainbank" is sold complete with mains adaptor and battery recharger and one free cell. The price is around £150 and additional cells cost under £20.

Further details **Ring Group, Gelderd Road, Leeds LS12 6NB. (0532 632421).**

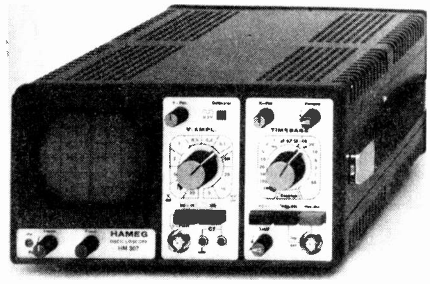
CATALOGUES

The latest catalogue from Ace Mailtronix is now available at a cost of 30p with a 30p voucher which is redeemable with orders over £5·00. Ace can also supply all RS stock items and have also helped many readers obtain particularly difficult to get components. So the next time you are looking for an awkward item try **Ace Mailtronix, Tootal Street, Wakefield, West Yorkshire WF15 JR.**

Also available now is the latest edition of Ambit International's Tecknowledgey series (the third) which follows the style of the other two with plenty of constructional circuits and component information. All three editions are available for £1·50 which includes p&p.

Ambit International, 2 Gresham Road, Brentwood, Essex CM14 4HN (0277 216029).

The latest TK Electronics catalogue contains a wide range of components and includes applications for triacs, UJT, timers and dimmers. The catalogue is available free of charge from **TK Electronics, 106 Studley Grange Road, London W7 2LX** (Please send a stamped addressed envelope). **Both TK and WATFORD ELECTRONICS can supply the chip (AY-3-1270) used in the Digital Temperature Controller (Oct. '79).**

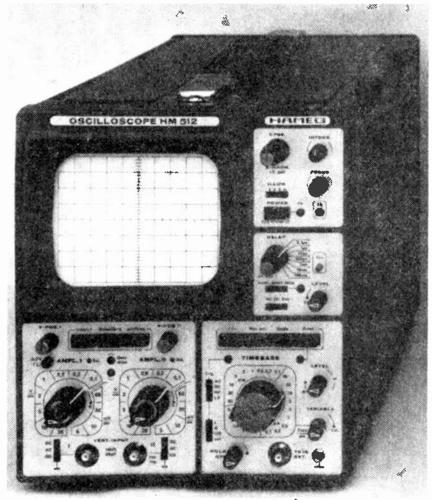


NEW SCOPE RANGE

Hameg is a new name in the high performance low cost oscilloscope market. Though until now relatively unknown in this country the company has established a dominant position in the West German market.

Their current range of products extends from the single trace HM307 10MHz instrument, which features a built-in component tester, up to the 50MHz dual trace HM812 with storage and sweep delay facilities.

The HM312 is a dual trace oscilloscope with a vertical amplifier bandwidth of dc–20MHz and 5mV/cm sensitivity. Full X-Y operation is achieved by switching channel 2 into the horizontal deflection system. This amplifier system is complemented by a wide



range calibrated timebase with 18 sweep speeds from 0·5µs–0·2s/cm.

The complete range and prices excluding VAT are as follows: HM 307–3 (£149), HM 312–8 (£250), HM 412–4 (£350), HM 512–8 (£580) and the HM 812–2 (£1,325).

For further information contact **Hameg Ltd., 74–78 Collingdon Street, Luton, Bedfordshire LU11 RX (0582 413174).**

LOW COST MULTIMETER

The new MINI 20 multimeter from Alcon Instruments has been designed specifically to cover the needs of the lower end of the market.

Built in ABS plastic, with a full-view anti-static cover and the simplest of controls, this instrument is ideal for applications where simplicity is the keynote.

One rotary-switch selects any 27 ranges in a.c., d.c. (both V & I) or resistance. The scale used is provided with an anti-parallax mirror

and clear calibrations to avoid ambiguity and error. The only other control is the ohms zero potentiometer, which projects from the right hand side of the instrument-case.

Only two terminations are used (4mm banana) so there is no possibilty of confusion in selecting a wrong socket for a probe, and the ranges provided cover most situations.

Sensitivity is 20kΩ/V d.c. and 4kΩ/V a.c. Accuracy is 2 per cent on d.c. and on resistance, and 3 per cent on a.c.—sufficient for most professional uses and other applications.

Ranges extend from 100mV to 600V d.c., 15V to 1500V a.c., 50µA to 600mA d.c., 30mA to 3A a.c., and up to 2kΩ and 2MΩ on resistance. There are also five dB ranges corresponding to the five a.c. voltage ranges.

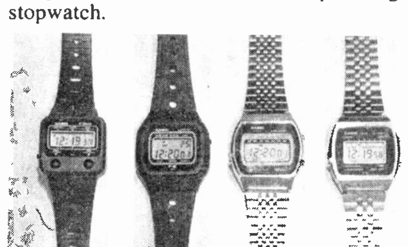
An internal battery provides power for the resistance ranges and protection is by both movement diode and fuse.

The instrument comes complete with case, leads and instructions at £27·37 including VAT.

Alcon Instruments, 19 Mulberry Walk SW3 (01-352 1897)

CASIO WATCHES

Four of the latest range of Casio watches are shown below. The F-8C has an eight digit readout of hours, minutes, seconds and date with a four year calendar. Both the F-8C and the F-200 sports have black resin cases and straps with the F-200 incorporating a stopwatch.



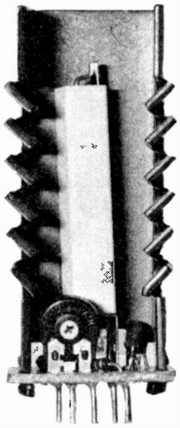
The 95QS-31B and 81CS-36B are stainless steel chronographs with six digit readouts and calendars pre-programmed to the year 2029. These models also have alarm and stop watch facilities. Prices F-8C (£10·95), F-200 (£15·95), 95QS-31B (£23·95) and the 81CS-36B (£35·95).

Tempus, The Beaumont Centre, 164-167 East Road, Cambridge, CB1 1DB (0223 312866).

LEDCo

The LEDCo company manufacture and market a wide range of replacement panels and modules for colour TVs.

A typical example is the CDA panel (colour-difference amplifier) fitted to the Pye 691, 693 and 697 chassis. The main problem with the board has been the heat generated by the four valves which have resulted in charred p.c.b.s and oxidisation of valve pins and holder contacts. The new replacement panel, which



requires no soldering, is a solid state design and is available with details of setting-up procedure, expected voltage reading and a circuit diagram.

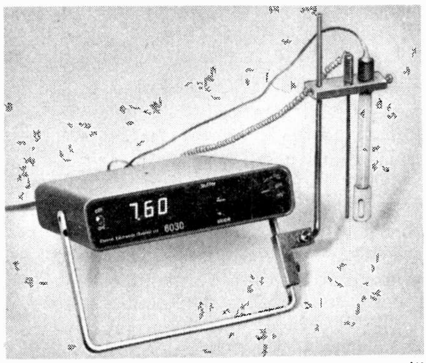
Another development is a solid state replacement for the PL802 which plugs right into the existing holder and requires no modifications.

For further information about these and other replacement panels. **LEDCo, 189a Livingstone Road, Thornton Heath, Surrey, CR4 8JZ (01-653 7575).**

pH METER

The 6030pH meter has been designed for the rapid and accurate determination of pH, millivolts and temperature values.

The unit measures over the range 0-14·00 pH to a resolution of 0·01pH and has completely automatic temperature compensation over the range 0-100°C. In the temperature measurement mode the instrument will measure from −149·9°C to 199·9°C to a resolution of 0·1°C. This is effected by the use of a high accuracy platinum resistance probe.



In the millivolt mode the instrument will measure over the range ±999mV to a resolution of 1·0mV.

A voltage output for each of the measuring modes is provided at the rear of the instrument and offers a 1mV per least significant digit output.

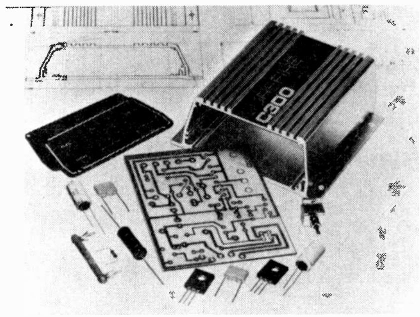
The Model 6030 is supplied complete with one plastic bodied, gell filled combination pH electrode, one PRT probe plus buffer powders. A convenient pH temperature compensation electrode holder is available which clamps to the front of the instrument.

The price of the 6030 is £199 plus VAT and p&p.

Channel Electronics (Sussex) Ltd., P.O. Box 58, Seaford, Sussex BN25 3JB (0323 894961).

TOP CDI SYSTEM AS KIT

Electronic ignition systems have the general advantage of greatly extending the life of contact breakers and plugs, also affording a fat spark for easy starting and obviating misfiring at high engine speeds.



Suretron Systems have for a number of years been marketing both the ES2000 and C3000 with the latter figuring very favourably against stern competition in *"Which"* magazine tests. Now, on special offer, this company provides the same electronics and therefore performance in kit form renumbered as the ES200 and C300. Purchasing either shows a considerable price saving, almost half the price of its completed counterpart. These are ES200—£13.95 and C300—£17.95 which includes VAT and postage.

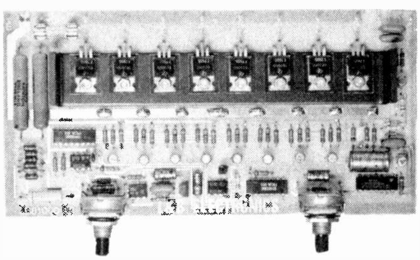
Suretron Systems (UK), Ltd, Piccadilly Place, London Road, Bath, BA1 6PW.

CHASERS

Two new modules have been introduced to the existing range of lighting control units from L&B Electronics.

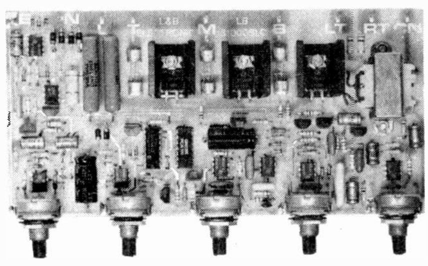
The LB81000 & C is an eight channel chaser capable of controlling a substantial number of lights.

A chase speed control allows a wide variation of chase rates whilst a second control allows a delay to be introduced between the



end of the chase cycle and the start of a new one. During this delay period, all the lamps remain off. Again the wide range enables this delay to be set to virtually zero, if required, so the sequence appears to start immediately after the finish of the last one. Both controls are mounted at the board edge, allowing easy presentation to your front panel.

Because the system logic allows only one channel of lamps to be powered at any given instant, the mains current consumption will never exceed the loading of one channel, ie, four amps max, although up to 8000 watts may be connected. This is a considerable advantage meaning that the module can be connected to a domestic mains supply, with a tremendous number of lamps (eighty 100W spots for instance). As each triac is triggered near to mains zero, no interference is produced on nearby amplifier equipment, and the use of heavy duty triacs and in-line fusing



gives protection against overload. Full logic design, using CMOS i.c.s, means no additional power supplies are required, so connection remains simple.

Additional features allow the chaser to be footswitch triggered (ideal for band stage effects). In this mode, the module may be set to give one chase cycle per footswitch pulse, or can be triggered into continuous cycles from a single pulse. Further trigger output and input pulses allow modules to be connected in series, to form 16, 24, 32, 40, etc., channels (there is no limit to the number), hence forming a line or tunnel of lamps, that may indeed be set to run as a continuous chase, or be footswitch controlled.

Each p.c.b. is fully assembled, tested, supplied with full wiring instructions, circuit diagram, and guaranteed for a year.

The LB31000SLC is a sound-to-light chaser. When fed. by a music source the module acts as a sound-to-light system, flashing three banks of lamps, bass, middle and treble. However, when the music signal ceases or becomes sufficiently low enough, the system automatically switches to a chase mode. Upon return of the music signal, the sound-to-light display is instantly resumed.

Five controls, mounted on the board, allow variation of chase speed, master volume for the sound input and individual bass, mid and treble settings for the perfectionist.

No additional components are required. The system is simply wired to the mains, the three banks of lights, and the music input (usually derived from across the speaker terminals). You will need a suitable case/panel.

Each board is thoroughly tested and inspected, guaranteed for a year and provided with wiring instructions and circuit diagram.

The price of the 81000LC is £25·50 and the 31000SLC is £28·90 including VAT, plus 50p postage and packing.

L&B Electronics, 45 Wortley Road, West Croydon, Surrey, CR0 3FB.

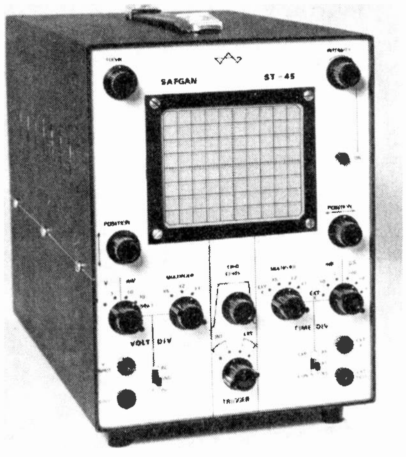
LOW COST SCOPE

Manufacturers of the ST-45 claim to have reached the peak of performance-quality to price ratio with the introduction of the SAFGAN ST-45 oscilloscope.

This single trace oscilloscope with 5MHz bandwidth, 10mV/div sensitivity and a display area of 6·4cm x 8cm with a graticule ruling of 8 x 10 divisions. The vertical amplifier which has 1MΩ plus approx 22pf input impedance uses a FET input stage followed by stages consisting of transistor arrays in order to achieve minimal drift of the trace with temperature changes. Input attenuator stages are set for best-pulse shapes and has ±5 per cent accuracy on all ranges. 50Ω input impedance attenuator settings are useful for r.f. work.

Overall time base speed range from 250ms/div to 200ns/div including multiplier and x5 expansion facilities; all timebase speeds are calibrated to ±5 per cent accuracy. External −x senstivity is 1V/div with 500kHz bandwidth.

Trigger level and +ve, −ve slope selection



on both internal and external trigger modes is also incorporated.

The instrument is mains powered with an approx power consumption of 10 watts. Aluminium covers are black with p.v.c. finish and are fairly scratch proof.

The price of the ST-45 is £125·00 plus VAT.

Safgan Electronics Ltd., 56 Bishops Wood, St. Johns, Woking, Surrey GU21 2QB (04862 66836).

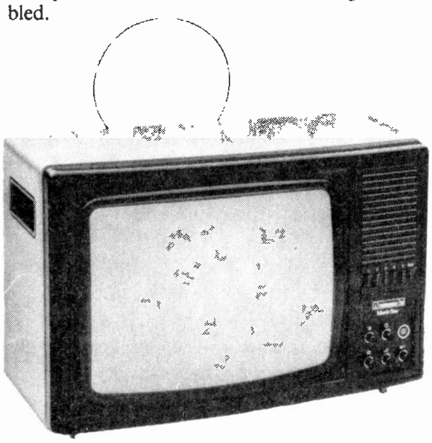
NEW COMPONENT SUPPLIERS

Our cover subject this month is the product of a new component supplier. This company—WICCA Electronic Systems Ltd—have been able to source the transducer and tank in order to develop the Ultrasonic Cleaner and have had the coil and transformer specially wound and the cases made up to form a complete kit for the project. WICCA are also now supplying various other components including a new Sanyo dual 30W amplifier module (STK 463) and a sound to light unit, see their advertisement in this issue for more details. **WICCA Electronic Systems Ltd., Orchard Works, Church Lane, Wallington, Surrey.**

Market Place

FERGUSON TX9

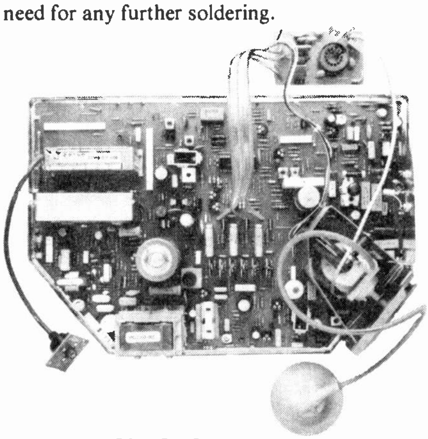
The first TV to feature Ferguson's revolutionary TX9 single board chassis is now available. This new colour set is a 14 inch portable model called the Moviestar 3755 and Market Place recently had the opportunity to visit the production line at Gosport in Hampshire to see how the set is being assembled.



The 14in Moviestar model 3755.

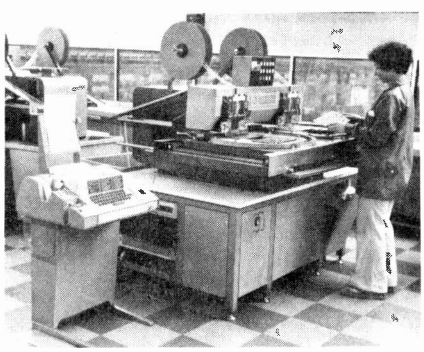
When Ferguson decided to design a completely new TV they realised that to compete with foreign manufacturers the new set would have to be automatically assembled to a very large degree, using the most up-to-date techniques available. This decision involved the company in a massive £10 million plus investment programme which when finished will make the Gosport factory the most advanced automatic TV production line in the UK.

The single board chassis has 70 per cent of its components automatically tested, inserted and soldered. After the rest of the components have been fitted the complete board is tested and assembled into the cabinet without the need for any further soldering.



The TX9 chassis.

Using automatic insertion techniques the component density of the p.c.b. can be greatly increased. Also as the number of components has been greatly reduced compared with their 9000 series chassis the overall effect is a



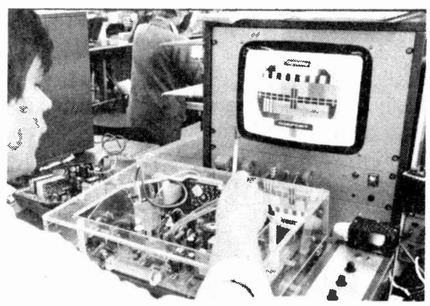
The automatic insertion system is computer controlled with the components being fed from a bandolier to the machine head where they are crimped into the p.c.b.

reduction in human errors and an increase in both performance and reliability in the set.

The 3755 model will be followed by 16in, 18in and 20in versions, each driven by the TX9 chassis without the need for any component or electrical changes. The TX9 also consumes less power than most other CTV's (50 per cent less than the 9000 series) and therefore generates less heat inside the receiver resulting in increased component life.

An optional 12 or 24V battery converter which has been designed for in-set installation is also available. Further developments will include Teletext, Viewdata and infra-red/ultrasonic remote control models.

One area where the 3755 will get a very good reception is servicing. If a set should need attention the engineer will find the chassis easily accessible and because it can be positioned vertically free access is available to both sides of the p.c.b. If the fault cannot be



After assembly the chassis is checked to assess picture alignment.

traced the chassis can be replaced in minutes.

Another advantage in using the same chassis in the 14in, 16in, 18in and 20in models is that the range of parts required for servicing is greatly reduced.

As TV production—like most areas of electronics—is a fiercely competitive business it is good to see a British company with the foresight and confidence to manufacture a well designed product to fill a definite market gap and using advanced production techniques to ensure a competitive price (around £250).

Scratch & Rumble Filter

R.A.Penfold

A scratch filter can be very effective at reducing the noise generated when playing worn or dust impregnated records. This type of filter merely attenuates high frequency signals above about 6 or 7kHz, and the background "crackle" of surface noise consists mainly of frequencies above this level. Comparatively little of the programme signal will be in this high frequency range, and so the noise is considerably attenuated with little, although admittedly some, of the wanted signal being lost.

A rumble filter operates at the opposite end of the audio frequency spectrum, and rolls off the low frequency response of the system below about 50Hz. This can be used to reduce noise produced by record warps or pressing imperfections.

Again, there will obviously be some loss of the wanted signal, but this will only be minimal. Most of the frequency range affected by a rumble filter lies below the lower limit of the audio spectrum. It may seem to be pointless to attenuate noise which cannot be heard, but it is not necessarily superfluous to do so. Record warps can generate strong low frequency signals which will vary the amplifier's biasing either side of its normal central level. This can cause the main signal to be clipped on one set of half cycles when the low frequency signal is at or close to its peak positive or negative level. Even if clipping does not occur, intermodulation distortion can still cause audible phasing type effects to be produced.

Although some hi-fi amplifiers and receivers incorporate scratch and/or rumble filters, this is by no means a feature of all designs. Also, many amplifiers and receivers that do have these filters only have simple 6dB/octave types. These can be quite effective, but do not give a level of performance equal to that of a sophisticated filter having an attenuation rate of 12dB/octave or more. It is possible to use an add-on scratch and rumble filter with most hi-fi systems, and it is a high performance unit of this type that forms the subject of this article.

BASIC FILTERS

Ideally a scratch filter would not attenuate frequencies below the turn-over frequency, and would eliminate all signals above this frequency. Similarly, an ideal rumble filter would not affect signals above the turn-over frequency, and would block signals below this frequency. Simple passive filters fall well short of this goal, and give an ultimate roll off rate of only about 6dB/octave as well as significant losses at frequencies well within the passband.

A basic R–C high pass filter uses the arrangement shown in Fig. 1(a). The component values are chosen so that the impedance of C is low in relation to that of R at pass frequencies, and the impedance of C is roughly equal to that of R at the desired cut off frequency. Thus, there is little attenuation at pass frequencies, and a loss of about 6dB at the cut off frequency, increasing by about 6dB/octave below this due to the losses produced by the increasing impedance of C.

A basic R–C low pass filter is shown in Fig. 1(b) and operates in much the same way as the high pass circuit. However, the capacitor and resistor have been swapped over so that as the impedance of C falls with increasing frequency, losses through R increase, as does the attenuation through the circuit.

The relatively slow roll off rate of these circuits can be greatly improved by using two or more filters in series. Unfortunately this still tends to leave significant losses at frequencies well below the cut off frequency.

ACTIVE FILTERS

This problem can be overcome by using an active filter of the type outlined in Fig. 1(c) (high pass) and Fig. 1(d) (low pass).

Taking Fig. 1(c) first, the series capacitance of C1 and C2 forms a simple high pass filter in conjunction with R1. The output from this network is taken to a buffer amplifier, and bootstrapping resistor R2 introduces positive feedback between the output of the buffer amplifier and the junction of C1–C2.

Whereas the negative feedback normally employed in audio circuits has the effect of flattening any variations in frequency response, positive feedback has the opposite effect and tends to increase any such variations. This is desirable in this case since it produces a fast roll off rate.

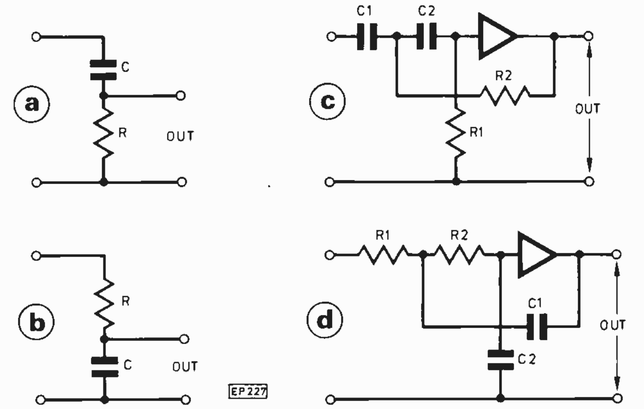


Fig. 1(a) Basic R–C high pass filter (b) low pass filter (c) active high pass (d) active low pass

At pass frequencies R2 does not have any real effect on the circuit since any change in voltage at the junction of C1 and C2 will be matched by an identical change at the output of the buffer amplifier. No voltage is developed across R2, and it is effectively nonexistent.

If R2 has a suitable value, at frequencies where the circuits response is beginning to fall slightly it will tend to reinforce the input signal, flattening the response and preventing the very gradual initial roll off that occurs with passive filters. Filters of this type often actually have a small peak in the response just above the cut off frequency.

At frequencies where C1–C2 and R1 introduce significant losses, voltage changes at the left hand end of R2 will no longer be fully matched by a change in potential at the other end. This results in some of the input signal current flowing through R2, and this component then effectively forms a second high pass filter network in conjunction with C1. This increases the attenuation rate to about 12dB/octave.

Thus this type of circuit does not attenuate signals that are well below the cut off frequency, and has a fairly fast attenuation rate. By using two or more R–C networks at the input it is possible to obtain an extremely rapid roll off rate.

The low pass version of this filter configuration functions in the same basic manner as the high pass one, but the resistive and capacitive circuit elements are, of course, transposed in order to obtain the correct filter action.

CIRCUIT

The complete circuit diagram of the scratch and rumble filter appears in Fig. 2.

The buffer amplifier for the rumble filter uses TR1 in the emitter follower mode. This has R6 as its emitter load and is biased by R4 and R5. Two sets of filter components are used at the input, the first consisting of C3, R1, C4, and R2, and the second one using C5, R3, C6, and the input impedance of the buffer amplifier. The latter is mainly determined by the

COMPONENTS . . .

Asterisked components should be repeated for a stereo channel

Resistors

R1*	5·6k	R7*	4·7k
R2*	12k	R8*	4·7k
R3*	6·8k	R9*	4·7k
R4*	120k	R10*	4·7k
R5*	150k	R11*	3·9k
R6*	3·9k	R12*	330

All miniature ¼ watt 5% carbon

Capacitors

C1*	100n type C280
C2*	4·7µ 16V
C3*	470n type C280
C4*	470n type C280
C5*	470n type C280
C6*	470n type C280
C7*	6·8n polystyrene
C8*	3·3n polystyrene
C9*	10n polystyrene
C10*	680p polystyrene
C11*	10µ 25V electrolytic
C12	2,200µ 25V electrolytic
C13	330µ 16V electrolytic

Semiconductors

TR1*	BC109
TR2*	BC109
TR3	BFY51
D1	1N4001
D2	1N4001
D3	BZY88C13V 400mW Zener

Switches

S1–S3 Double pole rotary on/off switches (3 off)

Transformer

T1 Standard mains primary, 12–0–12V secondary of 50 or 100mA rating

Fuse

FS1 1¼in 100mA

Miscellaneous

Main printed circuit board, and P.S.U. printed circuit board
Case of metal construction and having dimensions of about 203 × 152 × 63mm (see text)
Three aluminium control knobs
Panel neon indicator having integral series resistor for mains operation
1¼in in-line fuseholder
Phono input and output sockets (SK1 and SK2)
Wire, grommet, solder, etc

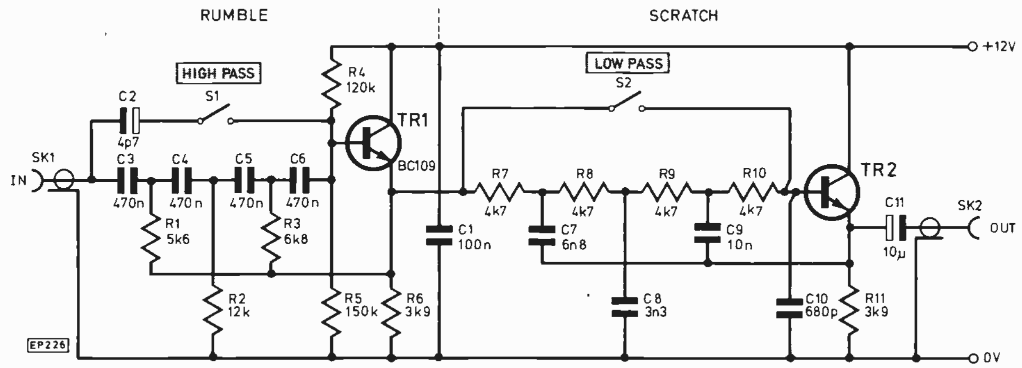


Fig. 2 Complete circuit

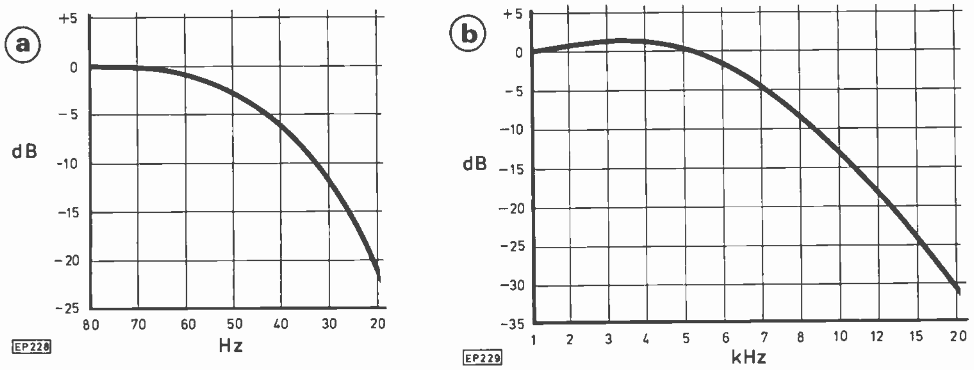


Fig. 3(a) Frequency response graph of rumble filter and (b) response of scratch filter

values of the two biasing resistors. S1 can be used to bypass the filter components and eliminate the filtering. C2 is merely a d.c. blocking capacitor.

As can be seen from the frequency response graph of Fig. 3(a), the rumble filter has a −6dB point at about 40Hz, and a roll off rate of approximately 18dB/octave.

TR2 is used in the emitter follower mode and is the buffer amplifier for the scratch filter. It has R11 as its emitter load resistor and is biased from the emitter of TR1 via filter resistors R7 to R10. C7 to C10 are the capacitive elements of the low pass filter, and again, two filter sections are used. When only the high pass filtering is required, S2 can be used to bypass the low pass filter networks. C11 provides d.c. blocking at the output.

The frequency response of the scratch filter is shown in Fig. 3(b). The −6dB point is reached at a little in excess of 7kHz, and the response then falls away at about 18dB/octave.

Negligible noise and distortion are introduced by the unit since both active stages have 100 per cent negative feedback.

MAINS P.S.U.

The circuit has a current consumption of about 3mA from 12V, and will work well on any supply potential from about 9 to 18V. A 9V battery supply can be used, but the prototype is powered from the simple mains power supply circuit given in Fig. 5.

This uses a push-pull rectifier and smoothing circuit feeding a conventional emitter follower series regulator. This gives an extremely well smoothed output of approximately 12V. S3 is the on/off switch.

Note that if an alternative mains supply unit is used, this must have a low ripple output since any noise on the supply lines will be coupled into the main signal path by the biasing resistors in the main circuit.

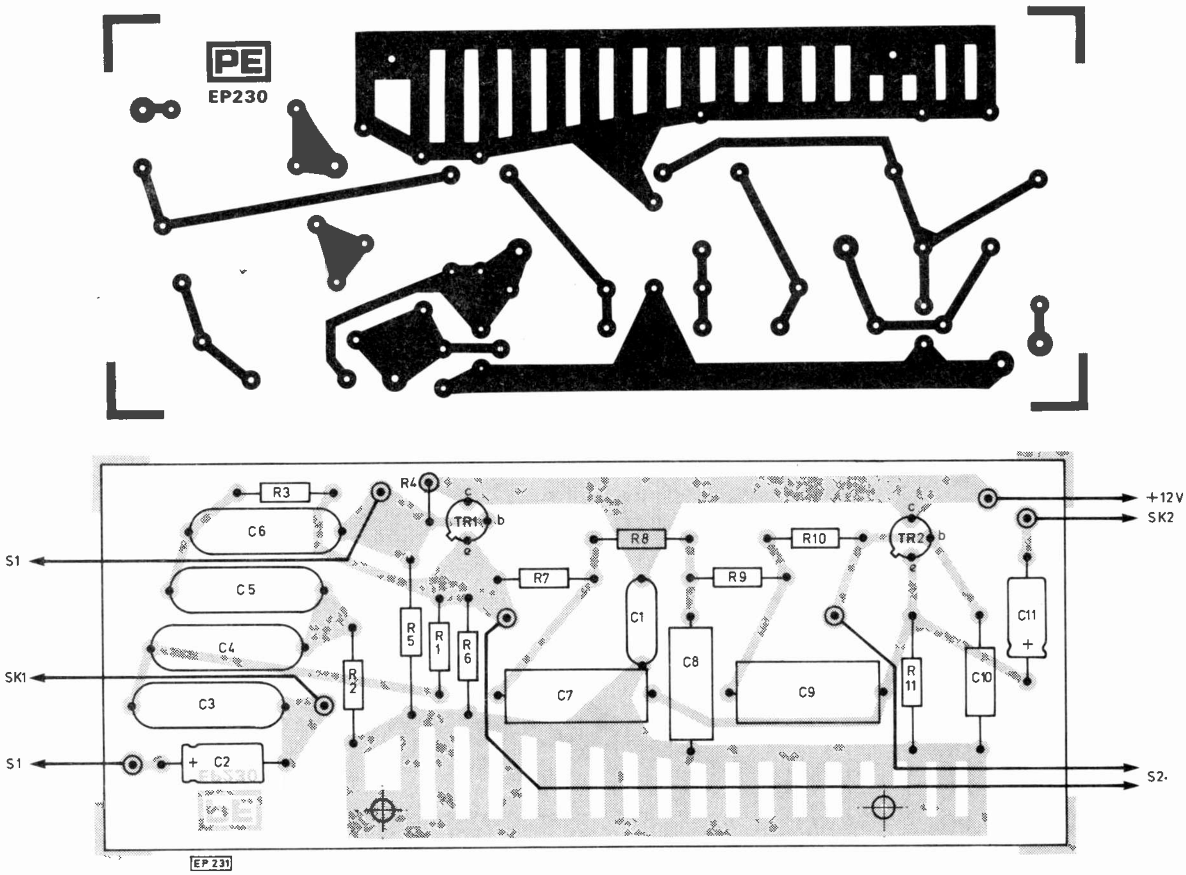


Fig. 4 P.c.b. and component layout

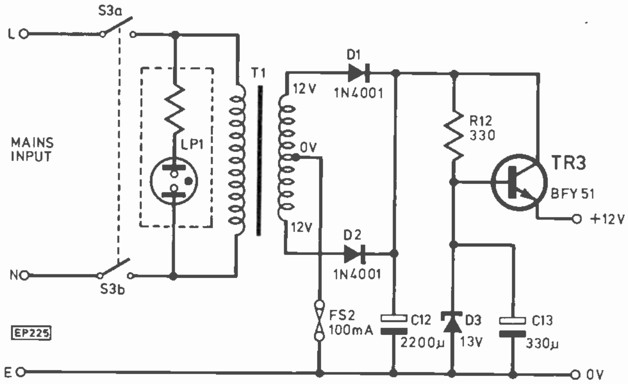


Fig. 5 Mains p.s.u.

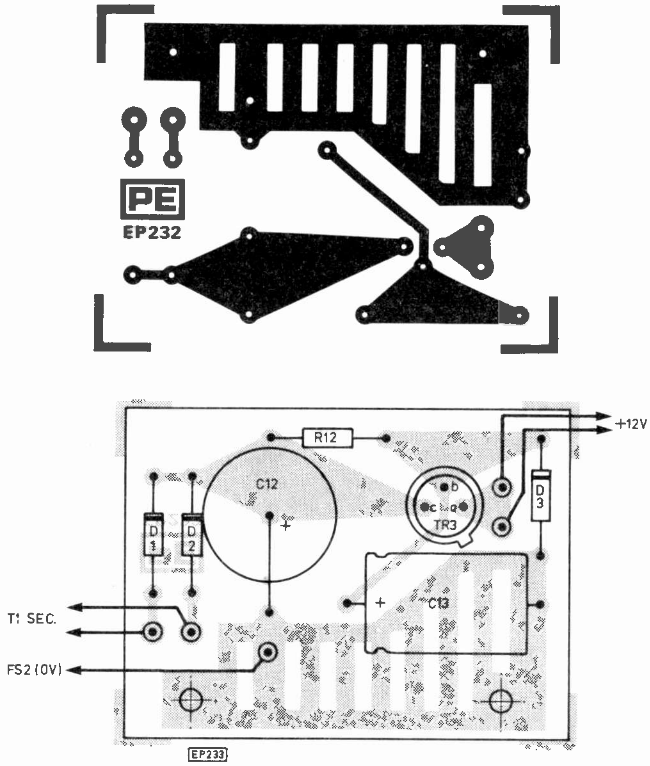


Fig. 7 P.c.b. and component layout for p.s.u.

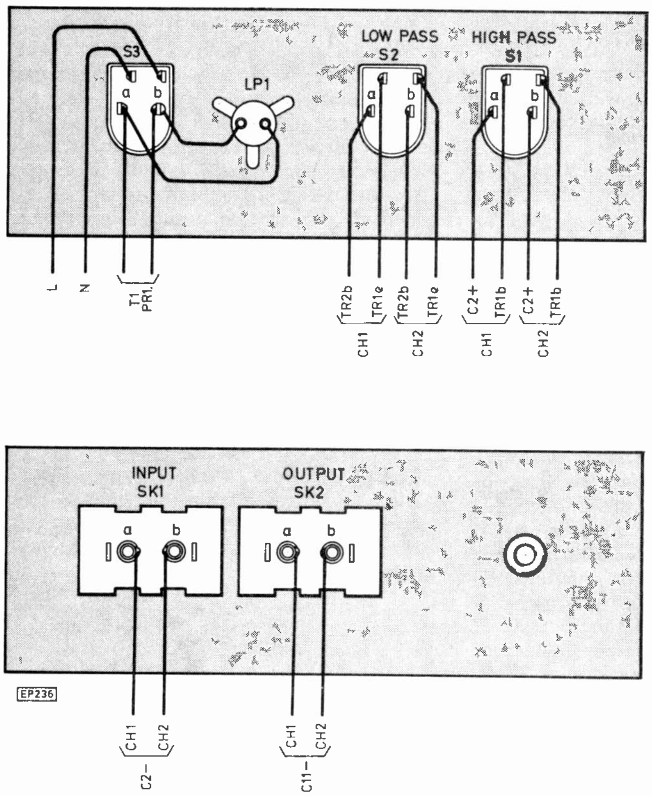
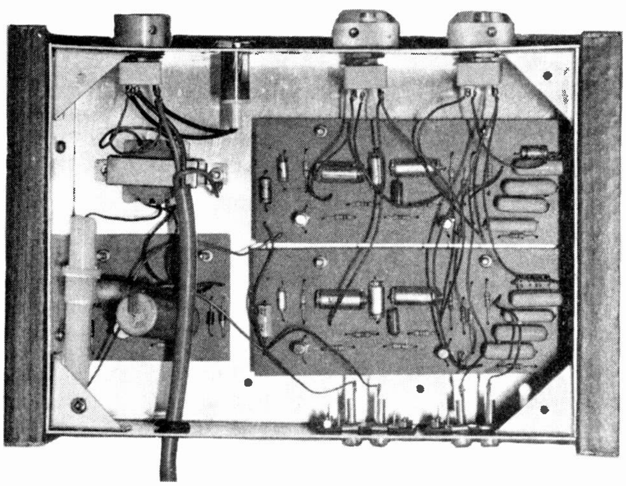


Fig. 6 Component assembly for panels



CONSTRUCTION

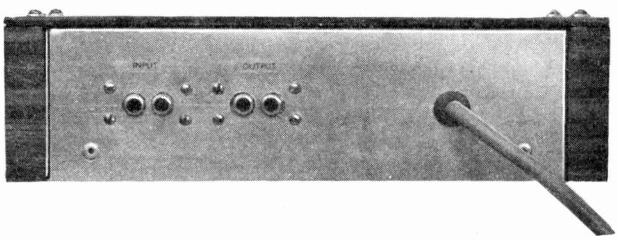
The housing for the prototype consists of a 203 × 152 × 63mm chassis and base plate to which a wood grain finish for top and sides was added to give a better appearance.

The filter components are assembled on a printed circuit board using the copper backing pattern and component layout illustrated actual size in Fig. 4. Of course, for stereo operation it is necessary to make up two of these p.c.b. assemblies, one for each channel.

A separate printed circuit board is used to accommodate most of the power supply components. Details of this and the other power supply wiring are provided in Fig. 7. The negative supply rail, and the earthy connections to the input and output sockets, are all carried by the metal chassis plus the mounting bolts and spacers for the p.c.b.s.

USING THE UNIT

It is necessary to connect the filter between the pre-amplifier output and the power amplifier input. Many amplifiers have a "tape monitor" facility or something of this nature which enables this to be easily achieved. It is not really feasible to use the unit with equipment which does not have such a facility unless it is fitted with a suitable pre-amplifier to enable it to be connected between the record deck and a high level input of the amplifier. ★



Semiconductor UPDATE...

FEATURING 8294 2920 SL446A SL441A R.W. Coles

JAMES BOND CHIP

If I were 'M' I would send our Jim off to Intel for a crash course in microprocessor encryption techniques before that bunch from SMERSH and SPECTRE get there.

Gone forever, it seems, are the five letter groups and secret code books of yesterday's spy, and disappearing too is the need for rack sized encryption and decryption systems at the FO and the ACME Import/Export Co. Intel have spoiled all the fun by designing a chip to do both jobs and, horror of horrors, *anyone* can buy one!

The mathematics of code generation and code breaking reached their zenith during the second world war, and as we now know, we (the British) were much better at breaking codes than the Germans were at generating them. It became obvious with the dawn of the computer age that there could be no such things as an unbreakable code, and the effectiveness of a code is now judged not by whether it can or cannot be cracked but simply by how long it would take the fastest available computer to crack it! It is quite feasible to generate codes which would take hundreds of years to crack, but for most commercial purposes a code which will afford a few years, or even a few weeks protection is quite adequate. Think of the cost of tying up a mainframe computer for a few weeks just to crack one message.

Because more and more "sensitive" commercial data is being transmitted from computer to computer over telephone and satellite links and being carried around on magnetic tapes or discs, the US government has identified the need for a data encryption standard which can be used by anyone who requires this kind of security. An algorithm has been produced by the National Bureau of Standards which will generate codes secure enough for all but MI5 and the CIA, and to implement this algorithm, Intel has produced the **8294** data encryption/decryption device. The 8294 is used as a peripheral chip in a microprocessor based system using an 8080 or similar CPU chip, and is therefore as easy to use as, say, an 8251 USART device. The 8294 fits into a 40 pin package and runs from a single 5 volt supply. It accepts data in 64 bit (8 byte) blocks and encrypts or scrambles it at the rate of 640 bits per second using a 64 bit "key" supplied by the user. The 8294 is normally controlled by the microprocessor but data can be transferred to and from the 8294 either under software control or by means of the much faster Direct Memory Access (DMA) technique. With the chip initialised and an eight byte key entered, encryption or decryption is achieved by simply entering eight data bytes and reading back the eight converted bytes. Simple, eh, Jim!

ANALOGUE MICRO

It had to happen I suppose. All you die-hard analogue fans who still feel that microprocessors will never replace the 741 op-amp or those lovely tuned filters using rows of carefully wound inductors and precision capacitors, stand by for a few nagging doubts!

Intel have done it again, by introducing a radical new microprocessor chip with analogue inputs and analogue outputs, to challenge traditional linear circuit designs in some of their most hallowed sanctuaries.

Imagine a single 28 pin chip running from plus and minus five volt supplies. To the input of the chip you connect a wide-band audio signal, and from the output you get a filtered 1kHz tone whenever the input signal is in-band. Sounds like a conventional 1kHz bandpass filter circuit, but in this case it's the Intel **2920** analogue microprocessor, and you tune the filter not by means of precision RLC components but by means of software instructions! Fed up with a 1kHz bandpass filter? No problem. The 2920 program is stored in an on-chip erasable PROM memory, so just give it a dose of UV light and reprogram for 500Hz. Fed up with filters altogether? Why not program up a function generator, or a full-wave rectifier or a logarithmic amplifier or—well the mind boggles! Actually you can do even more, because the 2920 has *four* separate multiplexed analogue inputs, and eight separate sample-hold output amplifiers, some or all of which can be programmed as TTL compatible logic outputs (to indicate under or over frequency in the filter example, perhaps).

Take heart all you clever analogue circuit fans, because you still need the same skills as before to design a 2920 application program, only the hardware really changes. To describe a filter you require a mathematical function whether you use LC components or the 2920. When you use the 2920 however, instead of choosing component values to suit the mathematical function, you write a software program instead. You still have to be a bit of a clever-clogs to get the function correct in the first place of course, and there is really very little scope for suck-it-and-see tuning techniques when using the new approach!

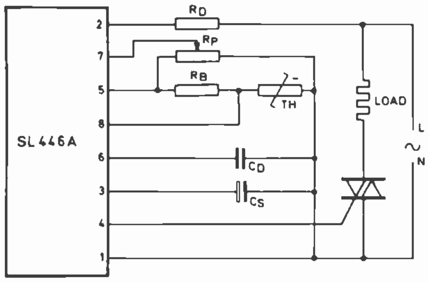
Internally, the 2920 has an analogue to digital converter at its front-end and a digital to analogue converter to generate outputs. Each time the A to D takes a sample of the input signal, the 2920 executes its entire program of up to 192 instructions. The time it takes to do this determines the input sample rate and hence the bandwidth of the system. With the longest program possible, single input frequencies of up to 6·5kHz can be dealt with (13kHz sample rate).

The architecture of the 2920 is not comparable to any "normal" microprocessor because of the requirement for fast accurate computation and the lack of any external data or address bus needs. Instruction words are actually 24 bits wide, and the internal arithmetic unit uses 25 bit precision to reduce error accumulation. Because the 2920 is timed from a crystal controlled clock source, the time and temperature drifts of conventional low frequency components can be all but eliminated.

So there it is you linear fans, time to retrieve that microprocessor primer from the waste paper basket!

ZERO VOLTAGE SWITCH

The **SL446A** from Plessey is a zero voltage switch intended for use in the on/off control of triacs and this device incorporates zero voltage point triggering in order to minimise radio interference.



Typical circuit for providing linear temperature control over a range of +5°C to 35°C.

Main applications are in switching resistive loads and replacing mechanical thermostats in central heating systems, washing machine heaters, water heaters and electric irons.

The device has a spike filter for reliable triggering and a pulse generator with a bistable arranged to eliminate half wave firing. A voltage sensing circuit inhibits the firing pulses when the supply is inadequate to guarantee proper circuit operation.

Another zero voltage switch in the same range is the **SL441A** which can be used to regulate a.c. power by varying the number of mains cycles applied to the load in a fixed timing period.

SOFTY Review...

A.A.BERK B.Sc. Ph.D.

SOFTY is one of the first in a new and exciting line in the micro scene—the information available to the public via advertising has, to date, made it unclear as to the exact position of this machine in the market place. The following article indicates the role of the system to both the hobbyist and the industrial user as well as describing its internal hardware and software structure. Thanks are due to Videotime Products for lending us a Softy for review.

How often, I wonder, have you wished you could pick up an MPU of any type and plug it into a totally general development tool, press a few keys and learn the instruction set by trial and error? Then, after experimenting with several processors, choose the most appropriate and write for it a set of routines to control your house, drive your car, or let you win ceaselessly at Startrek. The final software would then be blown into EPROM, and a system is born!

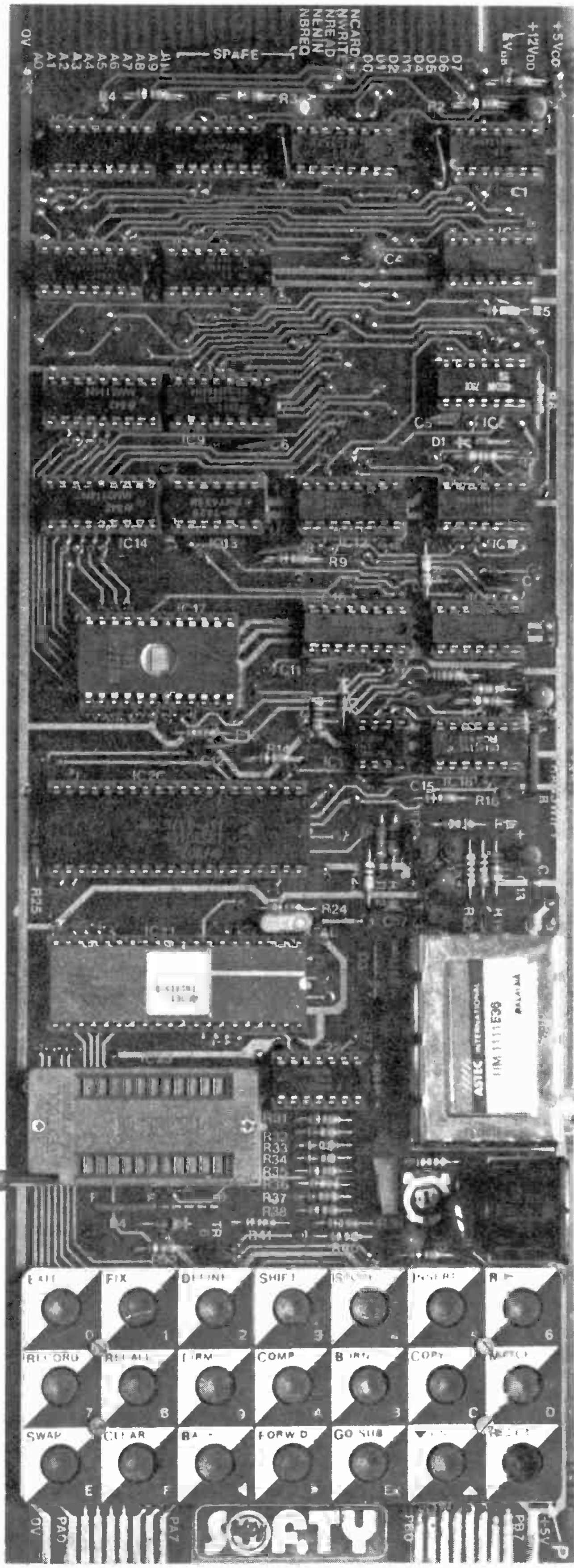
The snag is always with what is known as Firmware, i.e. initial program stored in non-volatile memory which makes your machine react with some degree of intelligence when switched on—called Firmware because it is normally supplied by the firm which sells the machine. All well and good, unless you wish to design and build the thing yourself. In order to do this you must write your own Firmware to enable the loading of data and programs into memory from a keyboard, running a display, editing, accepting interrupts, interfacing to a cassette, blowing programs onto EPROM etc., etc., etc. Many of these functions, so important in the stage of program and system development, may be quite useless to the final product—only being required, perhaps, to control a few sensors and solenoids in a washing machine! Clearly the general Firmware development tool would be a boon to anyone interested in micros. This is undoubtedly the slot which SOFTY tries to fill.

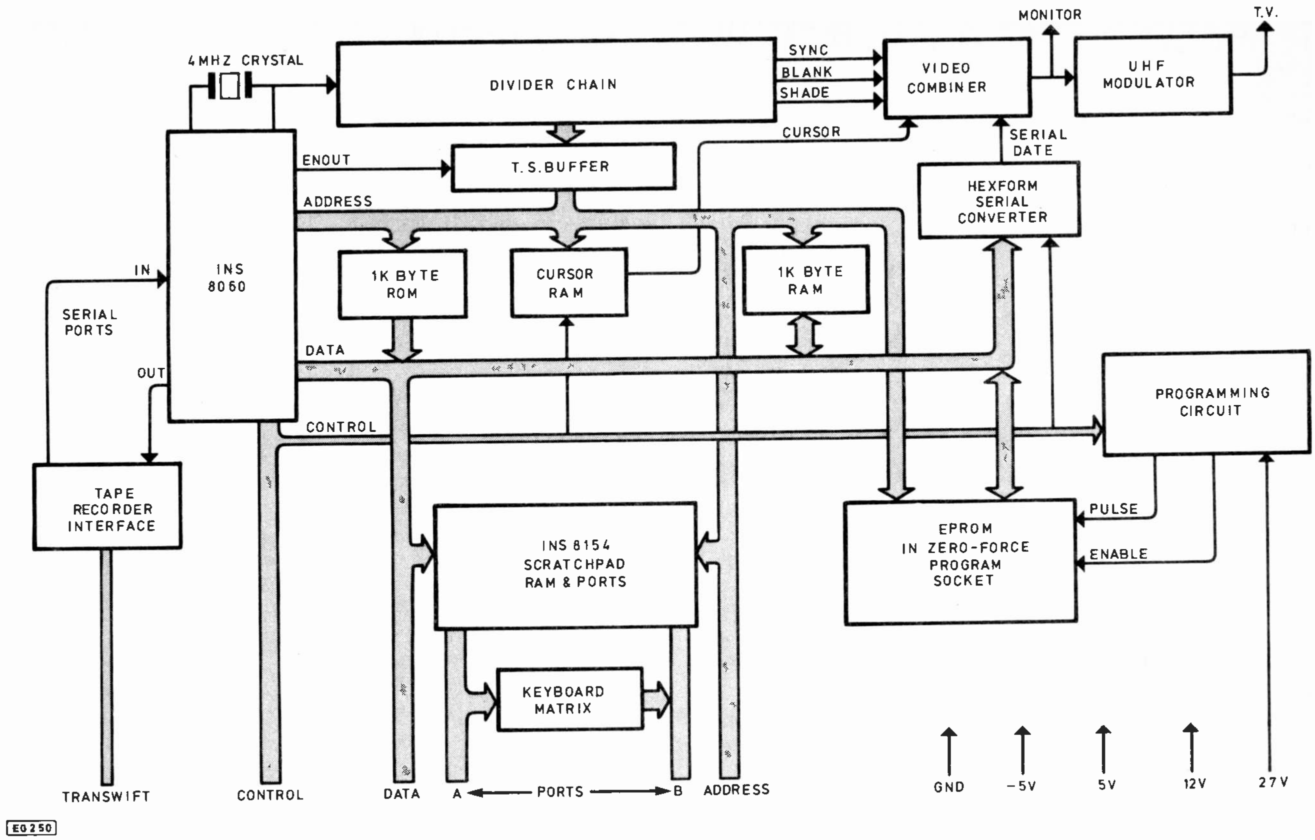
Softy may be used in three main ways:—

a) as a 2K block of embryonic Firmware forming part of the memory map of a system under development;
b) as an intelligent EPROM programmer for 2708's and 2716's;
c) as an MPU system in its own right for hardware control purposes.

Other areas are possible but considerably less appropriate—for instance, games could be played on its VDU or floating point calculation facilities developed, as with any other computing device.

I have purposely avoided mention, so far, of the particular MPU used in Softy—the reason being that Softy is a tool for a specific purpose and, as such, is more important for the facilities it offers than for the particular hardware it uses to achieve this end. Also, you will probably never see a Softy advertised with full 8K BASIC or expandable to 64K of memory and twin floppy discs. The MPU used in the SC/MP.





BLOCK DIAGRAM

Referring to the block diagram, a reasonably familiar overall pattern is discovered with bus lines, RAM, ROM, MPU, I/O ports, cassette etc. The details show some differences from the usual format; an EPROM burner is included, for instance, along with special RAM for the VDU cursor. The main difference is, however, in Softy's firmware itself. This is set up, basically, to manipulate the contents of three blocks of RAM — two $\frac{1}{2}$K pages and an area of 128 bytes of "scratchpad". Commands for the editing features as well as control of the ultra-fast cassette interface and EPROM burner are not typed in with alphanumeric characters but, instead, appear on the keys of the keyboard and are accessed via a "function" key, exactly as on a scientific calculator.

The VDU picture, as seen in the photographs, constantly displays 512 bytes in hexadecimal digit pairs. An area of reversed video (white characters on black) is also available at top and bottom of the TV picture—if your TV can show it. This is part of the 128 bytes of "scratchpad" RAM included in the INS 8154 RAM/IO chip. The screen itself is divided into four main areas of 128 bytes each, by shading, to assist the user in estimating the size and positioning of blocks of information. In addition, the user memory is used to store those positions on screen which are to be highlighted in a very bright shade for various purposes described below.

At the top of the screen four lines of reversed video may be displayed by adjusting the height control of one's set. Only the bottom one of these four is of major importance. It contains various useful bytes of information, such as current cursor address and contents of the SC/MP's registers. The meanings of these locations are shown in the annotated photograph.

The I/O ports of the 8154 device are used to scan the keyboard matrix, but may be utilised for hardware control and are brought out to the edge tracks below the keyboard—see the photograph of the p.c.b.

EDIT COMMANDS AND POWER UP

As seen on the heading photo, most of the keyboard keys have a dual purpose—i.e. hex digits as well as commands accessed by first pressing the FN key.

After power-up, the RESET key is pressed, giving a random collection of bytes on the screen randomly highlighted by bright patches corresponding to 1's in the cursor memory. The FN key is pressed twice to clear the cursor memory with the exception of the bright patch over the top left byte. This patch denotes the write-cursor position—i.e. where the next byte of information will appear if the keyboard keys are operated. To alter this byte, two hex digits must be keyed in, after which the user automatically moves onto the next location. The cursor may be stepped backward or forward by using the appropriate keys and hence any byte displayed may be altered—writing only occurring to the cursor position.

If the back or forward cursor keys are held down, the cursor moves a step at a time automatically until the 16th step when it will revert to stepping up or down the screen vertically one line at a time. When the cursor meets the top or bottom of the screen, the $\frac{1}{2}$K page displayed changes to the next adjacent—this may be the other half of the 1K of RAM or one of the two EPROM pages—if the user steps off the edge of the screen too many times (i.e. into a non-existent page), the machine aborts and must be reset before continuing. After reset, the cursor is at the top of the 1K of screen RAM and just below the user EPROM section. Thus, moving the cursor back takes it into the bottom of the lower $\frac{1}{2}$K page of EPROM. The contents of the EPROM placed in the zero-force EPROM socket may be copied into screen RAM by the "copy" command—accessed by pressing FN, followed by the "C" key. The full 1K is copied into the screen RAM by this process and may be altered by moving the cursor around and pressing hex keys as described above. If required, the whole 1K may be stored on, or recalled from, cassette by the "RECORD", or "RECALL", Commands. Alternatively, an erased EPROM may be inserted into the zero-force socket and the 1K RAM contents burned into it by the "BURN" Command. In this way, EPROMS are very conveniently copied with or without modification in around 2 minutes.

Other text editing commands include a block shift. The cursor is positioned over the final member of a block to be shifted and the DEFINE Command pressed (after the FN key, of course). Backward shifts of the cursor leave behind highlighted bytes on the screen. When the complete block to be shifted (a maximum of 127 bytes) has been highlighted, the SHIFT Command is entered. This allows the back and forward cursor keys to shift the entire highlighted block one position at a time for 16 moves, followed by movements of one line at a time, throughout the 1K of screen RAM. This provides a very graphic and useful block manipulation facility.

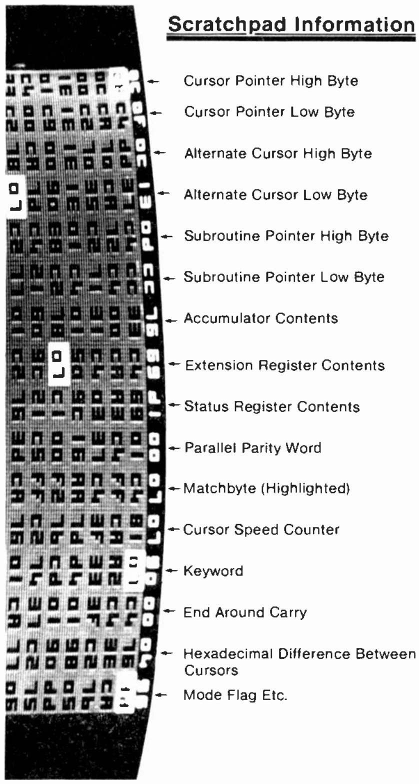
In order to search for all occurrences of a given byte, the MATCH command is used followed by the byte to be matched. All occurrences are highlighted—yet another use for the cursor RAM. The extra highlights may be erased by pressing FN twice. This function has been used to highlight the word SOFTY on the screen photo.

The whole 1K of RAM may be filled with 1's (FF) by the CLEAR Command. This is used for selective block storage on EPROM. The erased EPROM contains just 1's—during programming some of these are turned into zero's according to the data presented. If a block of the EPROM is to be left unprogrammed, it must be presented with FF bytes only. Thus, the screen RAM may be filled with FF and a selected area written to by cassette or keyboard. The "BURN" Command will then store this block in the EPROM leaving the rest to be programmed at a later date.

The Softy firmware may be copied into RAM by the FIRM Command for modification by the user. This firmware comes on EPROM anyway and may thus be copied into RAM, modified and then blown into an erased EPROM for immediate use. Who says computers can't reproduce!

PROGRAMMING COMMANDS

So far, screen editing and storage have been described without reference to the executing and testing of the routines being developed. As explained above, the heart of the Softy system is a SC/MP and routines for the SC/MP may be executed in screen RAM, EPROM or Scratch Pad



using various other commands on the keyboard—this facility is useful for developing programs for the SC/MP microprocessor without any extra hardware. The register contents are continuously displayed at the top of the screen, as indicated, and large numbers of uses can be envisaged for the machine as a controller.

There is a very graphic offset calculation facility included on the Softy, which is accessed via the FIX Command. This causes the current position of the cursor to be stored. The cursor may then be moved to any new position within the program under development. The offset between stored and current cursor locations is continuously displayed at the top of the screen, as are the absolute addresses of the two cursor locations. The current address location of the cursor is always displayed at top left of the screen, and screen RAM starts at address OCOO.

DEVELOPING GENERAL SYSTEMS

Most of the above editing, storage and program writing facilities would be very useful for developing any MPU system and it is here that the Softy finds its most exciting application. The system is designed to look like a 2K block of intelligent memory. That is, it has data, address and control busses to fit into any system at any base address. While the target system is not processing and using the busses, Softy may be used to Write a program into screen RAM using all its facilities for making the job easy. When finished, the program is automatically in the embryonic system's memory for running on the target's MPU, using the Softy VDU for output as necessary. No editing firmware or even RAM is necessary in the test system—Softy supplies it all.

The manufacturers, Videotime Products, have now produced an interface card with all the address and data bus lines fully demultiplexed, along with general address decoding to allow any bus-oriented MPU to be used. The designer sets up links on the interface p.c.b. to decide where in the MPU system's memory Softy will sit. All that is needed is an MPU with its own processer clock and RESET switch to develop a complete MPU system. The MPU Address and Data busses, plus R/W, are connected to the interface board and Softy takes over for program writing and hands back control to the external MPU for execution.

The final software is blown into EPROM and, along with some RAM etc., may be attached to the MPU system under development to complete the machine. The photograph of the whole system shows the interface board connected to a prototyped Z80 system. The prototype contains MPU, clock and RESET switch.

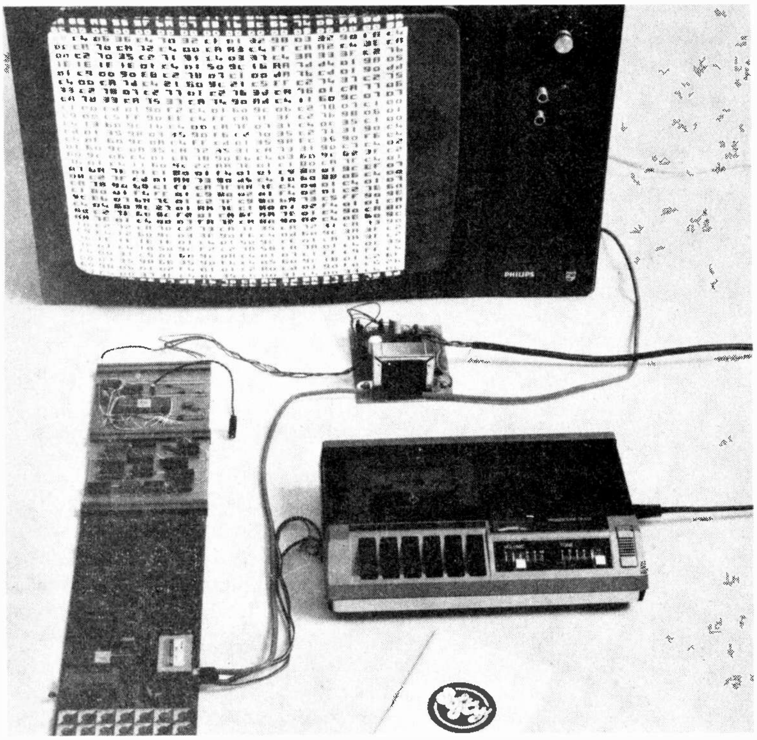
Videotime are hinting at producing a variety of such MPU p.c.b's, for different processors, to save the prototyper even the trouble of connecting Veroboard and ribbon cables to his favourite MPU!

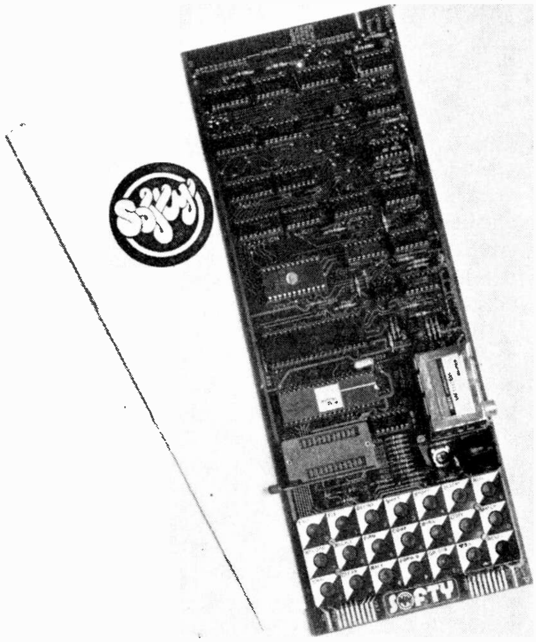
HARDWARE AND CONSTRUCTION

I did not have the opportunity to make up a kit from scratch and can only comment from an external viewpoint. The p.c.b. is covered with solder-resist and has a silk-screened component legend which should make construction easy. Tracks are no closer than usual, though components are a bit crammed around the DIN socket and a large Mylar capacitor did impede adjustments to the cassette interface pot quite considerably.

The keyboard is of the "click" calculator type and showed the usual tendency towards variation in performance but seemed adequate for the job.

My version was not through-plated and thus contained pins through the p.c.b.—perhaps a little disappointing on an article not made "down" to a price in most other ways—but again, in my experience, perfectly adequate. It was very nice to see a zero-force socket for the EPROM as standard, as well as u.h.f. modulator giving excellent TV performance.





The EPROM programmer will program both 2708's and multi-supply 2716's (in two halves) and these devices require several supply voltage levels. Videotime sell a small Power Supply Unit which proved adequate to power the complete system as shown in the photo—i.e. including a simple target system.

The EPROM burner is straightforward and controlled by a 555 timer to program at the maximum theoretical speed for the 2708 family of EPROMS (around 110 seconds). A 27 volt supply is included in the Videotime power supply unit for this purpose, but is left unconnected, for purposes of safety, until required.

The cassette interface is controlled by software and is little more than a couple of lines connected to serial-in and serial-out pins of the SC/MP processor. As a consequence, the "Transwift" system runs at over 2000 Baud (equivalent) and is considerably less prone to tape-speed variations than many other simple interfaces. The cassette plugs into a Din socket, just above the keyboard, which is wired to the international standard.

The cursor RAM is formed by a single bit by 1K 2102 chip. This is accessed by the VDU counter circuitry at the same time as the main VDU RAM and fed to the video mixing circuitry to brighten the VDU picture at the necessary locations as the electron beam strobes across the TV tube. While the SC/MP is not processing a program in user memory, it hands the Address and Data busses over to the VDU counters which address one of the four memory pages displayable. The page selected depends upon the state of two I/O lines on the 8154 chip which are kept updated by the firmware. The memory map of the system is not given and this appears in Table 1.

The address map depends upon a 74LS42 decoder and could easily be changed if necessary—though what this would do to the firmware, I can't imagine! A system under development would see Softy mapped out as in Table 1, in its memory, but at a different base address from 0000 if required.

TABLE 1

Address	Memory selected
0000—03FF	SOFTY's 2708-based firm-ware
0400—07FF	RAM/IO (8154) with some addressing redundancy
0800—0BFF	2708 (or 2716) Socket for user's EPROM
0C00—0FFF	VDU RAM (workspace) in two $\frac{1}{2}$K pages of display

The VDU, of course, is a very specialised binary data display device and has nothing to do, for instance, with displaying ASC11 characters. It is a device for displaying the exact binary contents of 512 memory locations—in hexadecimal digits directly. Thus, a special character generator ROM is used. The VDU electronics presents the 8 bits from any memory location to the ROM as two 4 bit "nybbles", for conversion into hexadecimal characters on a TV screen. This obviates the necessity for the usual software routines used to convert bytes into nybbles and nybbles into ASC11 codes.

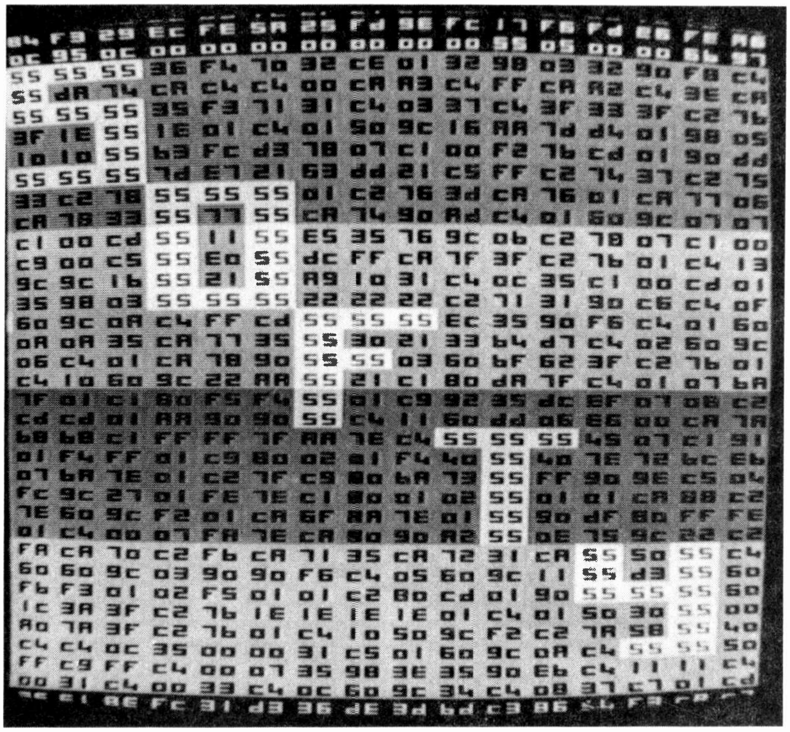
MANUAL AND SOFTWARE

As can be seen from the above, the software is thoughtful and very graphic. A few more traps against inappropriate commands could have been included, I feel, even though the whole thing is contained in just 1K of ROM. Try block shifting into the EPROM, for instance, and everything is lost—or, as mentioned, try shifting the cursor to a non-existent page and the machine locks completely.

A lot more description of the software itself would be of considerable use in modification and, most importantly, in using subroutines contained within the firmware. It is an excellent idea to include a special command for copying it to screen RAM—but of little use without, at least, an annotated listing.

The manual makes it clear from the beginning that Softy is a tool for those who know what they are doing. To this end it is very concise and makes reference to other literature, such as data sheets on specific devices. A reference table is given of the SC/MP instruction set, as well as an architecture diagram for both the SC/MP and the RAM/IO and a potted description of the RAM/IO's use as a parallel I/O port.

The Softy circuit diagram is given in complete detail as well as an adequate explanation for anyone familiar with MPU engineering. This is most useful for those willing to take the basic tool and use or modify it in their own way.



Construction is hardly covered at all but should be quite clear due to the component position labelling on the p.c.b.—all component numbering starts at the top right of the p.c.b. and should save endless hours of searching for a particular number of component.

Another section of the manual includes interfacing to the external system—though the SC/MP data sheet is essential to a complete understanding of the device. Control signals and memory—select logic are mentioned as well as product and program development.

An interpretive language of a very simple nature is actually listed for use in development, along with a couple of elementary sample programs to help the user familiarise him or herself with the system. The final section of the manual explains the software (annotated listing included) for interfacing Softy with an ex-GPO BAUDOT code printer. A little more on hardware would be useful at this point, along with methods of attaching it to the more common 8-level ASC11 machines.

Any well thought out tool can be made to perform wonders in the right hands. Think how a good engineer can extract complex information from an electrical device using just an oscilloscope. Softy is in this class—it is a well-constructed bench tool for anyone dealing with MPU products and requiring development and test facilities. It should not be placed in the lengthening string of hobbyist computers, each vying with the next for higher level languages and more photographic VDU displays.

Acknowledgement

The Softy was originally designed—hardware and software—by Barry Savage. Phil Morris, of Videotime Products, has updated the machine and designed the interface board for prototyping a general MPU system.

FRANK W. HYDE

PIONEER 11

Pioneer 11 is on its way out of the Solar system and into the Galactic space and none will know of its final fate. Its last encounter was the planet Saturn. At that time it had travelled more than 2,000 million miles from Earth, having started its journey in April 1973. The vehicle has more than justified the costs involved and is yet another tribute to the technology of space engineering. The first flypast was concerned with the planet Jupiter and opened the first chapter of a new view and model of the largest body in the Solar system. While Pioneer 11 continued its journey toward Saturn aided by the kick (gravitational) of the fastest rotating body, the Voyagers were to open the second chapter of the chronicle of Jupiter.

However all might well have been lost for there was a near case of disaster as Pioneer 11 approached Saturn's rings from the underside. The vehicle was at a distance from Saturn of 2·53 Radii 23 minutes, after crossing the plane of the ring system inside the orbit of Saturn's moon Janus, but not quite at the A ring. Calculations show that the spacecraft passed about 900 miles below and 1,500 miles slant distance to the "Pioneer Rock". It was discovered as a result of the change of behaviour of some of the on-board instruments. The charged particle instruments showed that during the time of the near encounter the flux of the 2-4MEV electrons dropped to a level a thousand times less over about 10 seconds.

The period of the drop-out indicates a body of the order of 124 miles in diameter. Earlier it had been thought that there was another body about this diameter. It is a 50-50 chance that this "Pioneer Rock" is that object. It would be unlikely that it could be discovered from earth based telescopes, being obscured by the ring system. A further confirmation of the "new" moon came from the magnetometer data. The short time resoltion instrument which showed a ten second oscillation at 15 seconds after the dip in the particle counts. Thus the conclusion was reached that this was a small body in the plane of the ring system, a body that was conductive.

The deflections of the path of the spacecraft have been studied. These are caused by the gravitational fields of three of the Saturnian satellites Iapetus, Rhea and Titan. The indications are that these three moons are of low density and made up of ices in the main with little rock or iron. These data also confirm that the flattening at the poles is as predicted but that the shape is not ellisoidal as it would be if the planet was homogeneous. It would seem likely that there are extensive areas of inhomogeneities. Some depressions may be as much as 75 miles.

Nothing has so far come to light to cause rethinking of the present models of Jupiter or Saturn. That is that the interior core of Saturn is about the same size of that of the Earth but three times as dense and consists of rock and iron. Around this would be a layer of metallic hydrogen which probably extends to about 0·58 of radius of the planet. Above that a layer of liquid hydrogen and then the atmosphere a gaseous mixture about 200 miles deep. It is here that there may be some need for remodelling.

MAGNETIC FIELD

The magnetic field is not so extensive as that of Jupiter. The magnetic field and the pulsating magnetosphere extended out to about a hundred Saturn radii before the spacecraft was free. This is half the distance found in the case of Jupiter. The magnetic field was very uniform which suggests that it is an uncomplicated dipole field. The dipole axis is within 0·1 degree of the spin axis. This fact is unique for the Solar system. The centre of the field does not coincide with the centre of the planet and is southbound at the equator. This is not unusual.

The magnetic field rotates with the planet at its rotational period of 10h 14m and this means that as it is faster than the orbiting satellites a "wake" is created in *front* of the satellites. The satellites would be subject, that is those inside the magnetosphere, to some disturbance. In fact a wavelike disturbance did appear when Pioneer 11 crossed Titan's orbit. A symmetry was observed in the stable inner region of the magnetosphere. This is partly responsible for the "cleaning up" of trapped radiation.

It had been anticipated that Saturn's ring would clear any charged particles in the inner area of the magnetosphere. It has been stated if this were not so Saturn would show strong radio emission. There is some confirmation of that in the writer's own experience. When observing Jupiter radiation in 1962 it was decided to use the 1,000 ft. radio telescope at Aricebo to "look" also at Saturn. No sign of radiation was observed. It was concluded that Saturn did not radiate or there was a mechanism to stop the radiation. This shows the importance of the spacecraft missions.

Some of the preliminary results show some details of various conditions. For example the infra-red radiometer could not detect the unlit side of the planet's rings. Even the Sun side was indicating a temperature of 70K. Some readings were available to provide average values for the A and B rings. The temperature of Titan at the cloud tops was about 75K. It is not expected that day and night temperatures will be available.

A weak hydrogen glow was detectable throughout the saturn system. It was noted that the ultraviolet emission brightened when the scan crossed the ring plane. This indicates that hydrogen clouds are present. Also it was noted that in the north and south polar regions brightening also occurred but was absent in equatorial regions. Ultra violet was detected at Titan but it extended only a short distance from the moon. It is unlikely that hydrogen cloud filled the satellite's orbit. It seems that the temperature at the exosphere, 1,110K, is rather lower than that of Jupiter.

ATMOSPHERE

A model of the atmosphere has been constructed which shows a surface pressure of about 15 atmospheres. Here the layer is hydrogen and helium at −65°F this merges into clouds of water-ammonia at a temperature of 45°F succeeded by a layer of water ice clouds starting at 9°F and falling to −63°F. The next layer is possibly ammonium hydrosulphide ice clouds falling to −135°F. Then another layer of clear hydrogen and helium falling to −210°F with ammonia ice clouds, above this a thin ammonia haze at −280°F at a pressure now down to 1 atmosphere. Above this level very thin dust particles followed by the rest of the clear upper atmosphere again hydrogen and helium, at 0·1 atmosphere the temperature falls to −306°F rising again to −240°F at the level which has fallen to 0·01 atmosphere.

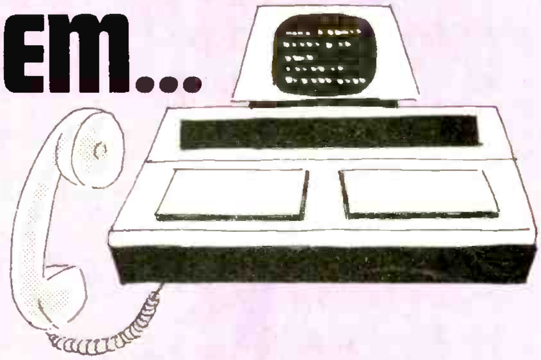
The satellite Iapetus exhibits a peculiar exterior appearance. It is about 900 miles in diameter and shows a wide difference in brightness very high one side and dark the other. The bright side is consistant with highly reflective material ice or snow but it is not possible to determine at this stage the composition of the dark side. Iapetus is the farthest satellite from its parent.

TAILPIECE

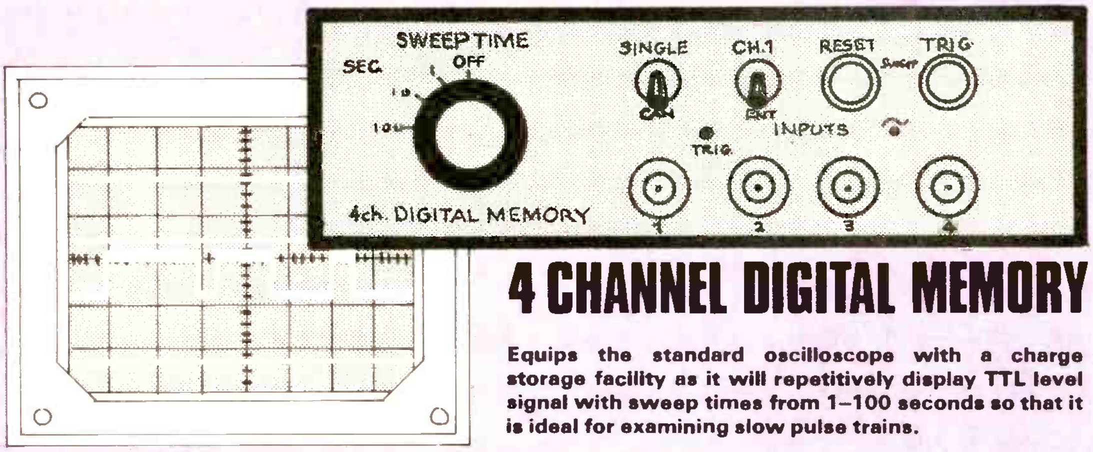
There is evidence to show that the Sun is shrinking. The Sun has been measured at noon on every day since 1750. The disk is measured at high noon on the transit telescope. The mechanics are that as the limb crosses the fixed meridian wire the time is noted and when the trailing limb crosses the wire the time is noted once more. From these two timings the horizontal solar diameter is determined.

...all in Next Month's issue!

ACOUSTICALLY COUPLED TELEPHONE MODEM...



If you have a telephone, then your computer can be coupled to any other computer—anywhere!!! Full "nuts n' bolts" constructional details and application notes are included. With your assistance, we shall also follow up with a Modem Users' Register.



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WATCH OFFER...

Seiko have done it again! This incredible new watch, which you will probably not find in the shops until next year, has both analogue and digital readout and—as has become their trademark—Seiko have presented it in a beautifully designed and finished stainless steel case, with matching bracelet.

The recommended retail price from Seiko is expected to be £125 and, believe us, this watch is worth every penny in looks alone. However, by arranging this exclusive offer we can save you £45 on that recommended price making the watch £79.75 including VAT and postage. To help spread the load we have also arranged for Access and Barclaycard payment.

The watch is only 8mm thick and has a battery life of about 3 years. The following facilities are provided:

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Counter	—Single counter up to 9,999 or dual counter up to 99 on each button.
Flags	—Showing setting mode e.g. Stopwatch, Counter or Time, plus those for the stopwatch.
Battery indication	—When batteries run low the display flashes.

The watch is splash resistant, anti-magnetic and shock protected, it comes in a handsome black presentation case complete with a fully illustrated manual showing in a clear, concise manner how to set and use all the functions. The accuracy is better than 10 seconds per month at normal temperature range (−10°C to +60°C). The watch is covered by a one year guarantee.

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A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

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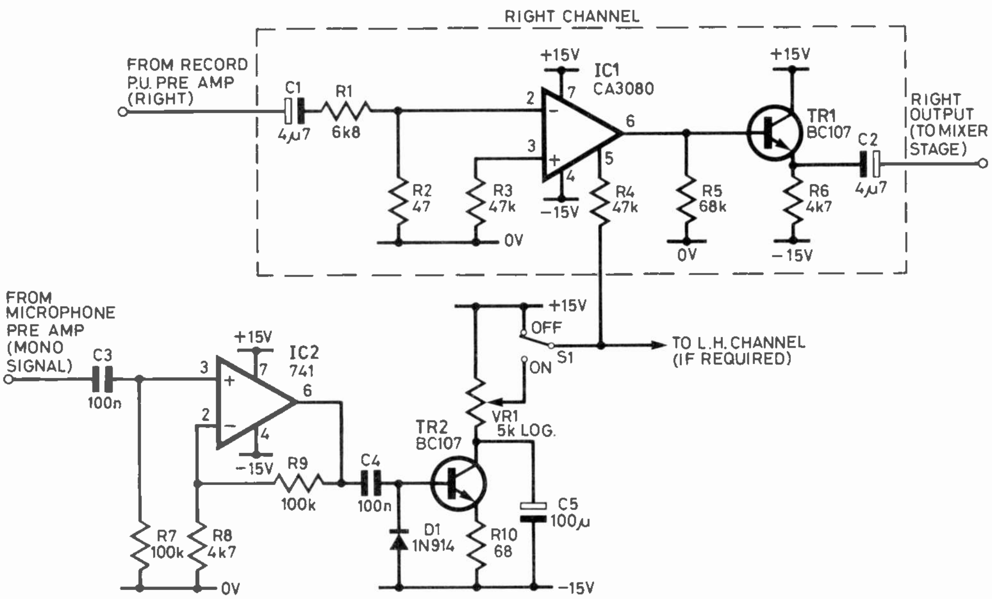
Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

SIMPLE AUTOFADE



THIS circuit automatically fades signals from one source (e.g. records or cassettes) when a signal is present from another source such as a microphone. This permits, for example, records to be faded whilst the DJ is speaking, and this facility is easily and cheaply added to most mono or stereo mixers.

The signal from, say, a record pick-up preamplifier is fed to a CA3080 operational transconductance amplifier, the gain of which is controlled by the current into pin 5. The microphone pre-amp signal is amplified by IC2 and rectified by D1 and TR2, providing the control current for both channels. S1 enables the autofade action and VR1 adjusts the depth of fade required. C5 determines the attack and decay times (20ms and 500ms respectively), while R4 alters the nominal gain of the circuit (approximately 0dB).

Sensitivity at the microphone input is about 35mV for full fade, and may be increased by reducing R8. Maximum input is 2V rms (more if R1 is increased), and fades of over 40dB are possible.

T. P. Hopkins,
Haywards Heath,
West Sussex.

R/C SERVO

IN the servo circuit shown in Fig. 1, ZTX300 and ZTX500 transistors are used throughout because of their small size. They are rated at 500mA which is more than sufficient for small modern servo motors.

The circuit works as follows: The 555 is connected as a monostable whose period is controlled by R5/C2 and the control voltage on pin 5. This voltage is derived from VR1, the servo feedback potentiometer and RA/RB. TR1 is a simple inverter. TR2 and TR3 are switched by TR1 and the output of the 555. Three possible conditions of the circuit can occur. (2a) shows the input pulse and the 555 period equal and both TR2 and TR3 cut off. (2b) shows the input pulse shorter than the 555 period. Now TR3 can switch on for a short while. This drives the motor via TR4, TR5, TR6. Similarly, in (2c), TR2 drives the motor via TR7, TR8, TR9. C3 and C4 smooth out the drive between pulses. The motor is connected by the servo gearing to the potentiometer, VR1. Thus the motor will move the potentiometer until the input and the 555 period are equal again.

Fig. 3 shows a simple servo tester circuit. This is simply a 555 connected as an astable to simulate the output of the decoder, i.e. a variable negative pulse of between one and two milliseconds every twenty or so milliseconds. Using this tester it is then useful for setting all them servos to the same neutral position which is very useful on a multi-channel system.

RA/RB should be selected to suit the servo used.

N. Roche,
Willingdon,
Sussex.

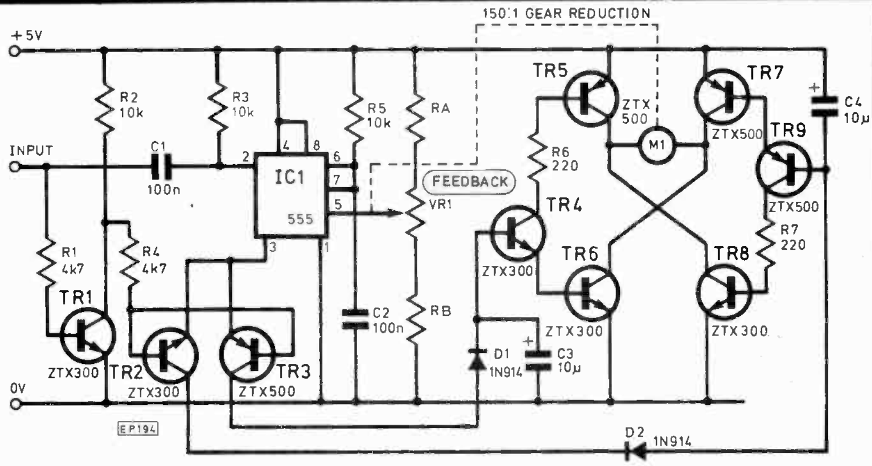


Fig. 1

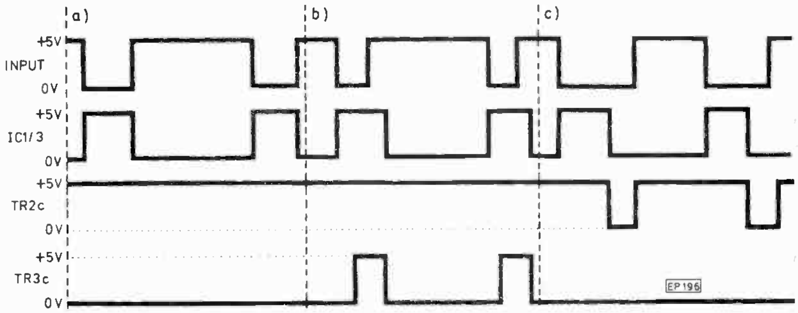


Fig. 2

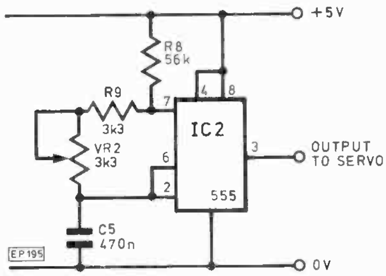
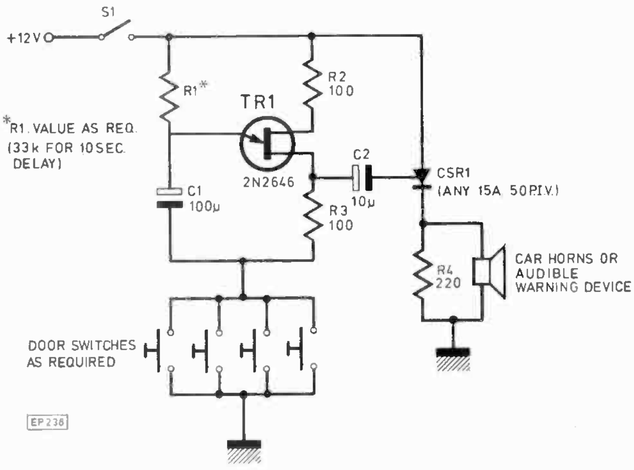


Fig. 3

CAR BURGLAR ALARM



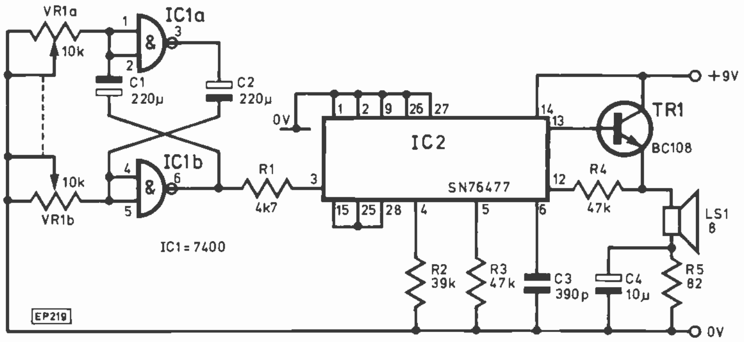
The unijunction TR1 is used as a time delay device with the switch-on time determined by R1/C1 (33 kilohms gives a switching delay of approximately 10 seconds). When the unijunction switches, the o/p pulse via C2 triggers CSR1 which activates either the car horn(s) or some external audible warning device.

R4 is used as a hold on path for SCR1 to prevent switch-off of the thyristor due to the interruptions of the car horn circuitry.

The circuit thus enables the driver to switch on the alarm internally before shutting the rear door, and vice versa when opening the door.

C. Guthrie,
Hardgate,
Clydebank.

PHASED WHITE NOISE



THIS circuit, using the SN76477N sound effects chip, produces a phased white noise output when VR1 is rotated, such as would be obtained by a system using several phase shift stages being fed with an input from a conventional white noise generator. The white noise section comprises the LSI chip, together with its associated components, which provide the programming requirements.

A single BC108 transistor feeds an 8 ohm speaker, together with a series resistor, which provides an audio output. In many cases the audio output will be taken directly to an amplifier, mixer or tape recorder.

Pin 3 of the SN76477N is connected, via R1, to the output of an astable multivibrator constructed around ½ IC1 (7400). VR1a and VR1b (dual gang pot) control the astable's rate.

The phasing effect is produced because the SN76477N exhibits a kind of voltage controlled filter effect when a slow clocking oscillator is connected to pin 3 of the device. If the speed of the external clock is below that of the SN76477N's internal noise oscillator then the internal oscillator is overridden and external circuit takes over.

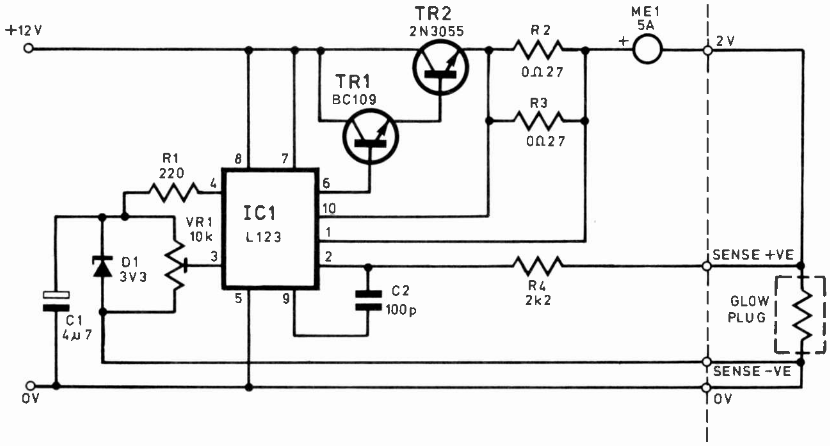
The circuit can be used to provide numerous special effects such as jet engines, rainstorm, thunder, wind, etc., in its present form. By connecting a 100n capacitor from pin 21 to ground, a 1M pot from pin 20 to ground and re-programming pins 25, 26, 27 as follows: pin 25—logic 0, pin 26—logic 0, pin 27—logic 1.

A further range of aircraft, helicopter and train sound effects can be obtained by operating VR1. The circuit can be easily constructed on 0·1in Veroboard and its recommended that a 28 pin DIL socket be used for IC1.

If the speaker output is not required omit TR1, R3, speaker, R4 and C3 and connect a 47k resistor from pin 11 to ground, a 10k resistor between pins 12 and 13 and connect to external amplifier via a 2·2µ/10V (C6) electrolytic capacitor with +ve terminal to pin 13. It is hoped these notes will encourage experimentation with this interesting and versatile i.c.

R. Otterwell,
Rochdale,
Lancs.

GLOW PLUG SUPPLY



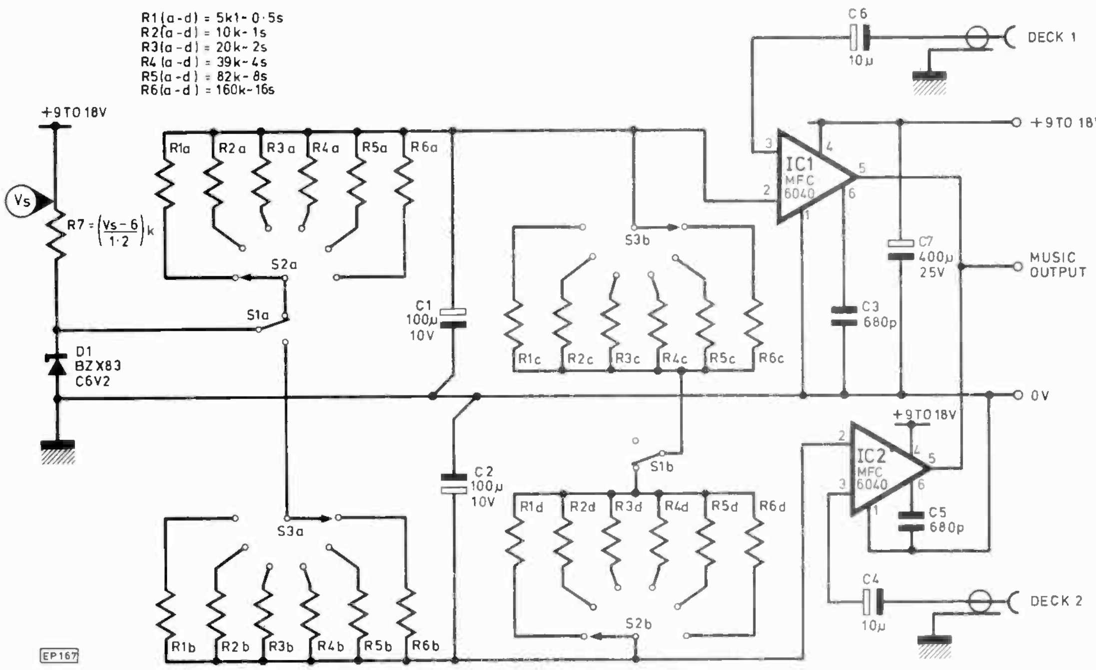
THIS circuit provides a regulated 2V or 1·5V supply for glow plug engines and overcomes the problems of battery internal resistance and connecting lead resistance by sensing the voltage at the plug terminals.

The internally regulated voltage at pin 4 is divided down and applied to pin 3 as the reference input. If the voltage at the +ve sense input differs from this then the output from pin 6 varies inversely to compensate. The −ve sense input is effectively connected in series with the negative supply lead, any voltage drop due to this lead's resistance is reflected into pin 3 by the level changing action of D1, the preset across D1 allowing 2V or 1·5V plugs to be accommodated.

The circuit is current limited to 5A by R1, the meter indicating o/c or s/c plugs and also plugs wet with fuel oil by a higher than normal reading. The unit is operated from a 12V battery which is normal field equipment for use with electric starters etc. Heavy duty twin cable can be used as connecting leads, the outer conducter carrying the plug current and the inner the minute sensing current.

R. MacFarlane,
Newtonhill,
Aberdeen.

A SEMI-AUTOMATIC DISCO CROSS-FADER



THE circuit shows a semi-automatic cross-fader for discotheque applications. A cross-fade is effected merely by operating a toggle switch.

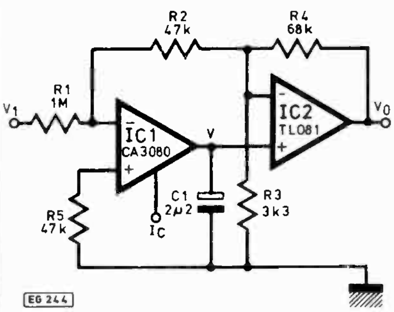
The MFC 6040 electronic auto-attenuators are operated by mutually symmetrical control voltages. The resistors R1 (a-d)–R6 (a-d) are selected to give a range of time constants from 0·5 to 16 seconds for the cross fading action. These are selected by two rotary switches, one for each deck, beforehand.

It is advisable to keep the signal inputs below 100mV to avoid excessive harmonic distortion. At 100mV this varies from 0·6 per cent ($V_s = 9$) to 1 per cent ($V_s = 18$). In any case, the i.c.s have a gain of 13dB (approx.).

C1 and C2 can be electrolytics, since leakage is not a critical factor, the charging current always being maintained on the relevant capacitor.

Ben Duncan,
Market Rasen,
Lincoln.

LOW PASS FILTER



THIS filter is built around an operational transconductance amplifier, the CA3080, and is a simpler alternative to double integrator VCFs where only a low-pass function is required. The transconductance, k, of the 3080 is directly proportional to the control current, I_c, over a three decade range, allowing a similar variation in time-constant.

The circuit is basically an integrator with negative feedback which converts it into a low-pass filter. Because the output stage of the 3080 acts as a current source, it is important that there should be no load on it apart from the capacitor, especially if very long time-constants are required. This is achieved by buffering the output with an f.e.t. input operational amplifier, and connecting the feedback resistor, R2, to the inverting input of the buffer, which is held at the same voltage as the non-inverting input by op-amp action.

It can be shown that the transfer function of the filter

$$\frac{V0}{V1} = \frac{-R2.}{R1} \quad \frac{1}{1 + sC1/k}$$

which is the expression for a low-pass filter with time constant of C1/k. The time constant is inversely proportional to the control current, I_c and will vary between 1ms and 1s with the 2·2uF capacitor shown, for I_c in the range 0·1–100μA.

The main drawback of the 3080 in this application is that the peak output current is limited to the value of the control current. To allow a reasonable input range, the signal must be attenuated at the output of the 3080 by a factor G where:

$$G = \frac{R1}{R2} > 20\,V1_{Peak}$$

To restore the signal level at its output the buffer has a gain of G. For the circuit shown G is 20 so a peak input of 1V can be accommodated.

Applications for this circuit include an envelope generator for synthesisers, where the long time constants obtainable are particularly useful, and since all the parameters can be current/voltage controlled, the circuit lends itself to remote control.

J. J. Lambe,
Farnborough,
Hants.

WIEGAND EFFECT in Ignition

DANCE

THE classical method of timing the ignition sparks in a vehicle requires a cam to open a pair of contacts, but most vehicle owners will be aware of the troubles which can occur when these points are not cleaned and set at regular intervals. Some of the simpler electronic systems employ a pair of contacts, but the ignition coil current does not flow through these contacts and the absence of sparking at the contacts greatly increases reliability. More advanced timing systems have employed magnetic and optical contactless sensors which produce pulses at the correct times. This article describes a new type of contactless magnetic sensor which enables considerably simpler circuits to be used than with other contactless systems and which is therefore considerably cheaper.

WIEGAND WIRE

The new system employs a small, thin specially processed wire known as a Wiegand wire (after John R. Wiegand who discovered an unusual switching effect). A section diagram of a distributor using this technique is shown in Fig. 1. The Wiegand wire is located in the lower leg of a slotted structure which also carries two magnets. The permanent magnet in the upper leg provides a saturating flux to the Wiegand wire in the absence of a rotating vane.

The rotating vane is made of a soft magnetic material and has as many fingers as the number of cylinders in the vehicle. When one of these fingers passes through the slot between the saturating magnet and the Wiegand wire, it effectively provides a short circuit for most of the magnetic flux from the upper magnet so that the small magnet in the lower leg provides the flux required to reset the magnetic switching wire. This small magnet is orientated so that it provides a flux of the opposite polarity to that from the upper saturating magnet.

A coil of wire is wrapped around the Wiegand wire. Each time the magnetism in the wire is reset, a sharp pulse is produced across this sensing coil. The amplitude of the pulse is typically a few volts, so it can be used without further amplification to trigger an electronic ignition circuit. The low impedance of the coil avoids any troubles due to noise pick up. The pulse is very sharp, the width of the pulse at half the peak height being typically 20µs, so the timing can be made very accurate.

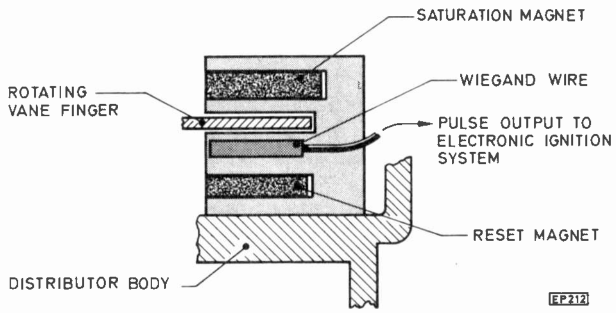
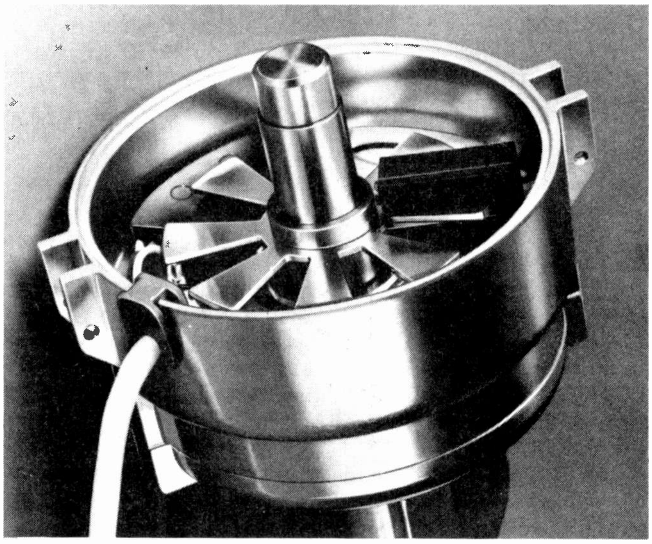


Fig. 1. A section of a distributor employing a Wiegand wire to generate the timing pulses



A Wiegand distributor; note the rotating vane made of a soft magnetic material

An advantage of the new technique is that no wires are required to carry any power to the sensing head. The two output leads from the coil (one of which can be earthed) are the only output connections required and this greatly simplifies the wiring.

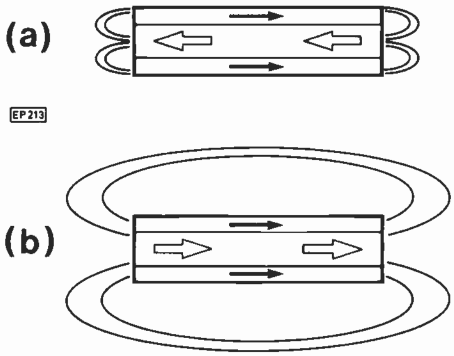


Fig. 2. A Wiegand wire (a) with no external applied magnetic field and (b) with an applied field great enough to reverse the direction of magnetisation of the core. Note the external field from the wire is much greater in (b) than in (a)

The time of switching of the Wiegand wire is a threshold effect determined by the level of the magnetic flux, so the pulses have the same amplitude and duration over the entire speed range of the vehicle from 'tick-over' to the maximum permissible engine revolution rate.

This type of ignition timing system can operate over a very wide temperature range with excellent stability. Indeed, the Wiegand wire is able to operate from −196°C (liquid nitrogen temperature) up to more than 260°C where the insulation of the wire may fail. The magnetic flux required to produce switching is almost constant over the temperature range. The output pulse amplitude variation with temperature is less than 5 per cent over a wide temperature range.

The output pulse from the Wiegand sensing coil is passed to a transistor switching circuit which allows a tank capacitor to discharge through the ignition coil so as to produce the ignition spark at the correct time. It is claimed that maximum combustion efficiency can be ensured using this system which maintains the accuracy of the timing to 0·25 degree.

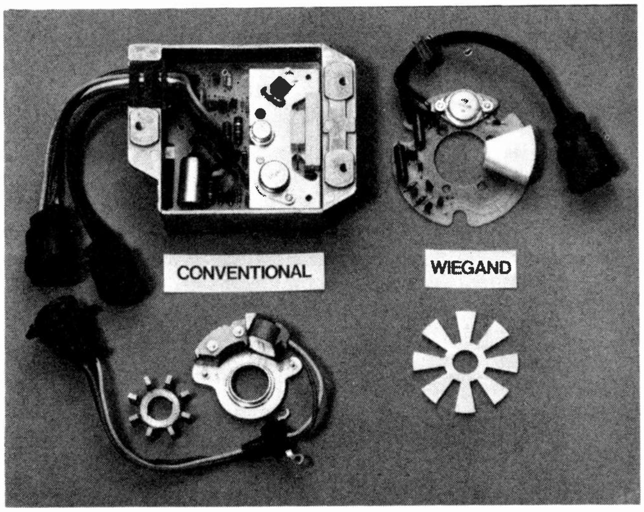
Wiegand systems are immune to the presence of dust, smoke, fuel or other vapours, vibration, dirt and moisture. There are no contact points to maintain and the system can provide a rate of engine revolution indication if required. A great advantage is the simplicity of the sensing unit and associated circuitry. The use of a Wiegand distributor will not alone improve the performance of a perfectly tuned engine, but it will normally improve considerably the reliability of racing cars under severe environmental conditions.

THE WIEGAND EFFECT

The Wiegand Effect is exhibited by wires made of a ferromagnetic material which have been suitably worked at the correct temperatures. Initially a homegenous wire about 0·25mm in diameter and little more than 10mm in length is taken; this wire is cold worked by twisting and stretching it, after which it is thermally tempered at about 300°C.

The wire thus produced has a magnetically 'soft' inner core which is easily magnetised by a weak magnetic field, but this inner core is surrounded by a shell of magnetically 'hard' material which requires a much larger field to magnetise it.

In the absence of an external magnetic field, the field from the outer shell of the Wiegand wire will pass through the soft core material with the result that the total external field due to the core and outer shell will be negligible. If an asymmetrical field is now applied so that its polarity is essentially parallel to the shell of the wire, a sudden reversal of the polarity of the field of the core occurs as the external field reaches a certain threshold intensity know as H_{set}. The flux from the core and from the shell now re-inforce each other externally so that the external magnetic field is greatly increased.



The Wiegand electronic ignition system on the right hand side employs only 17 components against the 40 components used in the conventional magnetic pick up system

When the external field falls and changes its polarity, the field in the core of the Wiegand wire switches back to its original direction. This occurs at an external field value H_{reset} which is much smaller than H_{set}.

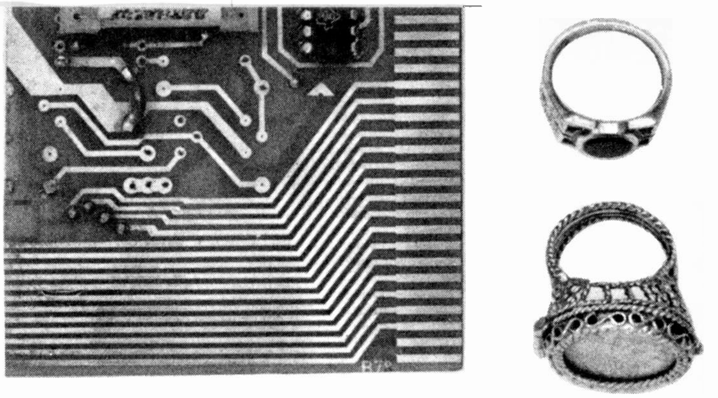
In a typical system, a coil of perhaps 1000 turns on a short Wiegand wire will produce output pulses of well over 1V across a 2k load. The pulse amplitude can be increased to over 10V if required. The pulse of the opposite polarity is much smaller in the normal asymmetrical drive system. In some systems a stronger external field is used so that the polarity of the shell is reversed after the polarity of the core has been reversed; in this case the switching is symmetrical.

OTHER USES

Apart from the use of the Wiegand Effect in vehicles for ignition timing and sensing the rate of engine revolution, it could also be used for sensing the rotation of each of the road wheels in anti-skid braking systems; when a wheel locks, the brake fluid pressure would be released for a fraction of a second before being re-applied so as to obtain the maximum braking effect automatically.

Wiegand sensors could also be used to provide data to a microprocessor which could control the ignition timing and the fuel/air mixture automatically so as to provide the best performance under all conditions.

Wiegand wires are also used in other applications, such as in plastic cards which control the access of people to certain areas or to railway stations, etc. and can be employed in electronic touch keys and for measurement of liquid flow. (Information on Wiegand products can be obtained from Sensor Engineering Co., Echlin Rd., Brandford, Connecticut 06405, U.S.A.) ★



ULTRASONIC CLEANER

ULTRASONICS is the term given to sound waves beyond audibility. This varies between individuals so it may be said that frequencies of 16kHz or greater are ultrasonic. If ultrasonic waves are propagated through a liquid then cavitation takes place. Cavitation is the term that refers to the formation of bubbles or cavities in the liquid. A typical example of cavitation is the churning of ships propellers which can considerably erode the propeller blades.

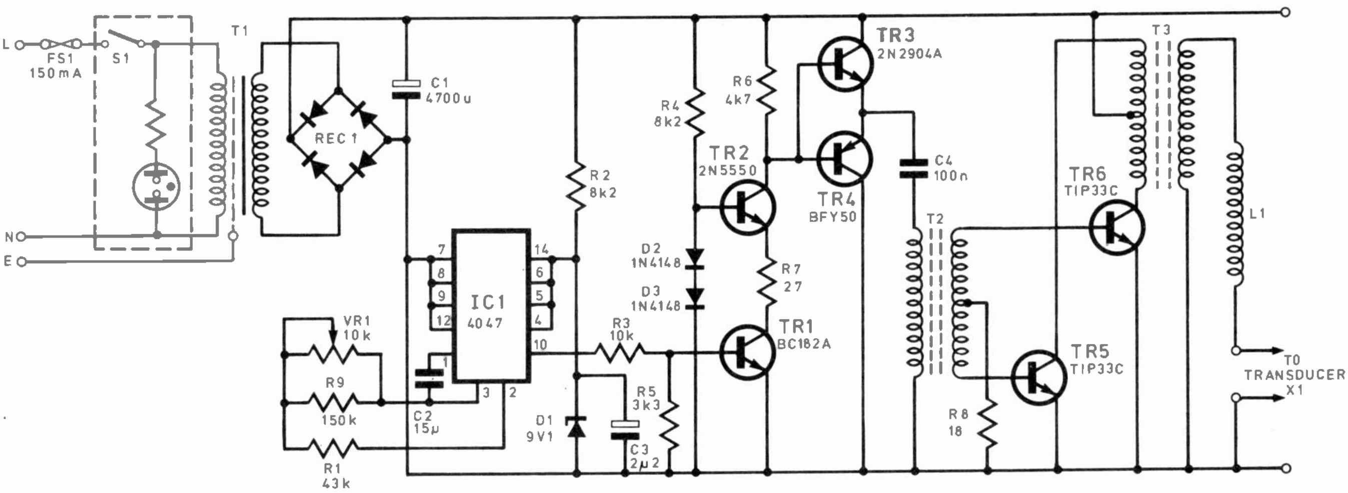
When cavitation is caused by the passage of ultrasonic sound, however, the effect can be usefully used for the cleaning or dispersion of dirt. This action is due to the high pressure caused locally by the collapse of the cavities. This happens when a region of compression, following rarefaction, leads to a pressure that can collapse a cavity. The gas or vapour in a bubble at this time is greatly compressed and when it collapses it produces a powerful shock wave that is responsible for the cleaning action.

Bubbles may be gas filled, vapour filled or a complete void. Gas filled bubbles take several pressure cycles to form and are dependent on dissolved gas in the liquid. The production of vapour bubbles or voids is very rapid and the cavity's life is short. Most of the noise produced by an ultrasonic cleaner is due to the formation and collapse of these cavities.

Ultrasonics are extremely useful when it is desired to clean items that have many small interstices such as items of jewellery or small mechanical or electronic assemblies. Ultrasonic cleaning is also used for items that have a patina such as old coins, since it will not damage this layer and therefore detract from an object's value.

CIRCUIT DESCRIPTION

The circuit diagram of the Ultrasonic Cleaner is shown in Fig 1. The tank's basic resonance centres on approximately 33kHz. IC1 is connected as an oscillator, the frequency of which can be adjusted by VR1 mounted on the front panel of the finished unit, allowing adjustment in use. IC1, a 4047 CMOS device, has a combined oscillator and divide by 2



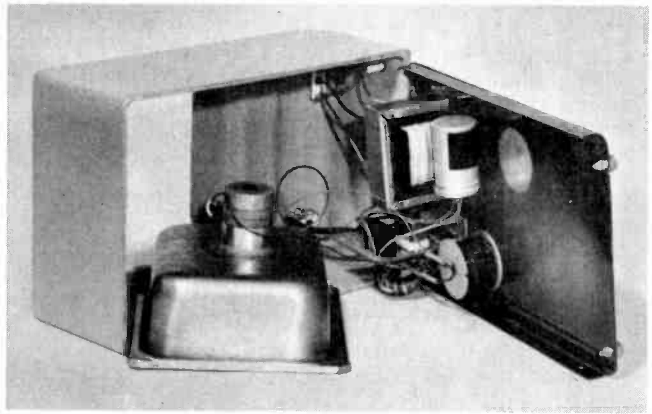
EG 236

Fig. 1. Complete circuit diagram of the Ultrasonic Cleaner

latch, so the basic frequency is set at around 66kHz, the actual output after the divide by 2 latch being a square wave of frequency around 33 kHz, with a precise 50/50 duty cycle. R2, D1 and C3 derive a 9V supply for the CMOS i.c. The resistor R9 prevents damage to IC1 whilst connecting VR1.

The output of IC1 is amplified by transistors TR1 and TR2 to give a voltage swing at TR2's collector of 40Vpk-pk. The collector voltage of TR1 is held low by TR2 whose base voltage is maintained by R4, D2 and D3 at approx. 1·2V. This arrangement overcomes the problem of the collector base capacitance of TR1 limiting the maximum rate of rise of the output voltage. TR3 and TR4 provide current amplification to drive the primary of T2 via C4.

The output of T2 is used to drive the output transistors TR5 and TR6 and R8 limits the maximum current. The reverse voltage helps to switch off the transistor quickly



Internal view of the Cleaner

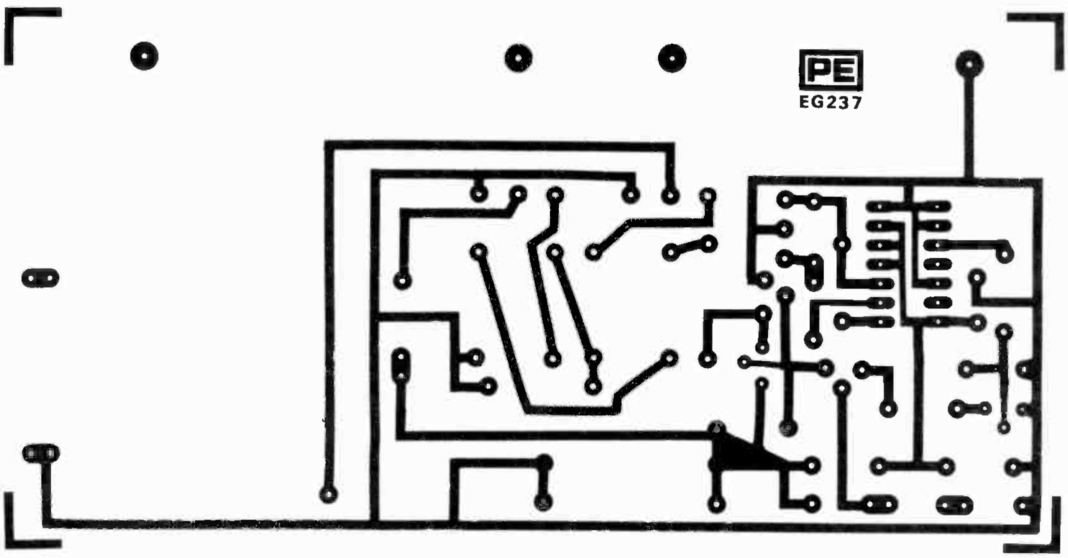


Fig. 2. P.c.b. design for the Cleaner.

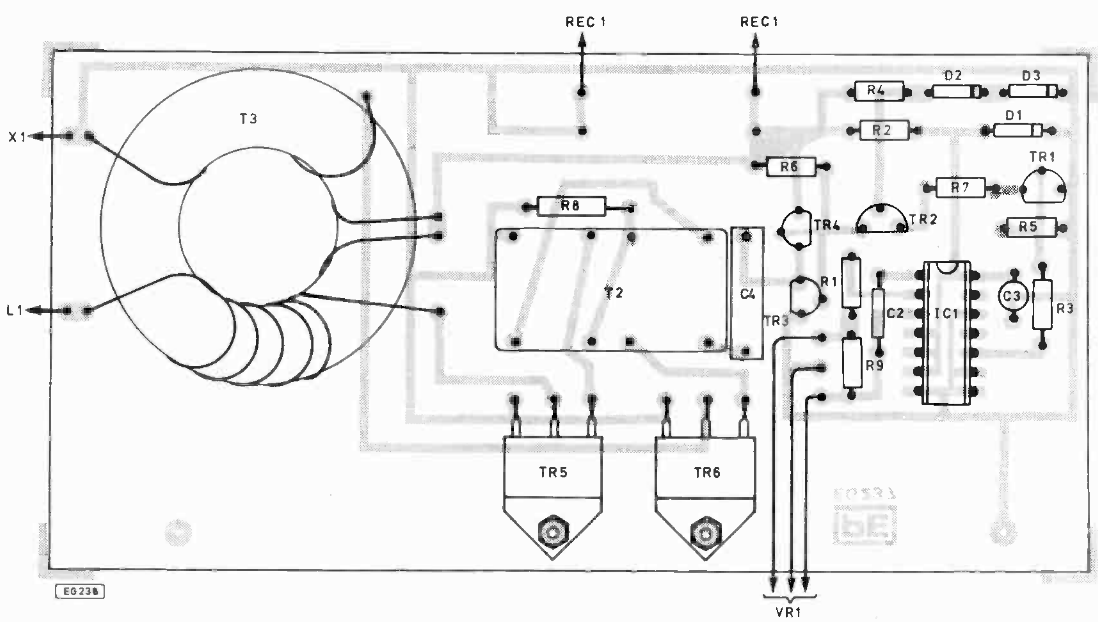


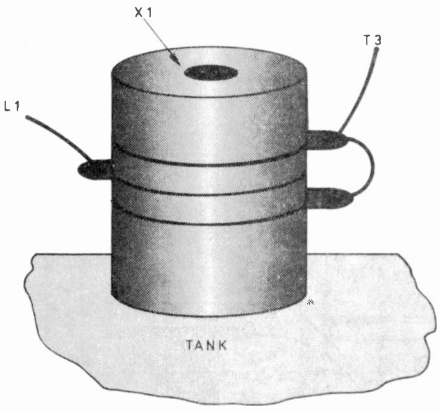
Fig. 3. Component layout.

which is the reason for using the drive transformer. L1 matches the parallel capacitance of the transducer to the secondary of T3 further improving the overall efficiency.

The power supply consists of transformer T1, bridge rectifier BR1, and smoothing capacitor C1. The fuse (FS1) and front panel mounted neon illuminated switch S1 complete the circuit.

CONSTRUCTION

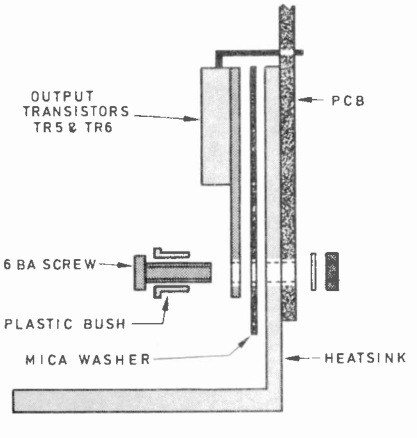
The transducer should be glued to the tank bottom using Araldite. The quick setting type is not suitable. The surfaces to be stuck must be thoroughly cleaned using a de-greasing solvent and the tank bottom lightly abraided. The transducer should be stuck centrally on the tank bottom by the aluminium end, which has been shot blasted to help adhesion. The tank should be inverted over a 40W light bulb so that the adhesive heat cures. The transducer face should be coated with adhesive, applied to the pre-heated tank, and a length of tape used to keep the transducer in contact with



EG240 **Fig. 4. Transducer (X1) wiring**

the tank. This can be removed when the glue has hardened. The lamp should be left on for one hour after mounting the transducer and the tank should not be used until the glue has had at least 36 hours to set. This is critical to the final performance of the finished unit, and care should be taken to get best results.

The p.c.b. design of the Ultrasonic Cleaner is shown in Fig 2 and the component layout is shown in Fig 3. After soldering and checking the p.c.b. it can be mounted on the aluminium mounting bracket which doubles as a heatsink. The output transistors TR5 and TR6 must be isolated using mica mounting kits (Fig 5). The output transistors should be



EG239 **Fig. 5. Heatsink mounting for TR5 and TR6**

soldered after they are clamped down to the heatsink. Care should be taken soldering IC1 which should be put in last. An i.c. socket may be used if preferred.

BASE PLATE

The base plate should be fitted into the cover of the unit and mounting holes drilled (two holes each side).

The components that mount onto the base plate are the mains transformer T1, the clip for capacitor C1, the p.c.b., inductor L1, the bridge rectifier and the four rubber feet. These components should be fitted to the base plate as shown in Fig. 7, taking care not to foul the tank. L1 should be glued to the base plate with araldite and must not be bolted through.

COMPONENTS . . .

Resistors

R1	43k
R2, R4	8k2 (2 off)
R3	10k
R5	3k3
R6	4k7
R7	27
R8	18 (2·5W)
R9	150k
VR1	10k

All resistors $\frac{1}{3}$W 5% carbon unless otherwise stated

Capacitors

C1	4700µ 40V
C2	15µ polystyrene
C3	2µ2 tant 16V
C4	100n

Semiconductors

D1	BZY 88C 9V1 Zener
D2, D3	1N4148 (2 off)
REC 1	BR1 8A
TR1	BC182A
TR2	2N5550
TR3	2N2904A
TR4	BFY50
TR5, TR6	TIP33C
IC1	4047

Inductors

L1	(UTWEL 1)
T1	Mains transformer 80VA 2A sec (UTWET 1)
T2	(UTWET 2)
T3	(UTWET 3)

Miscellaneous

Case & tank
Fuse holder
Fuse 1A
Neon switch (S1)
Two transistor mounting kits
Heatsink
Transducer X1

Constructor's Note

A complete kit of parts for the Ultrasonic Cleaner can be supplied by WICCA ELECTRONIC SYSTEM LTD., ORCHARD WORKS, CHURCH LANE, WALLINGTON, SURREY.

The kit price is £68·00 plus VAT and £1·81 p&p.

to front left transformer mounting bolt. Mount VR1 on the tank body and screw the base plate to the body using four self tapping screws. The transducer should be wired as shown in Fig 4.

The tank can then be mounted into the cover and adhesive used to make a waterproof seal.

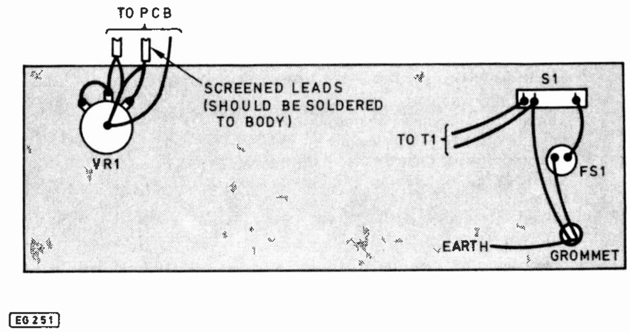


Fig. 6. Front panel wiring

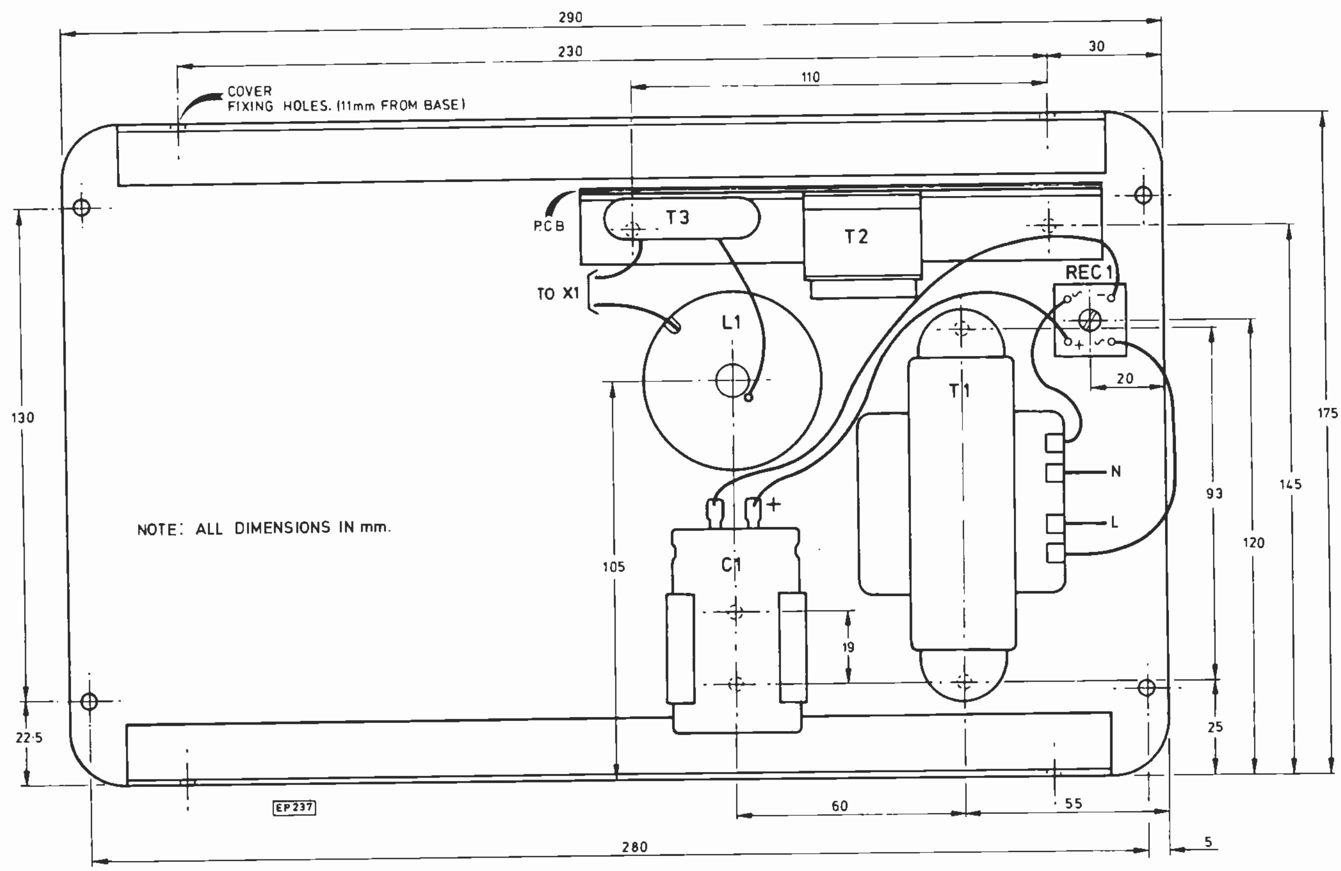


Fig. 7. Base plate wiring and drilling details

The mains switch, potentiometer VR1 and the mains fuse holder mount directly onto the fibre glass cover.

WIRING UP

The mains lead to the fuse holder and switch should be wired next (Fig 6). A 4BA tag should be soldered to mains earth for clamping to one of the transformer mounting bolts and the leads from the switch to the transformer should be about 5" long. The wiring to the base plate components can be carried out next. VR1 is connected with screened leads to the p.c.b. and the screens at the pot end should be soldered to the pot body. After the leads from the switch to the tank cover and transformer have been wired clamp the earth lead

TESTING

To test the unit fill the tank with water to within about an inch from the top and switch on, adjust VR1 until maximum activity is noted in the water. If a point cannot be found then recheck the p.c.b. for errors. The simplicity of the circuit should mean first time results.

Articles to be cleaned are suspended in the tank in the centre. If required wire holders can be made up to help support items. ★

When the prototype unit was tested in the office an ink drawing pen, which had been blocked up and left for three years, was placed in the tank. The result was a completely cleaned and working pen in a couple of minutes.

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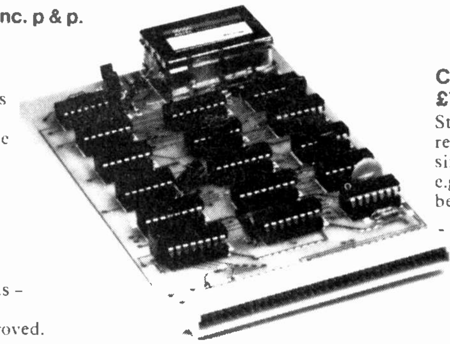

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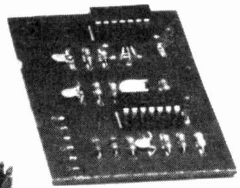

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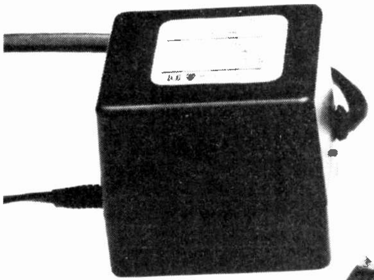

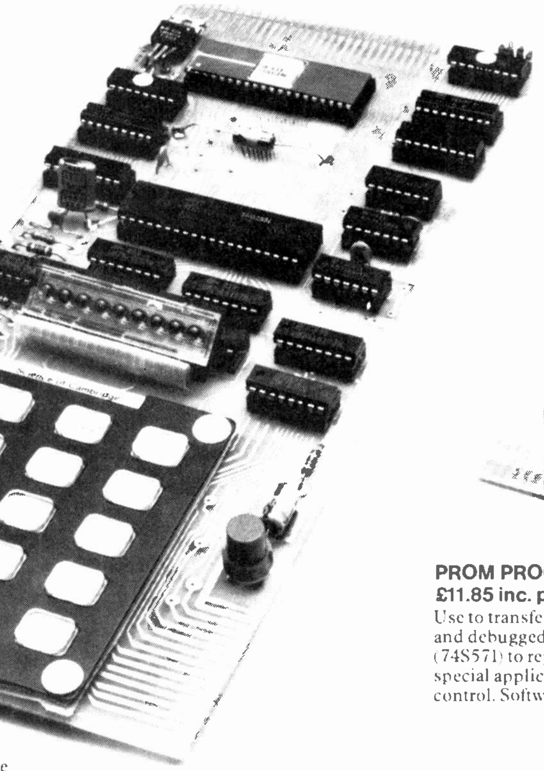

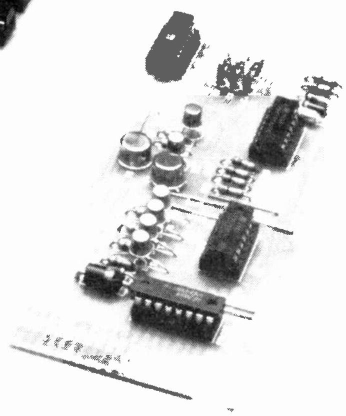

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74LS03	12p	74LS73	25p	74LS153	51p	74LS251	74p
74LS04	12p	74LS74	25p	74LS155	51p	74LS273	150p
74LS05	17p	74LS75	28p	74LS156	54p	74LS279	50p
74LS08	30p	74LS76	30p	74LS157	65p	74LS283	92p
74LS09	17p	74LS85	56p	74LS158	52p	74LS290	40p
74LS10	14p	74LS86	30p	74LS160	118p	74LS298	50p
74LS11	23p	74LS90	30p	74LS162	50p	74LS352	100p
74LS12	15p	74LS93	42p	74LS164	60p	74LS353	100p
74LS13	20p	74LS95	50p	74LS174	65p	74LS366	50p
74LS14	30p	74LS107	25p	74LS175	65p	74LS367	50p
74LS20	15p	74LS109	25p	74LS190	60p	74LS368	50p
74LS21	16p	74LS112	25p	74LS191	60p	74LS374	150p
74LS26	25p	74LS113	25p	74LS192	60p	74LS386	25p
74LS27	15p	74LS114	25p	74LS193	60p	74LS670	150p
74LS28	25p	74LS123	70p	74LS196	53p		
74LS30	14p	74LS125	30p	74LS197	53p		
74LS32	16p	~~74LS126~~	~~30p~~	74LS221	65p		
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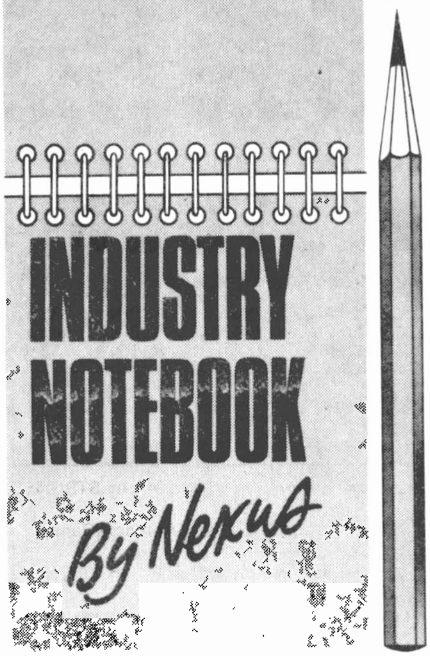


Chaos Ahead?

Every 20 years the nations of the world get together to examine the international regulations on radio communications services. Are they working well? Is the available spectrum being used efficiently? Should power limitations be imposed on short wave broadcast propaganda stations? Should amateur radio be squeezed out in favour of more essential services? These and many other questions.

This great jamboree is called the World Administrative Radio Conference, abbreviated to WARC 79. It is held under the auspices of the International Telecommunications Union. Twenty years ago at WARC 59 there were 87 participating countries. The self-determination movement and further progress in decolonisation has boosted the number of countries to 140 and, not unnaturally, all the new members are extremely proud of their new status as independent self-governing nation states.

The old rules still apply, one nation one vote. Little Fiji with 580,000 population, for example, has the same voting power as the UK's 56 million, the USA's 215 million or the Soviet Union's 257 million. This is not to say that wisdom is proportional to population or that the big powers should bulldoze their own demands through the conference. What happens in practice, however, is that the less prosperous countries which, almost by definition, are less able to form fairly balanced technical judgements, tend to vote either in solidarity with their own blocs or to side with the more prosperous countries from which they are already receiving or hoping to receive aid. There is also an unfortunate, but again natural, trend for newly emergent nations to take a swipe at their former "oppressors" whatever the merits of a proposal put forward quite honestly on purely technical and operational grounds.

The first big squabble came with the appointment of the WARC 79 chairman. The first nominated was from New Zealand, rejected by the non-aligned countries. Next was one from India, not acepted by the Western Group. Surely nobody would object to a candidate from neutral Switzerland? Not so, this worthy individual being rejected by the non-aligned group and the Western group. Eventually, after much behind-the-scenes lobbying, an Argentinian, R.J.P. Severini emerged as chairman.

One fears that more so than ever before, WARC 79 has become a political more than a technical conference. Even though the numerous sub-committees working entirely at the technical level make sound decisions their work may well be frustrated by the national and international voting pattern.

Attending WARC are some 2,000 delegates if you include official "observers" with special interests who will be lobbying in the corridors. I hope they enjoy their long sojourn in Geneva. Originally scheduled as a 10-week event ending on November 30, I forecast that this conference will go down in history as WARC 79/80. But better to have an extended conference with sensible results than a hodge-podge of ill thought out decisions which can only lead to even more chaos on the radio waves in the years ahead.

Telecom 79

Also in Geneva was the great Telecom 79 exhibition. This one for the world's telecommunications equipment manufacturers is staged every four years by the International Telecommunications Union, an agency of the United Nations. ITU's secretary-general M. Mili opened Telecom 79 by reminding us that there are some 400 million telephone lines today and that present projections indicate some 1,400 million by the end of the century. At today's prices this means the spending of an extra £1 trillion during the next 20 years.

No wonder this exhibition was chosen as the first launch platform for Britain's System X, the all-digital telephone system of the future. System X is a joint development between the British Post Office, Standard Telephones & Cables, Plessey and GEC. Overseas marketing is through a newly-formed consortium company, British Telecommunications Systems (BTS).

The BPO has endorsed the system (could it do otherwise?) by ordering the first nine System X exchanges which will go into service from 1981 onwards. BTS is not expecting quick results in exports but is taking the long-term view. System X cannot sell on technical merit alone. The big markets are in countries which have no indigenous telecommunications industry and they need financial support to invest in huge capital projects. They may also demand a share in the manufacture of equipment. So any negotiations tend to be complicated and lengthy.

At Geneva System X was one of the few digital systems demonstrated live—a great point in its favour against what is likely to become fearsome competition from the leading European and US manufacturers.

MEDE 79

The Military Electronics Defence Expo '79 staged at Wiesbaden was a frightening showcase of ingenuity. Military electronics is one field in which the Japanese have, as yet, made no impact. Except that one could not fail to note that nearly all the audio-visual displays of missiles homing on to targets and other awesome scenes were using Sony VCR equipment. At least aiding and abetting if not participating directly!

There was in fact one Far Eastern exhibitor, Veterans Electronics Communications Incorporated, who make combat radio, manpacks and vehicle-mounted, in the Phillippines. Their marketing arm is Vetronix Inc. and the company slogan is "High technology aimed at low budget targets". Translated this means Asia, Africa and South America. Their appearance in Europe could well have been not so much to sell here as to look for new lines to manufacture under licence.

This trend, which I have commented on before, is steadily growing. Technology transfer, today's big business, is tomorrow's threat, that is unless you can stay ahead in technology. But looking over the prime exhibits from the USA and Europe there seemed little chance of the tiddlers in electronics ever catching up with the big fish. They haven't the technical design teams or the financial resources. Even in the West costs are becoming so prohibitive that joint ventures are ever more necessary.

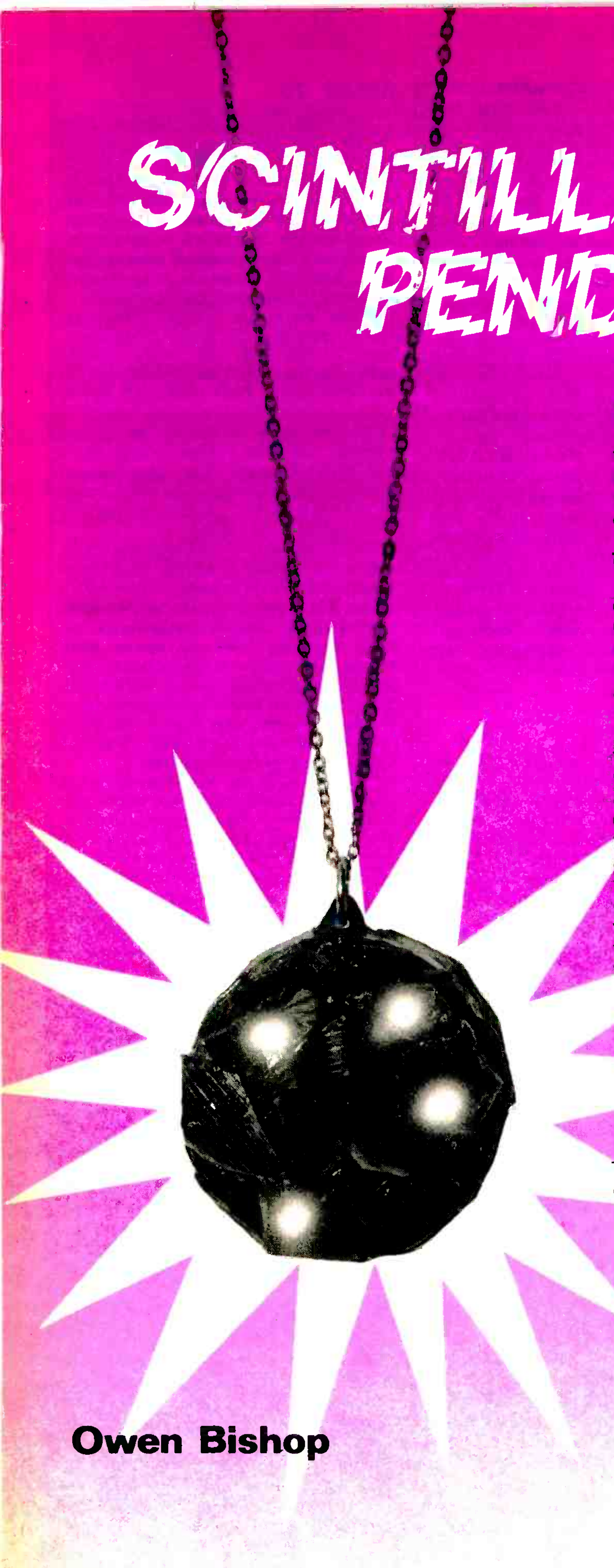
One can argue that all military spending is waste but one is also forced to the conclusion that the United Kingdom would indeed be in a sorry state in terms of overseas trade balance and unemployment but for exports of defence equipment with the very high added value afforded by high technology. A single example illustrates the point. Plessey alone have already completed their first £100 million of sales on Clansman equipment and they are only one of four British contractors on the project.

An interesting point on design philosophy arose during the technical conference at MEDE. Surprisingly two different viewpoints were expressed from the same company, RCA, although the speakers were from different divisions of the company and talking on different topics.

Our speaker, a software orientated person, was singing the praises of standard hardware in which software changes could be rapidly made to accommodate new or different applications as the military need dictated. This is a commonly accepted doctrine.

A second RCA engineer took the opposite view pointing out that hardware costs are constantly falling while software costs are constantly increasing. The implication here is that versatile systems can be implemented more economically through plug-in hardware modules. This speaker went so far as to state, "Ten years ago it appeared that software-controlled processing in a general purpose computer would provide maximum flexibility at minimum costs. In fact real-time software has proven to be very expensive and inflexible".

SCINTILLATING PENDANT



Owen Bishop

THIS project was designed as a piece of jewellery for evening wear. It produces a scintillating light effect from an array of light emitting diodes and could equally well be made up as a pin-on brooch or as a bracelet. There can be many varieties on the original theme so that the final product can be unique in appearance and activity.

CIRCUIT DESCRIPTION

The circuit is based on two CMOS i.c.s (Fig. 1). R1 is included for extra protection against static discharge. The CD4060B together with the timing capacitor C1 and resistors R2 and R3 provide an astable multivibrator and a 14-stage binary dividing chain. Outputs from stages 1, 2, 3 and 11 are not available. Reading from pin 7 down to pin 3 represents the multivibrator frequency divided by 16, 32, 64, 128, 256, 512, 1,024, 4,096, 8,192 and 16,384 respectively. These outputs, with the exception of that from pin 15 (÷1,024) and pin 2 (not used) are fed to the CD4052 dual analogue multiplexer/de-multiplexer. The function of one half of this i.c. is illustrated in Fig. 2. In effect it is a 5-way switch, through which current can flow in either direction, just as in an ordinary mechanical switch, except that the path through the switch in positions 0 to 3 has a resistance of about 120 ohm. Though we are calling this a switch, for this is how it functions, in fact the i.c. contains a number of CMOS transmission gates, under the control of the inhibit and the two control inputs A and B. With inhibit input high, the switch is open-circuit. With inhibit input low, one channel becomes closed-circuit, or "ON":

Inputs B	Inputs A	Channel On
0	0	0
0	1	1
1	0	2
1	1	3

The two analogue switches of the i.c. are used to direct the outputs from IC1 to the five l.e.d.s D1 to D5. D6 is lit directly

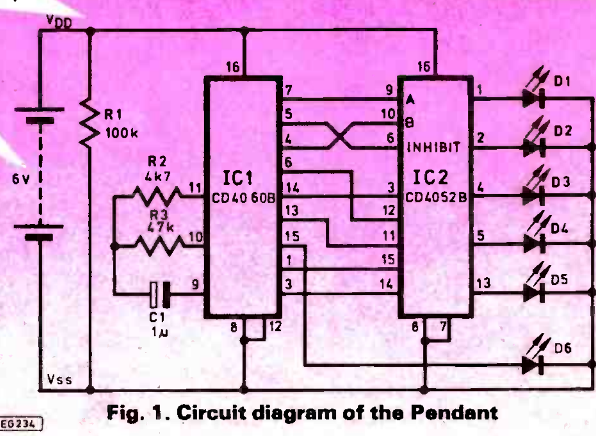
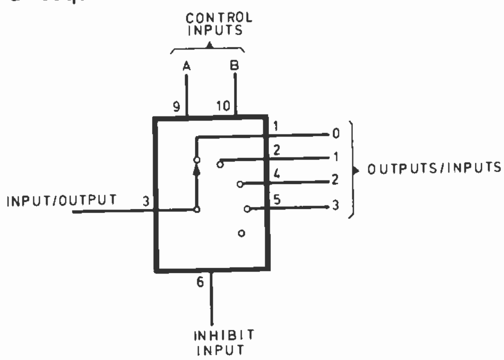


Fig. 1. Circuit diagram of the Pendant

from the output of pin 15, IC1. Four l.e.d.s D1 to D4 are connected so that they are illuminated in turn, depending on inputs to A and B, but only when the output of IC1, pin 14 is high. D5 is illuminated if one of the outputs it is connected to (pins 6, 13, 1 or 3 in turn) is high. The effect of this is to produce a sequence of illumination that is apparently



EG235 **Fig. 2. Function diagram of IC2**

random. The sequence is further complicated by the inhibiting action which cuts out some stages altogether. This action also ensures that for at least 50 per cent of operating time none of the l.e.d.s D1 to D5 are lit, so doubling battery life. D6 operates independently of IC2 and thus creates a further apparent randomness.

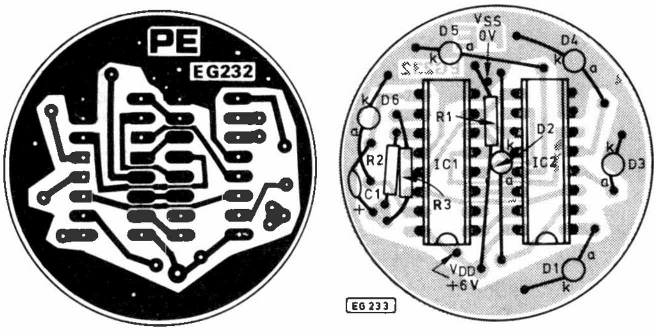


Fig. 3 and Fig. 4. P.c.b. design and component layout

The circuit has low current consumption (0·08 mA when no l.e.d.s are lit and about 10 mA per l.e.d. lit) so it will run for 10 hours or more from 4 button-cells. Though CMOS i.c.s and l.e.d.s can both be run from supplies of 3V, reduction of voltage increases the switch resistance and the intensity of light emission becomes too low for good effect.

COMPONENTS . . .

Resistors

R1	100k
*R2	4k7
*R3	47k

*See text
All resistors 0·125W, 10%

Capacitor

C1 1µ 35V tantalum bead

Semiconductors

D1 to D6	light-emitting diodes of constructors choice
IC1	CD4060BE
IC2	CD4052BE

Miscellaneous

Materials for mounting, according to individual design. Plastic resin kit, necklace chain, button cells (4 off) type 675.

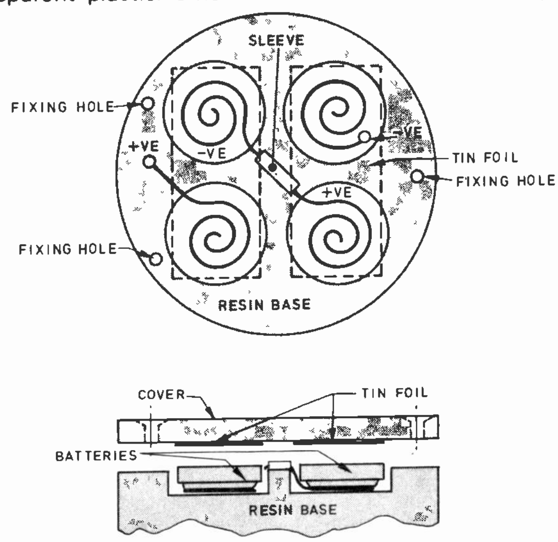
CONSTRUCTION

The p.c.b. design and component layout are shown in Figs. 3 and 4. If it is intended to hang the pendant from a chain, the p.c.b. may be extended to form a projecting lug with a hole drilled through it for attachment. Constructors will have realized that there are many ways of connecting the two i.c.s, with each way producing its unique sequence of illumination. At this stage you may prefer to set up the circuit on a bread-board and try varying the connections to obtain different effects. Some modification of the p.c.b. pattern may then be decided upon. Select the values of C1 and R3 to obtain the rate preferred and alter R2 so that its value is about 10 per cent of R3. There is also a choice of l.e.d.s.

The l.e.d.s should be mounted as close as possible to the board, so that their tops project only slightly above the upper surfaces of the i.c.s.

PRESENTATION

Here there is infinite scope for individuality and artistic ability. Some points have already been mentioned and it is important to work out these details fully before commencing construction. When the prototype circuit-board was complete and working, it was inverted in a cylindrical mould made from aluminium kitchen foil and cast into a disc-shaped block of clear resin. The front and edges of the disc were covered with irregularly shaped fragments of transparent plastic. Since the inner surface of each piece



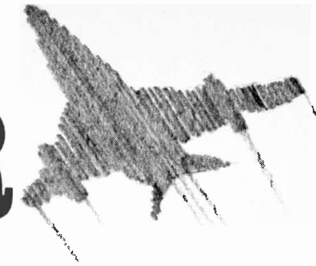
EG241 **Fig. 5. Layout and connection of batteries**

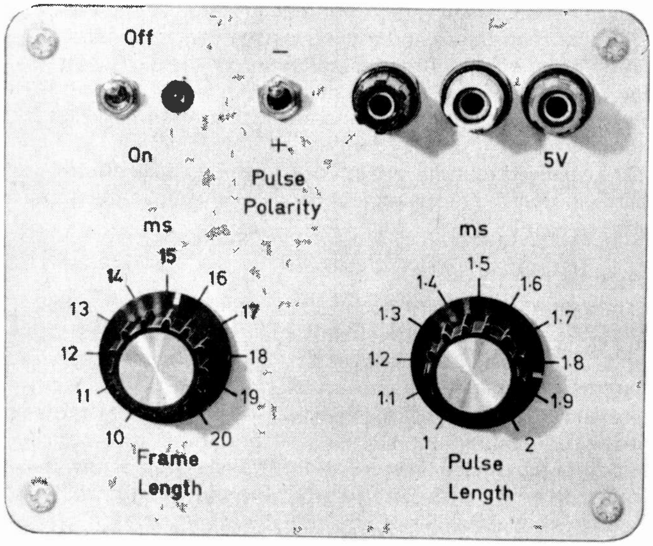
was corrugated, refraction caused the light from each l.e.d. to appear as a streak, its orientation depending on the orientation of the corrugations. A simple way of covering the l.e.d.s could be to cast the circuit in a disc of resin in a mould made from crumpled foil; the resin could be coloured red or any other shade by mixing in a few drops of pigment before pouring it into the mould. If you are really skilled you could contemplate mounting the circuit in an ornamental bezel, or perhaps cover it with a filigree network through which the l.e.d.s protrude. Alternatively, you could buy a ready-made mount and design the p.c.b. to fit it.

BATTERY CONNECTION

In the prototype, a second resin disc was cast on the back of the p.c.b., leaving 4 circular pits to hold the button cells, and using wire and foil strips to make the connections to the terminal pins on the board, and between cells (Fig. 5). The pendant was backed with a thin disc of Formica. ★

R/C SERVO TESTER





C.R.FRANCIS B.Sc.Ph.D.

MANY remotely controlled models operate very satisfactorily with simple on/off commands. The undercarriage of a model aircraft may be retracted or extended by this type of command for example, and similar applications abound. For more sophisticated control however, some form of proportional response is required. Imagine that we wish to steer a model car by some form of remote control, say radio control. By using two separate on/off commands we could arrange the wheels to be straight or hard left, or straight or hard right, and steering would be possible, if a little jerky. Using a proportional system the wheels could be made to imitate, or follow, the movements of a knob on the control set. The mechanical movements of the wheels would be carried out by connecting them to a servo-mechanism.

Now many proportional control systems may be used which do not involve electromechanical devices; such as voltage control of the frequency of a radio tuner through a varicap diode, or, more relevantly, control of an electric motor by pulse width modulation of the power supply. The most commonly used method in radio controlled models however, is the electromechanical servo mechanism, or servo.

Fig. 1. Layout of a typical servo. The potentiometer wiper is normally directly coupled to the output shaft, which is driven through reducing gear by the electric motor

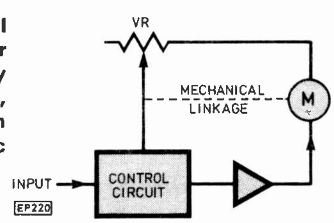
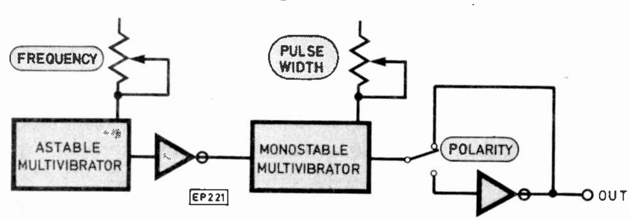


Fig. 2. Block diagram of the servo tester



TYPICAL SYSTEM

A typical modern radio control system uses pulses of variable width to transfer information. A short pulse will cause the servo to move to one end of its travel, a long pulse makes it move to the other end and intermediate pulses result in an intermediate position. A typical servo will contain an electric motor to drive its movements, a potentiometer to monitor these movements, mechanical linkages between these two, and a control circuit. These are all shown in Fig. 1.

Typical characteristics for the control pulses are as follows:
Frame length (the interval between successive pulses)—20ms
Pulse length—1ms to 2ms for complete range of travel
Positive pulses

Many servos may be included in a system by interleaving the control pulses, so that proper decoding and routing of the pulses will give simultaneous control. It is often convenient to operate a servo in isolation from the rest of such a system, and in this case a servo tester is ideal.

THE TESTER DESCRIBED

The servo tester to be described will control servos with the characteristics listed above, and furthermore the frame length is variable, from 10 to 20ms, and the pulses can be positive or negative going. Instructions will be given so that departures from these parameters may be accommodated. The tester can also supply up to 500mA at 5V to the servo under test. This should be adequate for most miniature servos, though electronic control of anything other than a small electric motor will require a more suitable power supply.

BLOCK DIAGRAM

A block diagram of the servo tester is shown in Fig. 2 and we can see that is is very simple. An astable multivibrator produces pulses of fixed length (about half a millisecond) but variable repetition frequency; this defines the frame length. The inverter is necessary simply to achieve the correct polarity for the triggering of the next stage, a monostable multivibrator.

When triggered this produces an output pulse whose length is variable, between 1 and 2ms. These pulses may be inverted, or not, in the final stage, to produce negative or positive going pulses.

CIRCUIT

A circuit diagram of the complete instrument is shown in Fig. 3. The astable multivibrator is built around a 555 timer; for convenience a 556 dual timer was used in the prototype, since another 555 is required for the monostable multivibrator. Although the 556 is specified in the circuit diagram and component list, two 555s may be used if preferred.

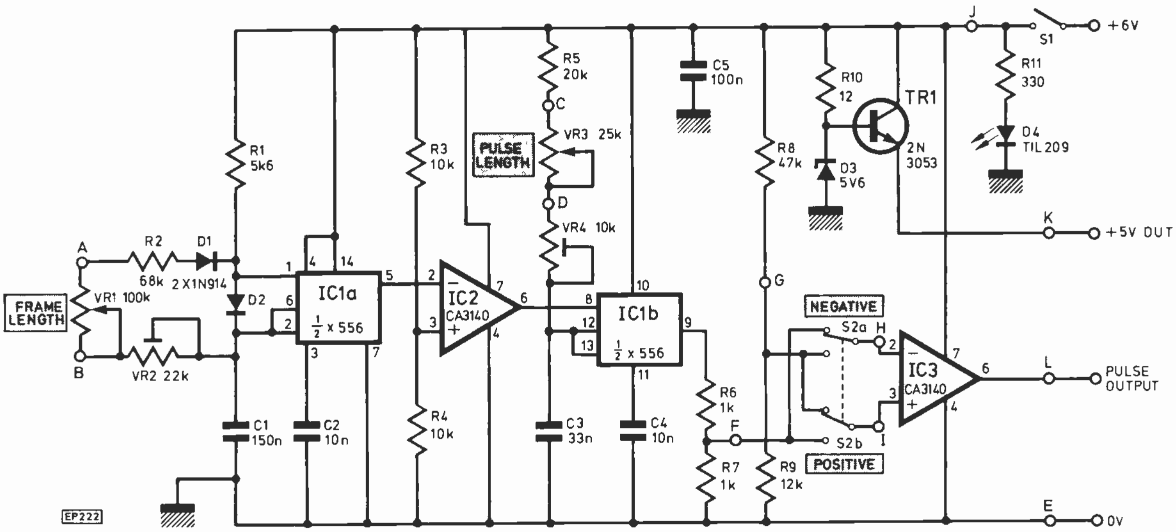


Fig. 3. Circuit diagram of the servo tester

When operating as an astable multivibrator the timer i.c. monitors the voltage on the timing capacitor, C1, as it charges through R1 and D2. The output voltage is, at this time, high. When the voltage on C1 reaches 2/3 the supply voltage, V_{cc}, the output voltage switches low and C1 starts to discharge through VR1, VR2 R2 and D1, into the discharge pin. When the voltage on C1 has dropped to 1/3 V_{cc} the trigger pin is activated, which restarts the sequence.

The period when the output is high, t_1, is governed simply by R1 and C1. The low output period, t_2, is controlled by VR1, VR2, R2 and C1. The relationships are:

$$t_1 = 0{\cdot}7\ R1\ C1$$
$$t_2 = 0{\cdot}7\ (VR1 + VR2 + R2)\ C1$$

R1 and C1 are chosen so that t_1 is shorter than any of the pulses required from the monostable. A period of 500 µs is suitable.

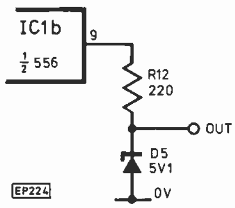
The second timer unit, IC1b, which is a monostable multivibrator, requires negative-going signals to trigger. Inversion is carried out by IC2, a CA3140, which is connected as a comparator. The output of IC1a is compared with a voltage of $\frac{1}{2}V_{cc}$, and the output of IC2 is high or low, if this output voltage is less than or greater than $\frac{1}{2}V_{cc}$, respectively. The output of IC1a is thus inverted. A CA3140 is used here (and for IC3) since the power supply is only 6V. A 741 will not operate reliably from such a supply.

The operation of a second timer as a monostable multivibrator is very straightforward. When a negative going signal is detected at the trigger pin its timing capacitor, C3, starts to charge via R5, VR3 and VR4, and the output goes high. When C3 charges to 2/3 V_{cc}, the output goes low and C3 rapidly discharges. The circuit is now ready to be retriggered. The time for which the output remains high, t_3, is controlled by R5, VR3, VR4 and C3, as shown by the equation

$$t_3 = 1{\cdot}1\ (R5 + VR3 + VR4)\ C3$$

The output from this timer is a train of pulses with the required time characteristics. The remaining parts of the circuit give the voltage characteristics we have specified.

Fig. 4. Modification to the circuit to provide pulses of +5V



SUPPLY

A 5V supply is provided for the servo under test, but the pulses are of only 4V, which will normally be satisfactory. This situation arises because the CA3140 which is used as a comparator in the output polarity switching stage can only swing up to 2V below V_{cc}. The voltages to be compared here are half the output from IC1b, and $\frac{1}{4}V_{cc}$. These are routed via S2 to the inputs of IC3, so that either the inverting or non-inverting action occurs.

If positive pulses only, of the full 5V, are required, then the modifications shown in Fig. 4 may be employed. Here the output is taken straight from the monostable stage, but is limited to 5·1V by the Zener diode, D5.

The 5V supply is provided by TR1. The emitter of this transistor is held about half a volt negative of its base, if sufficient current into the base is available. The 2N3053 is rated at 700mA maximum collector current, so the 500mA required for our supply is within its capabilities. At this level of collector current, quite a large base current is required to maintain the emitter about 0·5V negative of the base, so R10 has to have a low value. This means that with no load, D3 is also approaching its rated power dissipation if a 400mW type is used. To avoid trouble here a 1W type is recommended, though in the prototype a 400mW Zener was used without overheating.

Since D3 is a 5·6V Zener diode the emitter of TR1 should be held at about 5·1V, but remember Zener diodes are normally of 10 per cent tolerance. The output voltage is therefore only nominally 5V.

Veroboard was used in the construction of the prototype. A suitable layout is given in Fig. 5; note that the size of the piece of board was chosen so that it could be supported in slots in the plastic case. A heat dissipating clip was attached to TR1, though it is probably unnecessary. The wiring up of the various off-board components of the front panel, or lid, is illustrated in Fig. 6. Careful cable routing enables the board to be removed from the case easily for adjustments.

ADJUSTMENTS

Only two adjustments are necessary. The frame length control, VR1, is calibrated 10ms to 20ms. Set the control to its mid-point, 15ms. Now adjust VR2 while observing the output on an oscilloscope, or with a frequency counter. Vary VR2 so that the period between successive leading edges of the pulse train is 15ms, or if a frequency counter is being used, until the frequency is 66·7Hz. Check now that at each

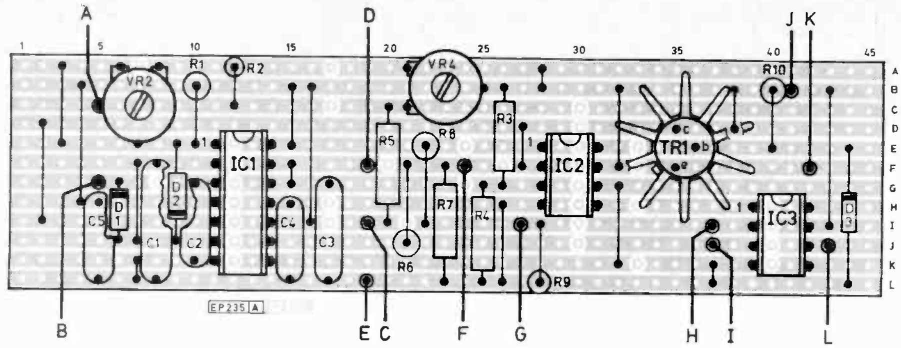
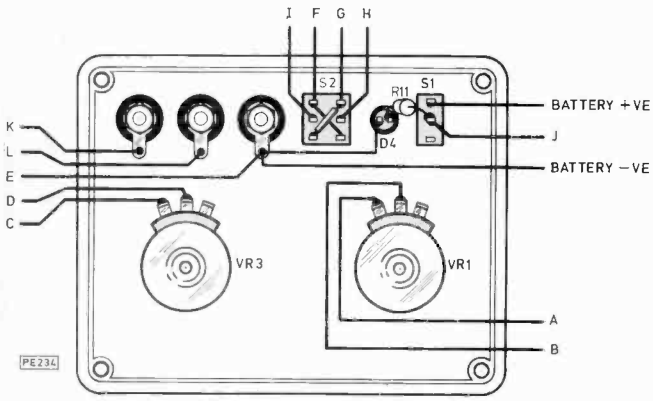
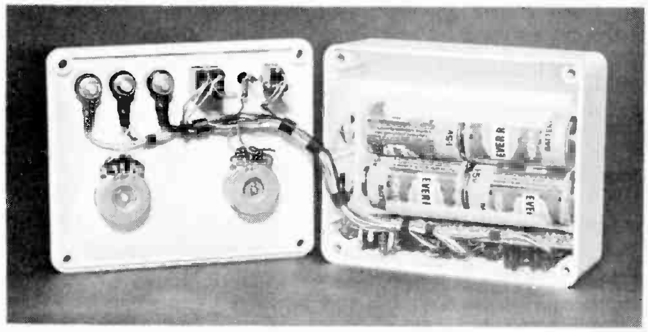


Fig. 5. Veroboard layout

Fig. 6. Control panel wiring





COMPONENTS . . .

Resistors

R1	5k6
R2	68k
R3, R4	10k (2 off)
R5	20k
R6, R7	1k (2 off)
R8	47k
R9	12k
R10	12
R11	330
VR1	100k linear
VR2	22k preset
VR3	25k linear
VR4	10k preset

Capacitors

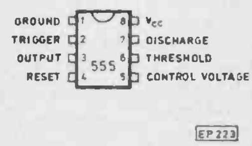
C1	150n
C2, C4	10n (2 off)
C3	33n
C5	100n

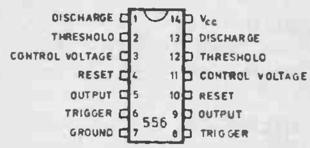
Semiconductors

IC1	556
IC2, IC3	CA3140 (2 off)
TR1	2N3053
D1, D2	1N914 or similar (2 off)
D3	5V6 Zener 1W (see text)
D4	TIL 209

Miscellaneous

S1 On/off switch
S2 Double-pole changeover switch
Terminal posts (3 off)
Veroboard
Plastic case
HP11 batteries (4 off)
Battery box for the above





end of the scale the markings are correct. Be prepared to accept some inaccuracies, bearing in mind component tolerances.

Next VR4 is similarly adjusted so that the 1ms to 2ms scale on the pulse length control is correct. An oscilloscope should be used for this measurement.

If no oscilloscope is available, but accurate measurements of resistance and capacitance can be made, then the necessary adjustments can still be carried out. First measure the capacitance of the timing capacitors C1 and C3, the resistance of R2 and R5, and the range of VR1 and VR3. The equations

$$t_2 = 0{\cdot}7\ (VR1 + VR2 + R2)\ C1$$
$$\text{and } t_3 = 1{\cdot}1\ (VR3 + VR4 + R5)\ C3$$

may then be used to find the required value for VR2 and VR4. A value is found for VR2 so that the extreme values of VR1 give values for t_2 of 10ms and 20ms respectively. Similarly with VR4 and t_3.

These equations should also be used to chose suitable components if time characteristics different from those in the prototype are required. If a pulse length of about half a millisecond or less is required, then the astable multivibrator pulse length must be reduced to a value less than the shortest output pulse. This may be done by increasing R1 in accord with the equation

$$t_1 = 0{\cdot}7\ R1\ C1$$

Do not reduce R1 much less than a kilohm. If a shorter time is then required, reduce C1 instead, but remember that R2, VR1 and VR2 will need changing to maintain t_2.

★

EPROM PROGRAMMER
PART 2 A.A. BERK B.Sc. Ph.D.

THE EPROM programmer is a straightforward device to add to any Bus-oriented MPU system, and this month an interface is described for the Compukit in particular, and other machines in general. A particularly simple machine to interface would be the KIM, for instance, since its "K" outputs provide 1K blocks of address decoding automatically. The only other connections are Data Bus, Address Bus and a single Read/Write line—again brought out to convenient external connections on the KIM.

Also, the rest of the hardware of the programmer is described along with Construction, Setting Up and Troubleshooting.

MEMORY AND SWITCHING

As explained last month, IC3 provides the cycling addresses for RAM and EPROM while programming. During this time, the RAM places data to be "burned" on to the programmer's internal Data Bus. It is essential that none of this is allowed on to the MPU's Data Bus to cause a conflict. Tri-State buffers (IC7 & 14) perform this isolation when their $\overline{\text{ENABLE}}$ lines are held at a logic 1 by IC13 as explained below.

In addition, the MPU Address Bus must be disconnected from the EPROM and RAM while IC3 is cycling, and IC3's counter addresses must be allowed through. This function is performed by the selectors IC10, 11, and 12 when their pin 1's are held at a logic 0 by IC1. A zero from IC1 is also allowed through to pins 1, 4, 5, and 13 of IC13 during programming. This holds pins 11, 3 and 6 at logic 1. Pin 11 holds IC7 in its Tri-State mode and the RAM in its "READ" state to allow data out of the RAM. Pin 3 of IC13 holds IC14 Tri-State and pin 6 is unused in the program mode. The R/W line from the MPU is also ineffective during programming as IC13a and IC13d are held with their outputs "high" by the above. Finally, the Chip Select pins of the RAM are held "low" by IC1's $\overline{\text{Q}}$ output via IC10.

While the machine is programming, IC9b produces 5 volt programming pulses to be converted to 27 volts for the EPROM. TR1, TR2 and TR3 perform this function. While Q and $\overline{\text{Q}}$ of IC9b are at 1 and 0 respectively, TR1 is *on* forcing TR2 *on* and TR3 is *off*. This connects the program pin of IC4 (pin 18) to the 27 volt supply via R4, and TR2's "on" resistance. When the opposite condition holds, TR3 turns *on* and TR1 and TR2 *off* forcing pin 18 of IC4 to Ground through R4, R3 and TR3's *on* resistance.

Using p.n.p. and n.p.n. transistors (TR2 and TR3) in this mode ensures that almost all of the current supplied by the 27 volt supply is used by IC4 and very little sunk to Ground. At no time (theoretically) is the +27 volt supply connected to Ground via the output transistors. The only consistent path to Earth is via TR1, which, with R12 and R11 in series, will draw something of the order of half a milliamp from the 27 volt supply. This is, of course, apart from the normal leakage of TR2 and TR3 when *off*, and during the fast change over from *off* to *on*, which is at relatively low repetition rate.

EPROM REQUIREMENTS

The 2708 specifications demand that, during programming, $\overline{\text{CS}}$ (pin 20) be held at +12 volts. Thus, switch S1 is connected to supply this as well as the 27 volt program pulse to IC4. The difference between 2708 and 2716 are catered for by links L1-L8. The 2716 must receive +12 volts on pin 24 during programming instead of +5 volts, therefore L1 and L3 are replaced by L2. L7 is replaced by L8 so that when S1 is switched out of program mode, +5 volts is again applied to pin 24. Pin 20 is A10 and not $\overline{\text{CS}}$ on the 2716, thus links L5 and L6 are used to apply a logic 1 or 0 to this pin, to select one or other 1K half of the 2716. Pin 18 doubles as the $\overline{\text{CS}}$ and Program pin, and hence, out of the program mode, linking L4 supplies the $\overline{\text{ENABLE}}$ signal from IC13b.

Thus, during Program mode, the machine is disconnected from all external systems. Addresses are generated internally by the counters and fed to the EPROM and RAM. The latter, being in Read mode, places data to be programmed on the internal Data Bus which is collected by the EPROM and "burned in" over a number of progam pulses.

When IC1 is reset, the machine re-enters its normal Read/Write mode. $\overline{\text{Q}}$ of IC15 is at a "1" and hence pins 1 of IC10, 11 and 12 select the external Address Bus which is then allowed to communicate with the RAM and EPROM.

The $\overline{\text{ENABLE}}$ line (pin 2 of IC8) must be low to select the EPROM programmer, and the host microcomputer generates this signal as a normal part of its address decoding. The nature of the decoding decides which locations in memory the EPROM programmer occupies. When it is selected, the $\overline{\text{ENABLE}}$ must go "low" which, through IC8a and IC10, sets a logic 1 on pins 1 and 13 of IC13. This allows the R/W from the MPU system to gate a zero on $\overline{\text{WRITE}}$ or $\overline{\text{READ}}$ (to IC7 or IC14) depending upon whether it is performing a write or read operation respectively. During $\overline{\text{READ}}$, R/W is "high" which, via IC13, places a zero on $\overline{\text{WRITE}}$. This controls data direction through IC7 and IC14. If the RAM is to be selected, either the MPU system or the user must place a zero on the external A10 line—this becomes a zero on $\overline{\text{CS}}$ to the RAM.

To select the EPROM, a logic one on A10 becomes zero (via IC13b) on the $\overline{\text{CS}}$ pin of IC4 as long as S1 is in the non-program position. The MPU system may thus use the RAM and EPROM as normal blocks of memory. Programs may be written to, and run, in either.

LED INDICATOR

While programming, the l.e.d. on IC8 is off, giving a positive indication of the state of the machine. If the l.e.d. is off after power up or at any time, a zero may be applied to the $\overline{\text{RESET}}$ line via IC1 and the programming cycle stops. A READY (and $\overline{\text{READY}}$) signal is generated by the EPROM programmer and may be used by the MPU system to determine when the programmer is "BUSY". The positive-going "Program Initiate Pulse", via IC1, may also be generated by the MPU system, or a push switch operated by the user.

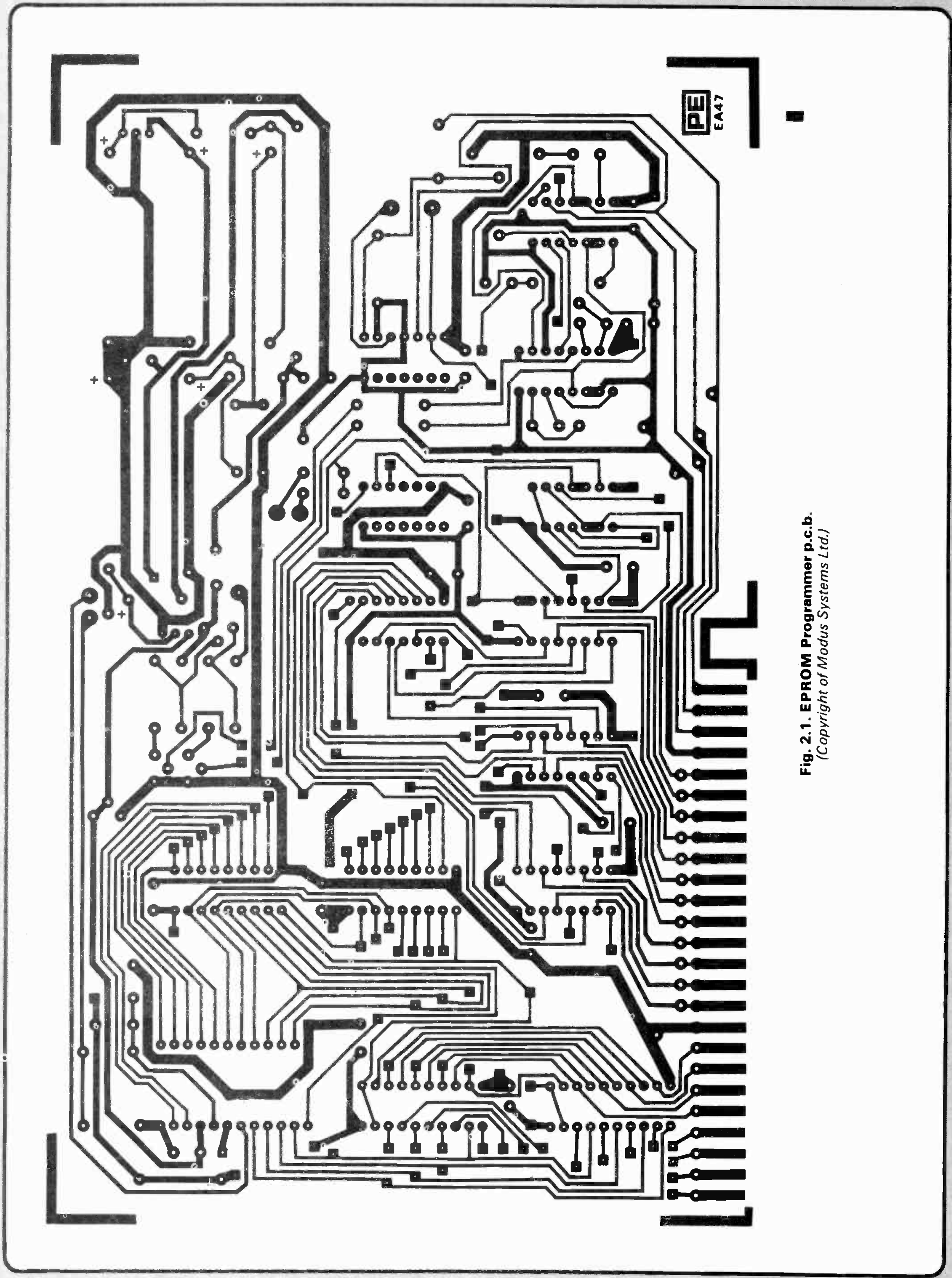


Fig. 2.1. EPROM Programmer p.c.b.
(Copyright of Modus Systems Ltd.)

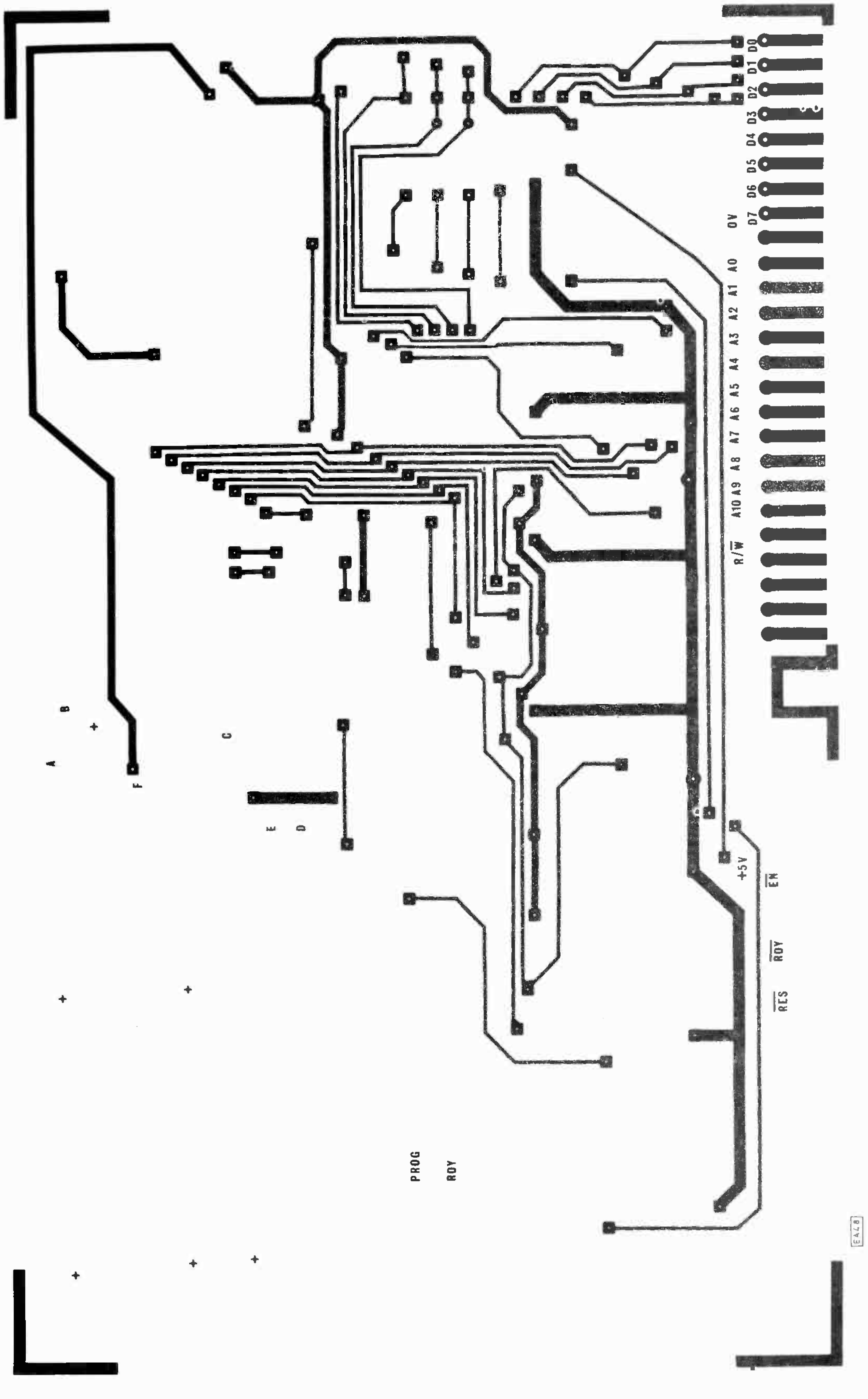


Fig. 2.2 EPROM Programmer p.c.b. (component side)
(Copyright of Modus Systems Ltd.)

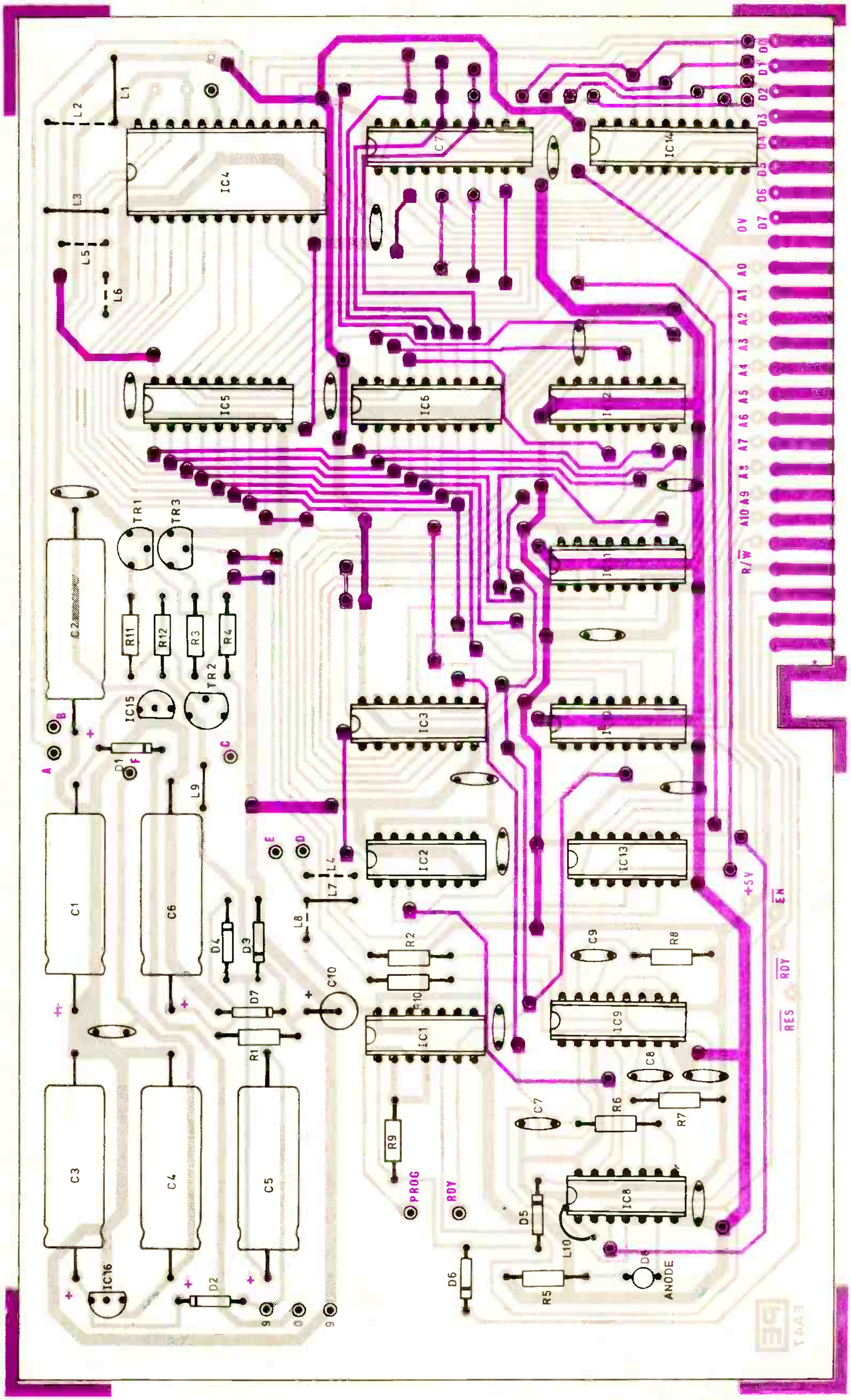


Fig. 2.3. Component layout. Note: R5 is 390Ω, and S1 is a d.p.d.t. Last month's components list is incorrect on these two points

CONSTRUCTION

The machine has been designed for ease of construction. All connections are made to the bottom of the board, except for through-pins, and the odd discrete component whose lead may act as a through-pin. All i.c.s point the same way and all external connections are labelled on the p.c.b.'s upper surface. See Figs. 2.1, 2.2 and 2.3.

External wire links appear on the p.c.b. only insofar as they provide flexibility of options as described in the text, and they may well be replaced by switches for convenience.

A good plan is to through-pin the board first. In general pins will not push right through the board and they should not be forced to do so. Push enough of the pin through to connect the two sides of the p.c.b., solder both sides and clip off the excess pin length. This produces a very neat aspect to the board. The exception is for the externally connected pins which may be left unclipped to facilitate solder or crocodile clip connection.

The i.c. sockets should be inserted and soldered next, followed by the discrete components. Make sure that regulators, diodes, transistors and capacitors are connected up correctly as shown in the component overlay diagram, or permanent damage will result. The correct positioning of transistors and i.c. regulators is indicated on the p.c.b.'s upper surface. Finally, insert the i.c.'s and turn to the set-up and testing section.

INTERFACE

Interfacing is a question of physically connecting wires for Data, Address and Read/Write lines, and arranging the address decoding.

A general interface with full MPU control of all lines is quite possible but is a little inappropriate for the majority of users, hence Fig. 2.4 suggests a simple interface where control is mostly directed by switches.

A two-bit I/O port on the MPU system could easily be utilised to provide 1's and 0's for $\overline{\text{RES}}$ (Reset) and $\overline{\text{PROG}}$ (program initiate). A further line could accept the $\overline{\text{READY}}$ signal from the EPROM programmer. However, most systems will require an EPROM programmer reasonably rarely and special software would be required for a fully MPU-controlled machine.

Thus, the EPROM programmer reset line is connected to a Ground switch and pull-up resistor, and the Program-Initiate pin to a +5V switch and pull-down resistor for hand use. A power-up reset is also suggested with a capacitor across the Reset switch. A 1K Address-Decode line is assumed here, thus only A0-A9 are fed to the programmer and A10, again, is set by hand to select RAM or EPROM. If a 2K or larger Address Decode line is available this may be connected to $\overline{\text{ENABLE}}$ and the programmer's A10 connected to the MPU's A10 line: RAM and EPROM are then addressable together.

If two separate 1K decode lines are available (as with KIM and COMPUKIT). then Fig. 2.5 suggests how they may be connected to achieve the same result. Here, a zero on $\overline{\text{D1}}$ or $\overline{\text{D2}}$ forces $\overline{\text{ENABLE}}$ to zero via nand gates a and b. If D1 is low, then D2 must be high and gate c receives two "1's, forcing A10 low which selects the RAM. If $\overline{\text{D2}}$ is low and $\overline{\text{D1}}$ high, then c receives a logic 1 and a 0. This forces A10 high, selecting the EPROM. A later section deals with interfacing directly to the COMPUKIT.

SETTING UP AND TESTING

Assuming the EPROM programmer has been connected to the MPU system via Data Bus, Address Bus, $\overline{\text{ENABLE}}$ and R/W lines, the correct links should be inserted for the EPROM type chosen. Table 1 describes all the link options

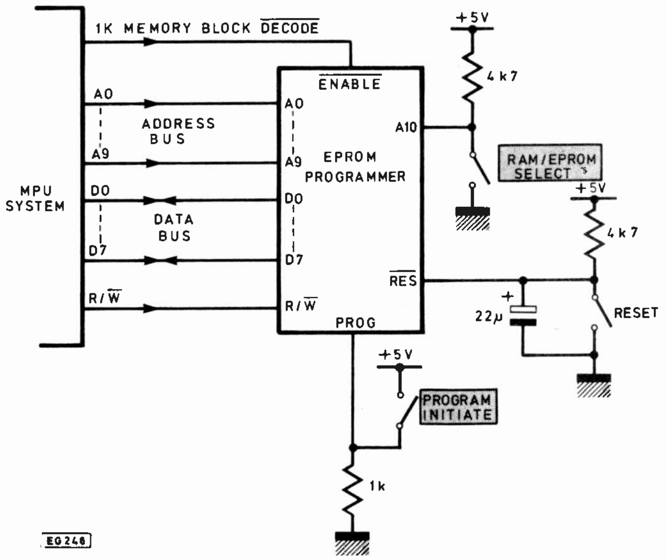


Fig. 2.4 Simple interface

on the board. Of course, any or all of the links could be replaced by appropriate switches if the links are to be changed frequently.

L5 and L6 must not both be connected simultaneously, even momentarily, as the power supply will be shorted. By using L5 and L6, each half of the 2716 is programmed separately, since the RAM holds just 1K of data and the 2716 has 2K. Connecting L1, L3, L7, excludes L2, L4, L8 and vice-versa. L9 is connected only for programming and a switch in this position (as for L5 and L6 if 2716's are to be used) would be most advantageous.

L10 should always be in place unless pin 1 of IC8 is required as a further $\overline{\text{ENABLE}}$ input. This can be used to simplify Address Decoding in some systems. In this case, L10 is left unconnected and pin 1 of IC8a connected to a top-side pad of the edge connector for external connections via the edge socket. L10 is assumed connected in the following.

Certain checks are worth making when first using the machine. Make sure, before applying mains, that the secondary windings of the mains transformer are connected correctly—centre tap to the centre pin.

AT SWITCH-ON

When first switching on, leave the EPROM out and L9 unlinked. Check the −5V and +12V supplies at the EPROM socket. Check +27V at L9.

The 12 volt regulator may become very hot during use. This can be replaced by a 1 Amp device at a very small cost if the overheating is excessive. Similarily, R1 dissipates some heat, and this can be replaced by two $\frac{1}{2}$W 2K resistors in parallel or a 1W 1K resistor if the problem is excessive.

TABLE 1

LINKS	OPERATION
L1, L3, L7	2708
L2, L4, L8	2716
L5	Selects lower half of 2716
L6	Selects upper half of 2716
L9	Supplies 27 volts to Program Pulse switches
L10	Places a "1" on pin one of IC8. This is *normally connected*—but see text.

Neither of these modifications proved necessary on the prototype, even after many hours of use.

If the l.e.d. is off after switch-on, short $\overline{\text{RESET}}$ to zero momentarily. If the light remains off, check the +5V supply and then refer to the Troubleshooting section. Assuming everything is okay, check that the RAM is working, by Reading and Writing to it using the MPU system's monitor. The RAM must be selected by connecting A10 to zero if the MPU system does not perform this action automatically (see the section on interfacing). A small memory test program may be written to check that information can be written to, and read from, each location in the RAM.

If the RAM operation is satisfactory, check that S1 is in the non-program position and plug the EPROM into its socket. The EPROM should then be selected by ensuring that A10 is at "one". A test may be performed without sacrificing the contents of the EPROM in the following manner. The RAM should be filled with random data and either the EPROM absent or S1 in the non-program position. Set the programming cycle going by applying a positive pulse to the PROGRAM line. The Address lines to EPROM should be oscillating with A0 (pin 8) changing the most rapidly, A1 (pin 7) at half that speed and so on up to A9 (pin 22). At the same time, D0-D7 should all be oscillating and R4 should be applying 0·5 ms pulses at 27 volts to pin C of S1 with L9 linked. These are all necessary conditions for the correct working of the system.

PROGRAMMING

Ideally, the sequence of operation is as follows. 2708 or 2716 links should be selected as in Table 1, with L5 or L6 in place if a 2716 is being used. A zero is placed on A10 and the RAM contents changed to the selected data for programming into the EPROM. If necessary, the contents of RAM may be checked—perhaps by running a program in the RAM block. Parts of the EPROM which are to remain unchanged must be presented with FF during programming and the corresponding blocks in RAM should contain FF, as explained in Part 1 last month.

Check that S1 is in the program position, link L9 and apply a logic 1 to the program line on IC1. The l.e.d. should switch off for about two minutes. During this time, the EPROM is being programmed. When the programming cycle is over, switch S1 back, take A10 to a "one" and check that the contents of the EPROM have been altered correctly. This may be done in several ways. A very convenient method of such verification is to write a program which compares the EPROM contents byte for byte with the contents of the RAM, or some "mirror" of the RAM contents in the MPU's RAM. An Error message could signal any disparities which may arise. Alternatively, if a program has been stored, it may be run *in-situ* in the EPROM.

L9 should be removed for safety, as soon as programming has finished.

TROUBLESHOOTING

The test given in the above section is a good one for checking that counters, address switches and the 27 volt switch are all working, as well as the RAM itself.

If reading from RAM and EPROM or writing to RAM is not occuring, check connection between MPU and pins of IC10, 11, 12, 7 and 14 with a continuity tester and check that, while out of program mode, address information is passing through to Address pins of RAM and EPROM. A similar check may be made for data on IC7 and 14. An oscilliscope is helpful in troubleshooting, and will normally narrow down the fault very quickly to a poorly-soldered joint, missing component or a solder bridge.

IC13's connections, particularly, should be checked very carefully throughout the system with a continuity tester, as this component forms a major link in the control of the machine.

If the programming cycle is not even starting, check that IC1 can be turned on and off by PROG and $\overline{\text{RESET}}$. Check the connections to IC9, where all the clocking information is generated, and check for appropriate length pulses on pins 13 and 5. Do not be alarmed if the 20µs turns out to be 30µs or the 0·5 ms is ±10 or 15%.

If the cycling is occuring but never stops, check that IC8c is connected correctly and read through last month's explanation of the working of the Program Timing and Control sections.

The usual theme for troubleshooting is to start at the clock, make that work and follow it right through the system. Again, a 'scope and a continuity tester are very important.

COMPUKIT INTERFACE

The EPROM programmer has been designed, in part, to be plug-compatable with the Compukit, and this section describes the actual connection necessary.

As in Fig. 2.4, connections for the Data Bus, Address Bus (A0-A9), R/W Line and $\overline{\text{ENABLE}}$ line must be provided for the interface. The first three groups are quite straightforward. The $\overline{\text{ENABLE}}$ line, however, varies from system to system.

The EPROM programmer, illustrated in Fig. 2.4 acts like a 1K block of RAM or EPROM, depending upon the state of A10. That block of memory must be inserted into the memory map of the MPU system and only enabled for the appropriate 1K of Memory Addresses. The KIM has a set of outputs (called K outputs) used specifically for this purpose of "slotting in" external blocks of memory.

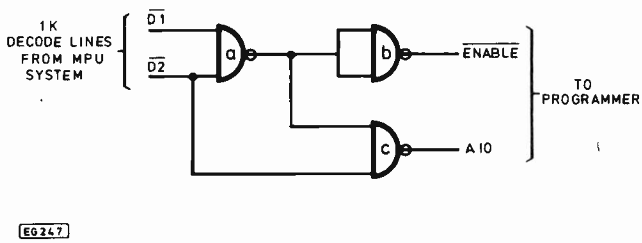


Fig. 2.5 Enable decode for Compukit and Kim

If a machine does not provide those external address-decoding lines, it is usually possible to replace an internal 1K block of Memory with the external block by using the internal block's dedicated Address Decoding line. This techinique is used on the Compukit. IC38 and IC52 on the Compukit are removed from their sockets and the EPROM programmer plugged into their place. This places the memory of the programmer in the address block: 1C00→1FFF. Of course, any of the 1K blocks from 0400 onwards may be used, but this will restrict the BASIC workspace. 0000→03FF may not be used as this provides scratchpad for the COMPUKIT's monitor program. Fig. 2.5 shows the Connection diagram for the above interface.

The Programmer's +5V power may be supplied by a Compukit with improved regulator heat-sinking. Two d.i.l. plugs and ribbon cable are most convenient for this link up and the cable may be soldered to an edge-connector socket which is plugged into the programmer's edge-connector surface. This forms a very neat job and allows instant unplugging of the devices when not in use.

The Address Decoding RS7 is supplied by IC38's socket in Fig. 2.6, as is the R/W line and Address Bus. Only half of the Data Bus is available at IC38's socket, hence the connection to IC52's socket. Use of the machine is quite simple. A10 is set to a low level to select the RAM and the program switch is off. $\overline{\text{RESET}}$ is brought low if the l.e.d. is off and the machine is ready for use. (Check that L10 is connected).

If some of the EPROM is to remain unprogrammed, a short BASIC program is written to fill addresses 1C00—1FFF with FF before the RAM is filled with a block of information to be stored in the EPROM. A program is given below for this process. The only point to remember is that all addresses and data are in *decimal* in BASIC.

```
10 FOR I = 7168 TO 8191
20 POKE I, 255
30 NEXT
```

This can be checked by replacing line 20 by:

```
20 IF PEEK(I) < >255 THEN PRINT I
```

Any locations not containing FF (255 in decimal) will be found and their addresses printed out on the screen. The erased EPROM may be checked by taking A10 "high" (which selects EPROM) and running this program.

The RAM may now be filled with binary information either by resetting the Compukit and using "M" to enter the machine code monitor, or by using the Compukit's powerful extended machine code monitor.

To program the EPROM, L9 is connected, the program switch (S1) thrown, and PROG brought high momentarily. When the l.e.d. comes on again, switch S1 back, remove S9, bring A10 to a high level and read the EPROM through to check the contents.

If Fig. 2.5 has been used to replace the upper 2K of memory with the programmer, the EPROM and RAM may be read and compared directly by the Compukit to verify EPROM contents. The connections for this would require IC37 and IC51 to be removed and RS6 (pin 8 of either socket) would be connected to $\overline{\text{D2}}$ (Fig. 3). $\overline{\text{D1}}$ would be connected to RS7 (pin 8, of IC38). The RAM would then reside at addresses 1C00→1FFF and the EPROM at addresses 1800→1BFF (DECIMAL 6144→7167).

The following program would check EPROM against Ram:

```
10 FOR I = 0 TO 1023
20 IF PEEK (6144 +I) < > PEEK (7168 +I)
   THEN PRINT (6144 +I)
30 NEXT
```

This will print out those addresses in EPROM which disagree with the RAM contents.

TABLE 2

Special EPROM programmer signals	Function
A10	HIGH level selects EPROM LOW selects RAM
$\overline{\text{RESET}}$	LOW pulse stops programming cycle
PROG	HIGH pulse initiates programming cycle
$\overline{\text{ENABLE}}$	LOW level selects RAM or EPROM depending upon A10
$\overline{\text{READY}}$ (output)	LOW level output from here implies programming cycle has stopped—l.e.d. in ON condition
READY (output)	Inverse of $\overline{\text{READY}}$ line

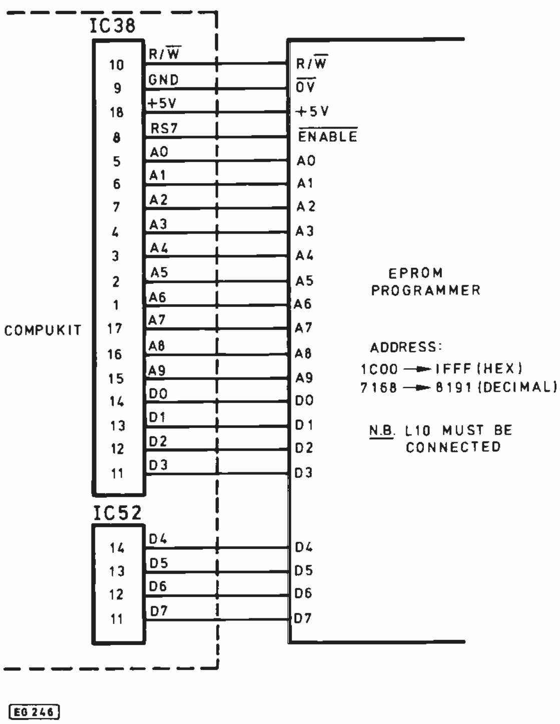


Fig. 2.6 Interface for Compukit

If this occurs, the RAM should be checked through for correct data and the EPROM reprogrammed. If a few unrelated locations remain unprogrammed, then either the EPROM was not fully erased or the chip is faulty. If many locations are incorrect, the programmer's operation must be suspected.

Adding the programmer to the Compukit, as in Fig. 2.6, does not in any way restrict the Compukit's memory, as 1K of RAM is still available in the programmer for normal use. This 1K of RAM, however, has the added advantage that its contents may be stored permanently.

ERASING

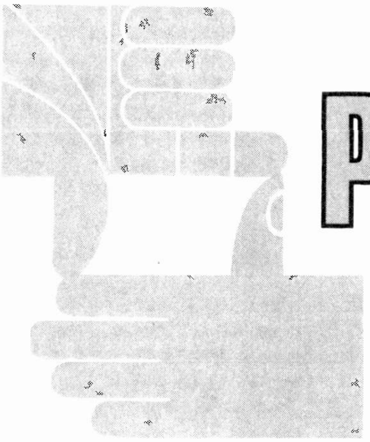
Erasure of the EPROM consists of shining a strong Ultra Violet light through the transparent quartz window in the package's upper surface. Short wave UV is required (around 2500 Angstrom units) and exposure time varies from 8 minutes to one hour or more, depending mainly upon UV intensity. A medicinal "sunray" light has been found to perform erasure quite effectively, and some experimentation for erasure time is essential.

Erasers may also be purchased and several are advertised in this magazine. In addition, PE has published an EPROM eraser (June 1978) as part of the CHAMP articles and this would be an excellent inexpensive alternative.

CONCLUSION

For many years, the problem of non-volatile memory storage has been solved by media such as paper-tape, disc and cassettes. These media are still important for mass storage. However, the coming of Micros has led to the need for permanent *alterable* storage of small capacity. This need is satisfied by the 2708 family and the EPROM programmer described here in an inexpensive, but hightly flexible manner.

In addition, anyone attempting the development of an MPU system from scratch, may use another system plus the programmer to produce the all-important and previously elusive System Monitor required by any machine when first powered up. ★



PATENTS REVIEW...

Copies of Patents can be obtained from :
the Patent Office Sales, St. Mary Cray, Orpington, Kent   Price 95p each

TOUCH SENSITIVE CONTROLS

Two recently published British patent applications disclose proposed improvements in touch sensitive controls. Application number 2013032 (filed under the new laws and dating back to July 1977) describes an idea by Jacques Lewiner and Claude Hennion of France. The aim is to provide a touch-sensitive electret suitable for use as a multiple key keyboard, for instance in a musical instrument. But according to the inventors the same principle can be adopted for the construction of sound and shock wave sensors.

Fig. 1 shows a touch sensitive electret which is already known. A sandwich is formed from outer electrodes 1 and 2, inner electret 4 and rigid spacers 6. The electret is of conventional dielectric foil with a permanent electric charge on at least one face F. In practice the electrode 1 is often formed by metalisation of a flexible electret 4 to give a combined thickness of less than 100 microns. When pressure is applied the charged face F moves temporarily closer to the electrode 2 and a small current flows in circuit 3. The spacers provide essential limiting of the electret movement but, being rigid, prevent the contacting areas of the electret from contributing any signal. This reduces overall efficiency.

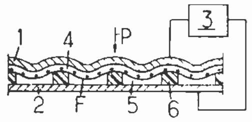


Fig. 1

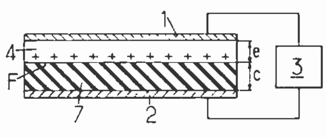


Fig. 2

Fig. 2 shows the invention. The rigid spacers 6 are omitted and an elastic layer 7 of elastomer is sandwiched between the electret 4 and electrode 2. The elastomer is more flexible, or softer, than the electret and has very high electrical resistivity, in the order of 10^{15} ohms/cm to 10^{17} ohms/cm. Because of its deformability the elastomer layer offers relatively little physical resistance to movement of the electret, but because of its high resistivity, prevents the formation of an inter-electrode conduction path. The inventors suggest that a silicon-based compound, for instance siloxane, is ideal. Impedance adaptation circuits are suggested to make the response more linear with pressure and frequency.

Thorn of Upper St. Martin's Lane, London, have filed a British patent application (2 013 984) which dates back to January 1979 and claims touch sensitive controls for electrical circuitry, particularly a domestic liquidiser or blender. The claim to a patent monopoly is very broad and doubtless readers will have their own views on whether Thorn's ideas were, or were not, new in early January 1979 when the application was filed. (The legal procedures open to readers who believe that ideas are not as new as inventors claim were detailed on page 68 of *Practical Electronics* April 1979).

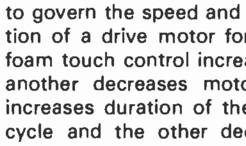


Fig. 3

Thorn proposes a strip of conductive foam of which the electrical resistance changes with finger pressure to produce an analogue control signal. This signal is used to govern the speed and duration of operation of a drive motor for a liquidiser. One foam touch control increases motor speed, another decreases motor speed, a third increases duration of the motor operating cycle and the other decreases the cycle duration. Fig. 3 shows one type of foam control. A strip of conductive foam 11 is sandwiched between flexible contact 12 and rigid contact 13. Pressure on contact 12 compresses the foam to decrease the resistance between contacts 12, 13. Another type of control is shown in Figs. 4 and 5. Foam strip 211 carries contacts 212, 213 and is supported by insulators 214, 215. Parallel conductors 216, 217 extend along the underside of the strip. A voltage is applied across contacts 212, 213 to create a potential gradient along the strip and pressure on the foam causes the conductors 216, 217 to assume the potential existing at the pressed point. Hence the voltage appearing at 216, 217 is independent of actual pressure.

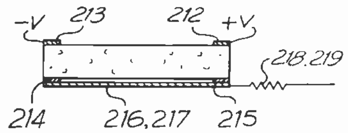


Fig. 4

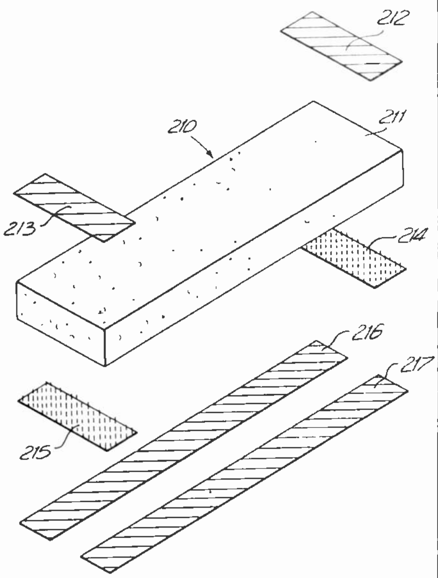


Fig. 5

Thorn suggest digital circuitry on which the analogue control signals operate. Essentially this relies on a clock pulse generator and divide by 16 counters with lines of l.e.d.s which are gated to display the desired time of motor operation as a bar of lights whose length varies with selected time. The l.e.d.s also indicate selected speed in a similar manner. A motor interface circuit uses a triac/diac combination to govern speed by phase control.

Readout...

A selection from our Postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Public Radio Facility

Sir, I am pleased to read the positive comments in your editorial addendum (on p. 67 Oct '79 P.E.) following the article *CB in the UK* by Dr. Mark Sawicki. The writer of the article did not refer to the many overwhelming disadvantages of the present useage in the 27MHz spectrum using amplitude modulation and in fact ignored the more than probable granting of v.h.f. or u.h.f. Public Radio Facility. Possibly frequencies in the 420-430MHz part of the u.h.f. spectrum will be granted, being eminently suited to local portable, mobile and base useage. Narrow-band f.m. will of course be used for a variety of technical reasons.

Not only is the present Trans-Atlantic lingo-apeing an insult to anyones intelligence but the propogation characteristics in the 27MHz region combined with aerial inefficiencies and proneness to interference combine to make that part of the spectrum the most unsuited to the task for which the public require it i.e. local personal communications. Pity the poor person stuck up on a mountainside with a 1 watt (a very enthusiastic rating more than likely!) hand-held unit with short whip aerial trying to get 20 miles or more with racous foreign interference to contend with. On u.h.f. there could be a community based repeater made avaiable for an emergency channel with built-in automatic scanning in all units to lock into such emergency transmissions.

Even now some users on 27MHz are trying to boost their range through the use of so-called linears which are very efficient at producing harmonics, especially when used by non-technical persons. Already some of the few users here in Ireland (illegal of course) have managed by using mistuned aerials or amplifiers to be heard on 2nd, 3rd and 4th harmonics, in addition to causing interference with their high power fundamental to paging and model control users. Advertising in the newpspapers and shop-windows is open and blatant, and the whole situation is fast getting out of control.

Hopefully the Personal Radio Service will shortly be announced on v.h.f. or u.h.f on a basis similar to that being advocated by the C.B.A. (Citizens' Band Association). There is some reluctance by the authorities however as to the possible release of frequencies for private communications.

The low price of some 27MHz units now being made available is I am sure due to massive over production and subsequent cash-flow problem. Dealers have to empty warehouses quickly. Let us hope that the resultant flow of equipment on to the market does not influence the introduction of an outdated and technically inferior service. British technology and production can rise to the challenge of a good v.h.f. or u.h.f. f.m. service.

Those who support 27MHz must not have had experience of the quality of v.h.f. otherwise they must want to join the nest of furtive clandestine operators trying to "work the skip", just a cult. I look forward to the announcement in British Parliament of an enquiry into the possible granting of a Public Radio Service.

D. Walsh, Co. Tipperary.

ROMs

Sir, Our ROMs have arrived! Our Compukit is working! But what a gruelling experience it has been. We saw the prototype on April 2nd and, under the impression that we were amongst the privileged few to have heard of it at this early stage, ordered immediately for delivery in about "ten weeks"—i.e. June 11th. By the time of the Chancellor's speech, delivery was promised for the end of June or "early July" so we paid in full while VAT was still 8 per cent. We collected the kit on July 5th with the ROMs promised for "two or three weeks", then "definitely August 15th". On the 15th it was again "two or three weeks"; three weeks later on September 5th it was "they are at Heathrow". On September 8th we got more impatient as term was approaching and we had already proved our Compukit worked (with Superboard ROMs), but we were satisfied with "We'll have them early next week and will post them to you by first class post on Tuesday or Wednesday". The following Thursday, the 13th, it was "Yes, we've sent them all off today". On Saturday 15th it was "I'm not sure at the moment but I'll check the files and if we haven't sent yours off already we'll send them off first thing on Monday . . . We posted them all off on Thursday and Friday".

On Tuesday 18th things changed: "You'll get yours next week—we sent 800 off last week to those who ordered their kits when it was announced in February and March". February? We saw nothing in print about the kit until May, and I have still not discovered where this "announcement" was made.

On Thursday 27th: Actually it was 500 . . . or 460 . . . sent off last week. The next batch of 1,000 is "at Heathrow" due to arrive on Saturday and to be posted to us "next week". By October 10th I had written three letters to COMPshop (ne'er any reply) and located Compukit owners with and without ROMs (the one with had ordered his kit three months after us). By the 18th we were told that two sets posted to us must have "got lost in the post" so another set was posted on the 19th by recorded delivery and this arrived on the 20th. More than four months late—but for the last six weeks we had been led to expect delivery almost every day. Perhaps we have wronged COMPshop—could the Post Office have lost all their replies as well as the two earlier sets of ROMs?

Incidentally, have you tried giving a "Memory size" of 20 or 30 thousand bytes? You will get a pleasant surprise! It is also interesting to compare strings in immediate mode, and to find how soon the random number generator recurs (it's after 1861 calls). However, we do find the Compukit to be excellent value for money and would now be building our second if we thought we could trust the supplier—but now we are waiting eagerly for the Nascom 2 we ordered an hour before the ROMs arrived!

C. C.H. Dawkins, Felsted School, Essex.

Unfortunately, as you are aware, the problems have affected many readers. At least Comp. now have kits (with ROMs) in stock.

Computerised

The purpose of my letter is to give profuse praise for the newest of my project completions—i.e. COMPUKIT UK 101 by Dr. Berk. After excruciating—and obviously unavoidable–delays in obtaining the BASIC ROMs, my computer worked first time and it has delighted and astonished me since that first magic moment. I am totally impressed and already, in my field of secondary education, it has proved to be a boon, and unforeseen uses loom. Exciting possibilities are glimpsed and oh! how I wish I were more capable of programming my ideas. My ineptness in this respect is a barrier, which, in middle years, is slow in being absorbed. I have great visions and moderate expertise to make them manifest.

I offer some suggestions for future consideration and the very fact that I take the trouble to write to you about them should add emphasis to my concern:

1. A "feed-back" column with short snippets.
2. This is the most important request:
   An article on graphics. I really would appreciate a structured article on the use of POKE and PEEK and their use in producing diagrams etc.
3. Your last article showed that POKE 530, 1 disables the CONTROL C use. What other facilities are there available hidden away in the ROM's? For example: I would like to write messages in immediate mode—more than one line produces SYNTAX ERROR. If I use the SHIFT P @ line feed I am left with @ which I do not want. Am I able to disable the @ sign but still obtain a new line?

I hope my letter conveys my real pleasure and appreciation and I hope my suggestions are constructive.

J. W. Coulthard, York.

We will be starting a "Computing Corner"—possibly next month—with some of the ideas you sent in. We will also look at your other suggestions.

Switching Regulators

D.L.H. Smith B.Sc.

THE SWITCHING regulator is a relatively new circuit for the control of d.c. voltages. It takes the place of a normal series regulator in a power supply. The basic problem with series regulators is that, because of the voltage drop across the pass transistor, they tend to be very inefficient. The ratio of output power to input power is typically in the range of 30–40 per cent in good conditions.

Because in switching regulators the regulating transistor is either switched on or off, very little power is dissipated in it, and efficiencies in the order of 70–80% are possible.

Apart from the obvious advantage of higher efficiency, the switching regulator has other advantages. Because of the nature of operation, a switching regulator can not only convert voltages down, but can also convert them up, and even invert the polarity. Consequently they have a wide use as unisolated d.c. to d.c. converters.

HOW THEY WORK

The basic switching-down regulator circuit is shown in Fig. 1. This consists basically of the following elements: switching transistor TR, storage inductor L, smoothing capacitor C, commutation diode D, and a controlling circuit (which will be discussed later).

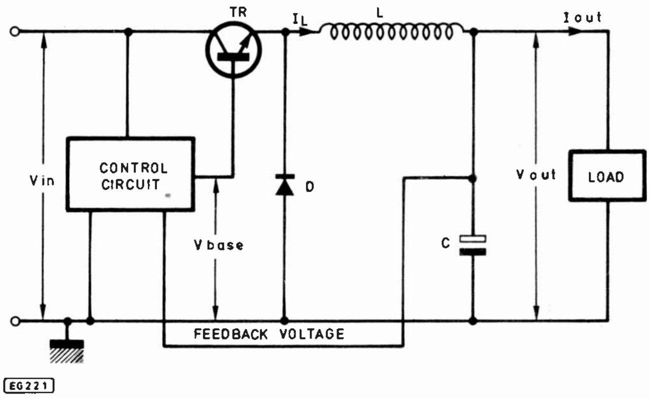
When the input voltage Vin is applied to the circuit, the control circuitry senses that the output voltage Vout is low, and switches the transistor on at time t_1. A current I_L flows through the inductor L into the load. The current in L reaches a peak value Ipeak, and the transistor is switched off at time t_2. The inductor is now storing an energy equal to $0{\cdot}5\ L\ I^2$peak. The current now flows into the capacitor C, the diode D completing the circuit. So energy is transferred from the inductor L to the capacitor C. The energy stored in the capacitor is equal to $0{\cdot}5\ C\ V^2$out, and provided that the energy dissipated in diode D is small, we can say that $0{\cdot}5\ C\ V^2_{out} \simeq 0{\cdot}5\ L\ I^2_{peak}$.

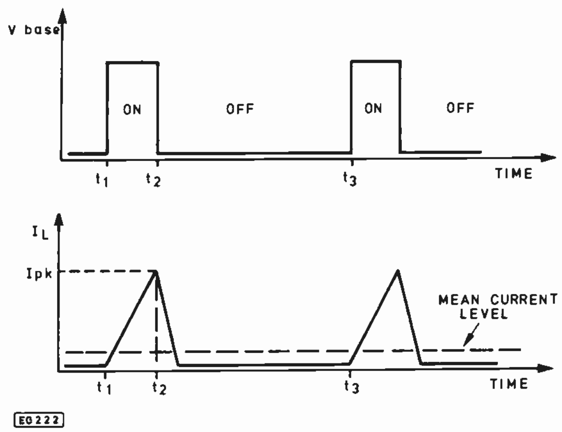
Now that C is charged up, it can supply current to the load. As the voltage across C falls due to the load, the control circuitry senses this and the transistor is turned on once again at time t_3, repeating the cycle. If the load takes little current from the output, the interval between the transistor switching on and off is large, and if more current is taken, the interval between switching is much shorter, and capacitor C is charged up more often, thus providing more current. These conditions are clearly illustrated by the two waveform diagrams Figs. 2 and 3.

The control circuitry consists basically of a voltage comparator, which compares the output voltage with a reference level. This feeds a voltage controlled oscillator, which then drives an output transistor. All these functions are normally included on one i.c.

SWITCHING-UP AND INVERTING REGULATORS

Since the switching regulator circuit works by the transference of the energy in the storage inductor to the capacitor, there is no reason why we cannot make the output





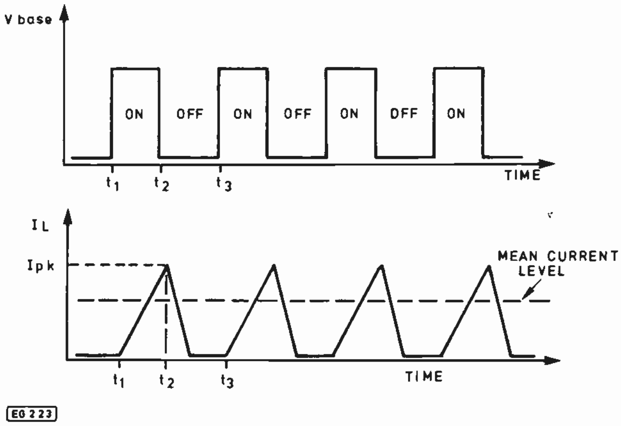
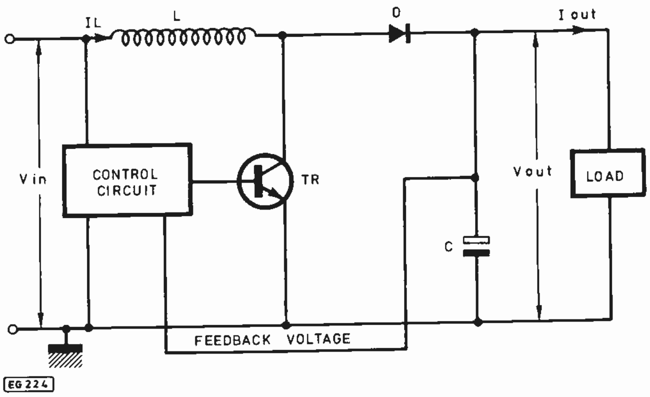


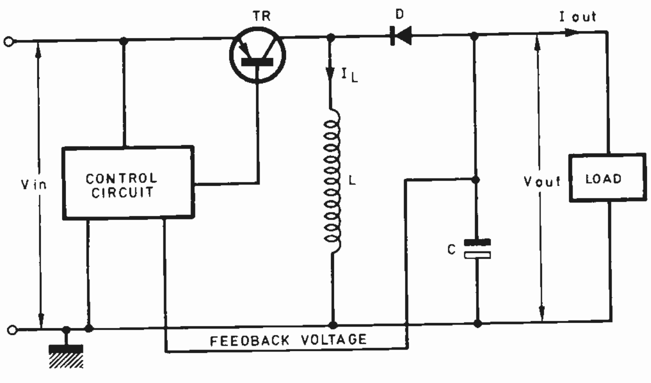
Fig. 3. As above but for high load current

voltage higher than the input voltage, provided we decrease the output current. However, we need to change the position of the commutation diode to prevent the smoothing capacitor from discharging back to the lower voltage input. The new circuit configuration is shown in Fig. 4.

When the transistor T turns on, the current in inductor L increases up to a peak current, storing energy as before. When the transistor is turned off, the only way the current from the inductor L can flow is through the diode D, transferring its stored energy to the capacitor C.

By using yet another circuit configuration, it is possible to invert the input voltage, so where the input voltage is positive with respect to ground, the output voltage is negative with respect to ground. In this case, it is possible for the magnitude of the output voltage to be greater than or less than the value of input voltage. The circuit used is shown in Fig. 5. It works in a similar way to the previous circuit, with a few changes, as explained here. The transistor TR is first turned on, the current through





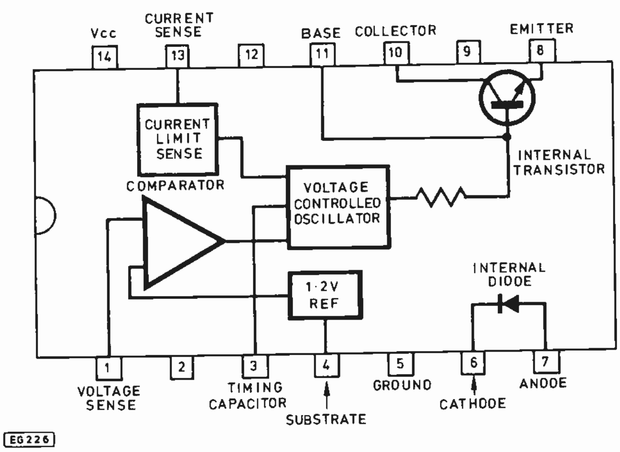


Fig. 6. Internals of the TL497. Pins 9 and 12 are N.C.

the inductor L again rises to a peak value. When the transistor is turned off, the current in the inductor flows into the capacitor C, charging it up. Again, the commutation diode D completes the circuit, but it is now in the opposite direction, charging the capacitor C negatively, which provides the negative output voltage.

CONTROL CIRCUITRY

One i.c. that provides all of the necessary functions for the circuits described is the Texas Instruments TL497. A block diagram of the i.c. is shown in Fig. 6.

For low output power circuits, the internal transistor and diode can be used as the switching transistor and commutation diode.

Operation of the i.c. is as follows: Pin 1 senses the output voltage (suitably divided down) and compares it with the internal 1·2 volts reference. If the output voltage is too low, the comparator voltage increases and drives the oscillator faster. The oscillator then switches the internal transistor. The current limit senses the voltage between pins 14 and 13 (across which there is normally a low value resistor). If the current flowing is too great, the oscillator is disabled.

Pin 4, the substrate, must be connected to the most negative voltage point in the circuit. This is so that the voltage appearing at pin 1 is of correct polarity. Pin 2 is always connected to ground.

In the case of higher output power circuits, the internal transistor is used to switch an external transistor, and an external diode is used, normally a fast switching type.

PRACTICAL EXAMPLES

Three practical examples are considered:

(i) Switching-down regulator, with an input of 11–15 volts, and an output of 5 volts at 1 Amp (Fig. 7).

(ii) Switching-up regulator, with an input of 11–15 volts, and an output of 24 volts at 300mA (Fig. 8).

(iii) Inverting-regulator, with an input of +12 volts, and an output of −12 volts with respect to ground (Fig. 9).

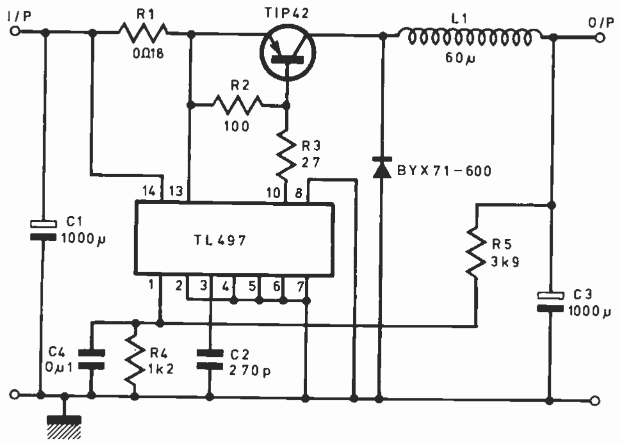
All of these circuits have quite high peak inductor currents, and hence need inductors which can handle this current at the required frequency. These can be wound on ferrite cores. Mullard type LA4348, or similar, with an inductance-per-turn factor (A_L) of 100.

In all of these designs an input capacitor C1 is included. This provides a charge store, to prevent current spikes occurring in the input leads. Capacitor C2 is the timing capacitor, which determines the length of the transistor conduction time (and hence peak), and the maximum operating frequency.

The resistor dividing chain R4 and R5 attenuates the output voltage to 1·2 volts so that it can be compared with the TL497's internal 1·2 volts reference. Capacitor C4 is included in the switching-down regulator circuit to improve the stability of the attenuated 1·2 volts signal.

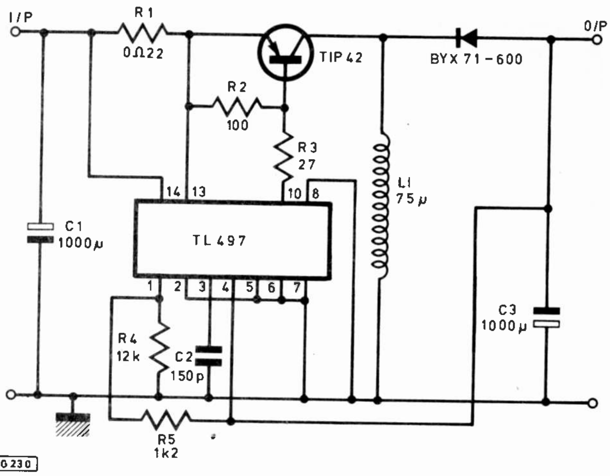
Resistor R1 is the circuit current sensing element. Current sensing performs two functions: (i) When switched on, the current sensing circuitry "soft-starts" the unit. This means that a large initial inrush of current through the transistor, which might damage it, is prevented. (ii) If too much output current is drawn, the current sense circuitry will limit it, preventing any damage. The current sense circuitry operates when the voltage across R1 increases above one transistor Vbe drop (about 0·6 volts).

In the circuits shown in Figs. 7 and 9, a TIP 42 p.n.p. main switching transistor is used. When the TL497's internal transistor switches on, the TIP 42's base is connected to ground via R3, the base current limit resistor, and hence is turned on. R3 was chosen as 27Ω, so that the TIP 42 base current (I base) would be great enough for the equation β I base > Ipeak, the



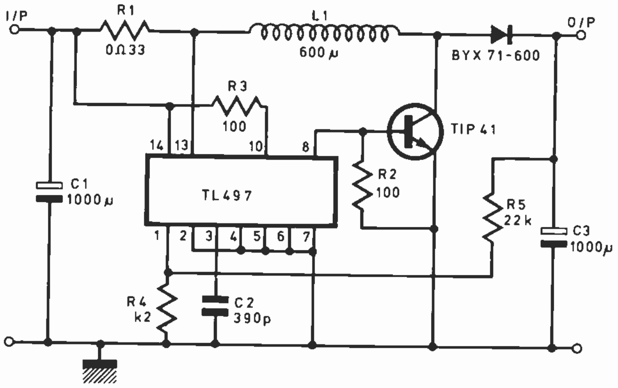
EO228

Fig. 7. Switching-down regulator. Coil: 25 turns of 20 SWG on Mullard LA4348 ferrite



EO230

Fig. 9. Inverting regulator. Coil: 27 turns of 20 SWG on LA4348



EO229

Fig. 8. Switching-up regulator. Coil: 77 turns of 26 SWG on LA4348

peak transistor current (where β is the transistor current gain). In the switching-up circuit (Fig. 8), a TIP 41 n.p.n. main switching transistor is used. When the internal TL497 transistor is switched on, current flows via R3 through it into the TIP 41 base, turning it on. The base current limit resistor is chosen for the same reasons already discussed.

The base-emitter resistor, R2 in all of the circuits acts as a stored-charge damping resistor. This rapidly removes the stored charge in the transistor's base, enabling faster switching and hence higher circuit efficiencies.

Finally, consideration must be given to the commutation diode. Normal rectifier diodes are very inefficient at these high frequencies. This is because they have a relatively high forward voltage drop, and a long reverse-recovery time (the time taken to switch from the conducting state to the non-conducting state). An ideal diode for these circuits is the BYX 71-600 fast switching diode.

The i.c. connections for the different types of circuit are shown in the following practical examples, Figs. 7, 8 and 9. Notes on construction: The current sense resistor between pins 13 and 14 should be at least a 2·5 watt resistor. The switching transistor and the BYX 71-600 should both be mounted on a heatsink insulated with mica washers and bushes.

All of these practical circuits have a peak inductor current of between 2 and 3 Amps and an overall efficiency of about 70 per cent.

CONCLUSION

Switching regulators do have some disadvantages; they tend to cost more than simple series regulators and have a larger output ripple voltage, in the region of 100–200mV. However, this is not much of a problem for many of the applications in which they are used.

Switching regulators are a relatively new type of circuit, which have been made possible by the introduction of low-priced control i.c.'s and fast switching diodes. They are beginning to find widespread use in industry, especially where efficiency is important.

News Briefs

NEW ASSOCIATION

AT A meeting in London recently an association was formed for computer retailers, which, it is hoped will be the end user's best guarantee of service and support. Called the "Computer Retailers' Association", it is also anticipated that every reputable firm in the industry will become a member.

The purpose of the Association is to maintain and improve standards within the industry and represent the industry to the outside world, government and press etc.

Companies willing to subscribe to the Association's code of practice should apply to Ms. Heather Hodgson, 47 Creswell Road, Newbury, Berks. Tel. Newbury 42486.

BACK AGAIN!

DORAM Electronics Ltd. is to be relaunched under the ownership of the Dutch "De Boer" Group, who will run mail order for both *kits* and *components* based on the current Dutch catalogue rather than the previous Doram range. However, warranties for goods purchased during the Electrocomponents ownership will be honoured.

RAIBC

THE NEW address of the Radio Amateur Invalid and Blind Club is 9 Rannoch Court, Adelaide Road, Surbiton, Surrey KT6 4TE.

The RAIBC, which last year celebrated its Silver Jubilee, comprises invalid and blind amateur radio enthusiasts, and local representatives who assist with visits, repairs and advice. The sole condition of membership is an annual subscription of £1 minimum for "Radial" the club newsletter, issued every six weeks. Details from the secretary, Mrs. F. E. Woolley.

Calculator Chips as Logic Devices

P.A. Birnie

POCKET calculators have now become a familiar part of life to most people and their price has dropped to a very low level—£4 for a standard 4 function machine being about average. This acceptance of calculators has not, surprisingly, extended to the most important part of the machine—the calculator chip itself which has been totally ignored by constructors as a very versatile and cheap device capable of performing a wide range of functions. A typical example is the General Instruments C680 series calculator chips, typified by the C-683, an 8 digit 4 function plus percent device which costs only £3·00 (one off) and with the addition of a few components will perform 8 digit up/down count with display decode and drive and other functions normally found in more expensive devices. The C-683 also operates on a nominal 9 volt supply making it CMOS compatible.

CALCULATOR OPERATION

For those unfamiliar with calculator operation, it is essential that the method of keying in information and display driving is thoroughly understood. Due to the requirement to limit the number of pins on the packages of calculator chips, it is essential that multiplex techniques are used and the "standard" display

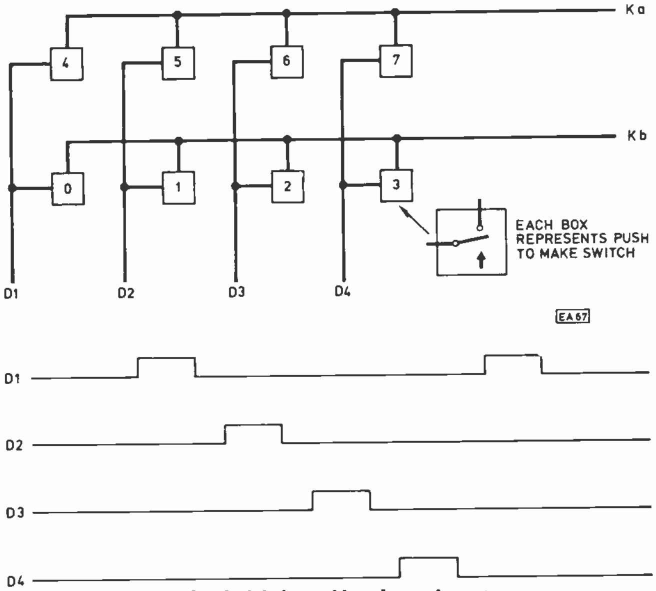


Fig. 1. Multiplexed keyboard system

multiplexing method is without exception adopted. The chip outputs seven segment drives and 9 digit drives plus a decimal point "segment" drive with one digit of the display having its digit driver enabled for a short period (a few hundred microseconds) and the segment drives then turn on the appropriate segments for that particular digit. Then the next digit of the display has its digit driver enabled for a similar period, segment drives as required for this digit being applied. Thus each digit driver is enabled in turn and it should be clear that if, say, all segments "a" in each display are commoned to a segment drive output (and b, c.....g), then by controlling the seven segment drive outputs and the nine digit drive outputs, the nine digit display can be operated using only 16 connections. The alternative approach where each segment is driven continuously requires 63 connections for the segments plus one for the common return.

KEYBOARD

Turning now to the keyboard, for a basic calculator, keys 0–9, + − × ÷ % · = C/CE are needed, 18 in all and these could be individually wired to the calculator chip. Instead of this, the keyboard itself is operated in a multiplexed mode as illustrated in Fig. 1. For simplicity, an eight digit keyboard is

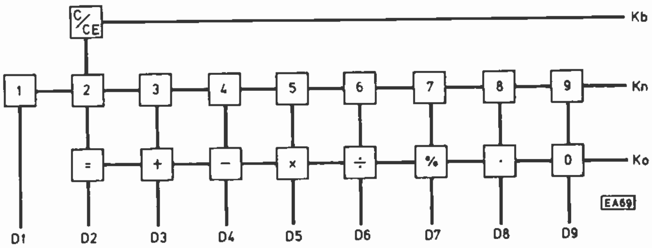


Fig. 2. Key matrix for the C-683

shown, although in practice many keys are interconnected in this type of matrix to reduce interconnections to a minimum. If we have four waveforms D1, D2, D3, D4 as shown and these are applied to the key matrix, then when say button 2 is depressed, the D3 waveform will appear at Kb. By simple gating, it would be possible to tell that button 2 was the one that was depressed as only this button will produce the 'high' pulse at this time i.e. in phase with D2. If the key matrix for the C-683 is studied (Fig. 2), then it can be seen that the number of wires from keyboard to chip is reduced from 19 to 12. Now comes the clever trick—the display drive circuitry produces digit drive waveforms, nine in all to enable, one at a time, the display digits. If these are applied to the D1-D9 keyboard connections then the keyboard only needs a further three connections to the chip.

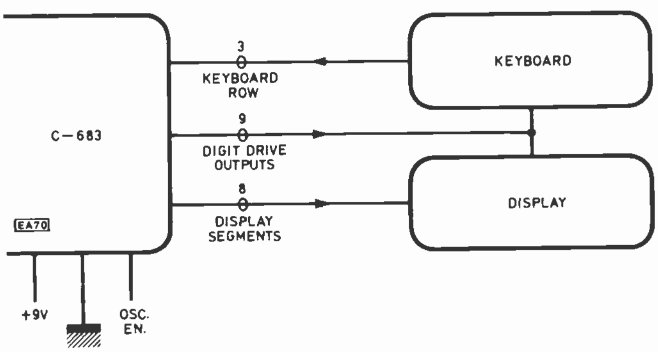


Fig. 3. Keyboard and display drive connections

Internal circuitry as before can detect which key has been depressed by detecting the phase of the signal received on one of the three keyboard "row" outputs. Thus in Fig. 3, a block diagram shows the keyboard and display drive connections required and by referring to Fig. 4, the pin-out diagram for the C-683, the purpose of most of the pins on the i.c. can be seen. Other pins are an oscillator enable pin, pin 14 which is tied to ground by a 470k resistor for normal operation and supply and ground connections. In the G1 calculator chip range, all the chips in the family have common keyboard and display pinout for ease of printed circuit board stocking by the calculator manufacturer. More complex calculators such as the C-596 15 function scientific use the spare pins (9, 10, 11) to extend the keyboard to more rows, giving a greatly increased number of functions.

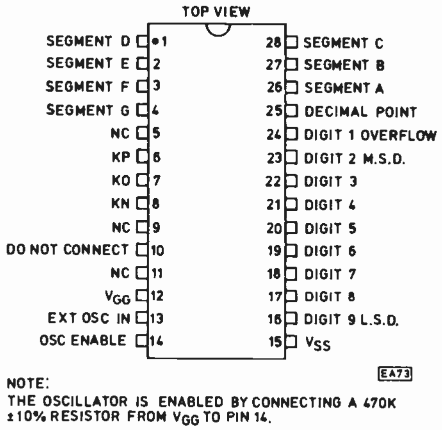


Fig. 4. Pin-out diagram for the C-683

CIRCUIT FUNCTIONS

Now that the theory of operation of the calculator chip has been established, it is necessary to investigate how, in practice, it can be made to perform a circuit function. Let us assume that we want to perform simple addition of a pulse stream, with the ability to count up or down. Some intelligent probing round the chip reveals that to perform multiple addition, the operations + 1 = need to be performed each time a pulse is to be added to the total in the calculator chip registers. Normally this would be performed by key depressions but when the chip is performing an "in-circuit" function, it is obviously necessary to use logic to simulate switch closures. The circuit shown in Fig. 5 can be used to generate the necessary waveforms in the following manner. The fully decoded decade counter CD4017 is clocked by a free-running oscillator with a period of about 50 ms and by connecting the 9th output of the counter to the clock inhibit input (pin 13), the counter will normally be in the halted state with output 9 high and all other outputs low. If a short positive going pulse is now applied to the reset pin, the counter will be reset and immediately start to count up to 9 again. Fig. 6 shows the waveforms associated with this device. Outputs 1, 3 and 5 are now used to simulate keyboard operations +, 1 and = respectively by means of IC2 and IC3. Thus for a + input, the calculator chip expects to see its D3 signal connected to Ko and this is performed by NANDing D3 with the digit 1 output (pin 2) of IC1, and using part of IC3 to OR this signal into the Ko input of the calculator chip. Similarly D1 is NANDed with digit 3 and fed to the Kn input after inversion by part of IC3, and D2 is NANDed with digit 5 and OR'd to the Ko input. Alternative digit outputs from the decade counter must be used to simulate the gap between pressing keys and the frequency of the drive oscillator must be such as to allow the calculator chip time to perform its keyboard input validation function and arithmetic operations before the next signal is input. The use of an oscillator period of 50 ms or greater appears satisfactory for addition and subtraction but longer periods of about 200 ms are necessary for multiplication and division. In the basic circuit shown in Fig. 5, S1 allows either D3 or D4 to be the first signal connected to Ko, D3 causing an addition to take place and D4 a subtraction. The resistors R1 to R3 are necessary to act as pull-down elements on the calculator chip digit drive leads since these are open drain outputs which can source current, but do not actually switch a logical level.

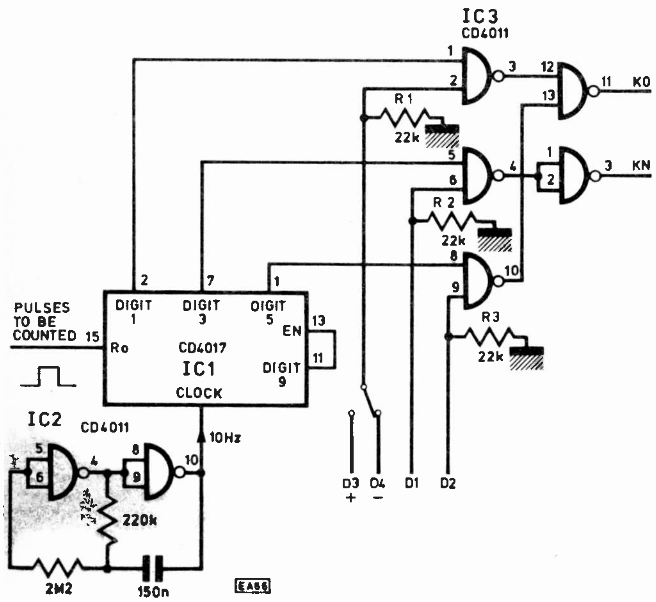


Fig. 5. Circuit to simulate key depression

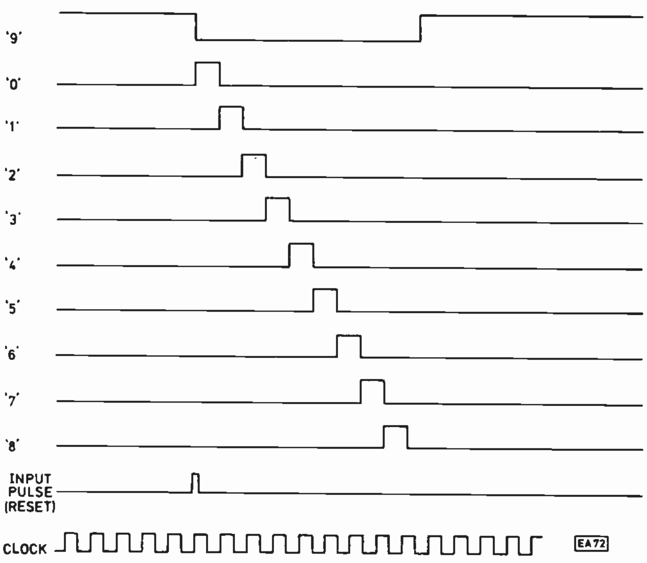


Fig. 6. Output waveforms of Fig. 5

UP/DOWN COUNTER

Using the circuit shown in Fig. 5, an up/down counter of up to 8 digits can be constructed and with the addition of a display and a few associated components, (Fig. 7) a four digit counter display module can be made at very low cost.

The addition of other components can allow the multiplication and division functions of the C-683 to be used, but this does introduce some complications as it is necessary to input the numbers, not as say binary but as a 1 out of 10. This can be done by using some decoder chips and an outline circuit is shown in Fig. 8. The CD4067 is a 16:1 multiplexer which is used here to select digit drive outputs from the calculator chip

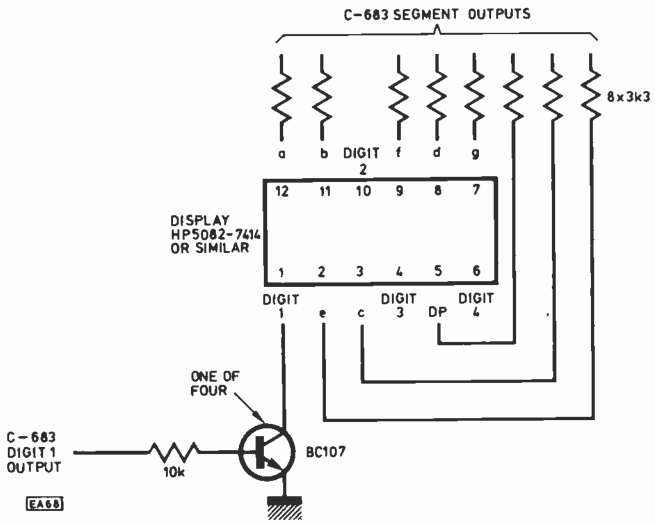


Fig. 7. Circuit diagram of a four digit counter display

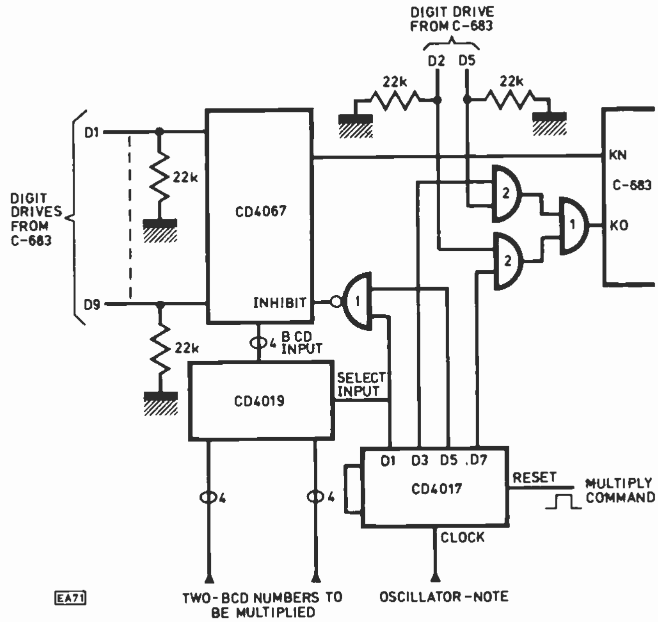


Fig. 8. Outline circuit for multiplication and division

according to the binary address applied. Thus for a binary address 0101, digit drive D5 is routed to the Kn input on the C-683, causing a "5" to be entered into the calculator chip—since 0101 represents 5 in 8421—b.c.d. code, the circuit clearly enters our "A" number. The next operation involves the digit 3 output of the CD4017, this being gated with D5 and then routed to the Ko input of the calculator chip causing the function multiply to be performed. If D6 was routed, divide would be performed. When the digit 5 output of the CD4017 occurs, it causes the quad 2:1 data selector—CD4019, to select the "other" input number and this is applied in b.c.d. form to the 16:1 multiplexer as before to cause the second number to be input to the calculator. Finally digit 7 output from the CD4017 is used to gate D2 from the C-683 into Ko on the same chip, causing the equals function to be performed and the answer to be displayed.

The description so far given illustrates only simple applications and with a little thought, circuitry can be constructed to say accumulate pulses over a period of time, divide the total by a fixed factor and then cancel the display to allow the process to be performed again.

Countdown

Organisers: Please send details of exhibitions, club open days and other events to Mike Abbott at least six weeks in advance. Inclusion will be subject to space etc.

BEX (Business Equipment Exhibition) Feb. 6-7. Queens Hall, Leeds. **K**
BEX Feb. 20-21. Pavilion, Bournemouth. **K**
IEA/Electrex Feb. 25-29. National Exhibition Centre, Birmingham. **I**
Viewdata March 26-28. Wembley Conference Centre, London. **O**
Computer-Aided Design (conference & exhibition) March 31-April 2. Metropole, Brighton. Details: CAD 80/0483-31261
Seminex April 14-18. Dept. Physics, Imperial College, London. **H1**
Communications 80 April 14-18. National Exhibition Centre. **I**
Electronic Test & Measuring Information April 22-24. Wythenshaw Forum, Manchester. **T**
International Conference On The Electronic Office April 22-25. London Penta Hotel. Organised principally by the Institute of Electronics & Radio Engineers. 99 Gower St., London WC1E 6AZ
North Midlands Mobile Rally April 27. Drayton Manor Park, Tamworth, Staffs. Details: Norman Gutteridge, 68 Max Rd., Quinton, Birmingham.
All-Electronics Show April 29-May 1. Grosvenor House, London. **E**
The Mersey Micro Show April 30-May 2. Adelphi Hotel, Liverpool. **O**
Compec Europe May 6-8. Centre International Rogier, Brussels. **L**
Great British Electronics Bazaar June 20-22. Alexandra Palace. Many improved features this year, to enhance the unique atmosphere of the "Ally Pally". There will be free "bring-and-buy" sales for all visitors. **E**
Intel Fair June 24. Wembley Conference Centre, London. **U**
Tempcon July 1-3. Wembley Conference Centre. Exhibition devoted to temperature control & measurement. **T**
Transducer July 1-3. Wembley Conference Centre. **T**
The 1980 Microcomputer Show July 10-12. Royal Lancaster Hotel, London. **O**

E Evan Steadman, 34-36 High st., Saffron Walden, Essex. ✆ 0799 22612
H1 Seminex Ltd., 79 High st., Tunbridge Wells, Kent, TN1 1XZ. ✆ 0892 39664/5
I Industrial Trade Fairs, Radcliffe Ho., Blenheim Court, Solihull, W. Midlands B91 2BG. ✆ 021-705 6707
K Douglas Temple Studios, 1046 Old Christchurch Rd., Bournemouth, Dorset BH1 1LR. ✆ 020 20533
L Iliffe Promotions, Dorset Ho., Stamford St., London SE1 9LU. ✆ 01-261 8437/8
O Online Conferences, Cleveland Rd., Uxbridge, Middx. UB8 2DD. ✆ 0895 39262
T Trident International Exhibitions, Abbey Mead Ho., 23a Plymouth Rd., Tavistock, Devon PL19 8AU. ✆ 0822 4671
U Brian Crank Associates, 58 London Rd., Southborough, Kent. ✆ 0892-31812 38414

News Briefs

ON THE BUTTON

IBA has just awarded a £16M contract for the high power u.h.f. transmitters needed to launch ITV's fourth channel in November 1982.

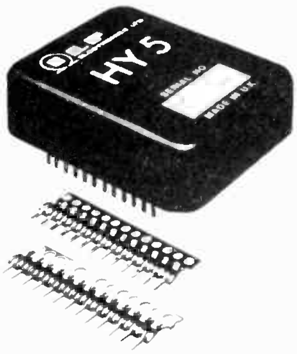
Divided, roughly equally, between Marconi and Pye, the contract covers the supply and installation of equipment necessary to transmit to 80 per cent of the entire population at the inauguration date of the new channel.

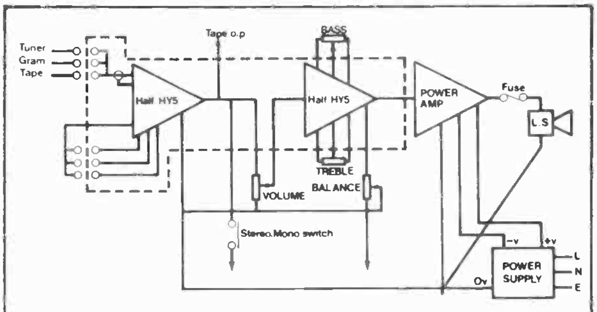
The fourth channel will be the first programme service to open in the UK where virtually all viewers already have receivers and aerials for a new entertainment dimension at no extra cost. A little initial aggravation in band searching will be inevitable but at last that unused button will have meaning.

and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER





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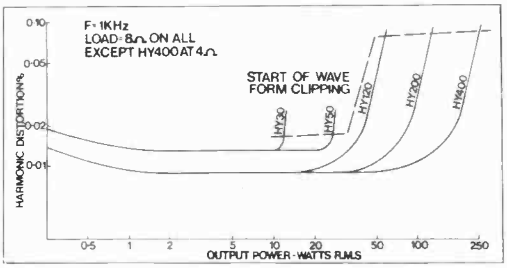
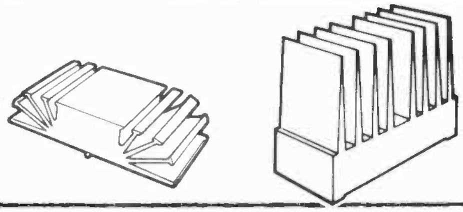
THE POWER AMPLIFIERS

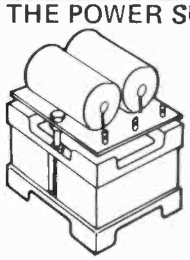


Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0 +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114x50x85	575	**£15.20** + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0- +45	114x50x85	575	**£18.44** + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	114x100x85	1.15Kg	**£27.68** + £4.15



Load impedance — all models 4 - 16Ω
Input sensitivity — all models 500 mV
Input impedance — all models 100KΩ
Frequency response — all models 10Hz - 45Hz - 3dB

THE POWER SUPPLY UNITS



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3	2 0	6·35	1 10
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21	4 0	8·79	1 31
51	5 0	10·86	1 52
117	6 0	12·29	1 67
88	8 0	16·45	1 89
89	10 0	18·89	1 89
90	12 0	21·09	2 24
91	15 0	24·18	2 39
92	20 0	32·40	O.A.

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105	3 0	9·42	1 52
106	4 0	12·82	1 73
107	6 0	16·37	1 89
118	8 0	22·29	2 39
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125	3 0	12·10	1 31
123	4 0	13·77	2 12
40	5 0	17·42	1 89
120	6 0	19·87	2 12
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18	4	2	4·46	1 10
85	5	2·5	6·16	1 10
70	6	3	6·99	1 10
108	8	4	8·16	1 31
72	10	5	8·93	1 31
116	12	6	9·89	1 52
17	16	8	11·79	1 52
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154	500	22·52	2·47
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1500	33·02	O.A.	93W
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235	330, 330	0-9, 0-9	2·19	0·44
207	500, 500	0-8-9, 0-8-9	3·05	0·85
208	1A, 1A	0-8-9, 0-8-9	3·88	0·90
236	200, 200	0-15, 0-15	2·19	0·44
214	300, 300	0-20, 0-20	3·08	0·90
221	700(DC)	20-12-0-12-20	3·75	0·90
206	1A, 1A	0-15-20-0-15-20	5·09	1 10
203	500, 500	0-15-27-0-15-27	4·39	1 10
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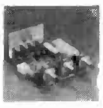

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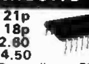

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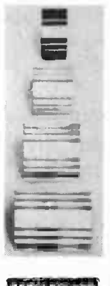

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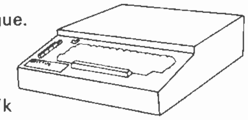

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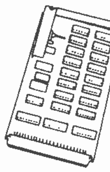

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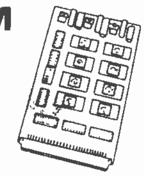

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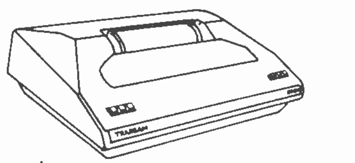

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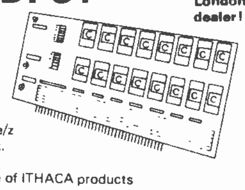

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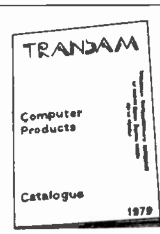

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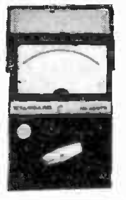

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7414	0.50	74110	0.36	74186	5.00	4040	0.58	4510	0.92	TBA120S	0.66	1.008	3.25
74H15	0.23	74111	0.58	74188	2.70	4041	0.72	4511	0.92	TBA641A	1.50	1.8432	3.50
7416	0.23	74113	0.30	74190	0.68	4042	0.67	4512	0.92	TBA800	0.78	2.000	3.25
7417	0.23	74116	1.50	74191	0.68	4043	0.80	4513	1.85	TBA810S	0.75	2.097	3.25
7420	0.11	74118	0.80	74192	0.62	4044	0.80	4514	2.30	TBA820S	0.68	2.457	3.25
7421	0.20	74119	1.50	74193	0.62	4045	1.25	4515	2.60	TCA270S0	1.60	3.276	2.60
7422	0.16	74120	0.95	74194	0.62	4046	1.05	4516	0.99	TDA2020	3.00	3.579	2.60
7423	0.21	74121	0.25	74195	0.60	4047	0.85	4517	3.75	ZN414	0.80	3.932	2.60
7425	0.23	74122	0.39	74196	0.72	4048	0.48	4518	0.90	**VOLTAGE**		4.000	2.60
7426	0.23	74123	0.38	74197	0.58	4049	0.33	4519	0.50	**REGULATORS**		4.433	2.60
7427	0.24	74125	0.32	74198	1.00	4050	0.40	4520	0.95	LM300H-T099	0.75	4.915	2.60
7428	0.26	74126	0.35	74199	1.20	4051	0.72	4521	2.20	LM309K-T03	1.30	5.000	2.60
7430	0.11	74128	0.75	74221	1.30	4052	0.72	4522	1.25	uA723-14	0.32	5.068	2.60
74S30	0.23	74130	0.50	74273	2.05	4053	0.72	4526	1.25	7805-T0220	0.70	5.185	2.60
7432	0.22	74132	0.55	74278	1.65	4054	1.00	4527	1.40	7812-T0220	0.70	5.875	2.60
7433	0.30	74134	0.38	74279	1.10	4055	1.05	4528	0.92	7815-T0220	0.70	6.000	2.60
7437	0.21	74135	0.70	74283	1.65	4060	1.00	4529	1.30	7824-T0220	0.70	6.144	2.60
7438	0.21	74136	0.52	74284	3.40	4066	0.48	4530	0.78	7905-T0220	0.78	6.553	2.60
7440	0.12	74137	0.80	74293	1.30	4067	3.25	4531	0.99	7912-T0220	0.78	8.000	2.60
7441	0.50	74141	0.55	74298	1.80	4068	0.20	4532	1.20	7915-T0220	0.78	8.867	2.60
7442	0.40	74142	1.95	74390	1.75	4069	0.17	4534	5.20	**LOW PROFILE**		10.000	2.60
7443	0.70	74143	2.50	74393	1.25	4070	0.17	4536	3.60	**DIL SOCKETS**		12.000	2.60
7444	0.70	74144	2.50	**CMOS**		4071	0.17	4538	1.25	8 pin	0.09	13.516	2.60
7445	0.52	74145	0.55	4000	0.13	4072	0.17	4539	0.99	14 pin	0.11	18.000	3.20
7446	0.60	74147	1.40	4001	0.15	4073	0.17	4541	1.05				
7447	0.48	74148	1.25	4002	0.15	4075	0.17	4543	1.50	LED's			
7448	0.56	74150	0.68	4006	0.85	4076	0.84	4549	3.92		0.25"	0.2"	
7450	0.11	74151	0.48	4007	0.16	4077	0.21	4553	3.60	RED	6.85	0.09	
7451	0.11	74153	0.48	4008	0.78	4078	0.18	4554	1.25	YELLOW	0.14	0.14	
74H52	0.23	74154	0.82	4009	0.40	4081	0.17	4555	0.75	GREEN	0.14	0.14	
7453	0.11	74155	0.50	4010	0.40	4082	0.18	4556	0.75	Led clip	0.25	0.35	
7454	0.11	74156	0.50	4011	0.15	4085	0.63	4557	3.25				
7460	0.11	74157	0.50	4012	0.15	4086	0.63	4558	1.25				
7470	0.25	74158	0.68	4013	0.40	4089	1.35	4559	3.95				
7472	0.22	74159	1.90	4014	0.78	4093	0.60	4560	1.98				
7473	0.25	74160	0.60	1015	0.70	4094	1.68	4561	0.72				
7474	0.25	74161	0.58	4016	0.40	4095	0.90	4562	5.50				
74S74	0.42	74162	0.62	4017	0.72	4096	0.90	4566	1.42				
7475	0.30	74163	0.62	4018	0.75	4097	3.30	4588	2.50				
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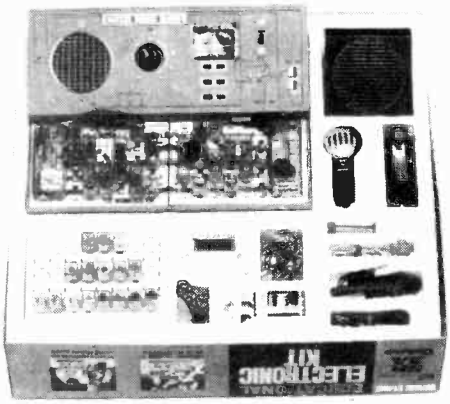

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12FE12	12+12	0·5A EACH	2·43	72p
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50FE12	12+12	1·8A EACH	3·74	84p
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60FE15	15+15	2A EACH	4·58	102p
80FE15	15+15	3A EACH	5·66	120p
06FE20	20+20	0·15A EACH	1·82	60p
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20FE20	20+20	0·5A EACH	3·06	84p
50FE20	20+20	1·2A EACH	3·74	84p
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90FE12	0-6-12	8A	6·75	138p
12FE24	24+24	0·2A EACH	2·43	72p

Type	Voltage	Current	£	p/p
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80FE24	24+24	1·5A EACH	5·66	120p
50FE28	28+28	0·75A EACH	3·74	84p
60FE28	28+28	1·1A EACH	4·58	102p
80FE28	28+28	1·4A EACH	5·66	120p
20FE30	30+30	0·35A EACH	3·06	84p
50FE30	30+30	0·75A EACH	3·74	84p
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20FE80	20-0-20	1A	3·00	84p
50FE80	20-0-20	2A	3·70	84p
60FE100	28-0-28	2·2A	4·50	102p
80FE70	24-0-24	3A	5·66	120p
90FE50	15-0-15	6A	5·80	120p
90FE80	30-0-30	3A	5·80	120p
100FE26	26-0-26	3·5A	6·05	138p
100FE28	28-0-28	3·5A	6·05	138p
100FE30	30-0-30	3A	6·05	138p
100FE36	36-0-36	3A	6·05	138p
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150FE26	26-0-26	5A	7·47	150p
150FE30	30-0-30	4A	7·47	150p
150FE36	36-0-36	4A	7·47	150p
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7442	.40
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74166	.99
74170	1.50
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74175	.58
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74181	1.44
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74188	3.18
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74199	1.30
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74LS55	.21
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74LS86	.31
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74LS96	1.33
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74LS123	.83
74LS124	1.60
74LS125	.41
74LS126	.41
74LS132	.69
74LS133	.45
74LS136	.41
74LS138	.67
74LS139	.67
74LS145	1.12
74LS151	.93
74LS153	.60
74LS154	1.50
74LS155	.83
74LS156	.83
74LS157	.65
74LS158	.65
74LS160	1.25
74LS161	.80
74LS162	1.33
74LS163	.80
74LS164	1.22
74LS165	.83
74LS166	1.90
74LS168	1.97
74LS169	1.97
74LS170	1.98
74LS173	.93
74LS174	1.12
74LS175	1.12
74LS181	3.19
74LS188	.51
74LS189	2.39
74LS190	.99
74LS191	.99
74LS192	1.20
74LS193	1.20
74LS194	.99
74LS195	1.12
74LS196	1.12
74LS197	1.12
74LS221	1.06
74LS240	2.39
74LS241	2.39
74LS242	2.39
74LS243	2.39
74LS245	
74LS247	1.25
74LS248	1.25
74LS249	1.25
74LS251	1.10
74LS253	1.06
74LS257	1.06
74LS258	1.06
74LS259	1.60
74LS261	
74LS266	.43
74LS273	1.95
74LS279	.65
74LS283	1.25
74LS289	
74LS290	1.05
74LS293	1.05
74LS295	1.50
74LS298	1.33
74LS348	1.60
74LS352	1.20
74LS353	1.06
74LS365	.54
74LS366	.54
74LS367	.54
74LS368	.54
74LS386	.41
74LS393	.97
74LS668	1.35
74LS670	1.97

CMOS

4000	.15
4001	.17
4002	.15
4006	.78
4007	.15
4008	.62
4009	.35
4010	.30
4011	.20
4012	.18
4013	.40
4014	.67
4015	.71
4016	.32
4017	.65
4018	.87
4019	.55
4020	.72
4021	.67
4022	.71
4023	.16
4024	.59
4025	.16
4026	1.50
4027	.35
4028	.60
4029	.75
4030	.60
4032	.95
4034	1.30
4035	.81
4040	.69
4042	.55
4043	.60
4046	.75
4049	.35
4050	.35
4051	.52
4052	.52
4053	.52
4054	1.27
4056	1.55
4059	5.34
4060	1.20
4066	.35
4068	.18
4069	.17
4070	.17
4071	.17
4072	.17
4075	.17
4077	.17
4081	.17
4082	.17
4085	.82
4086	.82
4093	.61
4099	1.50
4502	.77
4508	1.95
4510	.70
4511	.75
4514	2.50
4515	2.88
4516	.60
4517	4.19
4518	.65
4521	1.87
4522	1.26
4526	.83
4528	.66
4534	5.50
4536	3.48
4543	1.56
4553	4.45
4566	1.81
4583	.83
4585	1.14

LINEAR

703	1.21
709 8 pin	.41
710 14 pin	.42
710 T099	.69
711 14 pin	.35
741 8 pin	.23
741 14 pin	.42
741 T099	.46
747 14 pin	.78
748 8 pin	.38
748 14 pin	.40
748 T099	.55
753 8 pin	1.99
AY-1-0212	6.67
AY-1-5051	1.67
AY-1-6721-6	2.24
AY-5-1224	2.85
CA3046	.77
CA3053	.71
CA3075	2.86
CA3080	.77
CA3081	1.40
CA3082	1.40
CA3086	.45
CA3089	.95
CA3130E	.88
CA3140E	.38
CA3160E	1.20
ICL8038BC	9.75
ICL8038CC	3.75
ITT7120	2.12
LF351N	.45
LF356N	.85
LM301AN	.28
LM301AH	.51
LM307N	.51
LM307H	.89
LM308N	.75
LM308H	1.15
LM318N	2.35
LM319H	2.38
LM324N	.65
LM339N	.60
LM348N	.95
LM370N	3.27
LM371H	2.51
LM373N	3.50
LM374N	3.50
LM377N	1.89
LM378N	2.50
LM379S	4.48
LM380N-8	.99
LM380N-14	.85
LM381N	1.77
LM381AN	2.81
LM382N	1.36
LM386N	.87
LM387N	1.12
LM389N	1.08
LM725CN	2.98
LM1303N	1.18
LM1808N	2.22
LM1812N	6.49
LM1820N	1.17
LM3065N	1.23
LM3900N	.55
LM3905N	1.22
LM3909N	.75
LM3911N	1.28
M252-B1-AA	8.87
M253-B1-AA	9.20
MC1310P	1.26
MC1312P	2.25
MC1314P	3.47
MC1315P	4.95
MC1327P	.92
MC1330P	1.15
MC1350P	1.23
MC1351P	1.32
MC1352P	.92
MC1456CG	2.32
MC1458CP1	.56
MC1495L	5.31
MC1496P	.87
MC3302P	.71
MFC6030A	2.25
NE555N	.30
NE556N	.69
NE560N	3.50
NE561N	3.50
NE562N	3.50
NE565N	1.29
NE566N	1.39
NE567N	1.81
SL414A	1.94
SAA1024	3.95
SAA1025	5.62
SO6000V	3.46
SN76001N	.95
SN76003N	2.32
SN76008K	1.25
SN76013N	1.55
SN76013NO	1.38
SN76018K	1.25
SN76023ND	1.40
SN76033N	2.32
SN76532N	1.73
SN76544N	1.42
SN76660N	.65
SN76666N	.78
TAA320A	.60
TAA350A	2.70
TBA120B	.79
TBA231	.98
TBA5200	2.68
TBA651	2.05
TBA800	.92
TBA810AS	.99
TBA820	.82
TBA9900	2.55
TCA730	4.25
TCA740	4.50
TCA940	1.79
TDA1054	1.38
TDA2020	3.58
UAA170	2.29
UAA180	2.29
ZN414	.75
ZN404	.59
ZN423T	1.15
ZN424E	1.38
ZN425E	4.10
ZN459CT	3.82
ZN1034E	2.16
ZN1040E	8.98
ZNA116E	7.19
ZNA134	36.21

DYNAMIC RAMS

4027	3.46
4116(250ns)	7.75
4050(200ns)	2.87
4050(350ns)	2.70
4060(300ns)	2.75

STATIC RAMS

2102A(350ns)	1.33
2102A-2(250ns)	1.33
211A-1(500ns)	1.95
2112A-2(250ns)	2.11
21L02(350ns)	1.33
MM5257	7.97
MM2114	5.95
MC6810	3.48
4035(1000ns)	1.23
4045(250ns)	7.07

ROMS

2513(UC)	7.18
2513(LC)	7.18
MM5230	5.31

EPROMS

1702A	5.93
2708	7.20
2716	29.59

CPU's

8080	5.84
6800	6.91
9900	29.95

BUFFERS

81LS95	.99
81LS96	.80
81LS97	.99
81LS98	.80
74365	.60
74366	.60
74367	.60
74368	.60
8T26	2.80
8T28	2.80
8T95	1.80
8T96	1.80
8T97	1.80
8T98	1.80

INTERFACE

8205	3.45
8212	2.31
8216	2.39
8224	3.19
8228	4.75
8251	5.75
8253	7.97
8255	5.84

UARTS

AY-5-1013	4.20
MM5303	5.79

VOLTAGE REGULATORS

1 Amp +ve T0220			—ve T0220	
5v	7805	.89	7905	.98
8v	7808	.89	7908	.98
12v	7812	.89	7912	.98
15v	7815	.89	7915	.98
18v	7818	.99	7918	.98
24v	7824	.89	7924	.98
500mA +ve T03			**+ve SOT-32**	
5v	L005T1	1.35	L129	.85
12v	L036T1	1.35	L130	.86
15v	L037T1	1.35	L131	.85
500mA +ve T0220			**—ve T0220**	
5v	78M05	.64	79M05	.78
6v	78M06	.64	79M06	.78
8v	78M08	.64	79M08	.76
12v	78M12	.64	79M12	.78
15v	78M15	.64	79M15	.78
18v	78M18	.64	79M18	.78
24v	78M24	.64	79M24	.78
			723(DIL)	.43
			723(T099)	.79
100mA T092			LM304H	2.55
5v	78L05	.32	LM323K	6.66
6v	78L06	.32	LM325N	2.77
8v	78L08	.32	LM326N	2.77
12v	78L12	.32	LM345K	8.91
15v	78L15	.32	L200	1.95

CRYSTALS

100Khz	3.95
1·0Mhz	3.45
2·0Mhz	3.45
2·097152Mhz	3.45
3·27680Mhz	3.45
4·194304Mhz	3.45
4·433619Mhz	1.27
5·0Mhz	3.45
10·0Mhz	3.45
10·7Mhz	3.45

OPTO

7 Seg Displays

C.A. R/H ·3"		C.A.± 1 ·3"	
MAN51	2.50	DL701	1.50
MAN71	1.62	MAN53	2.50
MAN81	2.50	MAN73	1.62
MAN3610	2.31	MAN83	2.50
C.A. L/H ·3"		MAN3630	2.31
DL707	1.25	C.C. R/H ·3"	
MAN52	2.50	DL704	1.25
MAN72	1.62	MAN54	2.50
MAN82	2.50	MAN74	1.62
MAN3620	2.31	MAN84	2.50
.5"		MAN3640	2.31
DL721	2.50	**LED's**	
DL727	2.50	·125" inc. clips	
·6"		TIL209Red	.15
DL746	2.54	TIL212 Yel.	.20
DL747	2.54	TIL218 Red	.20
DL750	2.54	TIL232 Gr.	.20
·8"		·2" inc. clips	
DL846	1.62	TIL220	.16
DL847	1.62	TIL224	.22
DL850	1.62	TIL228	.22
		TIL234	.22

BAUD RATE GENERATORS

MC14411	6.75
MM5307	10.79

TV CONTROLLER

SFF96364	10.77

75 SERIES

75107AJ	1.75
75107BJ	1.75
75108AN	1.49
75182N	1.75
75452BP	.50
75491N	.58
75492N	.75

TRANSISTDRS

AC126	.22
AC127	.22
AC128	.22
AC176	.22
AC187	.22
AC188	.22
AD149	.81
AD161	.48
AD162	.48
AF114	.35
AF115	.35
AF118	.35
AF117	.35
AF139	.40
AF239	.48
ASY26	.48
BC107	.10
BC108	.10
BC109	.10
BC147	.08
BC148	.08
BC149	.09
BC157	.09
BC158	.09
BC159	.09
BC168	.14
BC169C	.12
BC177	.16
BC178	.16
BC179	.16
BC182L	.12
BC183L	.12
BC184L	.12
BC187	.32
BC212L	.12
BC213L	.12
BC214L	.12
BC327	.12
BC441	.35
BC461	.35
BC477	.25
BC478	.25
BC479	.25
BC547	.14
BC548	.14
BC549	.14
BC557	.14
BC558	.14
BC559	.14
BCY70	.17
BCY71	.17
BCY72	.17
BD131	.44
BD132	.44
BD135	.43
BD136	.43
BD139	.43
BD140	.43
BD239C	.36
BF160	.35
BF167	.32
BF177	.28
BF178	.29
BF179	.35
BF180	.23
BF181	.32
BF184	.24
BF185	.24
BF194	.10
BF195	.10
BF196	.10
BF197	.10
BF200	.32
BF244B	.35
BF272	1.29
BFX88	.28
BFY50	.23
BFY51	.23
BFY52	.27
BRY39	.74
BSX20	.21
MJ481	2.14
MJ2955	1.14
MJE340	.89
MJE2955	1.17
MJE3055	.92
MPF102	.40
MPF103	.41
MPF104	.41
MPF105	.41
MPF106	.58
MPSA05	.28
MPSA06	.28
MPSA55	.28
MPSA56	.28
MPSU05	.55
MPSU06	.82
MPSU55	.60
MPSU56	.64
OC28	1.79
OC35	.92
OC36	1.14
OC44	.36
OC45	.26
OC71	.29
OC72	.35
OC81	.31
ORP12	2.11
TIP29C	.68
TIP30C	.65
TIP31A	.51
TIP31C	.72
TIP32A	.58
TIP32C	.81
TIP41A	.72
TIP41C	.90
TIP42A	.74
TIP42C	.89
TIP2955	.72
TIP3055	.66
TIS43	.41
TIS91	.25
ZTX107	.13
ZTX108	.13
ZTX109	.13
ZTX300	.15
ZTX301	.18
ZTX302	.21
ZTX303	.20
ZTX304	.20
ZTX311	.20
ZTX312	.20
ZTX341	.20
ZTX500	.15
ZTX501	.16
ZTX502	.22
ZTX503	.17
ZTX504	.21
ZTX531	.26
ZTX550	.25
2N914	.36
2N1304	.58
2N1308	.63
2N1309	.68
2N1711	.23
2N1893	.35
2N2218	.36
2N2219	.23
2N2220	.30
2N2221	.26
2N2222A	.22
2N2646	.55
2N2904	.25
2N2905	.23
2N2906	.21
2N2907	.23
2N2925	.10
2N2926G	.12
2N29260	.12
2N3053	.23
2N3054	.59
2N3055	.51
2N3442	1.67
2N3702	.12
2N3703	.12
2N3704	.12
2N3705	.12
2N3706	.12
2N3707	.12
2N3709	.12
2N3710	.12
2N3711	.12
2N3772	1.94
2N3773	3.31
2N3819	.26
2N3904	.15
2N3906	.15
2N4248	.91
2N5447	.16
2N5449	.20
2N5777	.72
2N6111	.79
2N6288	.79
3N141	1.23
40673	.81

DIODES

AA129	.10
BA100	.17
BA102	.31
BA115	.25
BA145	.21
BA148	.21
BA154	.15
BAX16	.13
BB105B	.36
BR100	.36
OA47	.13
OA79	.13
OA90	.09
OA91	.09
OA200	.09
OA202	.10
IN914	.05
IN4148	.05

SOCKETS

	DIL	W/W
8 pin	.10	.24
14 pin	.13	.36
16 pin	.14	.39
18 pin	.20	.46
20 pin	.22	.59
22 pin	.25	—
24 pin	.28	.64
28 pin	.32	.89
40 pin	.47	1.12

IC PINS

100	.58
500	2.39
1000	3.98

ZENERS

BZY88 1.3v to 33v	.09
BZX61 3.3v to 100v	.15

RECT's

IN4001/2	.05
IN4003/4	.06
IN4005	.06
IN4006/7	.07
IN5400/1	.13
IN5402/3	.14
IN5404/5	.17
IN5406/7	.20
IN5408	.25
BY126/7	.13
BY164	.61

SPECIAL OFFERS

5×741 **1.00**

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8×4116 **58.00**

16×2102A-2 **18.95**

16×6810 **46.50**

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Model "B" Size 16 x 13¾ x 3in. **£4.50**

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15¼ x 13½ x 4in **£4.** 18 x 13¼ x 4in **£6.**
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14½ x 14¾ x 2½in Rosewood sides **£4.** Post £1 60
Ideal for record decks, tape decks, etc

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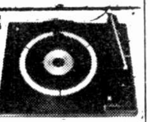

Ideal replacement or disco deck with cueing device and stereo ceramic cartridge. 3 speeds. Large turntable, modern design **£21** Post £1.60

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L/S **35p.** DP **60p.**
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Edge Pot 5K SP **45p**

80 Ohm Coax

FRINGE LOW LOSS **15p** yd
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With tweeter and crossover. 10 watt. 3 or 8 ohm. **£9.95** Post 75p
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Suitable Bookshelf Cabinet
Teak finish. For EMI 13 x 8 speakers. Size 16 x 11 x 8 inches approximately **£9.50** Post £1 60

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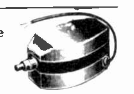

Suitable for cassettes, and all sizes of tape reels. A.C mains 200/250V. Leaflet S A E. Will also demagnetise small tools **£6**
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RELAYS. 12V DC **95p.** 6V DC **85p.** 240V AC **95p.**
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RCS SOUND TO LIGHT KIT Mk. 2 £18

Kit of parts to build a 3 channel sound to light unit. 1,000 watts per channel. Suitable for home or disco. Post 50p
Easy to build. Full instructions supplied. Cabinet **£4.50** extra
Will operate from 200MV to 100 watt signal

RCS "MINOR" 10 watt AMPLIFIER KIT

This kit is suitable for record players, guitars, tape playback, electronic instruments or small PA systems. Two versions available Mono, **£12.50;** Stereo, **£20.** Post 45p. Specification 10W per channel, input 100mV, size 9½ x 3 x 2in approx. SAE details. Full instructions supplied. AC mains powered. Input can be modified to suit guitar

R.C.S. STEREO PRE-AMP KIT. All parts to build this pre-amp. Inputs for high, medium or low imp per channel. With volume control and P C Board. Can be ganged to make multi-way stereo mixers **£2.95** Post 35p

MAINS TRANSFORMERS	ALL POST 75p
250 0 250V 70mA 6 5V 2A	£3.45
250-0-250V 80mA 6 3V 3 5A 6 3V 1A	£4.60
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300-0-300V 120mA 2×6 3V 2A C T 5V 2A	£8.50
220V 45mA 6 3V 2A	£2.50
HEATER TRANSFORMER 6 3V ½ amp **£2.00** 3 amp	£2.20
GENERAL PURPOSE LOW VOLTAGE Tapped outputs available	
½ amp 3 4 5 6 8 9 10 12 15 18 25 and 30V	£6.00
1 amp 6 8 10 12 16 18 20 24 30 36 40 48 60	£6.00
2 amp 6 8 10 12 16 18 20 24 30 36 40 48 60	£9.50
3 amp 6 8 10 12 16 18 20 24 30 36 40 48 60	£12.50
5 amp 6 8 10 12 16 18 20 24 30 36 40 48 60	£16.00

12V 100mA	£1.30	20V 40V 60V 1 amp	£4.00
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10-0-10V 2amp	£3.00	10V 30V 40V 2 amp	£3.50
30V 5 amp and 17V-0-17V		40V 2 amp	£3.50
2 amp	£4.00	20V 1 amp	£3.00
0 5 8 10 16V ½ amp	£2.50	20V-0-20V, 1 amp	£3.50
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AUTO TRANSFORMERS 115V to 230V or 230V to 115V 150W **£7.00**
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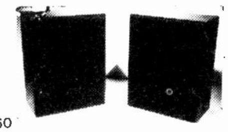
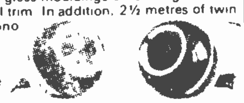
COMPACT SPEAKERS



Teak 4 or 8 ohm
White 4 ohm only
13 x 10 x 6in approx
50 to 14,000 cps
10 watts
£16 pair Post £1 60

EXTENSION SPEAKERS £3.95 ea.

Globe shaped cases in high gloss mouldings of red or green, are finished with chrome frontal trim. In addition, 2½ metres of twin lead already fitted with phono plug is supplied



Full Range Quality
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Impedance 8 ohms
Power Peak, 5 watts

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500mF 12V **15p;** 25V **20p;** 50V **30p;** 420mF/500V **£1.30.**
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8/350V **22p**	8+8/450V **50p**	50+50/300V **50p**
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32/500V **75p**	16+16/450V **50p**	100+100/275V **65p**
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SUB-MIN MICRO SWITCH, 25p. Single pole change over
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RESISTORS. 10Ω to 10M ¼W, ½W, 1W, 20% **2p;** 2W, **10p.**
HIGH stability. ½W 2% 10 ohms to 1 meg , **12p.**
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100 volt line model **£99** **£85** £1 60 carr

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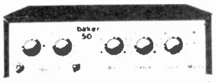

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Plugs 3-pin 20p; 5-pin 25p.
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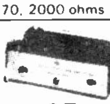
MONO PRE-AMPLIFIER. Mains operated solid state pre-amplifier unit designed to complement amplifiers without low level phono and tape input stages. This free-standing cabinet incorporates circuitry for automatic R I A A equalisation on magnetic phono input and N A B equalisation for tape heads. Phono sockets for input and output



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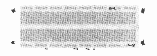
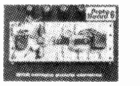


EXP300



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EXP300
550 contacts with two 50-point BUS bars. Size 152×53mm. **£6·95.**

PROTO-BOARD 6 KIT
630 contacts, four 5 way binding posts, accepts up to 6 14 pin DIPs. **£10·98.**

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Min. pulse width 300 nanoseconds, 300 KΩ input impedance, tests circuits up to 1·5MHz. Detecting pulse trains or single-shot event in TTL, DTL, HTL, and CMOS circuits. **£20·95.**

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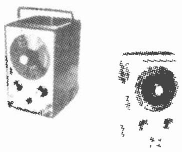

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Sinclair PFM200 frequency meter
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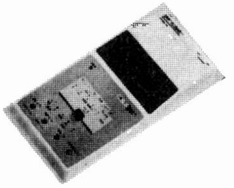
Range 20Hz to 200MHz. Accessories and illustration as for PDM35 below. **£57·95.**



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DC volts (4 ranges) 1mV to 1000V AC volts 1V to 500V DC current (6 ranges) 1nA to 200MA. Resistance (5 ranges) 1Ω to 20 MEGΩ. **PRICE £34·95.** AC Adaptor **£3·95** de luxe padded carrying case £3·50 MN 1604 Battery **£1·28.**
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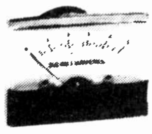

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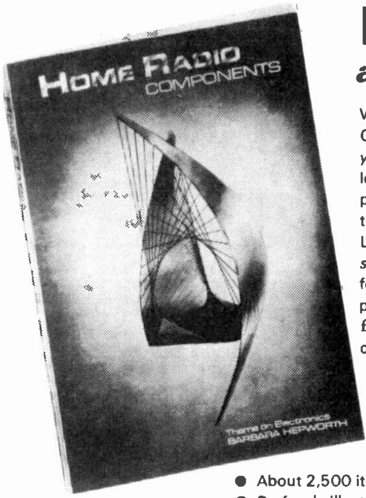

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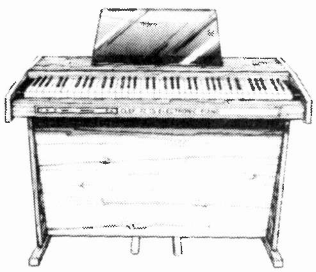

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AC125	0·23	BD124	1·50	OA5	1·09	1N4006	0·09	7413	0·37
AC126	0·23	BD131	0·40	OA7	0·63	1N4007	0·10	7416	0·37
AC127	0·23	BD132	0·44	OA10	0·74	1N4009	0·17	7417	0·37
AC128	0·23	BD135	0·39	OA47	0·16	1N4148	0·07	7420	0·20
AC141	0·29	BD136	0·39	OA70	0·35	1N5400	0·15	7422	0·23
AC141K	0·40	BD137	0·40	OA79	0·35	1N5401	0·15	7423	0·37
AC142	0·23	BD138	0·46	OA81	0·36	1S44	0·05	7425	0·35
AC142K	0·35	BD139	0·49	OA85	0·35	1S920	0·08	7427	0·35
AC176	0·23	BD140	0·51	OA90	0·09	1S921	0·08	7428	0·49
AC187	0·23	BD144	2·30	OA91	0·09	2G301	1·15	7430	0·20
AC188	0·23	BD181	1·26	OA95	0·09	2G302	1·15	7432	0·35
ACY17	0·98	BD182	1·36	OA200	0·10	2G306	1·27	7433	0·41
ACY18	0·92	BD237	0·46	OA202	0·10	2N404	1·15	7437	0·37
ACY19	0·86	BD238	0·63	OA211	1·15	2N696	0·29	7438	0·37
ACY20	0·80	BDX10	1·05	OAZ200	1·15	2N697	0·29	7440	0·21
ACY21	0·86	BDX32	2·30	OAZ201	1·15	2N698	0·35	7441AN	0·97
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AF114	0·86	BF154	0·20	OC23	3·16	2N1132	0·30	7454	0·21
AF115	0·86	BF159	0·26	OC24	3·45	2N1302	0·40	7460	0·21
AF116	0·86	BF160	0·18	OC25	1·04	2N1303	0·40	7470	0·40
AF117	0·86	BF167	0·23	OC26	1·04	2N1304	0·52	7472	0·38
AF139	0·46	BF173	0·23	OC28	2·30	2N1305	0·52	7473	0·41
AF186	1·38	BF177	0·28	OC29	2·30	2N1306	0·58	7474	0·46
AF239	0·52	BF178	0·28	OC35	1·73	2N1307	0·58	7475	0·62
AFZ11	3·16	BF179	0·29	OC36	1·73	2N1308	0·63	7476	0·46
AFZ12	3·16	BF180	0·35	OC41	0·92	2N1309	0·63	7480	0·63
ASY26	0·46	BF181	0·35	OC42	0·86	2N1613	0·29	7482	0·86
ASY27	0·46	BF182	0·35	OC43	2·59	2N1671	1·73	7483	1·04
ASZ15	1·44	BF183	0·29	OC44	0·69	2N1893	0·29	7484	1·15
ASZ16	1·44	BF184	0·29	OC45	0·63	2N2147	2·02	7486	0·40
ASZ17	1·44	BF185	0·29	OC71	0·63	2N2148	1·89	7490	0·60
ASZ20	1·72	BF194	0·10	OC72	0·63	2N2218	0·29	7491AN	0·92
ASZ21	2·30	BF195	0·10	OC73	1·15	2N2219	0·28	7492	0·69
AU110	2·30	BF196	0·12	OC74	0·74	2N2220	0·21	7493	0·69
AU113	1·96	BF197	0·14	OC75	0·74	2N2221	0·21	7494	0·92
AUY10	2·30	BF200	0·31	OC76	0·63	2N2222	0·21	7495	0·83
BA145	0·15	BF224	0·23	OC77	1·38	2N2223	3·16	7496	0·92
BA148	0·15	BF244	0·32	OC81	0·74	2N2368	0·20	7494	3·45
BA154	0·10	BF257	0·28	OC81Z	1·38	2N2369A	0·24	74100	1·73
BA155	0·12	BF258	0·30	OC82	0·74	2N2484	0·23	74107	0·52
BA156	0·10	BF259	0·37	OC83	0·74	2N2646	0·63	74109	0·81
BAW62	0·06	BF336	0·35	OC84	0·74	2N2904	0·29	74110	0·58
BAX13	0·07	BF337	0·35	OC122	1·73	2N2905	0·29	74111	0·81
BAX16	0·10	BF338	0·36	OC123	2·02	2N2906	0·24	74116	2·02
BC107	0·14	BFS21	4·55	OC139	2·59	2N2907	0·24	74118	1·15
BC108	0·14	BFS28	2·56	OC140	3·16	2N2924	0·24	74119	1·73
BC109	0·15	BFS61	0·23	OC141	3·74	2N2925	0·25	74120	0·95
BC113	0·14	BFS98	0·23	OC170	1·15	2N2926	0·16	74121	0·46
BC114	0·15	BFW10	0·74	OC171	1·15	2N3053	0·29	74122	0·69
BC115	0·16	BFW11	0·74	OC200	1·73	2N3054	0·58	74123	1·15
BC116	0·17	BFX84	0·25	OC201	2·02	2N3055	0·81	74125	0·63
BC117	0·20	BFX85	0·26	OC202	2·02	2N3440	0·69	74126	0·63
BC118	0·12	BFX87	0·24	OC203	2·02	2N3441	0·92	74128	0·69
BC125	0·18	BFX88	0·24	OC204	2·88	2N3442	1·26	74132	0·81
BC126	0·23	BFY50	0·30	OC205	2·88			74136	0·63
BC135	0·16	BFY51	0·30	OC206	2·88	2N3614	1·73	74141	0·92
BC136	0·17	BFY52	0·30	OC207	2·02	2N3702	0·13	74142	2·65
BC137	0·17	BFY64	0·30	OCP71	1·44	2N3703	0·15	74143	2·88
BC147	0·10	BFY90	1·44	ORP12	0·86	2N3704	0·15	74144	2·88
BC148	0·09	BSX19	0·24	R2008B	1·15	2N3705	0·15	74145	1·04
BC149	0·10	BSX20	0·23	R2009	2·59	2N3706	0·15	74147	2·30
BC157	0·10	BSX21	0·23	R2010B	2·02	2N3707	0·15	74148	2·02
BC158	0·09	BT106	1·44	T1C44	0·35	2N3708	0·12	74150	1·84
BC159	0·12	BTY79/4	3·67	T1C226D	1·38	2N3709	0·15	74151	0·97
BC167	0·14	BU205	2·02	T1L209	0·23	2N3710	0·12	74154	2·02
BC170	0·13	BU206	2·59	T1P29A	0·47	2N3711	0·12	74155	0·97
BC171	0·12	BU208	2·30	T1P30A	0·48	2N3771	2·02	74156	0·97
BC172	0·12	BY100	0·52	T1P31A	0·61	2N3772	2·30	74157	0·86
BC173	0·14	BY126	0·16	T1P32A	0·55	2N3773	3·45	74159	2·42
BC177	0·17	BY127	0·19	T1P33A	0·79	2N3819	0·41	74170	2·65
BC178	0·16	BZX61	0·21	T1P34A	0·84	2N3820	0·52	74172	5·06
BC179	0·18	Series		T1P41A	0·72	2N3823	0·63	74173	1·61
BC182	0·13	BZY88	0·15	T1P42A	0·81	2N3866	0·63	74174	1·73
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BC184	0·13			T1P3055	0·64	2N3905	0·15	74176	1·26
BC212	0·15	CRS1/40	0·69	T1S43	0·52	2N3906	0·15	74178	1·44
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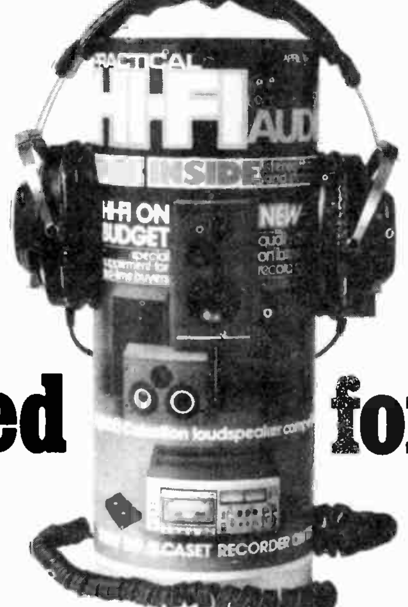

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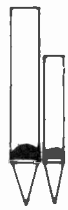

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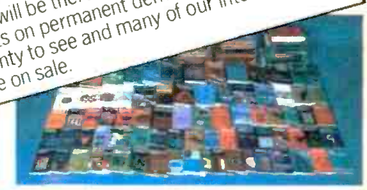

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