Easy to build projects for everyone

Everyday ELECTRONICS

NOV 79
45p

EE RADIO CONTROL SYSTEM

A COMPLETE 7 CHANNEL OUTFIT
PART 1–THIS MONTH

Special Offer
SOLAR ALARM DUAL-TIME WATCH

3 FUNCTION GENERATOR
BABY ALARM
MW & LW RADIO TUNER

Australia 85c South Africa 85c New Zealand 85c Malaysia $2·75

The perfect kit for miniature work!

ANTEX TCSU1 or 2 with CTC

Model TCSU1 Micro-Soldering Station

Model CTC-24volts. Priced at **£9.75**(1.87)

Model XTC-24volts. Priced at **£9.75**(1.87)

Accurate pin point temperature control between 65° and 400°C. Heating element and sensor built in tip of the iron for fast response. Interchangeable slide-on bits from 4.7mm(3/16")down to 0.5mm. Zero voltage switching, no spikes. No magnetic field, no leakage. Supplied with miniature CTC (35-40watt) iron or XTC (50watt). TCSU1 soldering station with XTC or CTC iron **£36**(6.44) Nett to Industry.

Model TCSU2– Specification as TCSU1 except temperature range 200°-400°C. Visual temperature indicators by square LED at 270, 300, 330 and 360°C. Priced at **£42.50**(7.50) Nett to Industry.

▭	▭	▭	▭
270	300	330	360°c

Model CX 17watts - 230 volts

A miniature iron with the element enclosed first in a ceramic shaft, then in stainless steel. Virtually leak-free. Only 7½" long. Fitted with a 3/32" bit. **£4.20**(.98)
Range of 5 other bits available from ¼" down to 3/64".
Also available for 24volts.

Spare element Model CX230E

Model X25 25watts 230 volts

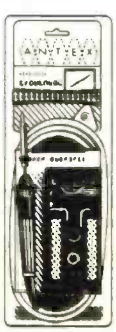
A general purpose iron also with a ceramic and steel shaft to give you toughness combined with near-perfect insulation. Fitted with 1/8" bit and priced at **£4.20**(.98)
Range of 4 other bits available.
Also available in 24volts.

Spare element Model X25/240E

Model SK3 Kit

Contains both the model CX230 soldering iron and the stand ST3. Priced at **£5.70**(1.49)
It makes an excellent present for the radio amateur or hobbyist.

Model SK4 Kit

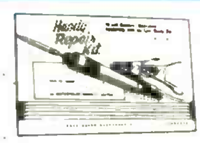


With the model X25/240 general purpose iron and the ST3 stand this kit is a must for every toolkit in the home. Priced at **£5.70**(1.49)

Model SK1

This kit contains a 15watt miniature soldering iron, complete with 2 spare bits, a coil of solder, a heat sink and a booklet. 'How to Solder'. Priced at **£5.95**(1.53)

Model MLX 12volts



The soldering iron in this kit can be operated from any ordinary car battery. It is fitted with 15 feet flexible cable and battery clips. Packed in a strong plastic envelope it can be left in a car, a boat or a caravan ready for soldering in the field. Price **£4.55**(1.14)

ST3 Stand.

A strong chromium plated, steel spring screwed into a plastic base of high grade insulating material provides a safe and handy receptacle for all ANTEX models soldering irons. Priced at **£1.50**(.57)

V.A.T. + P&P as shown in brackets ( )

ANTEX

Stocked by many wholesalers and retailers or direct from us if you are desperate.

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EE11

Top value test equipment from TANDY

LCD DIGITAL MULTIMETER.

Low-cost hand held digital multimeter with a full 3½ digit LCD display. 0.5% basic accuracy, auto polarity operation. 10 Mohm DC input impedance.
Reading to ± 1999.

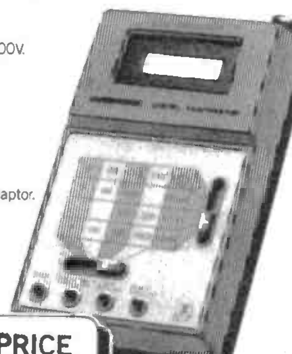
Scales:
DC volts: 1mV to 1000V (1% ± 1 digit accuracte).
AC volts: 1mV to 500V (1% ± 2 digits accurate).
DC current: 1µA to 200mA (1% ± 1 digit accurate).
Resistance: 1Ohm to 20 MOhms (1.5% ± 1 digit accurate).
Power source: 9V battery or AC with optional adaptor.
Size: 155 x 75 x 30 mm.
22–198

PRICE **53·19**

LOW–COST LCD MULTIMETER

A portable, compact sized multimeter with a full 3½ digit LCD display. Auto polarity operation, low battery indicator. 10 MOhm Input impedance.

Scales:
DC volts: 2–20–200–1000V.
AC volts: 200–500V.
DC current: 2–20–200MA.
Resistance: 2–20–200–2000 KOHM.
Power source: 9V battery or AC adaptor.
Size: 37 x 85 x 130 mm.
22–197



PRICE **39·93**

COMPONENTS AND PARTS

CAT. No.	DESCRIPTION	PRICE
276–032	LED	4 for 69p
276–033	LED	2 for 48p
276–034	LED	2 for 59p
276–142	Infra-Red Emitter Detector Pair	£1.37
277–1003	12V DC Automotive Digital Clock Module	£17.52
276–9110	6 pin edge connector for 277–1003	40p
276–1373	Power Transistor Mounting Hardware	50p
276–1363	TO–220 Heat Sink	60p
276–1364	TO–3 Heat Sink	81p

AC/DC 8 MHz OSCILLOSCOPE

A new approved 8MHz version of last years' winner! The advance design features of this oscilloscope make it an absolute essential for industrial uses on production lines, in laboratories and schools. Ideal for radio and TV servicing, audio testing, etc.

Specifications:
Horizontal axis: Deflection sensitivity better than 250mV/DIV. **Vertical axis:** Deflection sensitivity better than 10mV/DIV (1DIV–6mm). Bandwidth: 0.8MHz. **Input impedance:** 1MOhm parallel capacitance 35pF. **Time base: Sweep range:** 10Hz–100kHz (4 ranges). Synchronization: Internal (–) **Size:** 200 x 155 x 300 mm. Supply: 220/240 V/50Hz. **22–9501.**

PRICE **137·36**

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.

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The largest electronics retailer in the world.

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OVER 170 STORES AND DEALERSHIPS NATIONWIDE.

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.
Guaranteed same day dispatch

£22.65

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

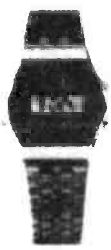
ALARM CHRONO with 9 world time zones

- 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



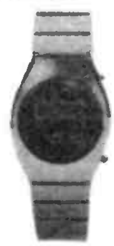
Powered from solar panel with battery back-up. 6 digit, 11 functions. Hours, mins., secs., day, date, day of week. 1/100th, 1/10th, secs., 10X secs., mins. Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet. Metac Price

£13.65

Guaranteed same day despatch.

M9

QUARTZ LCD Ladies Day Watch



Only 25 x 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.

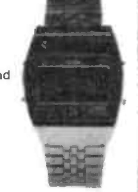
£10.20 Thousands sold!

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
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LONDON W.2
Telephone: (01) 723 4753

BI-PAK SEMICONDUCTORS,

TRANSISTORS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC107	£0·25	BC134	£0·21	BD178	£0·78	BFR40	£0·29	ZTX108	£0·12	2N3415	£0·18
AC113	£0·23	BC135	£0·17	BD179	£0·88	BFR79	£0·32	ZTX109	£0·12	2N3416	£0·33
AC115	£0·23	BC136	£0·21	BD180	£0·86	BFR80	£0·32	ZTX300	£0·14	2N3417	£0·33
AC117	£0·35	BC137	£0·21	BD181	£0·98	BFX29	£0·25	ZTX301	£0·14	2N3614	£1·15
AC117K	£0·39	BC139	£0·37	BD182	£1·04	BFX30	£0·35	ZTX302	£0·18	2N3615	£1·21
AC121	£0·23	BC140	£0·35	BD183	£1·09	BFX84	£0·25	ZTX303	£0·18	2N3616	£1·21
AC122	£0·16	BC141	£0·32	BD184	£1·27	BFX85	£0·28	ZTX304	£0·23	2N3646	£0·10
AC125	£0·21	BC142	£0·25	BD185	£0·78	BFX86	£0·29	ZTX330	£0·17	2N3702	£0·09
AC126	£0·21	BC143	£0·25	BD186	£0·78	BFX87	£0·25	ZTX500	£0·15	2N3703	£0·09
AC127	£0·21	BC145	£0·53	BD187	£0·86	BFX88	£0·25	ZTX501	£0·14	2N3704	£0·08
AC128	£0·18	BC147	£0·08	BD188	£0·86	BFX90	£0·43	ZTX502	£0·18	2N3705	£0·08
AC128K	£0·30	BC148	£0·08	BD189	£0·90	BFY50	£0·18	ZTX503	£0·14	2N3706	£0·09
AC132	£0·23	BC149	£0·08	BD190	£0·90	BFY51	£0·18	ZTX504	£0·29	2N3707	£0·09
AC134	£0·23	BC150	£0·23	BD195	£1·04	BFY52	£0·18	ZTX531	£0·29	2N3708	£0·08
AC137	£0·23	BC151	£0·25	BD196	£1·04	BFY53	£0·18	ZTX550	£0·18	2N3708A	£0·08
AC141	£0·25	BC152	£0·25	BD197	£1·09	BIP19	£0·44	2N388	£0·41	2N3709	£0·08
AC141K	£0·35	BC153	£0·29	BD198	£1·09	BIP20	£0·44	2N388A	£0·64	2N3710	£0·08
AC142	£0·42	BC154	£0·22	Type	Price	BIP19/20	£0·92	2N404	£0·23	2N3711	£0·08
AC142K	£0·35	BC157	£0·12	BD199	£1·14	BSX25	£1·67	2N524	£0·46	2N3772	£1·84
AC151	£0·23	BC158	£0·12	BD200	£1·14	BSX19	£0·21	2N527	£0·58	2N3773	£2·53
AC153	£0·25	BC159	£0·12	BD201	£0·92	BSX20	£0·21	2N598	£0·46	2N3819	£0·21
AC153K	£0·35	BC160	£0·30	BD202	£0·92	BSY25	£0·18	2N599	£0·53	2N3820	£0·40
AC154	£0·23	BC161	£0·44	BD201/		BSY26	£0·18	2N696	£0·15	2N3821	£0·69
AC155	£0·23	BC167	£0·14	202mp	£1·96	BSY27	£0·18	2N697	£0·14	2N3823	£0·69
AC156	£0·23	BC168	£0·14	BD203	£0·92	BSY28	£0·18	2N698	£0·14	2N3903	£0·12
AC157	£0·29	BC169	£0·10	BD204	£0·92	BSY29	£0·18	2N699	£0·37	2N3904	£0·12
AC165	£0·23	BC169C	£0·12	BD203/		BSY38	£0·22	2N706	£0·12	2N3905	£0·12
AC166	£0·23	BC170	£0·10	204mp	£1·96	BSY39	£0·22	2N706A	£0·14	2N3906	£0·12
AC167	£0·23	BC171	£0·10	BD205	£0·92	BSY40	£0·33	2N707	£0·55	2N4058	£0·14
AC168	£0·29	BC172	£0·10	BD206	£0·92	BSY41	£0·33	2N708	£0·16	2N4059	£0·16
AC169	£0·23	BC173	£0·10	BD207	£0·92	BSY51	£0·29	2N711	£0·35	2N4060	£0·16
AC171	£0·29	BC174	£0·17	BD208	£0·00	BSY95	£0·15	2N717	£0·35	2N4061	£0·14
AC176	£0·21	BC175	£0·40	BD222	£0·00	BSY95A	£0·15	2N718	£0·29	2N4062	£0·14
AC176K	£0·30	BC177	£0·18	BD225	£0·54	BRY39	£0·52	2N718A	£0·58	2N4921	£0·63
AC178	£0·29	BC178	£0·18	BD232	£0·63	BU105	£1·84	2N726	£0·33	2N4923	£0·75
AC179	£0·29	BC179	£0·18	BD233	£0·55	BU105/02	£2·24	2N727	£0·33	2N5135	£0·12
AC180	£0·23	BC180	£0·29	BD234	£0·63	BU204	£1·81	2N743	£0·23	2N5136	£0·12
AC180K	£0·32	BC181	£0·10	BD235	£0·63	BU205	£1·81	2N744	£0·23	2N5138	£0·12
AC181	£0·23	BC182	£1·25	BD236	£0·67	BU208	£2·19	2N914	£0·17	2N5172	£0·16
AC181K	£0·32	BC182L	£0·10	BD237	£0·63	BU208/02	£2·59	2N918	£0·35	2N5194	£0·64
AC187	£0·21	BC183	£0·10	BD238	£0·69	MJE2955	£1·04	2N929	£0·23	2N5245	£0·46
AC187K	£0·32	BC183L	£0·10	BD239A	£0·58	MJE3055	£0·69	2N930	£0·21	2N5294	£0·39
AC188	£0·21	BC184	£0·10	BD240A	£0·58	MJE3440	£0·60	2N946	£0·46	2N5296	£0·41
AC188K	£0·32	BC184L	£0·10	BDX32	£2·53	MP8113	£0·60	2N1131	£0·21	2N5457	£0·37
ACY17	£0·40	BC186	£0·25	BDY11	£1·50	MPF102	£0·32	2N1132	£0·21	2N5458	£0·37
ACY18	£0·40	BC187	£0·25	BDY17	£2·07	MPF104	£0·40	2N1302	£0·17	2N5459	£0·40
ACY19	£0·40	BC207	£0·13	BDY20	£0·92	MPF105	£0·40	2N1303	£0·21	2N5551	£0·41
ACY20	£0·40	BC208	£0·13	BDX77	£1·04	MPSA05	£0·23	2N1304	£0·21	2N6027	£0·39
ACY21	£0·40	BC209	£0·14	BF115	£0·25	MPSA06	£0·23	2N1305	£0·21	2N6121	£0·81
ACY22	£0·40	BC212	£0·10	BF117	£0·58	MPSA55	£0·23	2N1306	£0·29	2N6122	£0·81
ACY27	£0·40	BC212L	£0·10	BF118	£0·86	MPSA56	£0·23	2N1307	£0·29	2S301	£0·58
ACY28	£0·37	BC213	£0·10	BF119	£0·86	ND120	£0·21	2N1308	£0·35	2S302	£0·49
ACY29	£0·58	BC213L	£0·10	BF121	£0·58	OC20	£2·13	2N1309	£0·35	2S302A	£0·49
ACY30	£0·40	BC214	£0·10	BF123	£0·69	OC22	£1·73	2N1599	£0·40	2S303	£0·64
ACY31	£0·40	BC214K	£0·10	BF125	£0·58	OC23	£1·73	2N1613	£0·23	2S403	£0·82
AD130	£0·81	BC225	£0·30	BF127	£0·68	OC24	£1·55	2N1711	£0·23	2S305	£0·92
AD140	£0·69	BC226	£0·41	BF152	£0·29	OC25	£1·15	2N1889	£0·52	2S306	£0·92
AD142	£0·98	BC227	£0·18	BF153	£0·29	OC26	£1·15	2N1890	£0·52	2S307	£0·92
AD143	£0·86	BC238	£0·18	BF154	£0·25	OC28	£0·92	2N1893	£0·35	2S321	£0·66
AD149	£0·69	BC251	£0·17	BF155	£0·40	OC29	£1·09	2N2147	£0·86	2S322	£0·49
AD161	£0·40	BC251A	£0·18	BF156	£0·32	OC35	£1·04	2N2148	£0·81	2S322A	£0·49
AD162	£0·40	BC301	£0·32	BF157	£0·32	OC36	£1·04	2N2160	£0·00	2S323	£0·66
AD161/2	£0·81	BC302	£0·33	BF158	£0·32	OC41	£0·23	2N2192	£0·44	2S324	£0·82
AF124	£0·35	BC303	£0·32	BF159	£0·32	OC42	£0·25	2N2193	£0·44	2S325	£0·00
AF125	£0·35	BC304	£0·44	BF160	£0·35	OC44	£0·28	2N2194	£0·44	2S326	£0·82
AF126	£0·35	BC327	£0·18	BF162	£0·35	OC45	£0·23	2N2217	£0·23	2S327	£0·82
AF127	£0·37	BC328	£0·17	BF163	£0·35	OC70	£0·28	2N2218	£0·25	40311	£0·42
AF139	£0·40	BC337	£0·17	BF164	£0·55	OC71	£0·17	2N2218A	£0·23	40313	£1·09
AF178	£0·69	BC338	£0·17	BF165	£0·55	OC72	£0·28	2N2219	£0·23	40316	£1·09
AF179	£0·69	BC440	£0·35	BF167	£0·28	OC74	£0·30	2N2219A	£0·28	40317	£0·46
AF180	£0·69	BC441	£0·35	BF173	£0·23	OC75	£0·35	2N2220	£0·21	40326	£0·46
AF181	£0·67	BC460	£0·44	BF176	£0·44	OC76	£0·40	2N2221	£0·23	40327	£0·52
AF186	£0·58	BC461	£0·44	BF177	£0·30	OC77	£0·58	2N2221A	£0·25	40346	£0·52
AF239	£0·44	BC477	£0·23	BF178	£0·30	OC81	£0·25	2N2222	£0·23	40347	£0·75
AL102	£1·38	BC478	£0·23	BF179	£0·35	OC81DD	£0·28	2N2222A	£0·23	40348	£0·92
AL103	£1·36	BC479	£0·23	BF180	£0·35	OC82	£0·28	2N2368	£0·21	40360	£0·41
ASY26	£0·44	BC547	£0·12	BF181	£0·35	OC82D	£0·30	2N2369	£0·21	40362	£0·44
ASY27	£0·46	BC548	£0·12	BF182	£0·35	OC83	£0·30	2N2369A	£0·16	40406	£0·52
ASY28	£0·44	BC549	£0·12	BF183	£0·35	OC84	£0·44	2N2411	£0·29	40407	£0·40
ASY29	£0·44	BC550	£0·16	BF184	£0·23	OC139	£0·92	2N2412	£0·29	40408	£0·60
ASY50	£0·35	BC556	£0·16	BF185	£0·23	OC140	£0·82	2N2646	£0·54	40409	£0·86
ASY51	£0·35	BC557	£0·15	BF186	£0·30	OC169	£0·40	2N2711	£0·25	40410	£0·86
ASY52	£0·35	BC558	£0·14	BF187	£0·30	OC170	£0·40	2N2712	£0·25	40411	£0·00
ASY54	£0·35	BCY30	£0·63	BF188	£0·46	OC171	£0·40	2N2714	£0·25	40430	£1·09
ASY55	£0·35	BCY31	£0·63	BF194	£0·12	OC200	£0·44	2N2904	£0·25	40476	£1·84
ASY56	£0·35	BCY32	£0·69	BF195	£0·12	OC201	£1·09	2N2904A	£0·24	40494	£0·81
ASY57	£0·35	BCY33	£0·63	BF196	£0·12	OC202	£1·38	2N2905	£0·23	40495	£0·92
ASY58	£0·35	BCY34	£0·69	BF197	£0·14	OC203	£0·98	2N2905A	£0·23	40512	£1·55
ASY73	£0·35	BCY70	£0·17	BF198	£0·16	OC204	£0·98	2N2906	£0·20	40594	£1·04
AU104	£1·61	BCY71	£0·17	BF199	£0·16	OC205	£1·32	2N2906A	£0·22	40636	£1·27
AU110	£1·61	BCY72	£0·17	BF200	£0·35	TIC44	£0·33	2N2907	£0·23		
AU113	£1·61	BCZ10	£0·69	BF202	£1·04	TIC45	£0·40	2N2907A	£0·25		
BC107	£0·09	BCZ11	£0·69	BF222	£1·04	TIP29A	£0·46	2N2923	£0·17		
BC107A	£0·09	BCZ12	£0·69	BF224	£0·20	TIP29B	£0·48	2N2924	£0·17		
BC107B	£0·10	BD115	£0·58	BF240	£0·20	TIP29C	£0·51	2N2925	£0·17		
BC107C	£0·12	BD116	£0·92	BF241	£0·20	TIP30A	£0·46	2N2926G	£0·10		
BC108	£0·09	BD121	£0·75	BF244	£0·35	TIP30B	£0·48	2N2926Y	£0·09		
BC108A	£0·09	BD123	£0·75	BF257	£0·29	TIP30C	£0·51	2N29260	£0·09		
BC108B	£0·10	BD124	£0·81	BF258	£0·29	TIP31A	£0·46	2N2926R	£0·09		
BC108C	£0·12	BD131	£0·40	BF259	£0·40	TIP31B	£0·48	2N2926B	£0·09		
BC109	£0·09	BD132	£0·40	BF262	£0·69	TIP31C	£0·51	2N3010	£0·75		
BC109A	£0·00	BD131/		BF263	£0·69	TIP32A	£0·46	2N3011	£0·17		
BC109B	£0·10	132mp	£0·92	BF270	£0·41	TIP32B	£0·48	2N3053	£0·18		
BC109C	£0·12	BD133	£0·46	BF271	£0·36	TIP32C	£0·51	2N3054	£0·46		
BC113	£0·18	BD135	£0·44	BF272	£0·92	TIP41A	£0·51	2N3055	£0·46		
BC114	£0·18	BD136	£0·40	BF273	£0·41	TIP41B	£0·51	2N3391	£0·23		
BC115	£0·22	BD137	£0·40	BF274	£0·44	TIP41C	£0·55	2N3391A	£0·25		
BC116	£0·22	BD138	£0·41	BF324	£0·40	TIP42A	£0·51	2N3392	£0·23		
BC116A	£0·22	BD139	£0·41	BF336	£0·35	TIP42B	£0·53	2N3393	£0·23		
BC117	£0·23	BD140	£0·41	BF337	£0·35	TIP42C	£0·55	2N3394	£0·23		
BC118	£0·16	BD139/		BF338	£0·44	TIP2955	£0·69	2N3395	£0·25		
BC119	£0·29	140mp	£0·92	BF457	£0·43	TIP3055	£0·53	2N3402	£0·24		
BC120	£0·46	BD155	£0·92	BF458	£0·43	TIS43	£0·25	2N3403	£0·24		
BC125	£0·20	BD175	£0·69	BF459	£0·44	TIS90	£0·21	2N3404	£0·33		
BC126	£0·25	BD176	£0·69	BF596	£0·32	UT46	£0·23	2N3405	£0·48		
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7401	£0·13	7428	£0·30	7474	£0·29	74111	£0·67	74174	£0·75
7402	£0·13	7430	£0·15	7475	£0·33	74118	£0·92	74175	£0·71
7403	£0·13	7432	£0·25	7476	£0·29	74119	£1·36	74176	£0·67
7404	£0·13	7433	£0·35	7480	£0·51	74121	£0·28	74177	£0·67
7405	£0·13	7437	£0·24	7481	£0·98	74122	£0·45	74180	£1·73
7406	£0·25	7438	£0·24	7482	£0·78	74123	£0·46	74181	£0·67
7407	£0·25	7440	£0·14	7483	£0·67	74136	£0·60	74182	£0·81
7408	£0·15	7441	£0·58	7484	£1·01	74141	£0·63	74184	£0·81
7409	£0·15	7442	£0·46	7485	£0·78	74145	£0·63	74190	£0·78
7410	£0·13	7443	£0·81	7486	£0·25	74150	£0·78	74191	£0·71
7411	£0·20	7444	£0·81	7489	£1·96	74151	£0·55	74192	£0·69
7412	£0·17	7445	£0·75	7490	£0·37	74153	£0·55	74193	£0·67
7413	£0·28	7446	£0·69	7491	£0·74	74154	£0·94	74194	£0·71
7414	£0·58	7447	£0·55	7492	£0·40	74155	£0·58	74195	£0·69
7416	£0·28	7448	£0·64	7493	£0·35	74156	£0·58	74196	£1·21
7417	£0·26	7450	£0·13	7494	£0·86	74157	£0·58	74197	£1·21
7420	£0·13	7451	£0·13	7495	£0·58	74160	£0·67	74198	£2·13
7421	£0·23	7453	£0·13	7496	£0·58	74161	£0·71	74199	£2·13
7422	£0·18	7454	£0·13	74100	£0·98	74162	£0·71		
7423	£0·24	7460	£0·13	74104	£0·45	74163	£0·71		
7425	£0·22	7470	£0·29	74105	£0·44	74164	£0·78		
7426	£0·26	7472	£0·23	74107	£0·28	74165	£0·78		

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Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
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CD4001	£0·18	CD4016	£0·49	CD4027	£0·58	CD4044	£0·94	CD4071	£0·20
CD4002	£0·18	CD4017	£0·94	CD4028	£0·78	CD4045	£1·61	CD4072	£0·20
CD4006	£1·06	CD4018	£0·98	CD4029	£0·98	CD4046	£1·50	CD4081	£0·20
CD4007	£0·20	CD4019	£0·48	CD4030	£0·55	CD4047	£1·00	CD4082	£0·25
CD4008	£1·06	CD4020	£1·04	CD4031	£2·30	CD4049	£0·55	CD4510	£1·27
CD4009	£0·52	CD4021	£0·94	CD4035	£1·38	CD4050	£0·55	CD4511	£1·44
CD4010	£0·55	CD4022	£0·94	CD4037	£1·09	CD4054	£1·27	CD4516	£1·15
CD4011	£0·23	CD4023	£0·22	CD4040	£1·01	CD4055	£1·15	CD4518	£1·15
CD4012	£0·22	CD4024	£0·75	CD4041	£0·87	CD4056	£1·55		
CD4013	£0·48	CD4025	£0·22	CD4042	£0·83	CD4069	£0·20		

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Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
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CA3014	£1·55	LM304	£1·84	MC1350	£1·38	UA711C	£0·37	TAA550B	
CA3018	£0·75	LM308	£1·15	MC1352	£1·61	72711	£0·37		£0·40
CA3020	£1·96	LM309	£1·73	MC1469	£3·39	UA723C	£0·52	TAA621A	
CA3028	£0·92	LM320-5V		MC1496	£1·04	72723	£0·52		£2·30
CA3035	£1·61		£1·73	NE536	£3·06	UA741C	£0·28	TAA621B	
CA3036	£1·15	LM320-12V		NE550	£1·09	72741	£0·28		£2·88
CA3042	£1·73		£1·73	NE555	£0·28	741P	£0·23	TAA661	£1·73
CA3043	£2·13	LM320-15V		NE556	£0·69	UA747C	£0·69	TAD100	£1·50
CA3046	£0·81		£1·73	NE565	£1·38	72747	£0·69	TBA540	£2·42
CA3052	£1·84	LM320-24V		NE566	£1·73	UA748	£0·40	TBA810S	
CA3054	£1·27		£1·73	NE567	£1·96	72748	£0·40		£0·86
CA3075	£1·73	LM380	£0·98	UA702C	£0·53	748P	£0·40	TBA810	£1·13
CA3081	£1·73	LM381	£1·67	72702	£0·53	SN76013N		TBA820	£0·81
CA3089	£2·30	LM3900	£0·67	UA703	£0·29		£2·01	TBA9200	
CA3090	£4·14	MC1303L		UA709	£0·29	SN76023	£2·01		£2·88
CA3123	£2·19		£0·98	72709	£0·53	SN76110	£1·73	TCA270S	
CA3130	£1·07	MC1304	£2·19	709P	£0·29	SN76115	£2·19		£2·30
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AA120	£0·09	BAX16	£0·09	BY176	£0·86	OA47	£0·09	SD19	£0·07
AA129	£0·09	BY100	£0·25	BY206	£0·35	OA70	£0·09	IN34	£0·08
AAY30	£0·10	BY101	£0·25	BYZ10	£0·52	OA79	£0·12	IN34A	£0·08
AAZ13	£0·17	BY105	£ ·	BYZ11	£0·52	OA81	£ ·	IN914	£0·07
BA100	£0·12	BY114	£0·25	BYZ12	£0·46	OA85	£0·12	IN916	£0·07
BA102	£0·37	BY124	£0·25	BYZ13	£ ·	OA90	£0·12	IN4148	£0·07
BA148	£0·17	BY126	£0·17	BYZ16	£0·47	OA91	£0·12	IS44	£0·06
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20mm × 5mm chassis mounting	506	£0·18
1¼in. × ¼in. chassis mounting	507	£0·14
1¼in. car inline type	508	£0·18
Panel mounting 20mm	509	£0·23
Panel mounting 1¼in.	510	£0·37

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	7p	1A	615	6p	3A	619	6p
250mA	612	6p	1·5A	616	7p	4A	620	10p
550mA	613	6p	2A	617	6p	5A	621	6p
800mA	614	8p	2·5A	618	7p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2·5A	628
250mA	623	2A	626	3·15A	629
500mA	624	1/6A	627	5A	630

All 8p each

QUICK-BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 8p each

Type	No.	Type	No.	Type	No.
1A	635	2/5A	638	4A	641
2A	637	3A	639	5A	642

All 8p each

NUTS AND BOLTS

BA BOLTS—packs of BA threaded cadmium plated crews slotted cheese head. Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in. OBA	839	£1·38	½in. 4BA	846	£0·37
½in. OBA	840	£0·86	¼in. 4BA	847	£0·29
1in. 2BA	842	£0·75	1in. 6BA	848	£0·46
½in. 2BA	843	£0·52	½in. 6BA	849	£0·24
¼in. 2BA	844	£0·60	¼in. 6BA	850	£0·29
1in. 4BA	845	£0·51			

BA NUTS—packs of cadmium plated full nuts in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	855	£0·83	4BA	857	£0·35
2BA	856	£0·55	6BA	858	£0·28

BA WASHERS—flat cadmium plated plain stamped washers supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	859	£0·16	4BA	861	£0·14
0BA	860	£0·14	6BA	862	£0·14

SOLDER TAGS—Hot tinned supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	851	£0·46	4BA	853	£0·25
2BA	852	£0·32	6BA	854	£0·25

AUDIO LEADS

No.	Type	Price
107	FM Indoor Ribbon Aerial	£0·69
113	3·5mm Jack plug to 3·5mm Jack plug length 1·5m	£0·66
114	5 pin DIN plug to 3·5mm Jack connected to pins 3 & 5 length 1·5m	£0·96
115	5 pin DIN plug to 3·5mm Jack connected to pins 1 & 4 length 1·5m	£0·98
116	Car aerial extension screened insulated lead. Fitted plug and socket	£1·44
117	AC mains connecting lead to rcassette recorders and radios 2 metres	£0·78
118	5 pin DIN phono plug to stereo headphone. Jack socket	£1·21
119	2 + 2 pin DIN plugs to stereo Jack socket with attenuation network for stereo headphones. Length 0·2m	£1·04
120	Car stereo connector. Variable geometry plug to fit most car cassettes. 8-track cartridge and combination units. Supplies with inlined fuse power lead and instructions	£0·69
123	6·6m Coiled Guitar Lead Mono Jack plug to Mono Jack plug Black	£1·72
124	3 pin DIN plug to 3 pin DIN plug. Length 1·5m	£0·85
125	5 pin DIN plug to 5 pin DIN plug. Length 1·5m	£0·85
126	5 pin DIN plug to Tinned open end. Length 1·5m	£0·85
127	5 pin DIN plug to 4 Phono Plugs. All colour coded. Length 1·5m	£1·49
128	5 pin DIN plug to 5 pin DIN socket. Length 1·5m	£0·92
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1·5m	£1·21
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0·78
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 Length 1·5m	£0·95
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£1·13
133	5 pin DIN plug to 2 Phono plugs Connected pins 3 & 5. Length 1·5m	£0·86
134	5 pin DIN plug to 2 Phono sockets Connected pins 3 & 5. Length 23cm	£0·78
135	5 pin DIN socket to 2 Phono plugs Connected pins 3 & 5. Length 23cm	£0·78
136	Coiled stereo headphone extension lead. Black, length 6m	£2·01
178	AC mains lead for calculators, etc.	£0·52

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V–0–6V 100mA	£1·04
2022	9V–0–9V 100mA	£1·04
2023	12V–0–12V 100mA	£1·29

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280–0–6V 0–6V RMS	£1·84
2025	MT150–0–12V 0–12V RMS	£1·84

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V–0–6V 1 amp	£2·88	P & P 45p
2027	9V–0–9V 1 amp	£2·30	P & P 45p
2028	12V–0–12V 1 amp	£2·99	P & P 55p
2029	15V–0–15V 1 amp	£3·16	P & P 66p
2030	30V–0–30V 1 amp	£3·97	P & P 86p

STANDARD MAINS Primary 240V
Multi-tapped secondary mains transformers available in ½ amp, 1 amp and 2 amp current rating. Secondary taps are 0–19–25–33–40–50V. Voltages available by use of taps. 4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25–0–25V

No.	Rating	Price	
2031	½ amp	£3·81	P & P 86p
2032	1 amp	£5·06	P & P 86p
2033	2 amp	£6·27	P & P £1
2035	240V Primary 0–55V @ 2A Secondary	£7·30	P & P £1

SPECIAL OFFER
2042 240V Primary 0–20V @ 2A Secondary. By removing 5 turns for each volt from the secondary winding any voltage up to 20V @ 2A is easily obtainable ideal for the experimenter.
£1·50 P & P 86p

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	£1·73
156	11in	6in	3in	£2·92
157	6in	4½in	1½in	£1·79
158	9in	5½in	2½in	£2·43

ALUMINIUM BOXES Made from bright all. folded construction each box complete with half-inch-deep lid and screws.

No.	Length	Width	Height	Price
159	5½in	2½in	1½in	£0·85
160	4in	4in	1½in	£0·85
161	4in	2½in	1½in	£0·83
162	5½in	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	2 1/8in	5 3/8in	2½in	12in	3½in	8in	£5·45
168	2 5/8in	7½in	4in	16in	4½in	11in	£8·31

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Projects... Theory...
and Popular Features...

There are several active pastimes that depend entirely upon electronics though the participants are not necessarily involved in or even concerned with the techniques employed, but only with the resultant effects produced by some action on their part.

Radio control of models is a notable example. Its practice well demonstrates a marriage of technology and art. Anyone who has watched the adroitness with which an experienced and skilled operator manœuvres a model aircraft in the air above and around him causing the model to enact the antics of a real lifesize craft, can be filled only with admiration . . . and envy.

So it is no wonder that radio control has a very large following and is backed by a sizeable industry catering for the special needs of these R/C enthusiasts—from models of all kinds through servo-mechanisms to complete transmitters and receivers.

Of the large numbers who participate in R/C perhaps the majority buy everything ready made and concentrate on the "real business" of operating their favourite kind of model. A fair number do however add further to their enjoyment by building their own model aircraft, boats or wheeled vehicles. And finally some, certainly a smaller proportion of the whole, actually build their own radio transmitting and receiving equipment.

To this latter group, as well as to the general electronics enthusiast, we shall be directing special attention over the next few months. The *EE Radio Control System* is an "entire" system and it uses a well proven circuit that is equally amenable to the needs and requirements of novice as well as experienced operator. The overall project is a result of teamwork: three designers have co-operated to produce this system which has been subjected to exhaustive field tests, culminating in the very creditable achievements by one of the trio during the Manx Soaring Championships on the Isle of Man last August.

We hope that through this project many of our readers will discover another fascinating pastime and have the additional pleasure of modestly remarking to admiring onlookers—"Oh yes, I built the electronics myself".

And now for something quite different. Circuits simple, useful and all built on a standard size board. That sums up *Uniboards*, a new series of quick one-off's featuring commonplace discrete semiconductors that starts this month. Just the job for newcomers to cut their teeth on and assuredly worth more than a passing glance from older hands.

Fred Bennett.

Our December issue will be published on Friday, November 16. See page 740 for details.

Readers' Enquiries

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We cannot undertake to engage in discussions on the telephone.

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Everyday ELECTRONICS

VOL. 8 NO. 11 NOVEMBER 1979

CONSTRUCTIONAL PROJECTS

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ENLIGHTENING IDEAS FOR CHRISTMAS
see Page 740

3 FUNCTION GENERATOR

BY F.C.JUDD

IT MUST first be emphasised that this project requires the use of an oscilloscope for the adjustments necessary to obtain the correct mark-to-space ratio for each waveform and also the shape and purity of the sinewave. This cannot be done audibly, or with an audio signal reading meter.

An audio range signal generator of this nature is a valuable piece of test equipment and has dozens of applications in testing and performance measurement of both audio and other electronic equipment. It has a total frequency coverage of 15Hz to 100kHz in four ranges, see Table 1.

Table 1. Band coverage of the 3-Function Generator.

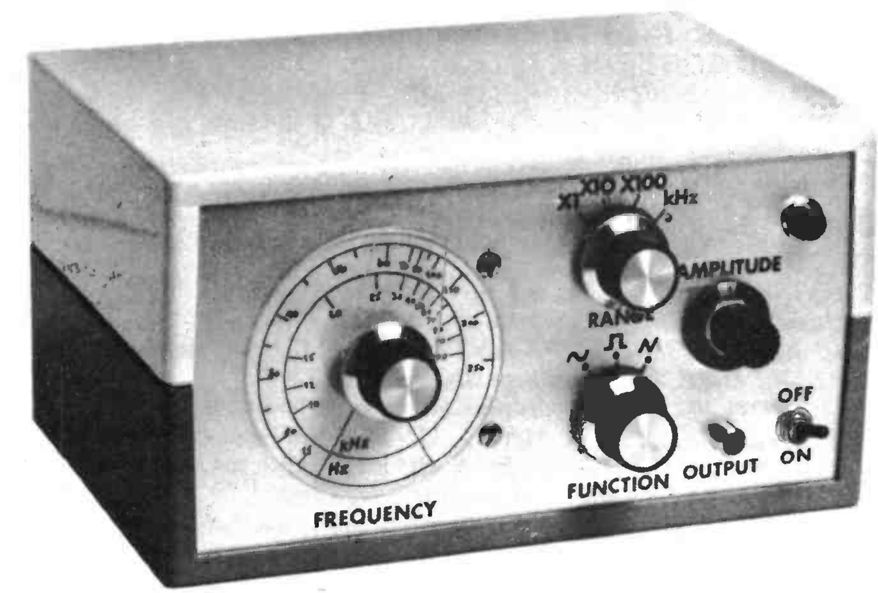
Band No.	Coverage
1 (×1)	15 to 250Hz
2 (×10)	150 to 2,500Hz
3 (×100)	1,500 to 25,000Hz
4 (×kHz)	10 to 100kHz

The output is continuously variable with maximum signal levels as shown in Table 2.

Table 2. Maximum output levels for the three functions.

Function	Level (volts)
Sinewave	1 (r.m.s.)
Square-wave	2·5 (pk-pk)
Triangular-wave	1 (r.m.s.)

The "r.m.s." levels are according to a normal r.m.s. type a.c. (audio signal) reading meter. The maximum level square-wave signal will also read out on a similar meter at about 1·5V (approximate r.m.s. value).



The sinewave signal has a minimum harmonic distortion factor of about 2 per cent when correctly adjusted but lower than this is not possible as the sinewave is obtained by electronic shaping within IC1 and not by pure generation.

Although the sinewave is not suitable for harmonic distortion analysis with a t.h.d. meter it is quite adequate for all audio equipment frequency response measurements, audio amplifier power output and bandwidth measurement, frequency comparison, and so on.

The triangle-wave is quite pure and also has numerous applications in electronics as well as audio, particularly as the "ramp" rise and fall is perfectly linear.

The square-wave has a rise time of only 2 microseconds and so can be used effectively for audio amplifier square-wave tests as well as for a "clock pulse" source with a 1-to-1 mark-space ratio at any frequency within the range of the generator.

THE CIRCUIT

The circuit diagram of the 3-Function Generator is shown in Fig. 1. Most of the work is carried out internally by the 8038 sine-square-triangle generator i.c. with external *CR* network-switching to provide the wide frequency coverage specified. The output signals from IC1 are coupled to an op-amp, IC2, with switched negative feedback to provide (a) a nominal output level of 1V r.m.s. from the sine and triangle waves with the least possible distortion of the waveforms (b) amplified square-wave, with limited negative feedback, to obtain a fast rise time and uniform flat top characteristic, even down to 15Hz and (c) a low

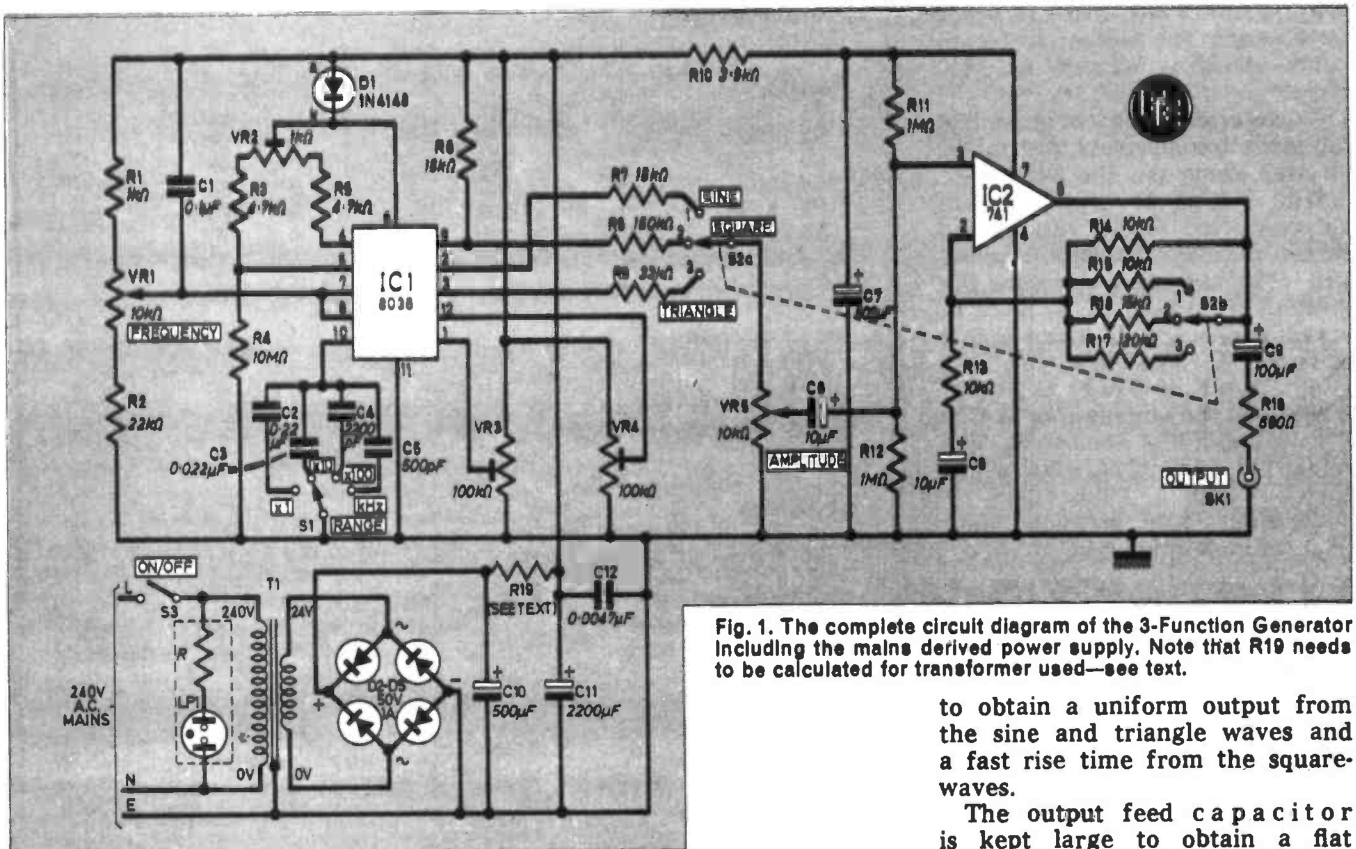


Fig. 1. The complete circuit diagram of the 3-Function Generator including the mains derived power supply. Note that R19 needs to be calculated for transformer used—see text.

impedance, nominal 600 ohms, for the generator output.

Calibration on the first three ranges (×1, ×10 and ×100) is uniform (since time constants are in decade ratio) so only the one scale is required. On the kilohertz (kHz) range, 10 to 100kHz, the time constant deviates in ratio to the others to limit maximum frequency to 100kHz. Above this value the square-wave would be of little use and in any case the frequency response of the 741 op-amp (IC2) starts to fall off above this.

If the calibrated scale printed with this article is copied or cut out and used, all frequencies should be within about 10 per cent of true.

More accurate calibration would of course be possible with the aid of a high grade laboratory type signal generator and oscilloscope but this is hardly necessary for normal practical use. However, the generator is very stable and will hold continuously at any set frequency to within a few cycles.

Incidentally by splitting the frequency ranges into four, the calibration is spread out much more and so makes it easier to get close to intermediate frequencies.

GENERATOR I.C.

Returning to the circuit we have the basic generator IC1 which has three outputs that simultaneously provide the sine, square and triangle waveforms, hence the switched selection of these by the ganged pair S2a and S2b. Frequency ranges are selected by S1 which simply brings in the appropriate *C* value to operate with VR1 the frequency control and R1, R2, the range limiters. Note that VR1 is a log. potentiometer—do *not* use a linear potentiometer. The preset VR2, is adjustment for the mark-space ratio of the waveforms and setting this is the first reason why an oscilloscope is essential.

The presets VR3 and VR4, set the purity of the sinewave and again this cannot be done without an oscilloscope although adjustment could, in this case, be made with the aid of a distortion bridge but more of this later.

The potentiometer VR5 is the signal level output control although it actually controls the level of signals from IC1 into the 741 op-amp which is a basic amplifier configuration with negative feedback switched as appropriate to obtain a uniform output from the sine and triangle waves and a fast rise time from the square-waves.

The output feed capacitor is kept large to obtain a flat topped square-wave down to 15Hz but in order to check this, an oscilloscope with a d.c. input on the Y-amplifier must be used. Scope amplifier input capacitors (a.c. coupling) are usually too small in value to obtain flat top square-wave displays at frequencies as low as 15Hz (see oscillograms in this article).

POWER SUPPLY

The circuit requires a smooth 30V d.c. supply. This is derived from the mains in a conventional manner. Mains voltage enters the unit via S3 and appears across the primary of T1; 24V a.c. (nominal) is produced across T1 secondary which is then full-wave rectified by the diode bridge D2 to D5, producing a d.c. level across C10 equal to the peak value of T1 secondary voltage (i.e. 24√2) plus an over-voltage due to the regulation factor of the transformer.

The prototype used a transformer with a secondary current rating of 250mA, resulting in total voltage at C10 +ve of 41V. The current required by the circuit is 25mA. Therefore to obtain 30V at C11 +ve, 11 volts must be dropped across R19 when 25mA flows.

From Ohm's law, $R19=11/0{\cdot}025 = 440$ ohms. The nearest preferred value above is chosen, i.e. 470 ohms.

To determine the value of R19 for other transformers that might be used, carry out the following.

With the power supply section not connected to the rest of the circuit, measure the voltage across C10, (V_m) and then calculate the value of a resistor, R_p, to place in parallel with C10 to cause 25mA to flow:

$$R_p = V_m/0{\cdot}025 \text{ ohms}$$

Measure the voltage now at C10 +ve, call this V'_m. Remove R_p. The value of $R19=(V'_m-30)/0{\cdot}025$ ohms.

Calculate R19 wattage from $(V'_m-30)\times0{\cdot}025$ watts.

CONSTRUCTION starts here

The complete generator and its power supply will fit comfortably into a Verobox type 75-1412K which has aluminium front and rear panels. The generator circuit board and its controls are situated on the front panel with the rear panel holding the power supply board and transformer.

Drilling details for the front panel are shown in Fig. 2. The diameter of some of the holes, e.g. the on/off switch and the panel mounted neon may need to be changed to suit the components used.

COMPONENTS

Resistors

R1	1kΩ	R7	15kΩ	R13	10kΩ
R2	22kΩ	R8	150kΩ	R14	10kΩ
R3	4·7kΩ	R9	33kΩ	R15	10kΩ
R4	10MΩ	R10	3·9kΩ	R16	15kΩ
R5	4·7kΩ	R11	1MΩ	R17	120kΩ
R6	15kΩ	R12	1MΩ	R18	680Ω
				R19	470Ω ½W (see text)

All ¼ watt carbon ±5% except where stated otherwise

Potentiometers

VR1 10kΩ carbon log.
VR2 1kΩ miniature horizontal preset
VR3, 4 100kΩ miniature horizontal preset (2 off)
VR5 10kΩ carbon linear.

Capacitors

C1	0·1μF ceramic or plastic	C7	500μF 25V elect.
C2	0·22μF ceramic or plastic	C8	10μF 15V elect.
C3	0·022μF ceramic or plastic	C9	100μF 15V elect.
C4	2200pF ceramic or plastic	C10	500μF 50V elect.
C5	500pF silvered mica	C11	2,200μF 35V elect.
C6	10μF 15V elect.	C12	0·0047μF ceramic or plastic

Semiconductors

IC1 8038 function generator i.c.
IC2 741 operational amplifier (8 pin d.i.l.)
D1 1N4148 or similar small signal silicon diode
D2 to D5 50V 1A bridge rectifier

See Shop Talk page 742

Miscellaneous

S1 1-pole 4-way rotary switch
S2 2-pole 3-way rotary switch
S3 mains single-pole on/off toggle
T1 mains primary/24V 25mA secondary—see text
LP1 mains panel mounting neon
SK1 panel mounting phono socket

0·1 inch matrix perforated board size 58 × 26 holes; 3-way terminal block; three-core mains cable; 8-pin and 14 pin d.i.l. sockets (1 off each); control knobs (4 off); case Verobox type 75-1412K; plastic spacers and 6BA fixings; rubber grommet to suit mains cable; 6BA solder tag; connecting wire; 1·5mm thick clear Perspex approx. 100 × 75mm.

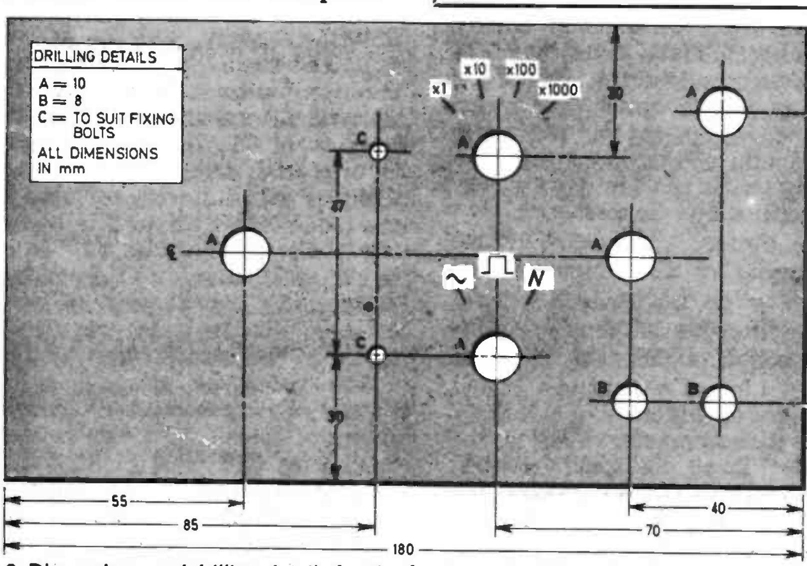
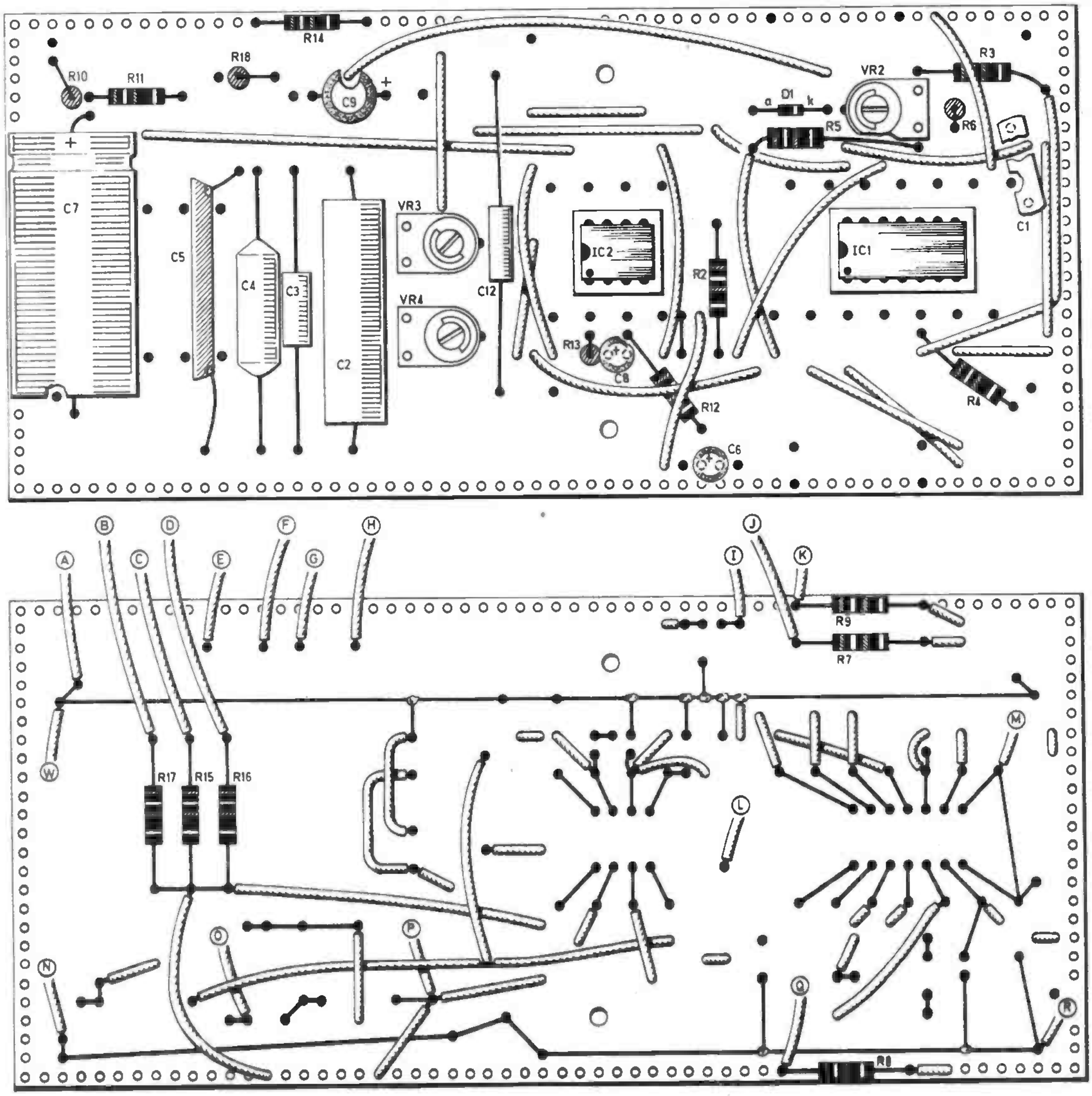
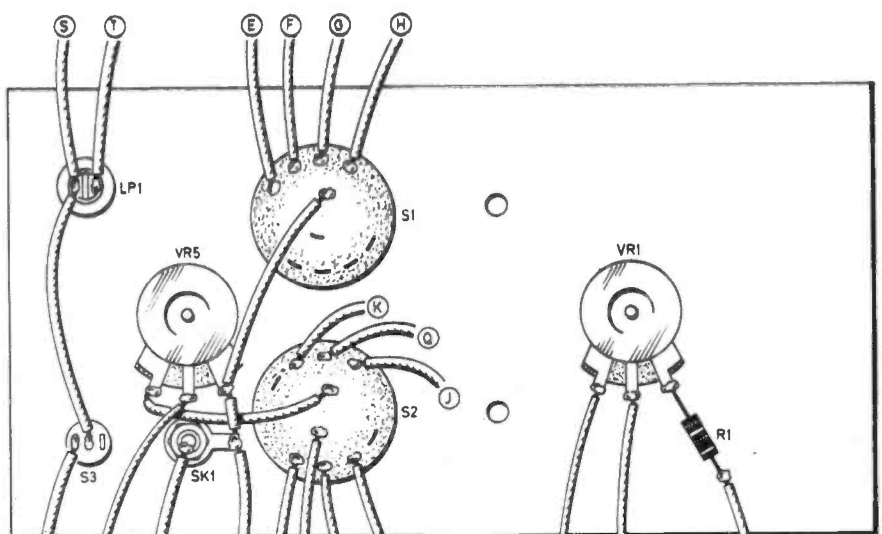


Fig. 2. Dimensions and drilling details for the front panel of the unit with some suggested panel markings.

The generator circuit is built on a piece of 0·1 inch matrix perforated board size 58×26 holes. The layout of the components and wiring details on both sides of the board and interwiring between the panel mounted controls is shown in Fig. 3. Although the generator circuit board layout is not critical, the constructor is advised to retain the position of all the components as closely as possible to avoid interaction and waveform cross-talk.

In the prototype the generator circuit board was mounted on the front panel using 30mm long plastic spacers and self-tapping screws.

3-FUNCTION GENERATOR

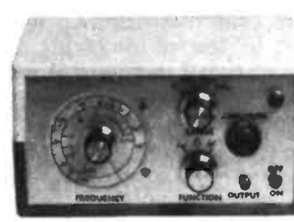
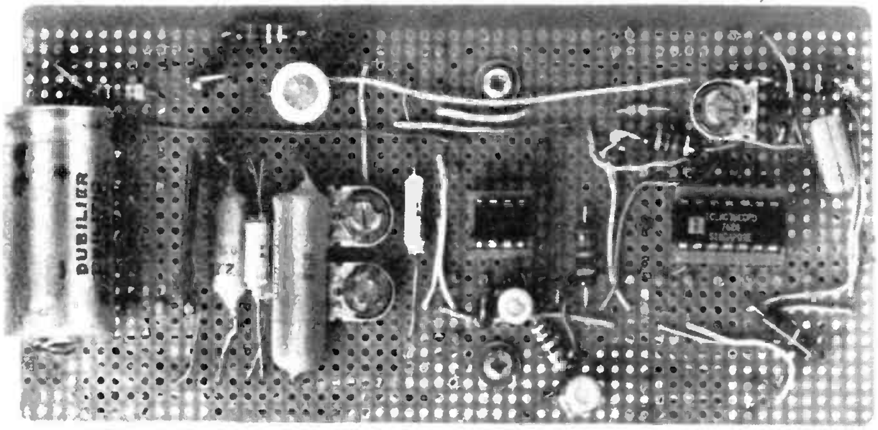


Fig. 3. Above. The layout of the components and interwiring on both sides of the circuit board. Note that some wires pass through holes to make connections to components/wiring at other locations. Left. The internal face of the front panel showing component positions, interwiring and connections to be made to the board.



The completed generator circuit board showing positioning of components.

There is no particular order to be followed in the assembly of components on this board except perhaps to begin by inserting the Veropins, used for component anchorage, and the i.c. sockets. Some interconnecting wires use tinned copper wire and others use p.v.c. covered wire. Where there is any danger of a link wire touching another wire or component lead, the p.v.c. type is essential. Alternatively, tinned copper wire and sleeving may be employed.

When assembly is complete, sufficient lengths of flying lead should be attached to the board to reach the panel mounted components, and this wiring carried out. The board can then be screwed in place on its spacers.

POWER SUPPLY SECTION

As previously stated, the power supply board is fitted with the transformer on the back panel. The board is mounted on spacers to keep it clear of the metal back panel. The layout of the components is shown in Fig. 4 together with the interwiring on the underside. Note that this differs slightly from that in the photograph. The author used two 1,000μF 25V capacitors in series to form a 500μF 50V capacitor. This has been replaced in the text and diagrams by a single capacitor of this value.

Secure the transformer to the back panel remembering to place a solder tag on one of the fixings for earthing purposes. Make the connection between the board and T1 secondary and secure the board in place; R19 should not yet be connected, its value may need to be determined as explained earlier.

The two wires interconnecting the boards should not be connected until R19 is in place. In the prototype, a convenient method of connecting the mains cable to the transformer primary was to use a short length of plastic screw-terminal. The mains cable should of course be passed out through the rear panel via a rubber grommet or strain relief bush. Complete the wiring to S3 and LP1.

CALIBRATED FREQUENCY SCALE

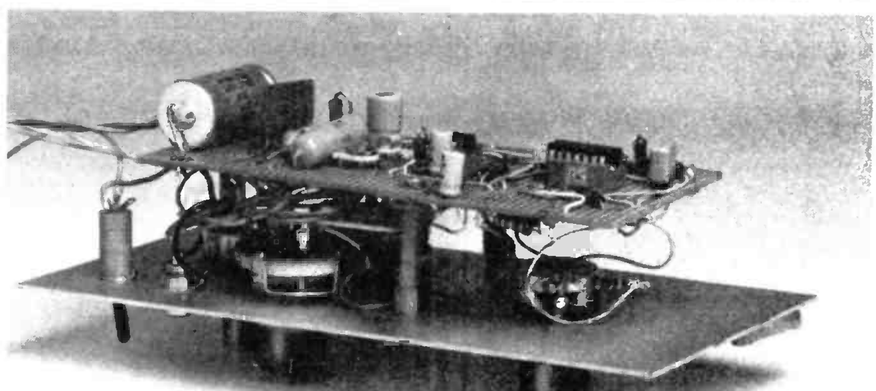
A full-size copy of the calibrated frequency scale as used on the prototype is shown in Fig. 5. This can be cut out or photocopied and pasted on thin card. It is secured under the locknut of the frequency control VR1 but if a thin Perspex plate can also be made to cover it, so much the better.

A graticule type pointer, like that on the prototype is also worth while and not difficult to make from thin Perspex to the size shown in Fig. 6 and which is glued (Araldite) or screwed to the back of a plain control knob

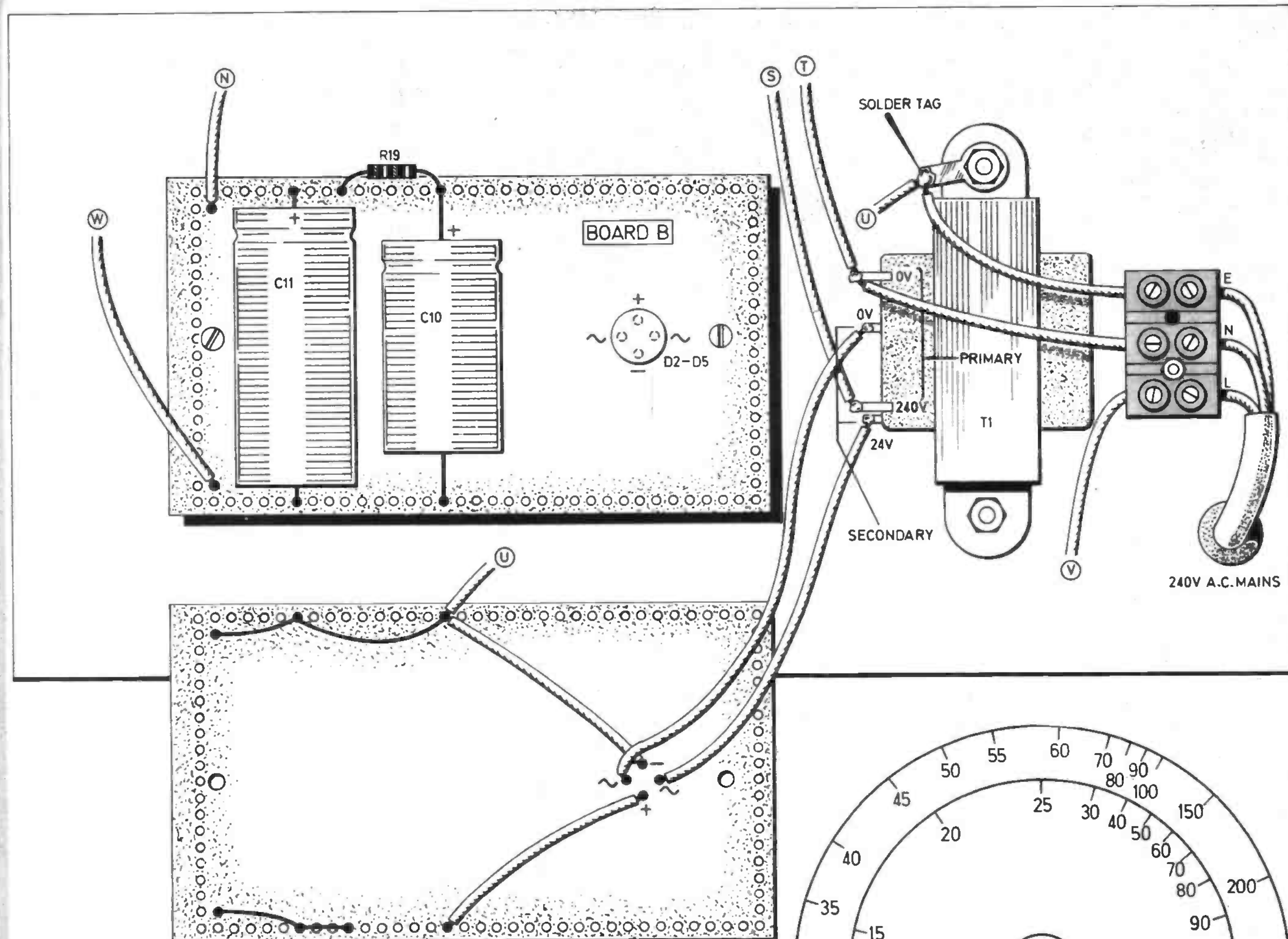
CHECKING OUT AND ADJUSTMENT

As already mentioned, an oscilloscope is necessary for adjustment of the presets VR2, VR3 and VR4. The oscilloscope Y-amplifier input is connected to the generator output socket and the output control set at maximum. A preliminary check with the frequency range switch S1 on ×10 frequency scale pointer at 100 (1,000Hz) and waveform switch S2 set to "square", will establish that the generator is operating, in which case first check the supply rail positive to ground voltage at the junction of R19 and C11 (power supply) which should be 30V ± 1V. If not, it may be necessary to slightly change the value of R19 to obtain 30V as close as possible otherwise the output level and calibration of the generator may be affected. With this done, adjust VR1 to obtain a square-wave (still at 1,000Hz) with a uniform 1-to-1 mark-space as in the oscillogram Fig. 7b. Next, switch S2 to sine-wave output and adjust VR3 and VR4 together, each a little bit one

COMPONENTS approximate cost £12 excluding case



Mounting of the generator circuit board on the rear of the front panel.



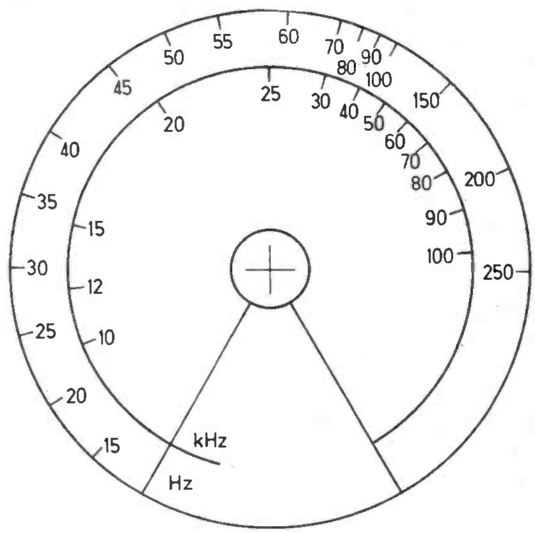
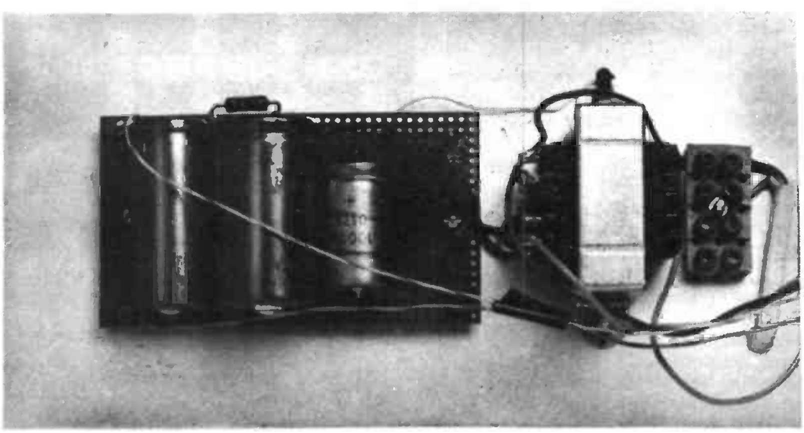


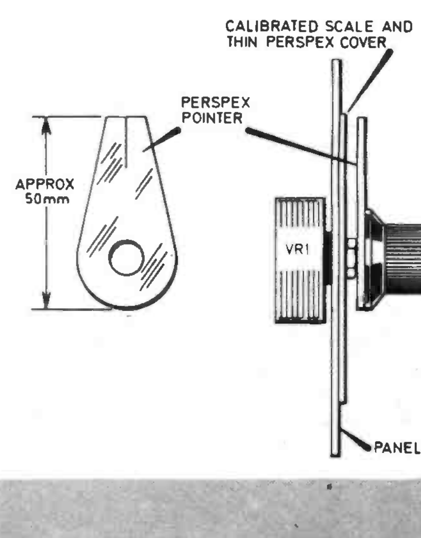
Fig. 4. Shows the power supply circuit board and transformer mounted on the internal face of the rear panel, and interwiring.

Fig. 5 (right). Full size copy of the frequency dial used in the prototype.

Fig. 6 (below right). Construction details for the frequency control pointer.

Prototype power supply board and interwiring. The two capacitors forming C10 have been replaced by a single capacitor.





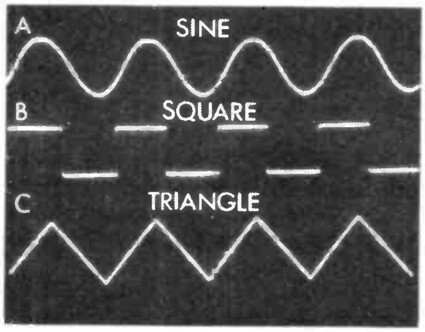


Fig. 7. Photograph of oscilloscope screen containing the three functions generated by the prototype (a) sinewave (b) squarewave (c) triangle-wave.

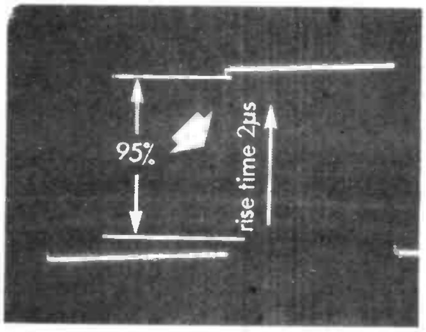


Fig. 8. Shows the rise time obtained from the prototype square-wave output signal.

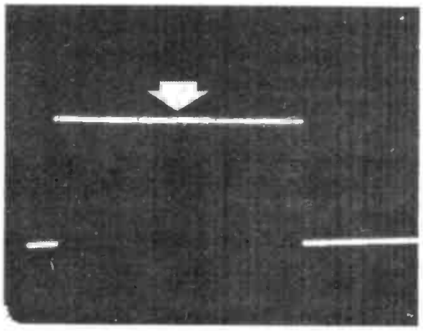


Fig. 9. Even at 15Hz the top of the squarewave is almost flat.

way or the other, to obtain the closest possible replica of the sinewave in oscillogram Fig. 7a. Each of the waveforms shown in this photo were taken from the prototype generator.

Now switch to triangle wave for which no other adjustment is necessary as its mark-space has already been established. It will appear as in the oscillogram Fig. 7c.

If an r.m.s. reading a.c. voltmeter is available check that the output level is appropriate from each waveform and over the whole frequency range. A reasonable assessment of this can of course be made with a calibrated oscilloscope.

If a distortion analyser is available, the sinewave purity can be adjusted with VR3 and VR4 until the lowest possible distortion i.e., about 2 per cent at 1,000Hz is obtained.

Some further checks on squarewave outputs can be carried out with a calibrated oscilloscope and preferably one with a d.c. input to the Y-amplifier and a time base range in the microseconds region. On a fast time base range the rise time of the square-wave can be verified and this should be in the region of 2 microseconds for 90 per cent of the rise as shown in the oscillogram Fig. 8.

At 15 to 20Hz the square-wave should have an almost perfectly flat top as in oscillogram Fig. 9 but this will only be apparent with d.c. coupling into the 'scope.

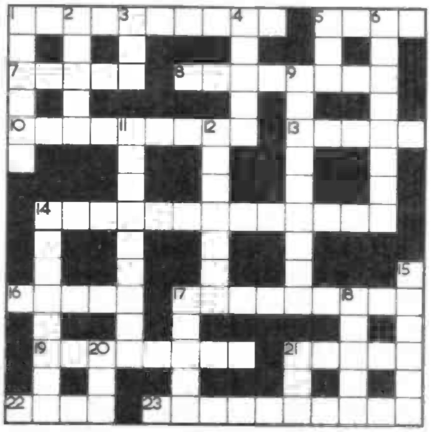
USES

An audio range three waveform generator of this nature is a very desirable item of test equipment but its full use requires an a.c. (audio range) voltmeter and an oscilloscope at least to carry out tests and measurements on audio amplifiers, tape recorders and various kinds of purely electronic circuitry as mentioned earlier.

With the extra essential items of test equipment as above, one could measure frequency responses of audio amplifiers and tape recorders, responses of tone-controls, filters and pre-amplifiers, carry out square-wave tests on amplifiers, check frequencies of other generators and oscillators and measure the power output of audio amplifiers etc.

Incidentally a quite good but secondhand oscilloscope is not difficult to get hold of at a reasonable price and is one of the most valuable of all the numerous items of test equipment to be found in workshops and laboratories. ☐

EE CROSSWORD No 21 BY D. P. NEWTON



ACROSS

1 Wound-up instrument found in magnetic fields (6, 4).
5 Rough and offensive.
7 We would usually not be clapped out of these conductors.
8 Analysis of integrated circuit system goes through the body.
10 Part of the less-heavy e.m. spectrum (5, 4).
13 Something fishy about this transistor output.
14 Wires with electromagnetic privacy (8, 5).
16 To r.m.s. about will give a rough passage (Anag.).
17 Chronological list for TV and calculator.
19 Single-minded tape (3, 5).
21 Carrier on the waves.
22 Horsey problem.
23 Maximum displacement across a wave (4, 2, 4).

DOWN

1 Defensive device against electrical disturbance.
2 No lag beside (Anag.).
3 It's no sin.
4 It's a sort of output as a matter of debate.
5 Random access memory, sheepishly.
6 To break up an electronic marriage?
9 A test or I'm guessing (Anag.).
11 *CR* might define one (4, 5).
12 Sound intensity measurer (1, 1, 5).
14 End of transmissions for the day (4, 4).
15 The table is turned into decorative activity.
17 Lagging behind or leading, we all pass through one from time to time.
18 --/---/·-·/···/·
20 Intellectual head-characteristic.
21 Beat frequency oscillator, to begin with.

Solution on page 730

MW & LW radio tuner

BY F.G.RAYER

A TUNER to provide a.m. reception on medium and long wave bands increases the scope and entertainment value of an audio amplifier. This tuner has sufficient output for even insensitive amplifiers, while avoiding the relative complication of a superhet circuit. Coverage is approximately 1600 to 600kHz m.w., and 490 to 185kHz l.w., or 360 to 145kHz l.w.

CIRCUIT DESCRIPTION

The circuit diagram of the tuner is shown in Fig. 1.

The circuit comprises an r.f. amplifier, TR1, a diode detector, D1 and an audio amplifier TR2 with high output impedance.

Signals generated in the aerial are fed via SK1 into L1 primary and induced into L1 secondary to reach the gate of the r.f. amplifier, TR1. The potentiometer VR1 is the gain and volume control. As the wiper of VR1 is moved towards L1 pin 5, the source bias is increased thereby reducing the gain of TR1. The aerial signal in L1 primary is attenuated at the same time.

The drain terminal of TR1 is coupled to the primary of coil L2, pins 5 and 6, which is tuned by the second section of the ganged capacitor, C1b. Each section has its own trimmer, C2 and C5 respectively.

Note that a dual 500pF gang can be used but will require a little extra space.

A tapping on the secondary winding of L2 is used as a signal source for the detector/smoothing capacitor D1/C6. A tapping is used to avoid unnecessary loading of L2.

The audio output from D1 is coupled to the base of audio amplifier TR1 by C7; TR2 is wired as a

COMPONENTS approximate cost £12 excluding case

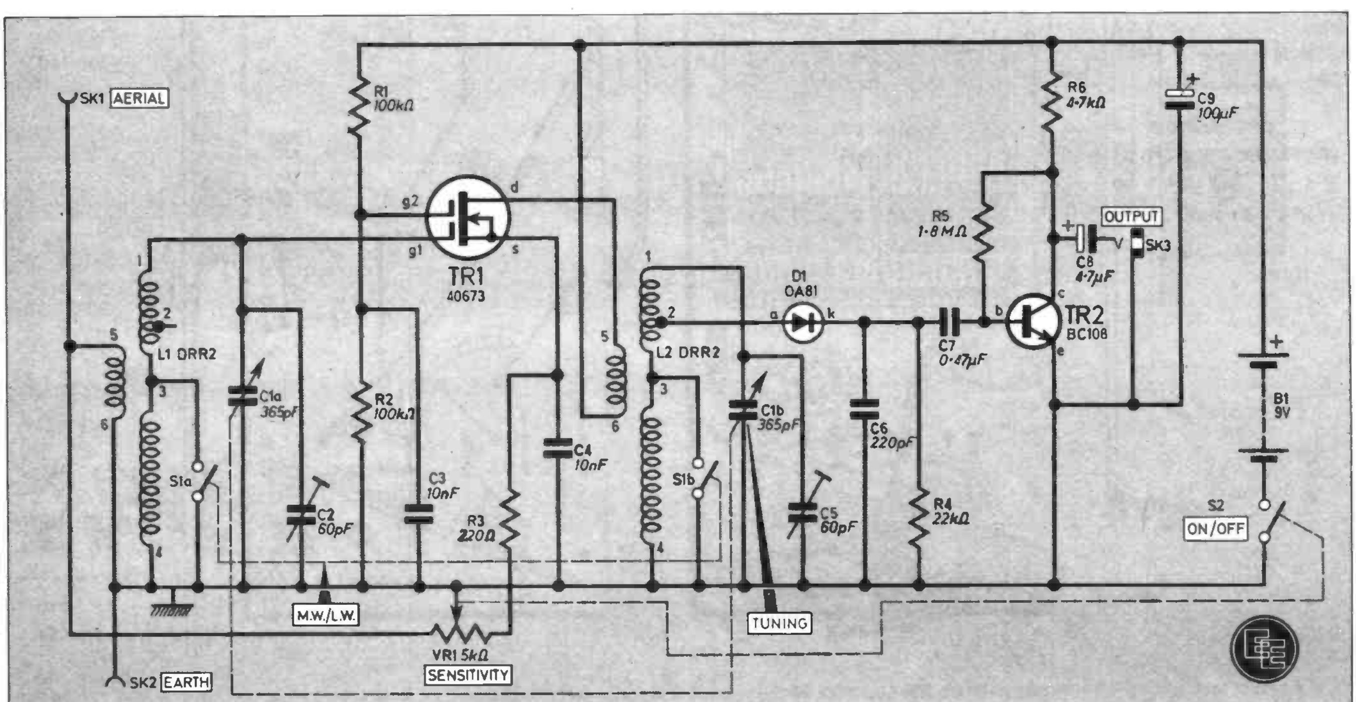


Fig. 1. The complete circuit diagram for the Medium and Long Wave Radio Tuner.

MW & LW radio tuner

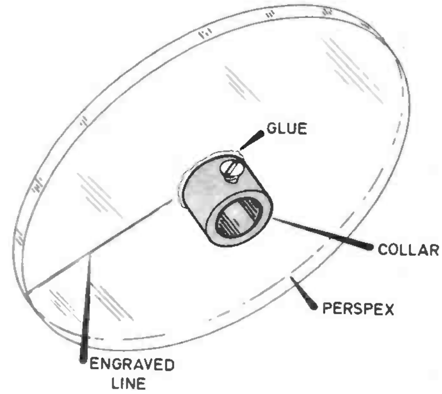


Fig. 3. Construction of a simple tuning pointer disc. Half of a brass spindle coupler is glued to a 70mm diameter Perspex disc with an engraved radial line.

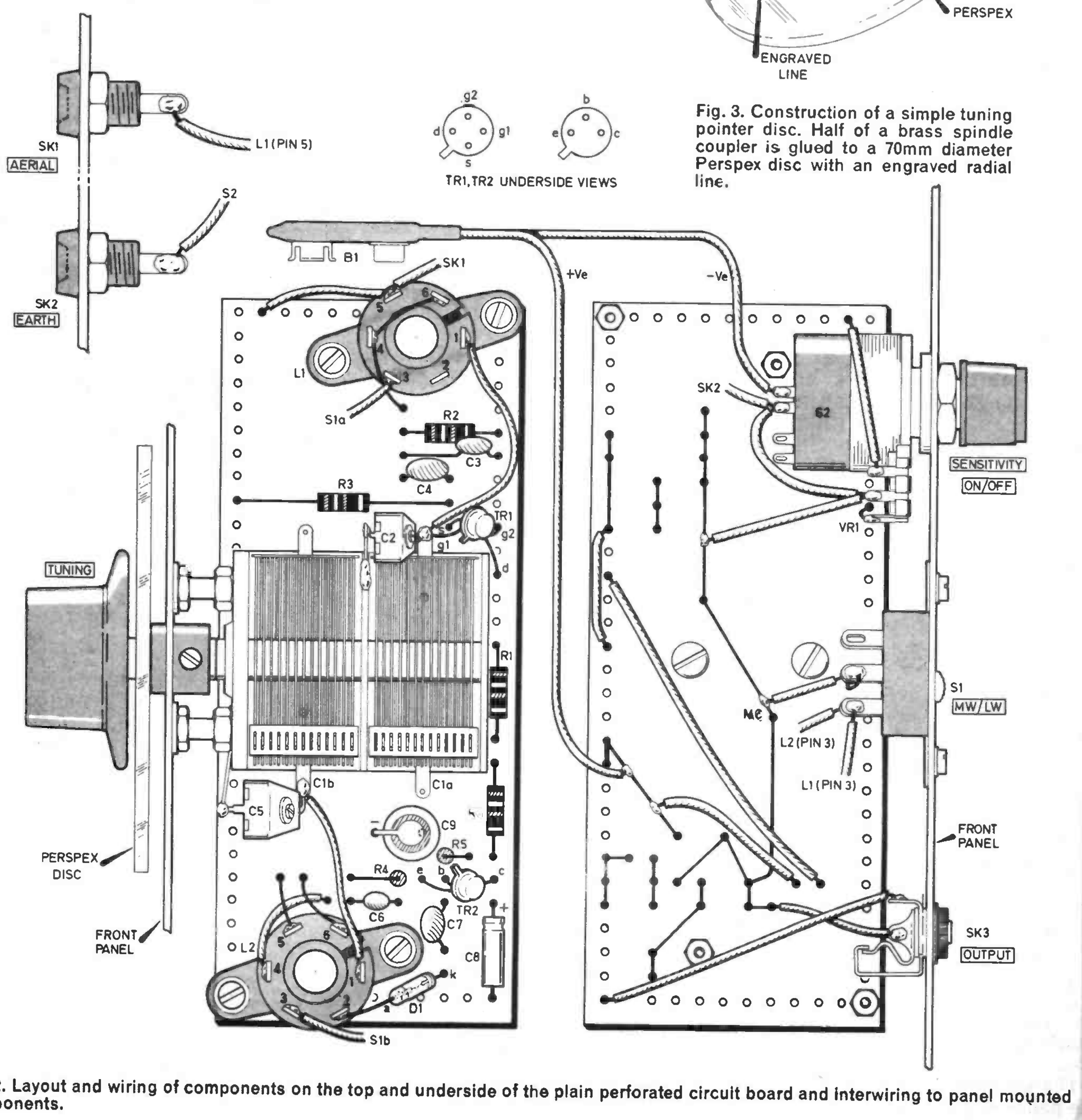


Fig. 2. Layout and wiring of components on the top and underside of the plain perforated circuit board and interwiring to panel mounted components.

common emitter amplifier providing considerable boost. The output is at the collector which is capacitively coupled to the output socket SK3.

TUNING COILS

The tuner uses two identical coils, having six tags, see Fig. 2. Count from the tag ring slot. Bandswitches S1a and S1b are sections of a slide switch, and short out both of the longwave windings (pins 3 and 4) for medium wave reception.

The coils are of fixed inductance, and do not have adjustable cores. The only adjustment necessary will be to the trimmers C2 and C5. To do this, tune in a signal near the high frequency end of the m.w. band (ganged capacitor nearly fully open) and rotate C2 and C5 for best results.

CONSTRUCTION starts here

COMPONENT BOARD

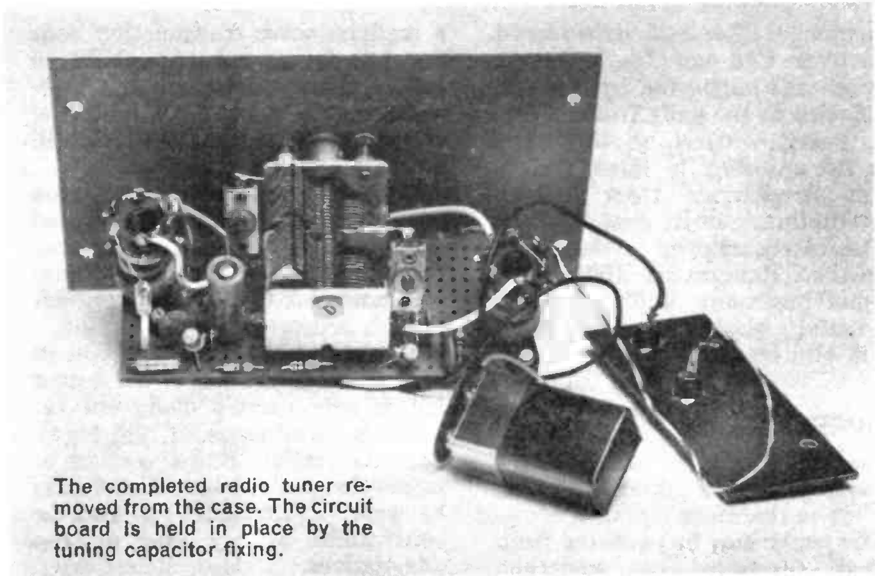
Most of the components including the dual-ganged capacitor are assembled on a piece of 0·15 inch matrix perforated board, 30×12 holes, as in Fig. 2. The 2-gang capacitor used has two threaded holes, so that the board can be fitted to it with short 4BA bolts.

First solder a lead to the capacitor rotor or frame tag, and bring it down through a hole in the board. This is the earthing point MC in Fig. 2. Extra washers or similar means of spacing about 3mm thick will be needed between this capacitor and the board.

Assemble and interconnect the board-mounted components according to Fig. 2. In many places the wire ends of components can reach to the required points. Elsewhere, 22s.w.g. or similar connecting wire is recommended.

Prepare the front panel to accept the panel-mounted controls and secure these and the board in position.

The ganged capacitor is fitted to the panel by means of three 12mm long 4BA bolts, with two nuts each, to lock against the capacitor and panel. This capacitor provides sufficient support for the board.



The completed radio tuner removed from the case. The circuit board is held in place by the tuning capacitor fixing.

Should a capacitor without slow motion be fitted, then this can come nearer the panel as the spindle will be shorter. Take care that the bolts are not so long that they project inside the capacitor.

The aerial and earth sockets, SK1, SK2 are to be mounted on a small piece of Paxolin or similar material to be fitted to the rear of the case.

Complete the interwiring as shown in Fig. 2.

Resistors
R1 100kΩ
R2 100kΩ
R3 220Ω
R4 22kΩ
R5 1·8MΩ
R6 4·7kΩ
All ¼W carbon ±5%

Capacitors
C1 2 × 365pF dual ganged (Jackson type 0), slow motion (preferred)
C2 60pF compression trimmer
C3 0·01μF ceramic or plastic
C4 0·01μF ceramic or plastic
C5 60pF compression trimmer
C6 220pF ceramic or plastic
C7 0·47μF ceramic or plastic
C8 4·7μF 6V elect.
C9 100μF 12V elect.

See **Shop Talk** page 742

Semiconductors
TR1 CA40673 or 3N201 dual gate silicon *n*-channel MOSFET
TR2 BC108 silicon *npn*
D1 OA81 or similar germanium diode

Miscellaneous
L1, L2 Repanco type DRR2 (2 off)
VR1/S2 5 kilohm carbon linear with ganged switch
S1 d.p.d.t. slide switch
SK1, 2 4mm insulated sockets or similar (2 off)
SK3 3·5mm jack socket
B1 9V PP3 or any other 9V battery
Circuit board; 0·15 inch matrix perforated board, size 30 × 12 holes; battery connector to suit B1; knobs (2 off); 4BA and 6BA fixings; Perspex and bush (for dial); Paxolin or similar, 100 × 40mm (to hold SK1, SK2); case 150 × 100 × 100mm.

Trimmers C2 and C5 are soldered directly to C1a and C2b, and their second tags supported by a short, stout wire to the gang frame. They are almost vertical, so that they can be adjusted by means of a small screwdriver from behind, with the tuner in its case.

The case employed in the prototype had dimensions 150×100×100mm internally, and was made of metal; plastic or thin wood could also be used.

POWER SUPPLY

Current drain is small (3mA measured) and an internal 9 volt battery is therefore suitable.

The tuner may be operated from a well decoupled and smoothed supply obtained from the main audio amplifier, of about 9 to 12 volts, with negative earth.

TRIMMING

Initially set the trimmers to near maximum capacity. Subsequently adjust both for best reception of a medium wave transmission near the h.f. band end (say 1600 to 1400kHz) as mentioned. For optimum results adjust C2 with the actual aerial and earth which will be used, already connected.

For the alternative l.w. band mentioned, cores may be obtained which can be screwed to the l.w. winding ends of the coils. These are not necessary, however, for 200kHz reception.

The aerial can be a few feet of wire indoors, or a somewhat longer indoor wire carried along one (or possibly two) walls of the room, near the ceiling. Either a short or rather longer out-door aerial may be used if available. It can be worthwhile to try one or two alternatives.

It is recommended that an earth connection be provided if feasible.

IN USE

The usual type of screened lead should be employed to feed the audio signals from the tuner to the main amplifier.

If the tuner is used for personal headphone listening, a high resistance headset approximately 2 kilohms will be most satisfactory.

Note that the values are so arranged that the maximum possible gain setting of VR1 brings the tuner to the point of regeneration, as this allows improved sensitivity. This was found to cause no difficulty with an earth provided, but with no earthing VR1 must be adjusted accordingly, or resistor R3 increased in value until it is just impossible to bring TR1 into oscillation. A resistor of about 1·5 kilohms should be suitable.

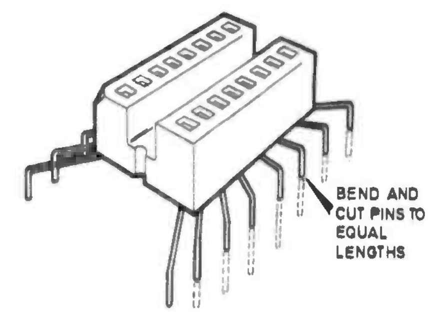
A tuning pointer can be made from a stout wire soldered to the capacitor spindle, or, as used in the prototype, a disc of thin Perspex about 70mm in diameter can be fitted to a bush with set screw, obtained from an old control knob with a line scribed along a radius of the disc. A 180 degree scale can be glued to the front panel behind the Perspex disc and later calibrated. ⌑

BRIGHT IDEAS

I.C. SOCKET

For sometime I have been using one of those *T-Dec* breadboards and to use a d.i.l. integrated circuit with this you need a special adaptor. This can cost between £2 to £2·50.

I first came up with the idea of an i.c. socket fitted with flying leads, but this proved to be a bit clumsy. Then I hit upon an idea of using a wirewrap i.c. socket, bending the pins as shown in the diagram and then snipping the ends level. The socket can then be plugged in and out of the T-Dec with ease.



The cost of the Wirewrap I.C. socket should be between 20 and 30 pence, which is a considerable saving on the original.

L. A. Privett, Barking.

The Adventures of Tanty Bead By Matthew Reed

SQUARE one FOR BEGINNERS

SEMICONDUCTORS is a term that embraces a very important family of electronic devices. The most widely used, and best known, of such devices are the diode and the transistor.

The simplest semiconductor device is the diode. This functions as a one-way device (or "valve") for electronic current. It has two terminals or lead-out wires. One connection is distinguished by a mark of some kind on the body of the component, and this is the *cathode*. For normal conduction this must be connected to the negative side of the circuit in which it is to be used. The other (usually unmarked) is the anode and goes to the positive side of the circuit. See Fig. 1.

There are a variety of diodes, varying size, shape and form. See Fig. 2.

One kind of device commonly encountered in electronic circuits is that generally known as a general purpose signal diode. Many of these resemble a small resistor in outward appearance and have a coloured band at one end of the body which identifies the cathode.

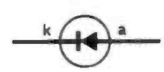


Fig. 1. Circuit symbol for a diode, with cathode (k) and anode (a) identified.

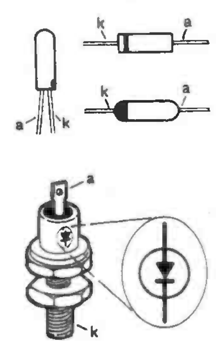


Fig. 2. Typical diodes and methods of indentifying the cathode.

A SPOT OF CONFUSION

Other types of diodes have some other kind of mark adjacent to the cathode lead.

Perhaps somewhat confusing is the use of a + sign or a red band or tip to denote the cathode on certain diodes. This is a throw-back to earlier days when diodes were used chiefly for power rectification. The positive side of the direct current (d.c.) output from a power rectifying circuit comes from the cathode of the diode rectifier, and so this method of coding makes sense. But when the diode is employed in other circuit arrangements the basic logic of this method of identification is somewhat obscure and confusion is frequently caused.

CIRCUIT SYMBOL

The symbol normally used for a diode in circuit diagrams is shown in Fig. 1. The "bar" represents the cathode. The arrow head represents the anode and points in the direction of conventional curent flow, that is positive to negative.

It has been general practice to mark the cathode of the diode symbol with an "+". But because of the possible confusion previously referred to, we have abandoned this and now mark the two ends of the diode symbol "k" and "a", representing cathode and anode respectively.

DIODE OPERATION

The diode conducts when the anode (*a*) is connected to the positive point of a circuit, and the cathode (*k*) to a more negative (less positive) point. See Fig. 3a.

When connected the other way round, (or if the circuit voltages reverse) the diode will not conduct, but becomes a complete barrier to the flow of direct current. See Fig. 3b.

When the diode is used to rectify alternating current (a.c.) it behaves like a switch, "opening" and then "closing" as the a.c. changes direction, that is swinging from positive to negative. See Fig. 4.

The unidirectional output from the diode is a series of positive going pulses. The negative-going half of the a.c. input is suppressed.

Fig. 3. (a) Diode forward-biased—conducts. Can be considered as a switch that is closed. (b) Diode reverse-biased—does not conduct. Can be considered as a switch that is open.

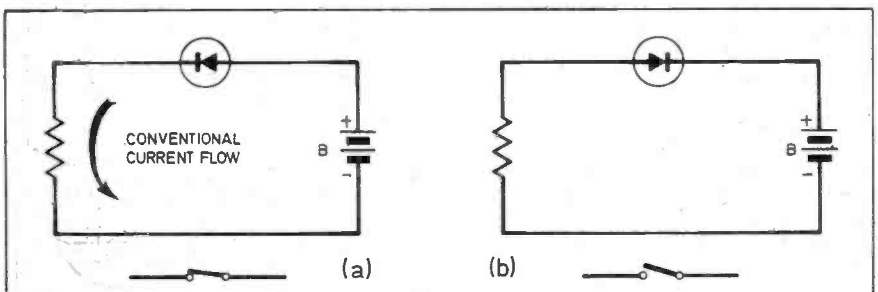
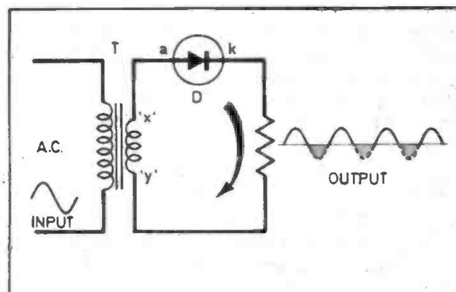


Fig. 4. Diode used as a rectifier of a.c. T is a mains transformer. When "x" is positive, the diode will conduct, and d.c. (conventional current) flows from cathode back to other end of transformer winding. When "x" is negative, the diode will not conduct.



UNIBOARDS

SIMPLE TRANSISTOR DESIGNS

By A.R. Winstanley

1

OPTO ALARM

The start of a new series of six easy-to-build transistor-based projects. All use a standard size piece of stripboard, 10 strips by 24 holes.

THIS simple single-transistor circuit is designed to sound a miniature audible warning device when light falls on to a photocell. The photocell is normally mounted in a dark room and the alarm is triggered when either the room lights are switched on or possibly when light from an intruder's torch falls directly on to the photocell.

The circuit will operate satisfactorily from a 9 volt battery but as it is probable that the device will come in for regular use the device described here can be wired to operate from the "9 Volt Power Pack" project to be described later in this series.

CIRCUIT DESCRIPTION

The circuit diagram of the Opto Alarm appears in Fig. 1. The photocell, PCC1 is an ORP12 light-dependent resistor which is located in the room to be protected, and is connected by means of PL1 and SK1. Together with R1, PCC1 forms a potential divider: the voltage at the junction of R1 and PCC1 varies with the amount of light striking the l.d.r.

In absolute darkness the resistance of an ORP12 is at least 10 megohms, and so the voltage at the junction of R1/PCC1 is very nearly that of the supply rail, 9V. Transistor TR1 is therefore firmly switched off as its base is not biased.

When light falls on PCC1, its resistance drops (albeit relatively slowly) and this causes TR1 to switch on. A triggering pulse is therefore delivered to the gate of CSR1 and this component conducts. The audible warning device (WD1) will therefore sound.

The thyristor will now remain in this low impedance state even if the triggering signal is removed. The only way to reset CSR1 and mute the alarm is in this case to switch off the mains power supply, or switch off the battery if dry cells are used instead. Resistor R5 will ensure that a minimum holding current is flowing in the anode-cathode circuit of the triggered thyristor, and so preventing any undesirable resetting.

BUZZER

It is important to note that conventional electromechanical buzzers should not be used in this circuit. They feature a very high current consumption normally, and apart from destroying the specified thyristor such a unit could greatly reduce battery life if the circuit is powered by conventional batteries. The miniature audible warning device used here has a current consumption of only 15-20mA.

Whilst the response time of the l.d.r. is relatively slow, experimentation with resistor values enabled a design to be produced which reacts quickly to a change in light: the alarm is triggered, for example, by a torch beam skimming over the photo-resistor in a darkened room.

Finally, C1 and C2 decouple the power supply and prevent triggering of the thyristor during initial switch-on. A 9 volt supply is connected via SK2, the tip of the jack plug being +9V as usual.

CONSTRUCTION starts here

The prototype was built into an ABS "Bimbox" type 4003. This measures approximately 85 x 55 x 35mm and has a steel front panel. The circuit can be accommodated neatly on a piece of 0·1 inch matrix stripboard, 10 strips by 24 holes.

There should be no problems with the construction of the circuit; Fig. 2 illustrates the recommended arrangement of components. As usual note carefully the connections to the semiconductors and in particular ensure the correct polarity of C1.

The metal panel of the box is drilled to carry the miniature buzzer and also the two jack sockets. A small hole is also required to enable the leadouts from the bleeper to pass through the metal panel to the circuit board inside.

All interconnections between the component board and front panel can be completed with stranded flexible hook-up wire. Make quite certain that both jack sockets are wired the right way round. Both sockets must be wired exactly as shown: note that the metal panel will in fact be connected to 0V through the jack sockets.

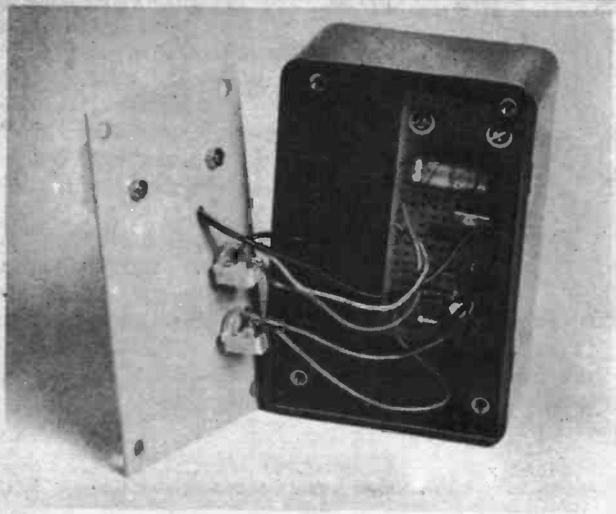
LIGHT SENSOR

The photocell arrangement in the prototype is shown in Fig. 2. The ORP12 is mounted upon a small piece of tagstrip and connected to its respective jack socket using twin-core flex terminated with a 3·5mm jack plug. The length of the flex can be in excess of 5 metres.

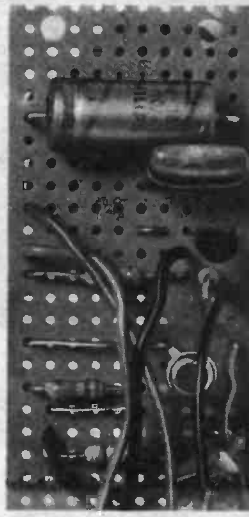
No setting up is required, simply mount the l.d.r. in the room to be monitored. Obviously it should not be obscured by any object in the room.

One final point is to remember to connect up all jack sockets *before* switching on the power. If this is not done then there is the possibility that the "9 Volt Power Supply" (if used) could be shorted out when the jack plug connecting it is being inserted into the jack socket.

If battery operation is required, the power input socket SK2 should be replaced by an on/off switch located so as to allow a PP3 battery to sit in the case. ☐



The completed Opto Alarm showing positioning of the circuit board and wiring to the jack sockets.



Completed circuit board.

COMPONENTS

Resistors
R1 22kΩ
R2 4·7kΩ
R3 680Ω
R4 2·2kΩ
R5 1kΩ
All ¼W carbon ± 5%

See Shop Talk page 742

Capacitors
C1 150μF16V elect.
C2 0·1μF polyester C280 or similar

Semiconductors
TR1 BC178 silicon *pnp*
CSR1 MCR102 thyristor rated 30V 0·8A or similar
PCC1 ORP12 or similar light dependent resistor

Miscellaneous
SK1, 2 3·5mm jack socket (2 off)—see text
PL1 3·5mm jack plug
WD1 miniature 9V audible warning device
Stripboard: 0·1 inch matrix, 10 strips × 24 holes*; case BIM4003 or similar; tagstrip; twin-core flex; stranded connecting wire; 6BA fixings including 5mm spacers; *Optional components*, 9 volt battery and connector; on/off switch.
* Available in packs of five boards.

Approx. cost Guidance only
£2.00 excluding case

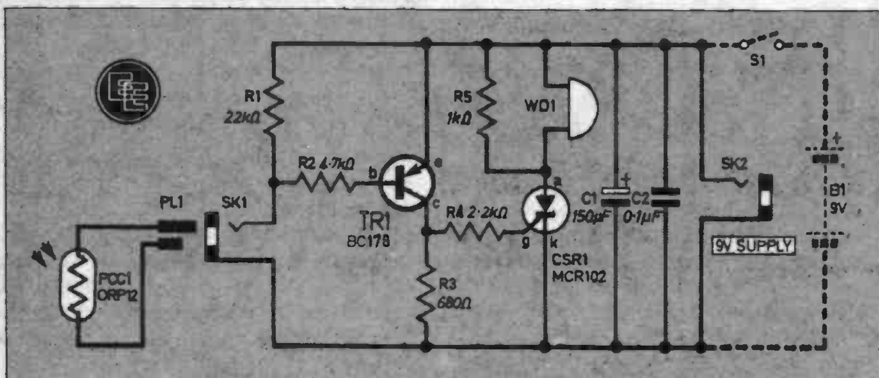
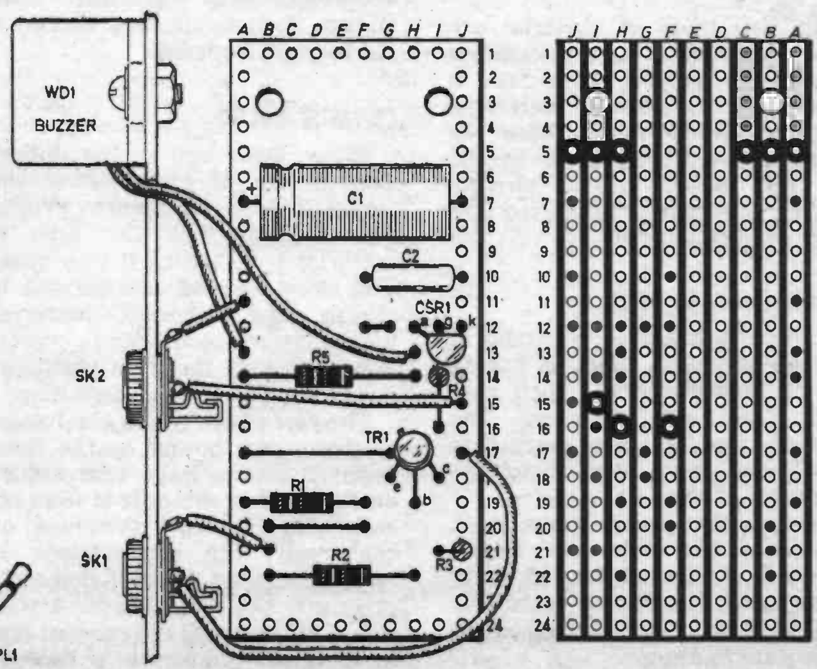
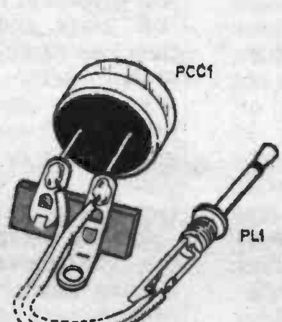


Fig. 1. The circuit diagram of the Opto Alarm. The dotted components replace SK2 for an integral battery version.





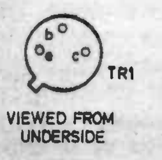


Fig. 2. The layout of the components on the topside of the stripboard and the breaks to be made along the copper strips on the underside and interwiring between board and panel mounted components. Left shows the l.d.r. fixed to a tag strip enabling the l.d.r. to be mounted and connected to a jack plug to suit SK1.

Part 2

By S. R. Lewis, B.Sc.

TEACH-IN 80

IN THE first part of this series, we looked briefly at the physics of conduction in solids. We will now look at the differences between materials that are good at conducting electricity, such as most metals, and those which can withstand extremely high fields without conduction, such as glass and most plastics.

The two types of material are called **conductors** and **insulators** respectively. There is, in fact, a third important class of materials, called **semiconductors**. These are normally reasonably good insulators but, under certain circumstances, they can be converted into fairly good conductors.

PHYSICAL MODELS

A physical model of the atoms in a metal considers them as having lots of **free electrons** which pass easily from atom to atom. The electrons move about so easily that they have been likened to the molecules of a gas.

An insulator, on the other hand, has atoms (or molecules) whose electrons are **bound very strongly** to the atom. It takes an extremely high field to move the electrons from atom to atom.

In semiconductors there is a different situation: all the electrons are held firmly to the atom so that there are not many free for conducting current. By supplying energy of the right kind certain electrons can be transformed into **conduction electrons**. There is not a gradual change but a sudden jump as the electron changes its character.

Materials which are semiconductors in their normal, unadulterated, state are called **intrinsic semiconductors**, examples being silicon, germanium, and carbon in the form of diamond.

OHM'S LAW

Many years ago it was noticed that a wire of given dimensions varied as to its conducting properties according to the type of material from which it was made. The effect can be summarised by saying that different materials have different resistance to current flow. Obviously, the term **resistance** needs a more precise definition.

The force with which conduction electrons are bound to the atom depends, as we have said before, on the type of atom. It is thus not surprising that the resistance, or, conversely, the **conductance**, of materials varies. What is more surprising is the fact that for a wide range of materials the current flow in a given conductor is directly proportional to the e.m.f. applied. Thus, if we know the current that flows when one volt is applied we can predict the current that flows when any other voltage is applied.

The ratio of the voltage to the current we call the "resistance". The mathematical way of defining resistance is by the equation

$$R=V/I$$

where R is the resistance, V the voltage and I the current. We call this equation **Ohm's Law** after its discoverer.

The units of resistance are **ohms**, one ohm being the resistance which allows one ampere to flow when one volt is applied. Conversely we can say that one ohm produces a voltage drop of one volt when one amp flows through it.

CURRENT VERSUS VOLTAGE GRAPH

Another way of visualising resistance is by plotting a graph of current against voltage in a given component. The resistance is then given by the slope of the graph.

A pure resistance gives a straight line current versus voltage graph—we say there is a linear relationship between current and voltage, see Fig. 2.1.

Other components may not give a straight line but we can still find the resistance at any point on the graph by drawing a tangent to the curve and then measuring the slope of this line.

SWITCHES

A **switch** can be defined as a two-state device—in one state it has extremely high resistance (it is an insulator), and in the other state it has very low resistance (it is a conductor).

The force which causes it to change state may be mechanical, as in an ordinary light switch, or an electric current or voltage, as in the case of a **relay** or an **electro-mechanical solid-state switch**.

Switches vary in their specifications as to how much voltage they can withstand in their insulating or "off" state, and how much current they can carry in their conducting or "on" state.

Switches can have more than just two contacts which are either open or closed. Mechanical switches with eight or more contacts are not uncommon.

A very useful type of switch is the **changeover type** where a **moving contact**, or **wiper**, makes contact with either one terminal or another. This type of switch can be used as a normally closed switch, a normally open switch, or can be used to switch from one voltage to another.

The circuit symbols for various types of switch are shown in Fig. 2.2.

RESISTORS

Perhaps the most common circuit element is the **resistor.** Resistors come in a variety of shapes and sizes but they all have a common function—to accurately set current levels in a circuit when given voltages are present.

Resistors are somewhat taken for granted in electronic circuits but it is quite remarkable that a component can give such predictable behaviour over a vast range of applied voltages.

Early resistors tended to be large rods of carbon even for quite low power dissipations. This was because internal heating was a problem in the solid type of construction. Modern resistors use sophisticated techniques to give very high performance and stability combined with small physical size.

The circuit symbols for various types of resistors are given in Fig. 2.3.

TYPES OF RESISTOR

The actual resistive part of a resistor can be carbon, a thin film of metal or metal oxide, or a wire made of a suitable alloy. The cheapest and probably the most widely used are carbon type but often, especially in precision instruments, the shortcomings of this type of resistor necessitate the use of more expensive metal film or metal oxide resistors.

The quality of a type of resistor can be judged in two ways: its tolerance and its stability with changes in temperature, humidity, etc. The concept of **tolerance** is, perhaps, a new one and therefore requires some elaboration.

TOLERANCE

When resistors (or any component for that matter) are actually produced, the manufacturer cannot ever make his components exactly match the nominal specification of that component. He must compromise between accuracy and cost so he does not attempt to make resistors of exactly the resistance required but, instead, specifies a band of values around the nominal within which the component is acceptable. In general, the closer the limits of acceptance are to the nominal value, the higher the cost.

The band around the nominal value is usually specified in terms of a percentage. A "ten ohm, five per cent" resistor is therefore a resistor whose real value can be anything from 9·5 ohms to 10·5 ohms.

Typical tolerances for resistors are 20 per cent, 10 per cent, 5 per cent, 2 per cent and 1 per cent. Tolerances of one per cent or better make the resistor what is called a "precision" resistor.

In general, the designer likes to produce circuits where **low tolerance** (high percentage) resistors can be used since this keeps down costs. However, there are many instances where **close tolerance** (low percentage) resistors are essential.

The concept of tolerance has led to the formulation of a range of values for resistors which all manufacturers now follow. These values are called **preferred** values and the way the actual values have been arrived at is quite interesting.

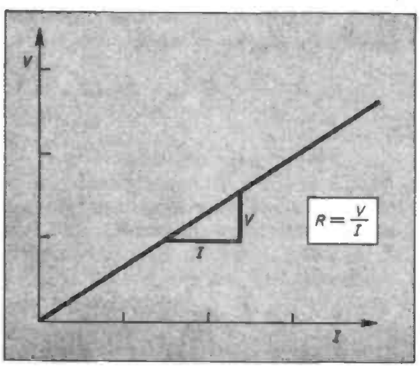


Fig. 2.1. Plotting current against voltage shows there to be a straight line (linear) relationship between the two. The slope of the graph gives the resistance.

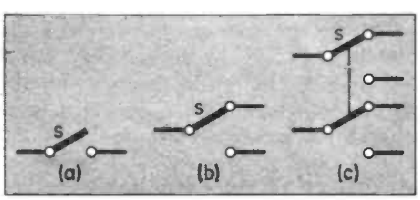


Fig. 2.2. Circuit symbols for switches. (a) shows a simple on/off type; (b) a changeover, and (c) a double-pole changeover.

PREFERRED VALUES

Since manufacturers cannot make a resistor of every value imaginable, they have arrived at a set of values which the designer can choose from. This obviously puts constraints on the circuit which the designer must be aware of.

We said earlier that a "ten ohm, five per cent" resistor could take any value up to 10·5 ohms. There is thus no point in making a resistor whose nominal value is less than this. So, what is the next highest value that he should make?

The lower limit of the tolerance band of the new resistor should not overlap with the upper limit of the "ten ohm" resistor. A little calculation shows that the next value is 11 ohms (to the nearest whole number). Using the same principle we can find the next highest value which turns out to be 12 ohms.

Continuing in the same way, a whole string of values can be found up to 100 ohms. Above this the values are simply ten times the previously calculated values.

It turns out that for five per cent resistors there are 24 values between 10 and 100 ohms. We call any set of values where the upper limit is ten times the lower limit

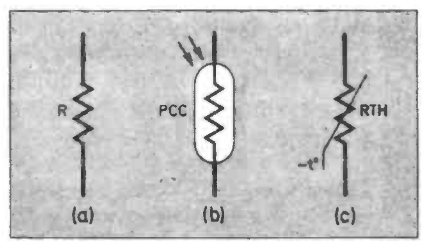
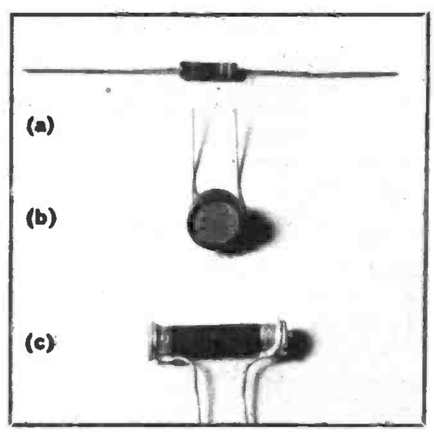


Fig. 2.3. Circuit symbols for resistors. (a) shows a simple resistor, (b) a light dependent resistor (l.d.r.) and (c) a thermistor.



Practical examples of the components depicted in Fig. 2.3. (a) resistor (b) light dependent resistor and (c) thermistor.

a "decade", so the previous statement can be summarised by saying that there are 24 values per decade. The values are all listed in Table 2.1 along with the other series for 20 and 10 per cent.

Each of these series is called an "E" series and to denote the particular one we mean, we follow the E with the number of values per decade. Hence Table 2.1 lists the E6 (20 per cent), E12 (10 per cent) and E24 (5 per cent) series.

POWER RATING

When we looked at conduction in solids we saw how electrons move—bouncing around in a random manner but with an overall drift against the field. The collisions which occur generate heat and the greater the current the more collisions occur.

Each collision therefore means that the electron loses some of its energy as heat. We say that power is dissipated when current flows in a resistive element.

The amount of power dissipated is proportional to the current flowing through, and the voltage across the resistor. Thus

$$P \text{ (power)} = I \text{ (current)} \times V \text{ (voltage)}$$

Heat will be dissipated in any resistive element in a circuit whether it be an actual resistor or a piece of wire, since this is bound to have some resistance at normal temperatures.

When resistors are designed, the manufacturer tests how much power the type of resistor can dissipate without any damage. If too much current is passed through a resistor it will get hot and eventually burn out. Thus when a resistor is given a power rating it is really a summary of the maximum voltage and current which the resistor can withstand.

To calculate these two quantities from the power rating and the value of the resistor, we must return to Ohm's Law.

If a voltage V is placed across a resistance R then the current I is given by

$$I = V/R$$

Now we have seen that

$$P = V \times I$$

so, substituting in this equation we get

$$P = V \times V/R \text{ or } P = V^2/R$$

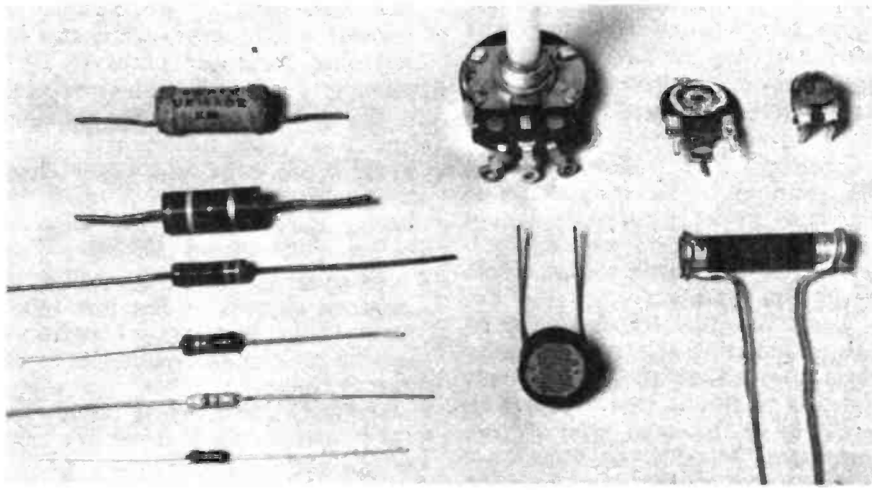
Rearranging we get

$$V = \sqrt{(P \times R)}$$

TABLE 2.1

Range of Preferred Values for Resistors

Tolerance	Series	Values per decade											
20%	E6	10				15				22			
10%	E12	10		12		15		18		22		27	
5%	E24	10	11	12	13	15	16	18	20	22	24	27	30
20%	E6	33				47				68			
10%	E12	33		39		47		56		68		82	
5%	E24	33	36	39	43	47	51	56	62	68	75	82	91



Typical resistors (left) a wire-wound 5 watt fixed resistor, and (below) carbon resistors ranging from 1 watt to 1/10th watt. (Top right) three variable resistors (potentiometer): standard control type and two miniature presets. (Bottom right) light dependent resistor and thermistor.

Let us look at a real case. What is the maximum voltage which we can safely apply across the 100 ohm, one watt resistor?

$$V = \sqrt{(P \times R)} = \sqrt{(1 \times 100)} = 10V$$

We can find the maximum current by substituting

$$V = R \times I \text{ in } P = V \times I$$

giving

$$P = R \times I \times I \text{ or } P = R \times I^2$$

Rearranging, $I = \sqrt{(P/R)}$

Again, let us look at a real example. What is the maximum current that we can pass through a $\frac{1}{2}$ watt, 47 ohm resistor?

$$I = \sqrt{(P/R)} = \sqrt{(\tfrac{1}{2}/47)} =$$

just under 0·01A (10mA)

In transistor and other semiconductor circuits, currents are usually very low, rarely rising over a few tens of milliamps. In these cases we will rarely find resistors over $\frac{1}{2}$W and usually not more than $\frac{1}{4}$W. It is only where large currents are flowing (as in power supplies or the output stages of amplifiers) or high voltages are present (as in valve circuits) that we encounter high wattage resistors.

COLOUR CODING

Resistors are usually marked with their values using three coloured stripes on the body of the resistor. The first two indicate the two digits in the value and the third the multiplier. Thus, for instance, red red orange is 22 followed by three noughts, which implies 22,000 ohms.

A fourth band is used to indicate the tolerance of the resistor.

The **colour code** is summarised in Table 2.2.

TABLE 2.2

RESISTOR COLOUR CODE

Carbon and metal oxide resistors normally have their ohmic value printed on the body in some form of colour code taking the form of four coloured bands. Values are evaluated with the use of the table below:

Colour	1st/2nd digits (A/B)	Multiplier (C)	Tolerance (D) ±%
Black	0	1	–
Brown	1	10	1
Red	2	10^2	2
Orange	3	10^3	3
Yellow	4	10^4	4
Green	5	10^5	–
Blue	6	10^6	–
Violet	7	10^7	–
Grey	8	10^8	–
White	9	10^9	–
Gold	–	10^{-1}	5
Silver	–	10^{-2}	10

EXAMPLE: A resistor colour coded as Orange-white-red-silver, would have a value of 3·9kΩ ±10%.

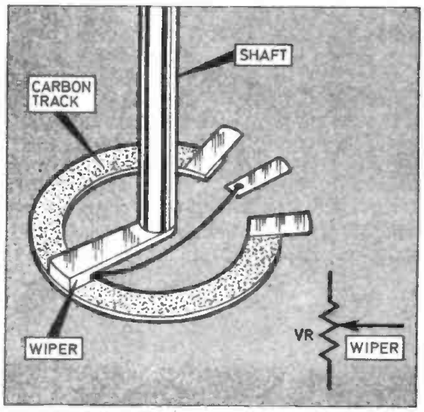


Fig. 2.4. The construction of a typical potentiometer.

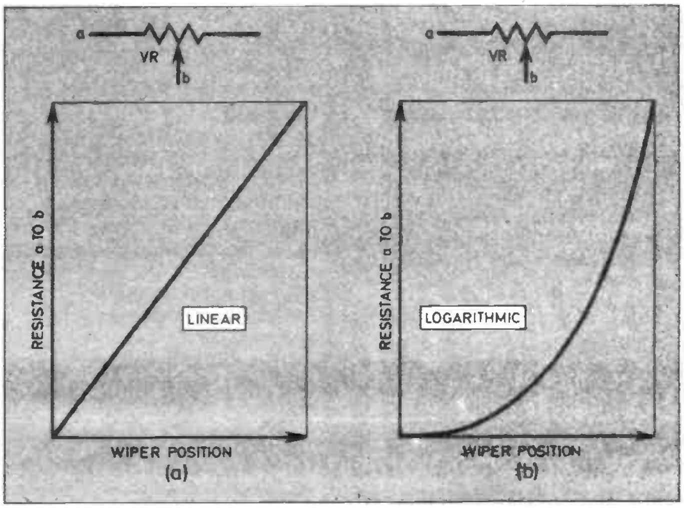


Fig. 2.5 (a) A linear potentiometer has a linear relationship between the wiper position and resistance whilst (b) a logartithmic potentiometer produces a non-linear graph.

POTENTIOMETERS

In electronic circuits the requirement often arises to be able to change a certain parameter (volume, brightness, tone, etc.) under manual control. The cheapest and most readily available variable component is the **variable resistor** or, in its usual form, the **potentiometer.**

A potentiometer is a three-terminal device and has quite a simple internal construction (Fig. 2.4). It consists of a resistive track either of carbon or similar material (though sometimes it is a coil of wire) with electrical contacts at either end brought out to two terminals. Electrical connection is also made to a third terminal but this can make contact anywhere along the track, the actual position being set manually either by a rotating shaft to which the wiper is mechanically but not electrically connected or, in the case of slider potentiometers, by a linear movement.

To use the potentiometer as a variable resistor, the movable contact and one of the other terminals are used. With the wiper at one end of the track there will be virtually zero resistance between the two terminals; with it at the other end, the full resistance of the track will be seen. At intermediate positions a resistance dependent on the position of the wiper will be seen (Fig. 2.5a).

The most commonly used type of potentiometer has a **linear** relationship between wiper movement and resistance. In other words if wiper movement is plotted against resistance a straight line is seen. However, the need sometimes arises for a potentiometer with a non-linear characteristic. The most common type of this sort is the **logarithmic** type. The relationship between the wiper position and resistance being shown in Fig. 2.5b.

Such potentiometers are used where the parameter to be varied does not have a linear relationship to any easily varied circuit parameter. For instance, sound output power is a logarithmic function of electrical power so varying electrical power with a linear potentiometer would give large changes in volume at one end of the potentiometer and small changes at the other. Using a logarithmic potentiometer evens out the adjustment over the range of the potentiometer.

MEASUREMENTS USING POTENTIOMETERS

The name "potentiometer" sometimes gives rise to confusion as it does not appear to be any sort of "meter". However, with suitable calibration and the use of the simplest of meters it can indeed be used for measuring.

If a voltage is placed across the resistive track then the wiper of the potentiometer can be used to tap off a proportion of this voltage (Experiment 2.1). If a simple meter is placed in the wiper of the potentiometer then it will indicate when current flows out of or into that wiper.

An unknown voltage (which must be less than that across the potentiometer track) can now be measured by connecting it across the wiper and one end of the potentiometer. Providing the knob is calibrated we can simply adjust the wiper until no current flows and this can only occur when the unknown voltage exactly equals that across the potentiometer.

LIGHT DEPENDENT RESISTORS

Ordinary resistors are designed so that external influences such as light, heat and mechanical stress have very little effect on the nominal resistance. There are, however, special resistors which exhibit marked changes in resistance with these influences.

Light dependent resistors (l.d.r.s) are made of a special material which produces more conduction electrons when exposed to light. They should not be confused with solar cells which are sources of e.m.f. not completely passive as l.d.r.s are.

Experiment 2.2 shows a simple light meter using a readily available l.d.r.

THERMISTORS

Another type of resistor called a **thermistor** exhibits large changes of resistance with temperature. Any heating tends to increase conductivity since electrons get "knocked off" as the heat agitates the atoms. However, in thermistors, the materials are specially chosen so that the changes are large.

EXPERIMENT 2.1: A SIMPLE VOLTMETER

Components needed: 100kΩ resistor

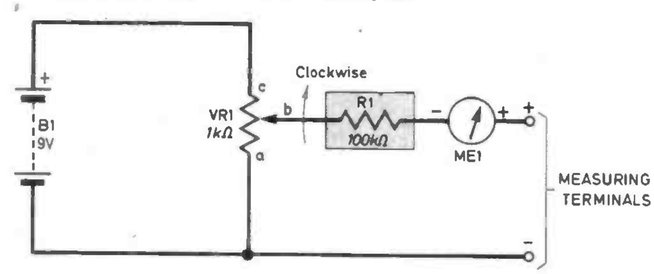
To use a potentiometer as a voltmeter, the scale of the potentiometer needs to be calibrated. Because the track is linear, we know that equal divisions on the scale will represent equal changes in resistance. Thus it is simply necessary to divide the scale into ten equal increments using for instance a protractor.

Note that the rotation of the knob is restricted to 270 degrees (three quarters of a full rotation) so only this part needs to be divided up (see Fig. 2.6(c)). Each of the ten divisions can be further subdivided into two or maybe ten if it is intended to try to make more accurate measurements but since the battery voltage is not known to a high degree of accuracy this is not really a practical proposition.

The circuit of the simple voltmeter is shown in Fig. 2.6(a) and the board layout in Fig. 2.6(b). Note the 100kΩ resistor in series with the meter. This is not really part of the voltmeter but serves to protect the meter should the wiper of the potentiometer be at 0V and the positive end of the meter connected to a voltage.

Each division of the scale represents one tenth of the voltage across the potentiometer, in this case 9V. Connect say a 1·5V torch battery across the "voltmeter" terminals (note the polarity). Adjust the potentiometer until the meter reads zero, that is mid-scale. Read off the scale.

The reading should be about 1·7 corresponding to a voltage of approximately 1·5V. Note that the "meter" cannot read more than the voltage across the potentiometer—in our case 9V.



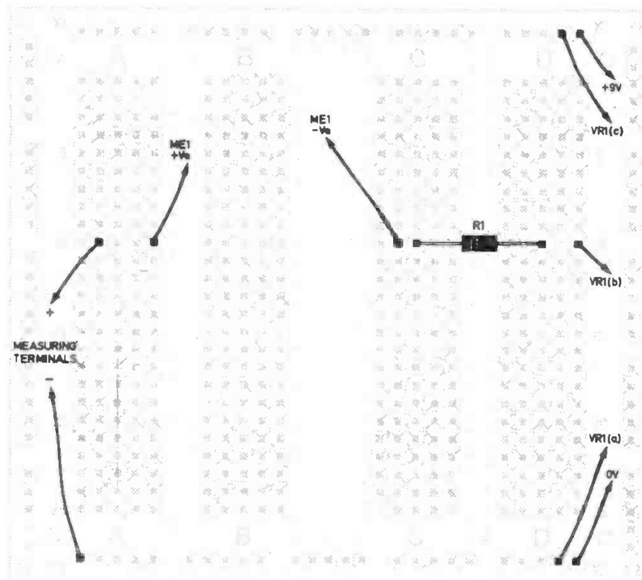


Fig. 2.6. A simple voltmeter which can be built on the Tutor-Deck. (a) shows the circuit diagram and (b) the component layout on the deck. (c) shows the potentiometer scale.

EXPERIMENT 2.2: A SIMPLE LIGHT METER

Components needed:

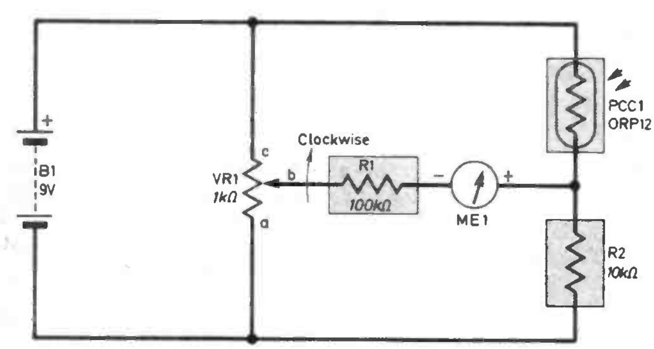
ORP12 light dependent resistor
10kΩ resistor
100kΩ resistor

The change in resistance of a light dependent resistor (l.d.r.) with illumination can be measured using the simple voltmeter described in the preceeding experiment. In order to convert the change in resistance into a change in voltage we need to pass a current through the l.d.r. Our voltmeter can only measure up to 9V so the voltage across the l.d.r. needs to be about a few volts in normal light to make a useful light meter.

The data tells us that the resistance in sunlight is about 3·5kΩ so placing a 10kΩ resistor in series with it and connecting the combination to the 9V supply used for the potentiometer should produce a reading of about 3V.

The complete circuit of the simple voltmeter is shown in Fig. 2.7 (a) and the board layout in Fig. 2.7(b).

Adjust the potentiometer until the meter reads zero and note the reading. Now vary the light that falls on the l.d.r. either by shading it or by taking it closer to the light source. Adjust the potentiometer to bring the meter back to zero. For decreased light the scale reading should fall indicating that the resistance of the l.d.r. has risen. With increased light the meter reading should rise indicating a fall in the resistance of the l.d.r.



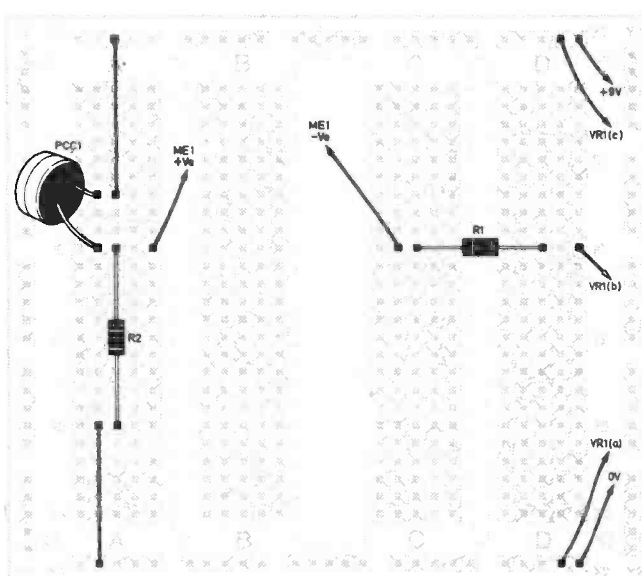
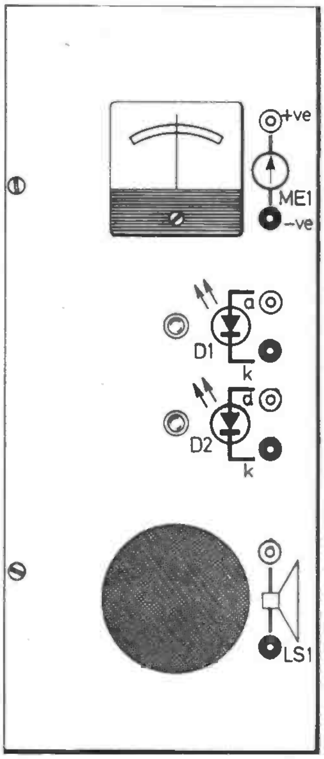


Fig. 2.7. A simple light meter using a light dependent resistor. (a) shows the circuit and (b) the component layout.



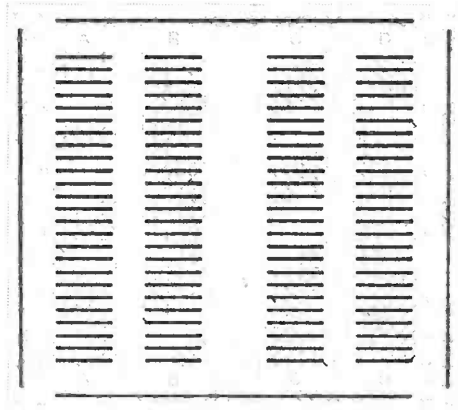
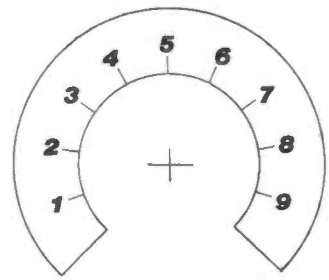


Fig. 2.9. Diagram of the Eurobreadboard indicating how individual sockets are permanently interconnected inside the board.

Fig 2.6c (below).



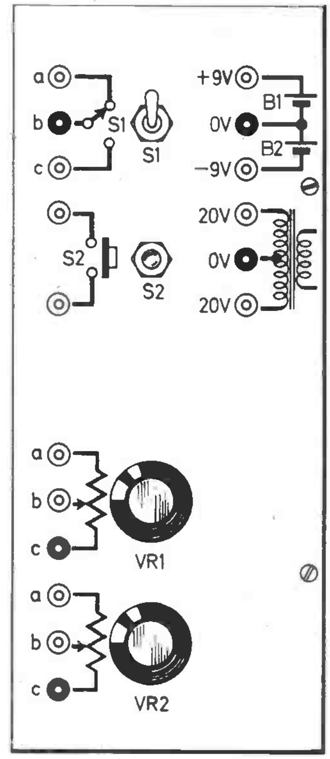


Fig. 2.8. Left and right hand panels of the Tutor Deck.

Since current through any resistive element tends to produce heat, these resistors tend to exhibit a resistance which goes down as current goes up.

In older types of television receivers one could find thermistors in the heater circuits of the valves. These valve heaters tend to have very low resistance when cold so a thermistor was used to limit the initial current but to allow the right current to flow once the heaters warmed up.

The thermistor just described has a **negative temperature coefficient**, this is indicated by the sign −t° (see Fig. 2.3c). There are also available **positive temperature coefficient** (+t°) thermistors. In the case of these devices, their resistance **increases** when the current increases beyond the "normal" working current.

STRAIN GAUGES

If a piece of wire is stretched it tends to reduce its cross section which in turn tends to increase its resistance. This principle is used in **strain gauges** which are used to measure mechanical stress. Thin conductive layers are formed on a flexible substrate. When the substrate bends the conductive layer is stretched and the resistance changes.

In Part 3 we will look at electric circuits and see how Ohm's Law enables us to calculate currents in each component of a circuit

PART 2 QUESTIONS

2.1. A resistor of 100 ohms has 5mA flowing through it. What is the voltage across it:
- **a) 0·5 volts**
- **b) 5 volts**
- **c) 0·05 volts?**

2.2. 250 volts is applied across a 10,000 ohm resistor. How much current will flow:
- **a) 2·5 amps**
- **b) 25mA**
- **c) 250mA?**

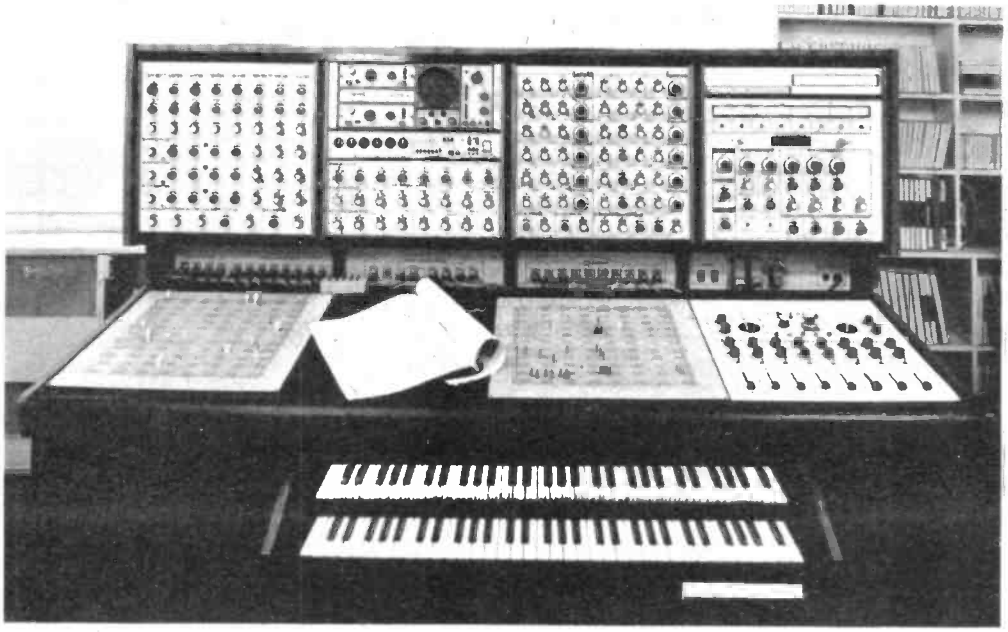
2.3. How much power is dissipated by the resistor in the previous question:
- **a) 6·25 watts**
- **b) 0·625 watts**
- **c) 25 watts?**

2.4. What value is a resistor with the colour code yellow, violet, red:
- **a) 47 ohms**
- **b) 4700 ohms**
- **c) 270,000 ohms?**

2.5. What colour code will a resistor of 150,000 ohms have:
- **a) brown, green, yellow**
- **b) brown, green, orange**
- **c) yellow, green, black?**

PART 1 ANSWERS

1.1. b) 1.2. d) 1.3. c) 1,4. b) 1.5. b) and c)



By B. H. Baily

Synthesisers EXPLAINED PART 1

THE BIRTH of electronic sound generation was probably around the time of the early valve-operated radios, which succeeded the old "cat's whisker" crystal sets. The use of electronic vacuum tubes, or valves, brought with it the property of amplification, which is the boosting of the minute signals from the radio aerial.

With amplification came the possibility of feeding back a boosted signal in order to further boost the overall result. An adjustable control was provided so as to allow accurate feedback to be set such that the maximum boost would occur, without overdoing it and causing over-feedback which resulted in oscillation.

Over-use of the "reaction control" as it was known, caused all manner of squeaks and whistles to emerge from the then-popular horn loudspeaker! Enter the new age of electronically-produced "music", as the earlier version of the audio oscillator was born.

ELECTRONIC ORGANS

It was not long before oscillators were used to produce the basic tone generators of the first valve electronic organs. These used a bank of twelve such oscillators, each of which produced one note of the top twelve notes of the organ keyboard. (Twelve notes comprise one chromatic octave, i.e. including sharps and flats or "black" notes).

The remaining octaves were derived, note for note, by dividing the frequency from each oscillator by a factor of two to produce a note exactly one octave lower. For instance, top *C* frequency would be divided by two to produce the note *C* one octave lower.

So the tone generation section was built up to include twelve oscillators and one divider per oscillator for each octave below which the keyboard or keyboards spanned. The oscillators and divider stages were left powered and running at their own particular frequencies continuously, and their various outputs selected as required by the depression of a key or keys on the keyboard. This requires at least one wire per key and often more in some designs.

A basic organ schematic is shown in Fig. 1.1, in which it will be seen that the oscillators feed signals to their respective dividers, from which a large number of individual signals emerge, one for each note of the keyboard (or keyboards). Sometimes these signals are switched direct by the keyboard, but in this example gating circuits are shown which do the switching electronically, which is more common nowadays.

The signals "chosen" by the depressed keyboard keys are commoned on to a single line in the diagram, but often these are fed out on a separate line per octave for reasons we need not worry ourselves at this point. The selected notes are fed to a *Tone Forming circuit*. The purpose of this block is to add the desired quality of sound which would be absent were we to listen to the "raw" signals produced by the oscillators and dividers.

In actual fact, the waveform of the dividers and oscillators is normally a squarewave, which is the shape shown in the diagram. If this shape is amplified and reproduced in a loudspeaker, it is similar to the sound of a clarinet. Obviously, it is not desirable for our organ to sound like a clarinet all the time, or any other single instrument, for that matter. So the squarewave signals are passed to the Tone Forming circuits for modification.

The circuits in this block perform various forms of modification on the signals fed into it. Each circuit is designed to modify a squarewave to produce a more complex waveform which will resemble a different instrument, e.g. trumpet, flute, violin, etc. The circuits are switched in and out by the *Stop Tab* switches, one stop tab per effect.

The stop tabs may be used singly or collectively to produce a myriad of different effects, and the final composite signal is passed to the output amplifier, via the Swell Pedal for amplification and reproduction as sound by the speaker.

SYNTHESISER PRINCIPLES

So much for the very basic principles of electronic organs. Now for the very different philosophy of synthesiser design. For the purpose of this series we shall restrict our dealings with the *monophonic* synthesiser, which is the design which is played one key at a time only. The polyphonic types are currently very expensive and use many of the electronic organ principles.

One of the most striking differences between the electronic organ and the monophonic synthesiser is the latter's comparative simplicity of design; at least so far as a comparison of the schematic diagrams of the two instruments is concerned. The actual circuit design of the component blocks of the synthesiser are by no means simple, as very high accuracy of performance over wide ranges of use must be maintained.

OSCILLATORS

In the synthesiser we do not use twelve oscillators, running all the time irrespective of whether they are being used at any one time. Instead, we use one or more (generally two or three) oscillatoors, which are designed to be very versatile. Each oscillator is made to respond to a certain voltage applied to its "voltage control" input.

The frequency, or pitch of signal created by the *voltage controlled oscillator* is accurately related to the voltage applied. In order for this to be possible, it is necessary for the oscillator to be widely variable, instead of being fixed at one pitch, as is the case with each oscillator in the organ.

RESISTOR LADDER

In Fig. 1.2, it is shown how the voltage controlled oscillator is controlled by the keyboard. A chain or ladder of resistors is connected in series between the positive and negative terminals of a source of direct current voltage. A current flows through each resistor, and a portion of the total supply voltage appears across the ends of each resistor. If each resistor is the same ohmic value (same resistance value), then the voltage developed across each will be the same.

Suppose the voltage across each resistor were 0·1 volt, then, starting from the bottom resistor, the first junction of resistors would have 0·1 volts on it, the next one up would have 0·2 volts, the next 0·3 volts and so on.

To each junction of resistors is attached one end of a pair of switch contacts operated by one key of the keyboard. The other ends of the contacts are commoned together and taken to the voltage control input line of the voltage controlled oscillator. Now, if the bottom keyboard switch is operated, the voltage control line of the v.c.o. (voltage controlled oscillator) is connected to the first resistor junction and 0·1 volts is applied. Similarly, the operation of any of the other keyboard switches will result in a different voltage being applied. Hence, for each key, a different voltage, and a different pitch from the v.c.o.

Notice the outputs from the v.c.o. Three different outputs are shown in Fig. 1.2, though in some designs others are possible. The shape of the waveform differs at each output, but its pitch or frequency does not.

The pitch of all three outputs depends, as stated earlier, upon the voltage applied at the v.c.o. input, but the shape, or tonal quality of the three outputs are different.

The smooth-looking shape at the top output gives a mellow tone, and its shape is known as sinewave. The second output shape, known as triangular, gives a less smooth sound, as may well be expected from its appearance, and is similar, but not identical to the effect on organs known as "diapason". The third output shape is a square-wave, and, as we have mentioned before, this sounds rather like a clarinet.

Already, another difference has appeared between organs and synthesisers; we do not derive all our effects from a single wave-shape, but can have three or more at our disposal, at root, i.e. direct from the oscillators. This is not to say that we do not use any form of tone forming circuits in a synthesiser, but simply that we start with a wider base on which to create our various effects.

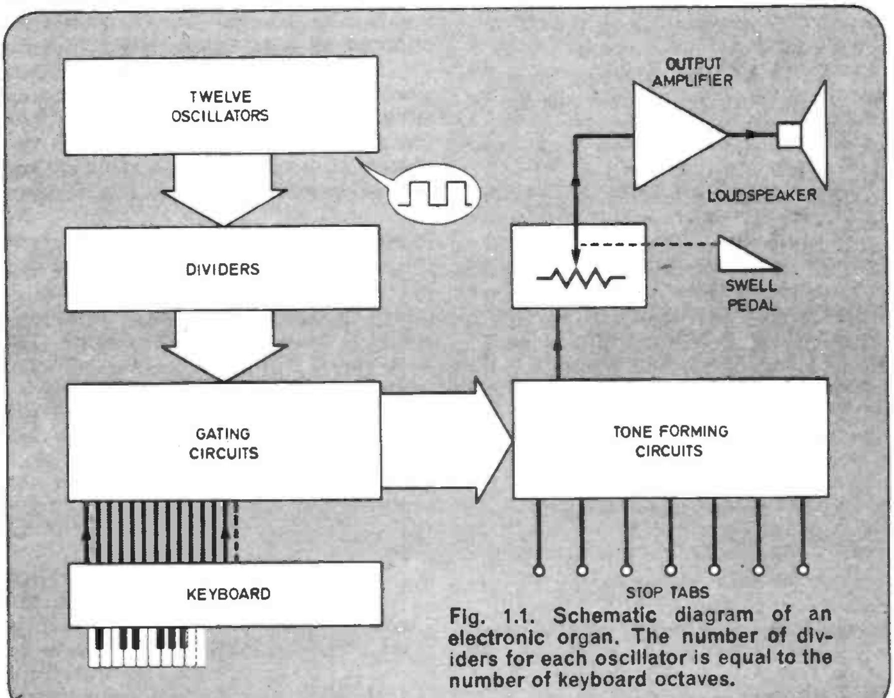


Fig. 1.1. Schematic diagram of an electronic organ. The number of dividers for each oscillator is equal to the number of keyboard octaves.

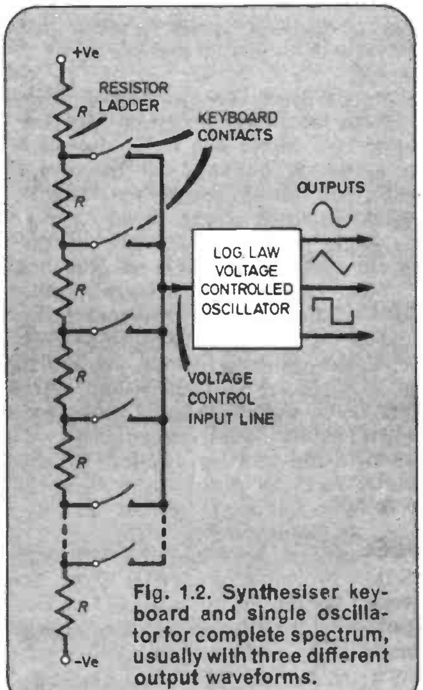


Fig. 1.2. Synthesiser keyboard and single oscillator for complete spectrum, usually with three different output waveforms.

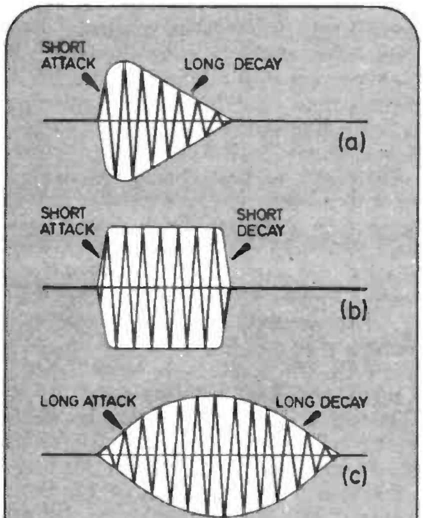


Fig. 1.3. Envelope shapes: (a) sustained piano (b) damped piano (c) bowed violin with sustain.

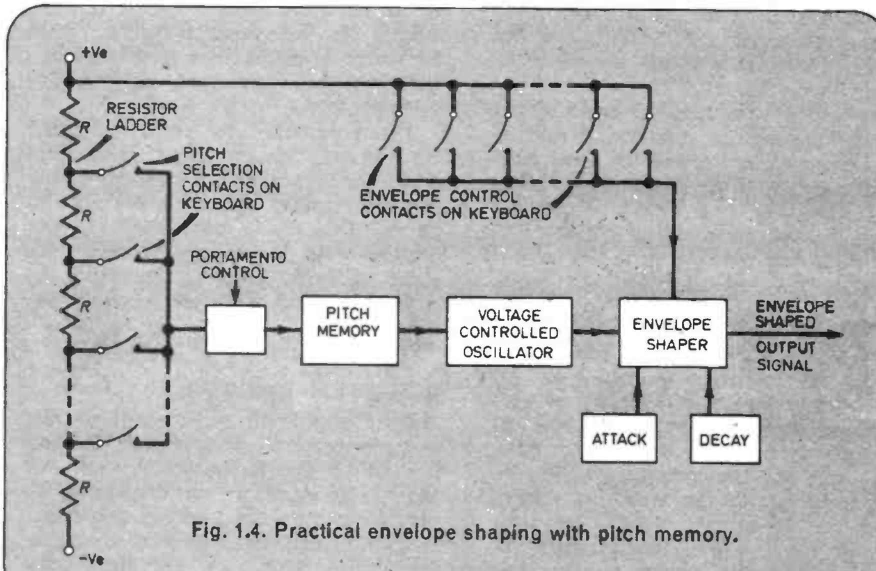


Fig. 1.4. Practical envelope shaping with pitch memory.

We will leave the tone-generation section, as the oscillators are known, at this point, and return to it in more detail later, as there are other important sections which should be introduced to give a wider view on basic principals.

ENVELOPE SHAPING

Even if we are not musicians, we are able to distinguish one instrument from another, even if the same note is played on each. Why?

Well, already we have touched upon differences in quality of tone, or waveshape. This is only one way by which sounds are distinguished. Another way is the way in which the note commences, sustains, and dies away or decays. These qualities are collectively known as the *envelope* of a sound.

Consider first, the sound of a piano note. As the internal hammer strikes the strings (there are more than one per note, each tuned to the same pitch), the sound commences almost explosively, and decays away gradually if the key is held down or the sustain pedal is pressed as depicted in Fig. 1.3a. But throughout the length of the audible note period the same *pitch* is created. The volume or *amplitude* of this pitch, however, starts large, and diminishes with time. If, on the other hand, the piano key is struck and immediately released, a damper is applied to the strings and the note starts abruptly as before, but ends almost as suddenly as shown in Fig. 1.3b.

Already, we have met two different shapes of envelope. One has an abrupt beginning or *attack*, and a slow *decay*, and the second has abrupt attack again, but also abrupt decay.

A third example, for good measure, would be the bowed note of a violin. If the player draws the bow slowly and gently over a string, gradually pressing the bow harder over its travel, the note will build up attack slowly, and give a long attack period. When the bow is removed, the string will slowly decrease its vibrations and a long decay will result (Fig. 1.3c), as in the sustained piano note considered. Notice that the envelopes do, in fact, envelope the waveforms of the three examples, and hence the name.

ENVELOPE GENERATION

In synthesisers, we produce envelopes, as with other effects, electronically. This involves the use of special circuits which have variable parameters with respect to time. We will consider this in more detail later.

In order that the *envelope shaper circuit* can perform its task, it must be informed when it is to do so. The instant that a key is pressed on the keyboard, a signal is sent to the envelope shaper to tell it a note is being played. The envelope shaper will have built into it the controls required to set the attack and decay rates. When a key is pressed, the attack of the envelope will be commenced from this instant. If a long attack is required, the signal from the v.c.o. will be gradually allowed to pass through the envelope shaper with increasing amplitude until full strength or volume is reached. If short attack is set, the full signal will be passed immediately through the envelope shaper.

But what about decay? Attack is easy, as we have just seen, but if we press a key in Fig. 1.2 and release it, we see that immediately the release occurs the contacts of the key separate and the voltage on the v.c.o. input line disappears! So, with the best envelope shaper in the world, if there is no signal to apply a decay shape to, we cannot shape it.

What we need is some way of telling the v,c.o. to stay oscillating after any key is released, and to remain sounding that note for some time afterwards, but to change its pitch immediately any other note is pressed. This circuit is not an unduly complicated device, thanks primarily to the facilities offered by the v.c.o. design. The circuit, known by function as *pitch memory* is called in electronic terms a "sample and hold" circuit. It is placed electronically between the keyboard pitch selection line and the input of the v.c.o., and its basic function is to use a capacitor which charges up to the voltage selected by a keyboard switch. When the switch is released, the capacitor charge remains, and, via a special circuit, holds the v.c.o. input line at the same voltage until it is "told" to change to a new value by the depression of another key.

PORTAMENTO

A useful spin-off from the use of the sample and hold circuit is the simple inclusion of another valuable function, known in musical terms as *Portamento*. When portamento is applied, instead of the pitch memory changing the voltage at the v.c.o. from one value to another as a new note is pressed, the change is made variable in velocity, i.e. the note will "glide" from the last note played to the next played.

Fig. 1.4 shows a schematic of all the facilities discussed so far. The envelope shaper is triggered simultaneously with the application of a voltage to the pitch memory, by means of a second contact on each key of the keyboard. These contacts are known as the envelope control contacts. In Fig. 1.4 they are connected to the positive voltage line and are all commoned at each end, so that operation of any one will connect the envelope control line to the positive rail, telling the envelope shaper circuit when to start shaping, and when to start decaying the signal.

Other refinements can be incorporated into the envelope shaper, such that the decay can start before a key is released, but the same basic principle applies.

FURTHER COMPARISONS

Having considered the basic circuits in a synthesiser, a further comparison with electronic organs would not be out of place. Our simple organ circuit did not consider envelope shaping. This is because few organ manufacturers find it economical to provide very much in the way of shaping. Sustain is often supplied, but in a conventional organ design, this means providing a separate decay circuit for every note of the keyboard! Admittedly, the circuit is not as complex as our envelope shaper in the synthesiser, but it must be provided in bulk!

Again, attack can be provided in organs, but where provided it is generally either present or absent, as set by a switch, and attack is normally restricted to a very short relative time.

Portamento on organs is rare or non-existent. Sometimes a "glide" facility is provided, which gives a smooth flattening of the played music, of at best about a semitone. Portamento in a simple synthesiser can be applied simply by making the pitch memory capacitor charge slowly through a variable resistor!

Another feature offered by most organ manufacturers is vibrato. This is the continual variation in pitch of all notes, and is achieved in organs by applying a relatively slow sinewave to each oscillator to change its pitch up and down alternately by about half a semitone each way. In the synthesiser this is achieved in much the same way by applying a low-frequency sinewave to the keyboard resistor ladder such that it is varied or "wavered" up and down by a small amount. In fact, it may be made more than a small amount if desired, so as to give special effects.

In short, the use of oscillators which are voltage controlled allows many things to be done. As will be seen later, oscillators are not the only circuits which can be voltage controlled, and the use of this principle in synthesisers has created the tremendous versatility which we associate with them.

To be continued

Helping Hand

There is no hobby that I am aware of, that is in any way comparable to Electronics, in the possibilities it offers, for developing from a pastime into a truly worthwhile career. The model train enthusiast does not want to be an engine driver, the amateur sailor, a ship's Captain, or the stamp collector wish to run a sub-post office, now with your electronics enthusiast, I was about to say, "The Sky is the Limit", but with news of America's *Pioneer II* after a voyage of six years, sending back to Earth pictures of Saturn, would anybody blame me for saying of the electronics enthusiast "His aspirations are bounded only by the Universe"? I think not!

It is satisfying to feel you are part of the picture and when you reach my number of years you can remember serving young lads with components, and in due course serving their children with similar things. Mind you, it can have its humiliations.

I remember a young lad (no names, no pack drill) that I served with electronic bits and pieces and now he owns a company with a two million pound turnover and along he comes and offers to buy me out! To think, twenty years ago, I was patting him on the head and complimenting him on his intelligence. That's where I went wrong, I should have patted him on the head with a brick!

Seriously though, in reality I get a great kick out of every success story, especially if I have played some minor part in helping these novices along the path to success.

Trouble Shooter

Take for example the case of John Morgan, who used to work for me many years ago. John was undoubtedly a very bright lad and when he emigrated to America his electronic talents were soon spotted. He finished up as chief service engineer (or trouble shooter as they call them over there) to one of the biggest computer companies, at an astronomical salary.

We exchange magazines and occasional letters and he has an Uncle in this country who tells me of his various exploits. Apparently he is so highly thought of that when all else fails they say "Send for John Morgan" and he has a special card enabling him to travel anywhere in the world by whatever mode of travel is the quickest.

Only recently a large engineering firm came to a grinding halt because of a computer failure. The firm was large enough to have four resident engineers but after a three days struggle they gave up, and the management said "Send for John Morgan".

John hops on a Jumbo, a car waiting at the airport whisks him to the factory and twenty minutes later all is humming again. The only people who were upset, were the four disgruntled engineers, who said to John, "Look old man, you might have at least hung it out for half a day or so"!

Well, this country needs all the John Morgans it can produce. A good electronic designer or service engineer will never be without work but this brings me to my final point.

Next Question

I am often asked why we have no technical staff in our shop and part of the answer is in the difficulty in recruitment. I was forcibly reminded of this the other day when a colleague of mine told me he was trying to find a good knowledgeable lad for his establishment. A reasonably large number turned up, some had even completed one year of a City and Guilds course.

To sort out the wheat from the chaff he decided on a few simple questions. Some of the answers were to say the least surprising. One applicant was asked, "What is the purpose of a transformer?" After five minutes deep thought he said "Doesn't it transform Electricity into Copper?" The next question was "If you have an amplifier with an 8 ohm output and four 8 ohm speakers, how would you connect them up?" A long time elapsed and then the lad looked up hopefully and said "With wire?"

Finally, one was asked, "If you connect two capacitors in series, each one, 2 microfarad 1000 volts working, what would be the capacity and the working voltage?" Back came the incredible answer, "The total working voltage would be one, and the capacity 47 ohms!!"—What a pity they had not taken EVERYDAY ELECTRONICS regularly!

EE RADIO CONTI

There have in the past been a number of articles published in the model and home electronics press on the subject of radio control, these have always tended to be either parts of the system or ideas on which a constructor can base a system. These systems have then suffered a further disadvantage in that they are not usually suitable for model aircraft.

What is to be described during the next few months is a radio control system of up to seven channels complete with all the necessary trimmings, which will be capable of being used in aircraft, cars and boats to name the three basic sides to R.C. modelling. Technically the system should be comparable with, and in some cases should be superior to, anything available on the market both in kit and ready-built form and therefore if constructed correctly should give many years of good service.

The EE Radio Control System is constructed mechanically around parts which are commercially made for the R.C. industry and are also readily available to the home constructor. Electrically the system is constructed on printed circuit board and makes use where possible of integrated circuits to make construction as "fool-proof" as possible. All these components should be available from sources advertising in this magazine.

The equipment comprises the following units:

Transmitter

Receiver

Servos

Speed Controller

Field Strength Meter

Battery Charger

Total cost for entire system: £170 approx. *A comparable commercial equipment would cost £225 plus.*

LICENCE

Before going on any further the constructor should be made aware of the law concerning the use of radio-control equipment. As in the case of all transmitting apparatus a licence is required before the equipment can be used, this can be obtained from: The Home Office, Radio Regulatory Dept., Waterloo Bridge House, Waterloo Bridge, London S.E.1, and costs £2·80 for five years which at 56p a year is cheap at twice the price!

SYSTEM CONCEPT

When designing an R.C. system there are many considerations to make, especialy concerning the transmitter, as to the type of circuit to be used. Amplitude or frequency modulation (a.m. or f.m.) for instance. In this case a.m. was chosen because of its longer development and "track" record.

For radio control purposes f.m. is still very young and has not as yet, in the opinion of the authors, lived up to manufacturers' claims in terms

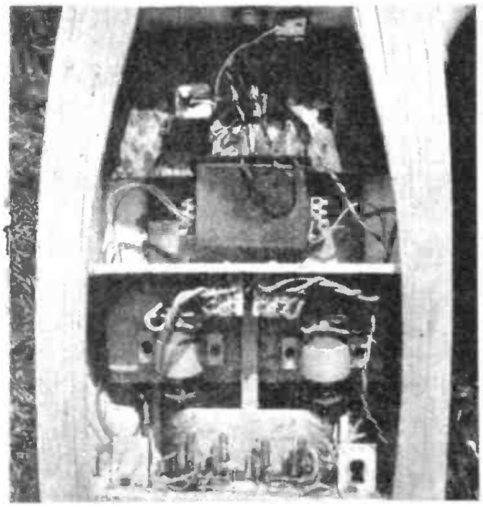
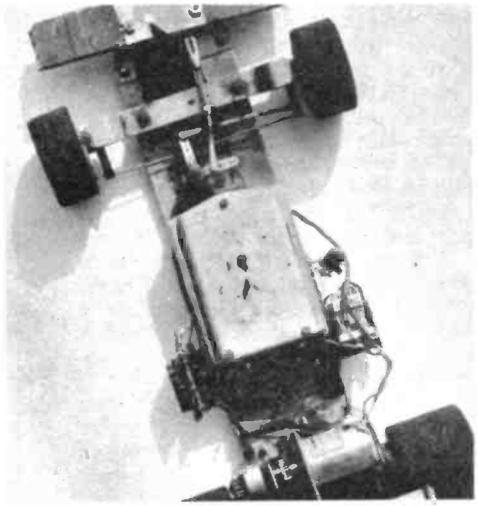
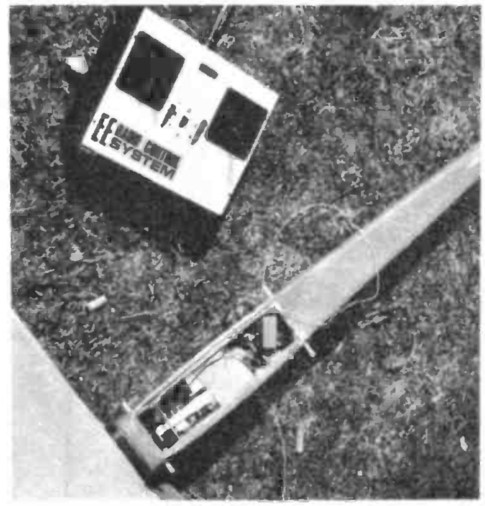
IT'S A WINNER!

A new British record was set by Lawrence Armstrong, one of the co-authors of this new series, in the Isle of Man Soaring Championships last August.

Using the prototype EE Radio Control equipment, he kept a model glider aloft for 7 hours 8 minutes, adding 1½ hours to the old record.

Our author went on to acquire further distinction by securing second place in the Thermal Soaring Competition.

Congratulations Lawrence. You have demonstrated what can be achieved with the EE Radio Control System. Other R/C enthusiasts will be spurred to reach similar heights using this proven equipment.

ROL SYSTEM

PART ONE

INTRODUCTION & TRANSMITTER DESCRIPTION

By L. ARMSTRONG
H. DICKINSON
W. WILKINSON

of better performance and reliability. It also has the disadvantage of requiring tighter tolerance and therefore more expensive crystals.

With regard to the encoding section of the transmitter, the normal half-shot system as in Fig. 1.1 was rejected in favour of a linear ramp system (Fig. 1.2) which has better temperature and supply voltage coefficients. A further advantage of this system is that "plug-in channels" can be used as described later.

The receiver is a double-tuned-input superhet using plug-in crystals with an i.f. of 455kHz.

The servos and speed controller use the latest i.c.s.

THE TRANSMITTER

The complete circuit of the transmitter appears in Fig. 1.3. It will be seen that this is composed of four sections: Channel Switching, Encoder, R.F. Stage and Power Supply.

CHOICE OF ENCODER

The object of the encoder is to 100 per cent modulate the r.f. circuit with a series of pulse widths varying from

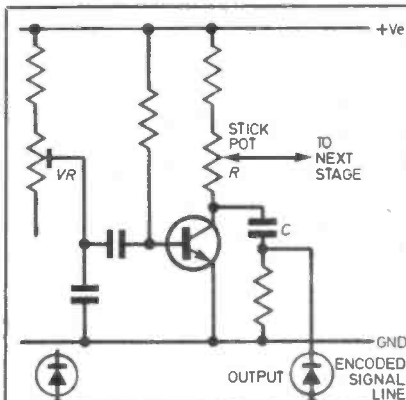
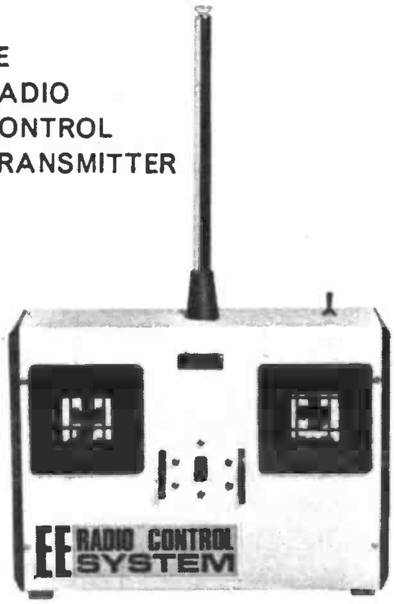


Fig. 1.1. A simple half-shot circuit. This works on a *CR* charging curve where the charging time is determined by the stick pot position. This circuit would be repeated for each channel, and require the setting up of seven pre-set pots.

1ms to 2ms dependent upon the position of the sticks on the transmitter.

In starting to design the encoder many things were taken into consideration and it was decided to make the encoder as versatile as possible. Two functions were considered vital: (i) the ability to easily reverse the effect of stick movement on the pulse width, for example increasing instead of decreasing pulse width when the



stick is moved in one direction; (ii) the ability to easily reduce the pulse width variation with stick movement. Although this second feature was not put on the prototype details are given on how to facilitate the feature.

This second consideration is very useful when learning how to fly because a novice always tends to oversteer at first which always ends up in the initial and usually expensive crash. Another useful use for the reduced throw is in cars and boats where during a race a minimum amount of movement is required to complete a course at speed, yet at slow speed a lot of movement is required to manœuvre around.

Most existing commercial systems use a multivibrator driving a series of half-shots the pulse widths of which are controlled by the stick positions. This type of encoder is very difficult if not impossible to arrange such that the two main facilities now required can be incorporated. The half-shot method is also vulnerable to temperature and supply voltage changes and is also non-linear due to it relying upon a *CR* charging curve, the curve being its disadvantage.

With the advent of cheap integrated circuits it now becomes possible to design a very versatile encoder which will now be described in detail.

LINEAR RAMP ENCODER

Fig. 1.2 is a schematic diagram of a linear ramp encoder. This is a simplified version of the final circuit (Fig. 1·3) and uses identical component references. The eight-position switch *S* however is in reality an electronic device (IC1) as explained later. This switch scans around the potentiometers attached to the control sticks, remaining at each position until the pulse is complete. IC3a forms an

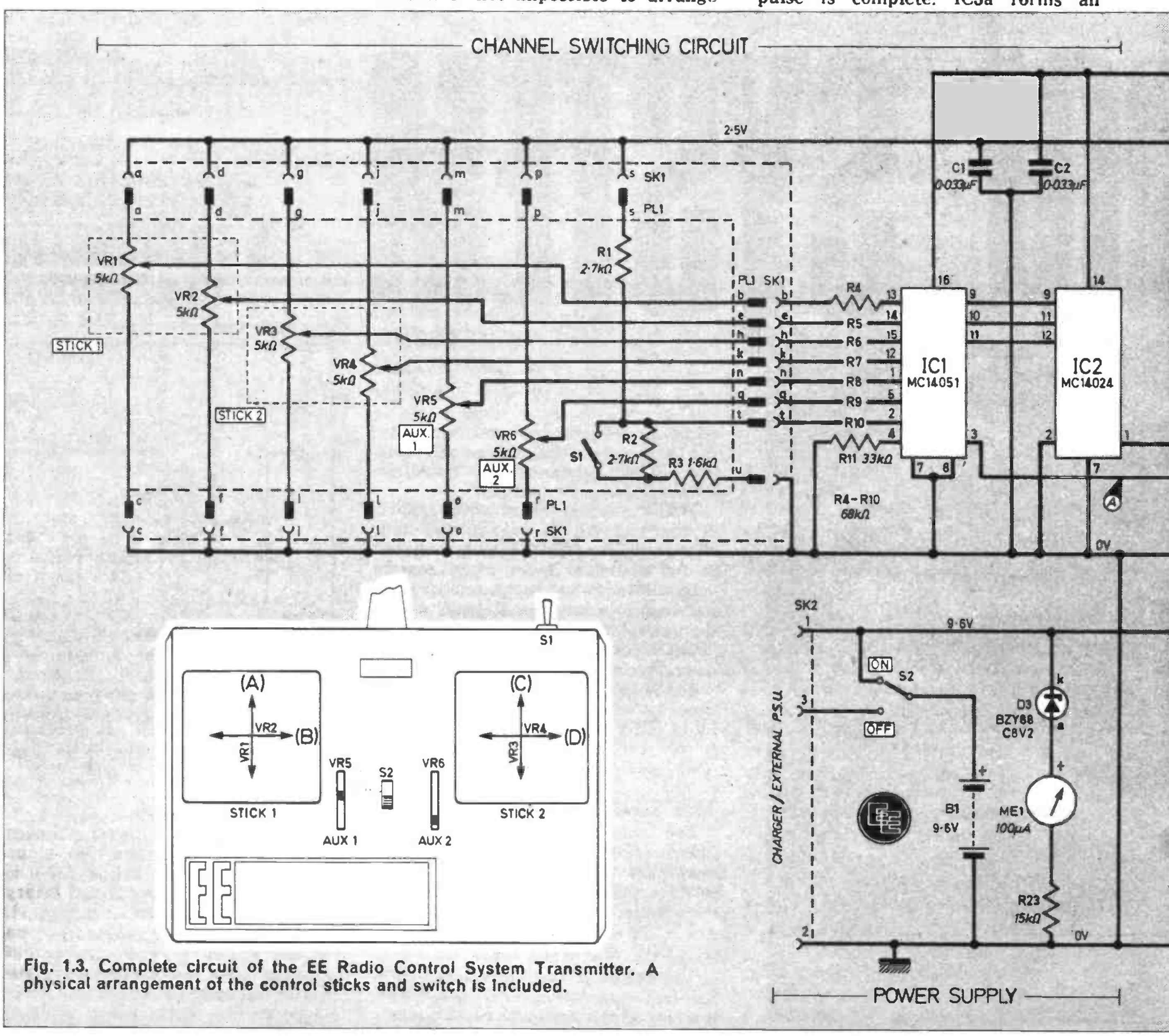


Fig. 1.3. Complete circuit of the EE Radio Control System Transmitter. A physical arrangement of the control sticks and switch is included.

inverting buffer amplifier between these potentiometers and the comparator IC3c.

The capacitor C6 is allowed to charge up from the constant current source *I* until the voltage is the same as that at the output of IC3a which in turn, as explained, is dependent upon the stick position. This voltage is detected by IC3c and inverted by IC3d causing TR2 to turn on and discharge C6.

Once the voltage on the capacitor drops below the output of IC3a, TR2 is turned off and C6 allowed to charge up again. The time delay through IC3c and IC3d is long enough to ensure that C6 is fully discharged before TR2 turns off. The capacitor therefore is constantly discharged and allowed to charge up to a voltage dependent upon the stick position: thus as this voltage varies so the voltage to which C6 charges varies and as a result the time between discharge pulses varies.

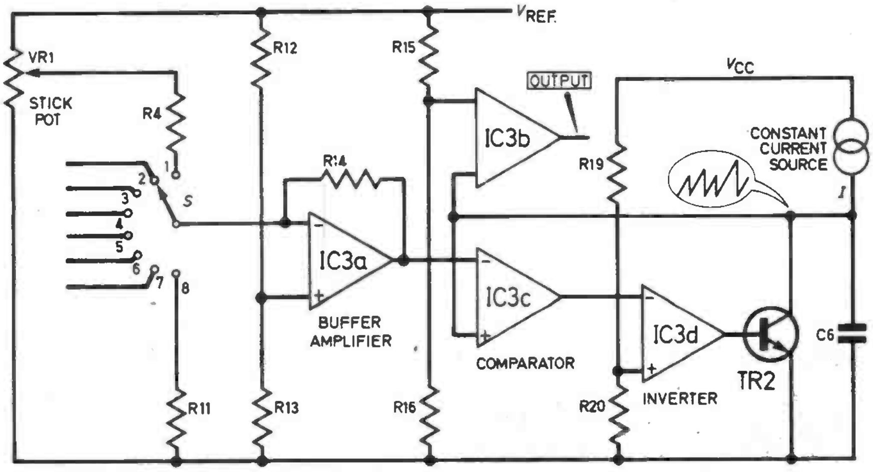
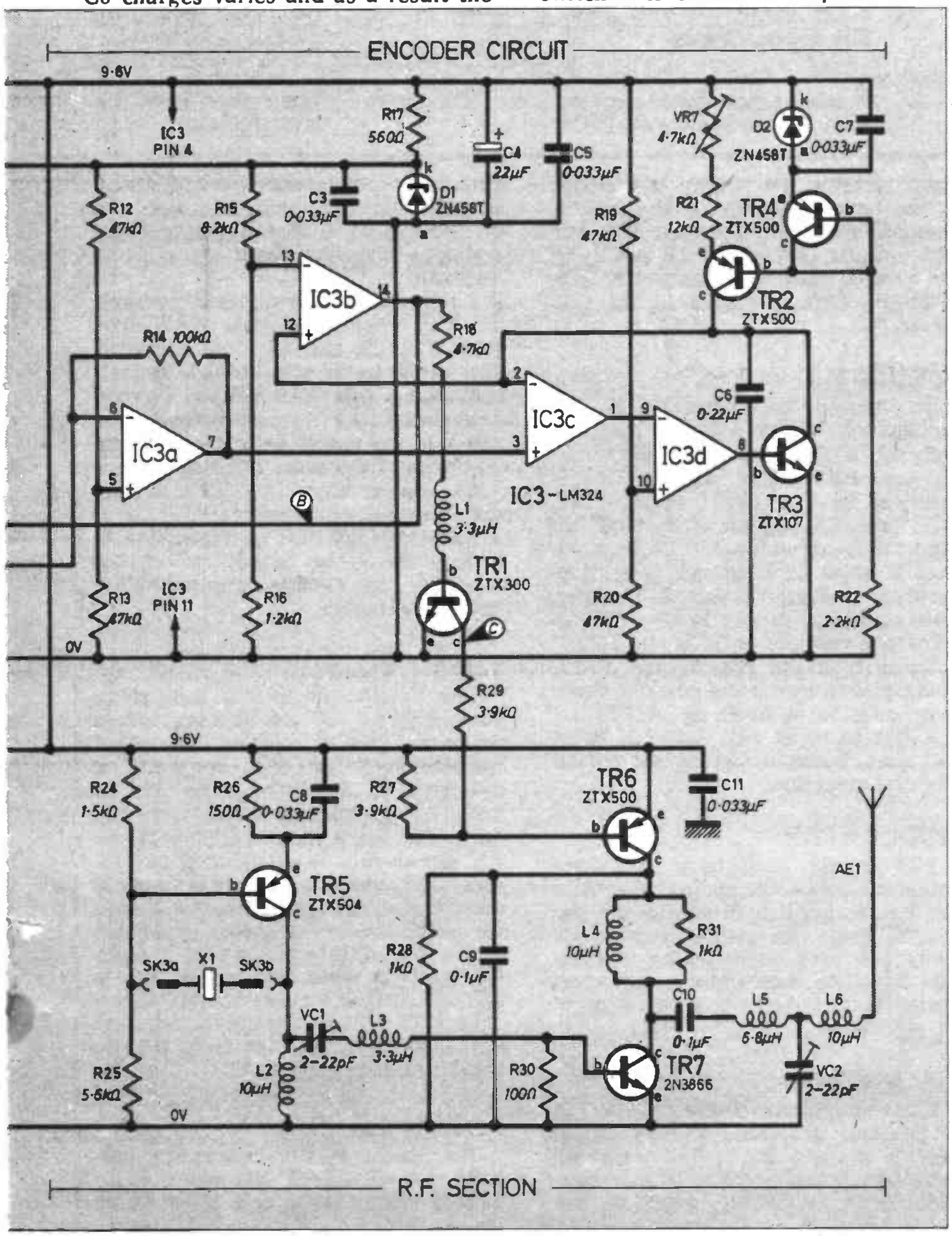


Fig. 1.2. Linear Ramp Encoder: basic circuit.

Each time C6 is discharged the switch *S* is caused to step on to the next position. It can be seen therefore that the time between successive discharges will depend upon the voltage on each successively selected stick potentiometer, thus producing a series of pulses the widths of which are governed by all the control stick positions in sequence.



SYNCHRONISING PULSE

In order to synchronise the receiver (described later) it is necessary to have a long pulse between each set of control pulses. This is produced by arranging an eighth position to *S* which switches in a voltage such that the output of IC3a goes very high causing the capacitor C6 to charge to a much higher voltage, so producing a much longer pulse than the normal control pulses.

IC3b detects when C6 is discharged and produces a narrow pulse at its output. This pulse is used to both sequence *S* and drive the r.f. modulator to produce a correctly coded radio signal.

CAPACITOR TYPE

In practice the type of capacitor used as C6 was found to have a great deal of effect on the circuit performance. After looking at a variety of types, both electrolytic and non-polarised, the best performance was found to be from polyester capacitors, so for best effect a capacitor of this type should be used.

Fig. 1.4 shows the waveforms to be expected at various points in the encoder.

Refer to Fig. 1.3 for the final practical circuit of the encoder.

ELECTRONIC SWITCH

The switch used to look at each voltage in turn is a CMOS analogue switch IC1. This is a device which is dependent upon the digital binary code appearing on pins 9, 10 and 11, will present the signal appearing on one of the inputs on to the output "A" (pin 3) with an effective resistance of 200 ohms.

The code appearing on pins 9, 10 and 11 is changed by the counter in IC2 being clocked as already mentioned by the output of IC3b so as to present the next channels in sequence on to the output.

VR1-VR6 represent the six stick potentiometers whilst R1, R2 and R3 form the resistive network required for the switch channel (S1). R11 is the resistor used to set the sync pulse width wider than the remaining channel pulses.

CONSTANT CURRENT SOURCE

The capacitor C6 is charged from the constant current source formed by TR2, TR4, R21, R22, VR7, D2 and C7. The reference Zener diode D2 is an accurate voltage source over wide temperature and current variations and forms the heart of the current source. TR4 is used purely to cancel out any effects caused by the *V*be of TR2. VR7 varies the current to enable the centre pulse width to be set up on all channels.

STICK POTENTIOMETERS

As mentioned previously one requirement of the system is to be able to change round the potentiometers on the sticks without affecting the neutral position. This is achieved by arranging that the pot. wiper is in the centre of the pot. when the stick is in the neutral position, thus causing no change in the voltage on the wiper of the potentiometer when the connections are reversed and therefore maintaining the same neutral pulse width whichever way round the pot. is connected.

The second requirement was to be able to reduce the effect of the stick movement on the pulse width. The change in pulse width with stick position is goverend by the gain of IC3a. The gain is the ratio of R14 to whichever input resistor (R4-R10) is selected by IC1. It can be seen therefore that the effective pulse width change with stick movement can be altered by changing the appropriate input resistor. To ensure no change in the neutral position if the gain is changed a biasing network R12 and R13 ensures that when the pot. is in the neutral position the output of IC3a is at the same potential as the pot. wiper.

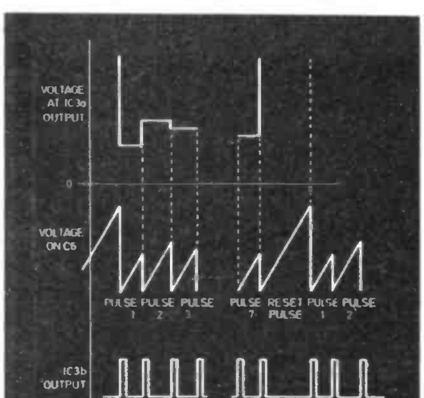


Fig. 1.4. Encoder waveforms.

TRANSMITTER

Resistors

R1	2·7kΩ	R17	560Ω
R2	2·7kΩ	R18	4·7kΩ
R3	1·6kΩ	R19	47kΩ
R4	68kΩ	R20	47kΩ
R5	68kΩ	R21	12kΩ
R6	68kΩ	R22	2·2kΩ
R7	68kΩ	R23	15kΩ
R8	68kΩ	R24	1·5kΩ
R9	68kΩ	R25	5·6kΩ
R10	68kΩ	R26	150Ω
R11	33kΩ	R27	3·9kΩ
R12	47kΩ 1%	R28	1kΩ
R13	47kΩ 1%	R29	3·9kΩ
R14	100kΩ	R30	100Ω
R15	8·2kΩ	R31	1kΩ
R16	1·2kΩ		

R12, R13 ¼W ±1% metal oxide. All others ¼W ±2% metal film.

Potentiometers

VR1-6 5kΩ carbon track, linear law (6 off) *part of stick assembly—see below*
VR7 4·7kΩ horizontal mounting miniature skeleton preset

Switches

S1 miniature toggle switch s.p.d.t.
S2 Noble slide switch d.p.d.t. (SLM)

Capacitors

C1 0·033μF disc ceramic 10V
C2 0·033μF disc ceramic 10V
C3 0·033μF disc ceramic 10V
C4 22μF 25V elect.
C5 0·033μF disc ceramic 10V
C6 0·22μF polyester (see text)
C7 0·033μF disc ceramic 10V
C8 0·033μF disc ceramic 10V
C9 0·1μF disc ceramic 25V
C10 0·1μF disc ceramic 25V
C11 0·033μF disc ceramic 10V
VC1,2 2-22pF miniature polypropylene trimmer (2 off)

Semiconductors

TR1 ZTX300 *npn* silicon
TR2 ZTX500 *pnp* silicon
TR3 ZTX107 *npn* silicon
TR4 ZTX500 *pnp* silicon
TR5 ZTX504 *pnp* silicon
TR6 ZTX500 *pnp* silicon
TR7 2N3866 *npn* silicon
D1, D2 ZN458T 2·45V 5mA high tol. reference (Ferranti)
D3 BZY88C8V2 8·2V Zener
IC1 MC14051 CMOS analogue switch multiplexer (Motorola)
IC2 MC14024 CMOS 7-stage binary counter (Motorola)
IC3 LM324 Quad *pnp* input op. amp. (National)

REGULATED SUPPLY

To ensure the accuracy of the voltage seen at the wiper of the stick pots the sticks have to be set across an accurate voltage supply. This is achieved by the shunt regulator D1, R17 and C3. Again this uses an accurate Zener reference D1 to maintain a good performance over temperature and supply voltage changes. This regulated supply is also for the reference voltages on IC3a and 1C3b.

Because of the possibilities of r.f. being picked up on the encoder there is a buffer stage made up of TR1, L1 and R18 to block any stray r.f. Point "C" then becomes the output to the modulator section.

MODULATOR

TR6 is the modulator transistor which is used to 100 per cent modulate the P.A. stage; it is driven by the signal *"C"* from the encoder section. C9 slows down the edges of the modulation envelope thus reducing spurious radiation caused by sharp switching of r.f. signals.

R.F. SECTION

The requirement of the r.f. stage is to produce a stable 27MHz signal capable of operating on 25kHz spacing between channels with as little as possible (and preferably none at all) radiating interference on other r.f. bands. This r.f. signal then needs to be modulated with the relevant encoded information from the encoder section.

The stable 27MHz signal is produced by the crystal oscillator TR5, R24, R25, R26, C8 and L2. The output of the oscillator is then tuned by VC1 and L3. This series-tuned circuit serves a second function in tuning the input of the power amplifier TR7 and so making for a more efficient stage.

The power amplifier TR7 is a standard Class C r.f. amplifier with L4 as a collector load. R31 is introduced to reduce the *Q* or "goodness" of the load L4, thus avoiding any instability in the P.A. stage.

TUNED OUTPUT

The T network of the P.A. stage formed by L5, L6 and VC2 serves two purposes. First it enables the output impedance of the P.A. stage to be matched to the impedance of the aerial in use; second it filters out any harmonics which may be present in the r.f. signal. C10 is introduced to provide a d.c. block to the aerial to avoid excessive d.c. currents flowing should the aerial become accidentally shorted to the transmitter case or even ground, for instance when the transmitter is left switched on on damp grass.

Fig. 1.5 shows the relationship of the modulation envelope to the incoming encoded signal *"C"*.

POWER SUPPLY

The whole of the transmitter circuits run off a 9·6V nominal voltage battery supply. To enable the state of

Inductors
L1 3·3μH r.f. choke
L2 10μH r.f. choke
L3 3·3μH r.f. choke
L4 10μH r.f. choke
L5 6·8μH r.f. choke
L6 10μH r.f. choke
} Maplin

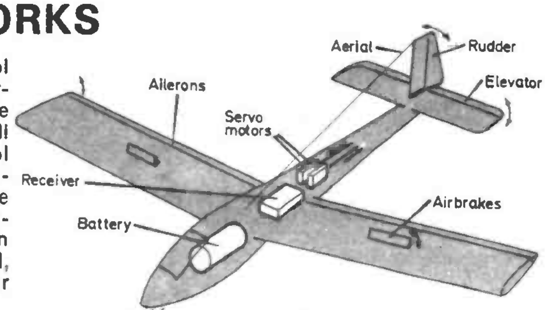
Battery
B1 9·6V 500mAH button cell Nicad battery pack

Meter
ME1 miniature meter 100μA d.c. f.s.d.

Sockets
SK1 p.c.b. socket block 3-pin 7-way with plugs (SLM)
SK2 DIN socket 3-way
SK3 crystal socket, horizontal mounting (SLM)

Miscellaneous*
Nicad button cell end-caps (2 off)
Dual-axis open gimble sticks including 2 potentiometers (2 off)
Single-axis auxiliary sticks including 1 potentiometer (2 off)
Metal case with plastics side panels.
Aerial. Aerial base.
**All available from* SLM Model Engineers, Cheltenham.

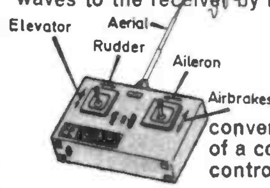
HOW IT WORKS



The EE Radio Control System is a pulse proportional system utilising the 27MHz radio band. Like all forms of remote control the idea is to transmit information from one place to another in order to control some function and in this case control a model, whether it is a car, boat or aircraft.

The information starts out as a voltage across a potentiometer connected to the control sticks. This voltage is then converted into a digital pulse whose width is proportional to the voltage. Several of these pulses are grouped together into a series pulse train, one for each function to be controlled, and the whole train is repeated 50 times each second to enable changes in information to be quickly transferred to the model.

With the information now in digital form, it is then transmitted by the radio waves to the receiver by the switching on and off of the carrier wave (amplitude modulation). The radio waves are received by the receiver in the same way as a normal domestic receiver and then the pulse train is fed into a decoder where the pulses are split up into their individual channels. Each pulse now goes into a servo which converts this variable pulse width into the physical movement of a control arm which can then be used to move a particular control function of the car, boat or aircraft.



these batteries to be monitored a small meter ME1 is used to measure the supply voltage. The batteries used are the nickel-cadmium type of rechargeable cells and as such have a very shallow discharge curve during their "useful life" after which the voltage drops off very quickly.

A fully charged eight-cell pack gives around 10 volts out, and fully discharged 8·5 volts—so to enable us to see this discharge process in more detail we can use an offset meter technique by inserting a Zener diode (D3) in series with the meter which then gives the meter a starting voltage of 8·2V in the low position. R23 is then used to set the full-scale voltage. With a 100μA f.s.d. meter a 15 kilohm resistor gives full scale of around 10V.

It will be found that after the batteries have been taken off charge and the set switched on the meter needle will probably hit the end stop; however it will soon settle down away from the stop after a couple of minutes use.

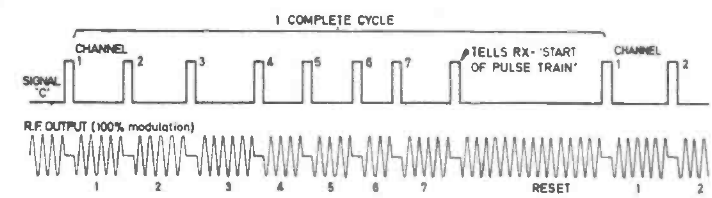


Fig. 1.5. Related waveforms of the encoder output and the modulated envelope of the P.A. stage output.

TABLE 1.1.
CHANNEL CONFIGURATIONS AVAILABLE AND REQUIRED STICKS

No. of Channels	Single Axis Sticks	Dual Axis Sticks	Aux Stick	Switch
2	2	–	–	–
3	1	1	–	–
3	2	–	1	–
4	–	2	–	–
4	1	1	1	–
5	–	2	1	–
6	–	2	2	–
6	–	2	1	1
7	–	2	2	1

CHARGING

Charging is accomplished by connecting to pins 2 (earth) and 3 (+ve) of the DIN socket, when the set is switched off, and passing a constant current through the cells. More details of this will be given when the charger is described later in the series.

Another facility on the set is to be able to use an external power source by connecting to pins 2 (earth) and 1 (+ve) on the DIN connector. This was used by the authors to enable the transmitter to be used for long days on the flying field where the five hours to be expected from the internal batteries was not sufficient. Switch S2 must be set to "off" when using an external power supply, otherwise the internal battery will be "on-charge".

HOW MANY CHANNELS

The system as already described has seven channels, so the components list shows the components required for all seven channels. However, depending upon your requirements (and pocket) you can in fact build any size of system from two channels up to the full seven channels.

Next month we will be describing how to construct a transmitter covering from two to seven channels. In the intervening period you can make up your mind on your system size and purchase the required parts.

In order to help you Table 1.1 shows some of the many channel configurations available and the required sticks. When deciding upon the system size do not just judge upon your present requirements but try and plan for the future as modifications later on can be very messy and untidy. We ourselves strongly advise the full system as this should see you through a good few years service and give you good value for money.

Next Month: Building the transmitter

LETTERS

Great Interest

I am writing this letter to express my thanks to your great magazine (EE). I started to buy EE two years ago, and when I received my copies I read them with great interest but deep down I didn't understand a word of the scientific jargon, but within the two years of reading EE I have become familiar with most of the Electronic World including the Microprocessor and I have already built a Labcentre designed to my needs. So I thank you for the knowledge I now possess.

S. Barton,
Spalding,
Lincs.

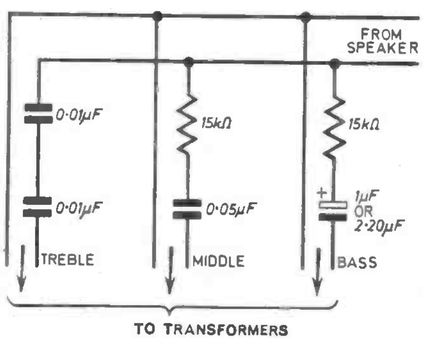
Sound Division

I have built your *Sound-to-Light Unit* with 3 Channels.

I thought that you may be interested to see how I divided my frequencies; bass, middle and treble, see Fig. 1.

Thank you for a most interesting magazine.

M. A. Garty,
Bristol.



Hot Ferric

I have only just read the excellent article on making Printed Circuit Boards (January 1979) and while I cannot fault it, I think a word of warning might not be out of place.

A year or two ago we produced our own Etching Kits and in the process I learnt quite a lot about Ferric Chloride. Judging by the picture in the article the Ferric Chloride used by the writer is a fairly weak commercial type, rock hard and not too easy to dissolve but it has the advantage of having no heat problems.

There is on the market to-day quite a big quantity of Ex-Government, pure anhydrous Ferric Chloride which is almost a different substance. It is usually double packed in thick plastic and double sealed. It has the appearance of dark brown ground coffee and it is much stronger. About one and a half desert spoonfuls (plastic of course) would make enough etching solution for several boards. Its one drawback is that it produces intense heat in contact with water. We advise customers always to add the crystals to the water a little at a time, and not the other way round.

To give you a rough idea of the heat generated, if you add something less than two desert spoonfuls to a jam jar, one third filled with water, by the time the last of the chemical is added, it is too hot to pick up! Another odd side effect we found, and that is, if you make the solution a little too strong, *no etching* will take place!

Although it is always looked upon as poisonous and corrosive and should always be treated as such, you may be surprised to learn that it was used for water purification by the American Forces.

A. Sproxton, Director,
Home Radio, Mitcham.

Better Reception

I have just completed the construction of your *Pocket Radio,* shown in the June 1979 issue. I have found the performance was very poor, the volume control having little effect on the volume being produced.

I narrowed this problem down to C4, value 10µF, this takes several seconds to charge up and therefore is too large. I replaced it with a smaller 0·1µF non-electrolytic capacitor. This enables the volume control to be used to the best of its ability.

I live in an area of strong signal strength, but the radio still gives a poor performance I decided, therefore, to use an external aerial—a 30ft piece of gash co-ax cable. This can be plugged in to the radio when it is used in my bedroom. (A 0·1 to 0·22µF capacitor was placed between the aerial and the tuning capacitor). The Radio now gives a much better reception than before.

I hope this information may prove useful to other readers.

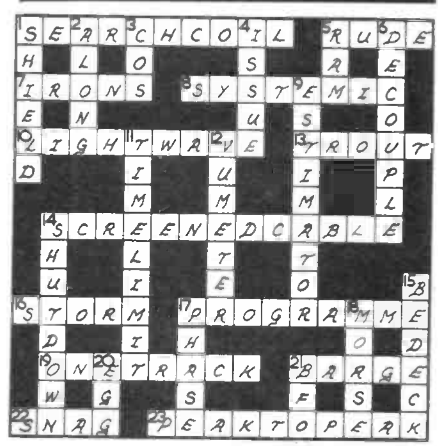
K. P. Holohan
Preston,
Lancs.

PLEASE TAKE NOTE

NICKEL CADMIUM BATTERY MONITOR (*September 1979*)

On page 587, column 3, paragraph 1, line 7 should read . . . equipment *switched Off* all should . . .

Crossword No. 21—Solution



JACK PLUG & FAMILY...

BY DOUG BAKER

Everyday News

BIG REWARDS FOR MICRO IDEAS

Three announcements this month (September) help to highlight the efforts being made to get to grips with the microelectronics revolution.

BRITISH MICROPROCESSOR COMPETITION

Suddenly everyone can get into the microprocessor scene, yes even amateurs, by entering the British Microprocessor Competition organised by its joint sponsors—the National Research Development Corporation (NRDC) and the National Computing Centre Limited (NCC). Their aim—to stimulate and encourage British innovation in the use of microprocessors in any type of product, process or service. This is a competition for the best invention incorporating a programmable microelectronic device.

Prize money totalling £20,000 will be awarded to entries with working models, and those without a working model. First, second and third prizes in the working model category are £10,000, £5,000 and £2,000 respectively, whilst first and second prizes in entries without working examples are £2,000 and £1,000.

The competition is open to all individual residents in the UK, including UK registered companies, and other organisations located in the UK such as universities, polytechnics and other institutions engaged in education or research.

The NRDC and NCC staff will judge the competition with 4 main criteria in mind—the degree of novelty, its potential commercial value, the technical and commercial viability and the standard of documentation.

Although the winners names will be announced next year their ideas will be protected; publication only taking place when patent protection exists. All rights are protected for the designer and there is no obligation for further involvement by either party.

The NRDC, which this year celebrates 30 years of idea development, have indicated their willingness to look at non-winner ideas along with the winners inventions with a view to offering financial support to develop them. A sum of half a million pounds has been allocated to provide just this backup!

The closing date of the competition is Friday, 14 December 1979 and official Entry Forms and details are freely available from The National Computing Centre, Oxford Road, Manchester M1 7ED.

NATIONAL MICROELECTRONICS COMPETITION

A rent-free £30,000 factory for one year is one of the inducements being offered by the Peterborough Development Corporation in the National Microelectronics Competition.

The aim of the NMC is to find ideas which are simple to manufacture and have got a ready market. Top prize is £4,000 and the only restriction is that no company with a turnover in excess of £2 million may enter. The challenge is to prove that the application is technically sound and that it can be produced and sold at a profit.

The Corporation, with the sponsorship of Barclays Bank and Finance for Industry, offers apart from the new factory, the prospect of £250,000 venture capital from Finance for Industry.

Closing date for the National Electronics Competition is 31 January 1980.

REGIONAL HELP

Another local authority promoting interest in microelectronics is the Lothian Regional Council of Scotland. They plan to fund a micro aid plan to the tune of £350,000 over the next five years, which they hope will bring microelectronic technology to companies in the area.

This initiative will bring the Edinburgh University Wolfson Microelectric Institute directly into contact with local firms regardless of their level of technical knowhow. They also hope that local schools and polytechnics will become involved.

Part of the £70,000 per year investment will go towards setting up a new professorship of microelectronics at Edinburgh University and also help to fund three high level engineers, who will seek potential applications of microelectronics. The engineers will approach companies rather than wait for potential micro users to make the first response.

On the Air

Europe's largest supplier of mobile radio, Pye Telecommunications Ltd., recently made known its views on the subject of CB radio.

In the event of the Government deciding in favour of CB, they feel that the u.h.f. frequency band would be the most appropriate. They argue that u.h.f. is more suitable for the high population density of the UK.

The use of u.h.f. prevents interference with hi fi, television, radio and other electronic devices. It will also avoid harmonic interference into other users of the spectrum, police, fire, ambulance services etc.

Predictable range and channel re-usability is possible with u.h.f. Using u.h.f. gives high quality transmission and reception.

Finally, selection of the u.h.f. band would avoid the problem of the re-allocation of existing users, model control, which would make 27MHz CB slow and costly to implement.

International Prestel

The British Post Office is to test-market an international Prestel service for travelling businessmen and government officials.

The trial is planned to last a year and will cover selected users in up to six countries. If there is sufficient interest the international service will be additional to the UK national Prestel service.

YOUNG ENGINEER FINALS

HRH The Prince of Wales will present the "Young Engineer for Britain 1979" awards at the national final to be held at the Wembley Conference Centre on October 25.

A record entry of over 300 youngsters with some 180 projects joined the trail to become "Young Engineer for Britain 1979". Following regional finals which were held around the country during June and July, 38 projects have been selected to appear at the national final. These cover a wide range of applications from a wind tunnel to a leaf raking machine and from a signature reproducing machine to an emotionally active robot.

Boss sells Boss

Having built up Boss Industrial Mouldings Ltd., into one of Europe's largest manufacturers of enclosures, indicators, breadboarding systems and other hardware products, Ian Boss has formally sold all his interest in the organisation which now becomes part of the Pistor Elektrotechnik Group of West Germany.

—ANALYSIS

THE FILLING IN THE SANDWICH

There are many big producers who are not mass producers, but batch producers of many different products. A batch may be half a dozen units or fifty or so. They may be for specific customers with different delivery dates. Individual finished units may need to be married up into a system and tested as such before shipment. The number of different units being made at any one time may run into hundreds.

This is the sort of manufacturing operation undertaken at Hewlett-Packard's minicomputer facility at Grenoble, France. Cyril Yansouni, the plant's general manager, had quite a problem in keeping tabs on where every product in various stages of assembly was and what was happening to it. He already had those two indispensables, computer-aided design and computer-aided automatic test equipment at the outer ends but needed, as it were, the filling in the sandwich.

He calls it CAM (Computer-Aided Manufacturing) and spent 30 months designing the equipment and integrating the system in his own plant.

The cornerstone of his CAM system is shop-floor data capture using specially designed easy-to-use computer terminals at every stage of manufacture to provide real-time product tracking information at every stage of production, assembly and testing.

Over 1,200 products a week pass through the production lines. Each is given a traveller card which stays with it at every stage. The terminals have two slots, one for a badge reader which identifies the person using it, the other for the traveller card which carries data about the product, what it is, who has ordered it etc. Date and time of arrival in a department is automatically transferred with the rest of the data to the central computer.

The result of the exercise is that production is speeded up and bottlenecks eliminated. At the same time the cost of components being worked on along the lines has been cut by about £1 million despite the factory output having doubled in two years.

Nobody is working any harder than they did before. And nobody is losing his job. In fact they are planning to expand the work-force from 500 to 800 people in the coming year.

Part of this increase is due to the data capture terminals which H-P is now marketing. Over a thousand will have been made and shipped to other manufacturers with similar problems by the end of this year.

Brian G. Peck.

Engineering Famine

Despite relatively high unemployment figures there is a serious shortage of engineering staff. Earlier this year GEC alone had vacancies for 1,600 engineers, 1,100 technicians and 800 craftsmen.

Those training now for the electrical and electronics professions and trades need never be out of work.

VIDEO NEWS

Firm evidence of the growth of electronic news gathering and associated technologies in Europe is provided in the latest contracts placed with Sony Broadcast Ltd.

During the past six weeks orders totalling some £858,000 have been placed for Sony video recording equipment by the State Broadcasting organisations of Austria, Italy, Poland and Switzerland.

A specialist Viewdata Exhibition for information providers and others professionally engaged in using and operating viewdata and teletext systems is to be held at the West Centre Hotel, London, on November 7-8.

BREADBOARD '79

This year's Breadboard 79, the kits and bits show for the home electronics enthusiast, has moved to larger premises.

The venue is the Royal Horticultural Halls, Elverton Street, Westminster, London, SW1, from 4 December to 8 December inclusive.

Over 90 exhibition stands will feature microcomputer systems, analysers, logic test accessories, hi fi amplifier kits, as well as a varied range of construction kits and TV games.

Everyday Electronics will be there.

MOBILE JAM

Mobile radio channels have become so congested that the Home Office is to conduct trials with single sideband transmission with 5kHz channel spacing. Present channel spacing with frequency and amplitude modulation is 12·5kHz or 25kHz.

SSB could double the number of channels usable with no interference, thus allowing for considerable expansion of the mobile services used by businessmen and other organisations.

LOOKING BACK

A 20 page booklet to mark the 50th anniversary of the formation of Pye Radio Ltd., is now available, free of charge, to readers on application to Pye Ltd., Publications Dept, 137 Ditton Walk, Cambridge.

The Story of Pye Wireless traces the history of Pye Receivers from when they were originally produced by W. G. Pye & Co. Written by Gordon Bussey the publication is illustrated with photographs of receivers from 1922 onwards and scenes in the Pye factory early years.

UK-USA PHONE CABLE GETS GREEN LIGHT

The final seal was placed on an international agreement recently for a new £100 million telephone cable between Britain and the USA that will boost Britain's transatlantic cable links by more than 50 per cent.

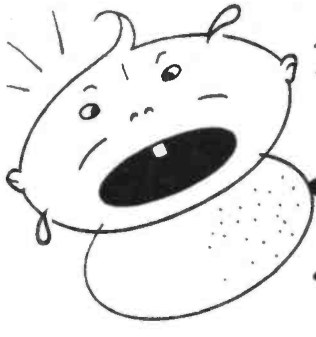
At present more than 20 million phone calls are made each year between the UK and USA, and more than half go by cable. The demand for telephone service between the two countries has been growing by a steady 15-20 per cent a year throughout the 1970s and shows no sign of slackening.

Called *TAT 7*, this giant submarine system, with a capacity of 4,200 simultaneous connections, will carry phone calls, computer data and telex messages between Europe and the USA and Canada. A sizeable part of its cost will be spent in Britain on cable manufacture.

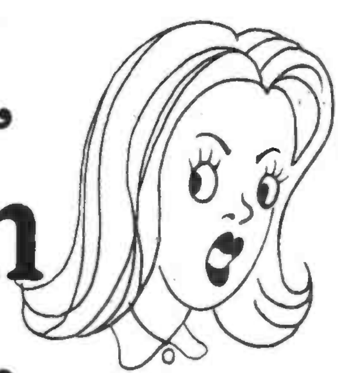
The new system is due to come into service in 1983. It will run some 3,400 nautical miles between Porthcurno (Land's End) and Tuckerton, New Jersey. At the British end it will continue for some two miles inland, terminating at the Post Office's Land's End repeater station.

The cost of the project is being divided equally between North America and Europe. On the European side, Britain is partnered by 17 other participants and her share—22 per cent of the total, is the largest of all those. There are seven participants in the project on the North American side, including the American Telephone and Telegraph Company which has the largest single share in the system, amounting to some 40 per cent of the total.

Manufacture of the new system will be shared between the USA, Britain and France. About 2,700 miles of cable will be made in Britain by Standard Telephone and Cables Ltd, under a contract worth some £30 million.



Baby Alarm



By E. M. Lyndsell

THIS piece of equipment has been devised to allow sounds generated in one place to be heard in another. In particular, from one room where a baby or child is situated to another, such as the bedroom or lounge occupied by the parents or baby sitter. The unit uses a microphone to pickup the sounds and these signals are amplified to produce the same sound in a loudspeaker mounted in the control box.

The Baby Alarm is completely safe, and the child is in no danger if he/she "acquires" the unit. The alarm is powered by a single PP3 9V battery and is economical, quiescent current being approximately 2·5 milliamps.

CIRCUIT DESCRIPTION

The complete circuit diagram of the Baby Alarm is shown in Fig. 1.

Signals generated in the crystal microphone insert MIC1 are passed to a high impedance buffer amplifier TR1, and f.e.t. wired as a source follower. This stage provides no amplification, but is included to provide low loading on the crystal microphone which is essential for a flat frequency response.

The effect of high loading on such a microphone is to provide a very "tinny" effect. Not entirely essential for specified application, this stage does however allow the circuit to be used in other applications where clear speech is required, e.g. an intercom.

The output from the source follower appears across VR1 used as a volume control, and from here to IC1, connected as a non-inverting amplifier. Resistors R6 and R7 provide the necessary biasing for an op-amp operating from a single power supply. Gain is approximately equal to the ratio of R5 to R4 i.e. 1000. The output signal is fed to and heard in LS1.

CONSTRUCTION starts here

CONSTRUCTION

The prototype unit used a piece of 0·1 inch circuit board size 20 strips x 30 holes. The uppermost five strips are not used electrically but provide space for mounting screws. The prototype used self-adhesive horizontal mounting strips in preference to fixing nuts and bolts.

The layout of the components on the topside of the board and the breaks to be made along the copper strips on the underside are shown in Fig. 2.

Begin by soldering in the wire links followed by the resistors and capacitors. Take care when soldering in the f.e.t.s as these can be easily damaged when being soldered. Use of heat-shunts is recommended. F.e.t.s can also suffer damage by "leaky" irons. A couple of turns of tinned wire wrapped around and shorting all leads during soldering will prevent such damage. Remember to remove the wire afterwards. Finally position and solder in IC1.

Sufficient lengths of flying leads should next be connected to the board. A short length of

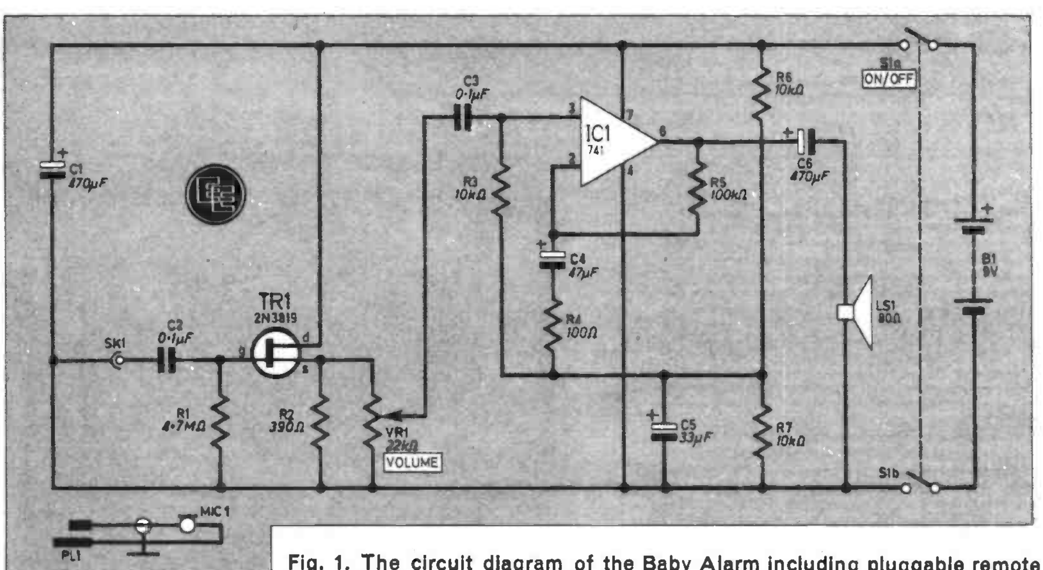
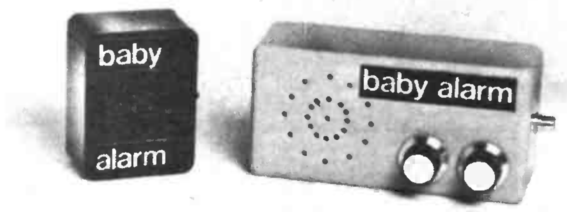


Fig. 1. The circuit diagram of the Baby Alarm including pluggable remote microphone.



Baby Alarm

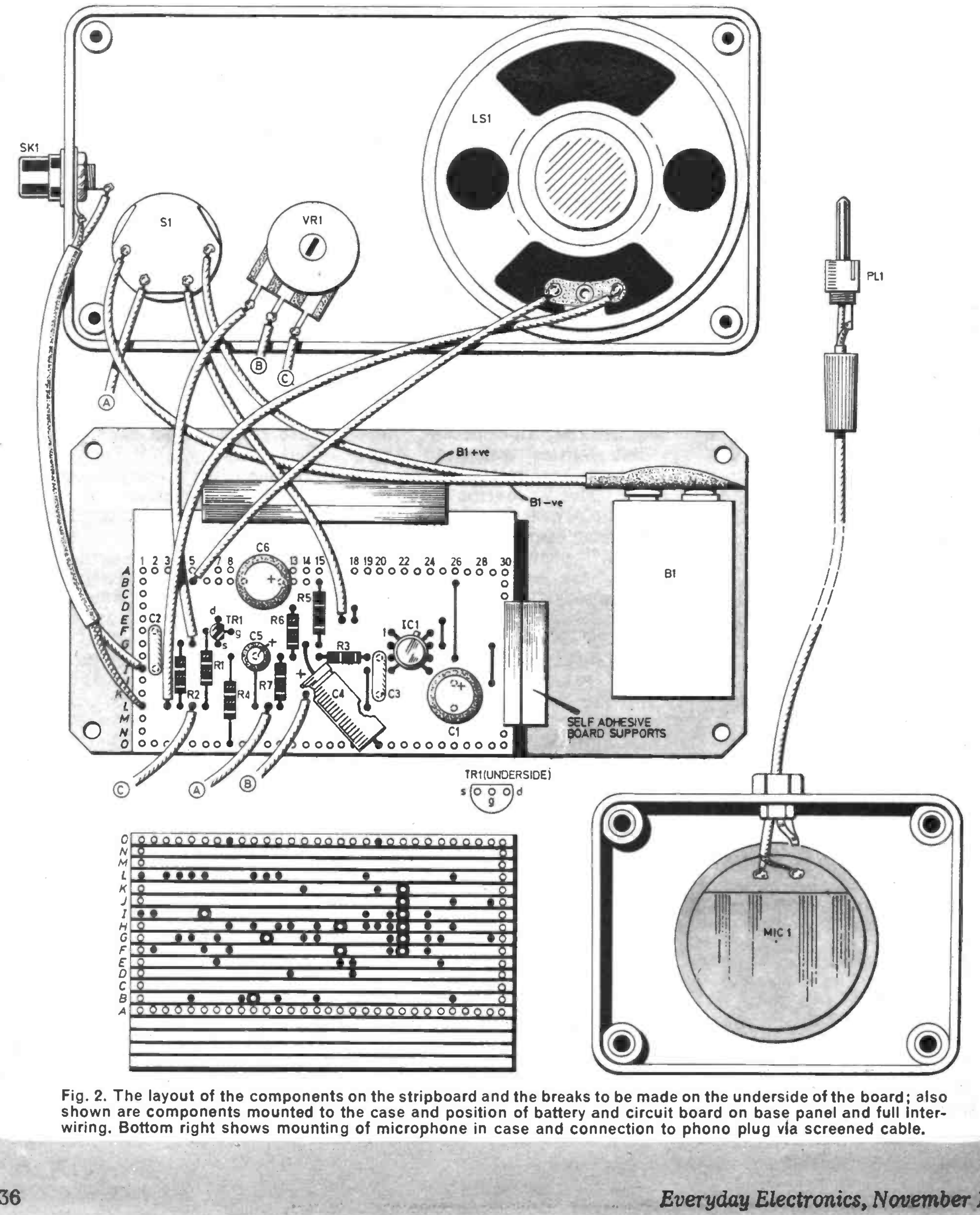
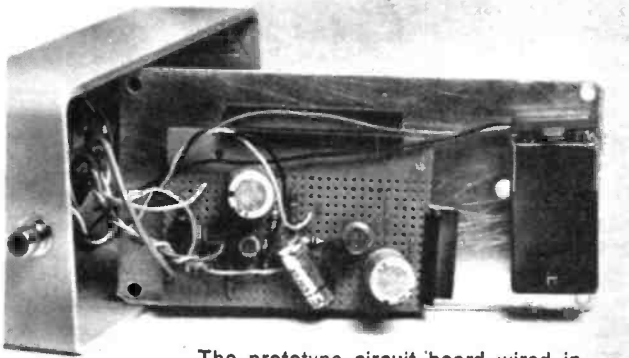
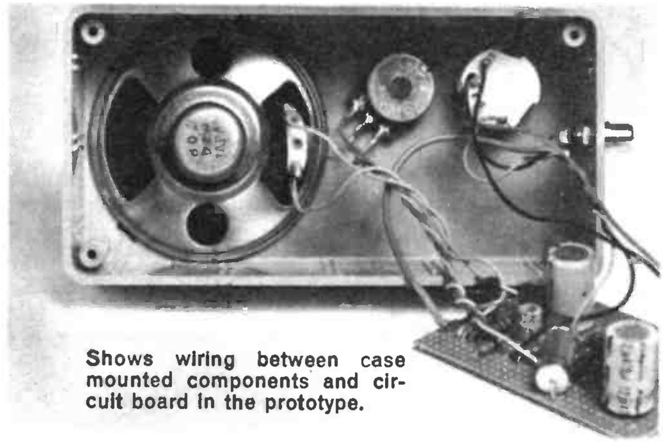


Fig. 2. The layout of the components on the stripboard and the breaks to be made on the underside of the board; also shown are components mounted to the case and position of battery and circuit board on base panel and full interwiring. Bottom right shows mounting of microphone in case and connection to phono plug via screened cable.



The prototype circuit board wired in and fitted to the base panel.



Shows wiring between case mounted components and circuit board in the prototype.

screened lead to connect to the input socket SK1 was used in the prototype, but this is not essential.

CASE

The author used a plastic box to house the unit, approximate dimensions 150×75×45mm. The case was used "inverted" so as not to show any panel fixing screws. The intended front panel is used for the base panel to which the circuit board and battery are fixed. The latter was secured with a self adhesive foam pad.

Prepare the box to accommodate S1, VR1 and SK1 and drill a pattern of holes above where the speaker is to be positioned to allow the sound to escape and reach the user.

In the prototype the speaker was glued in position using a polystyrene glue. Fix the components and wire up to the board as shown in Fig. 3.

The base panel (lid) can now be secured, and rubber feet fitted for good measure.

MICROPHONE

The microphone is mounted in a smaller plastic box (inverted as before). Drill a pattern of holes above MIC1 position and glue the latter in place. Solder sufficient lengths of screened cable to MIC1 to join the two boxes in their final positions. The cable should pass out through a gripping (or stain relief) grommet and terminate in a plug to match SK1.

TESTING

Plug the two units together and switch on. A click should be heard in the loudspeaker. Turn up the volume control. If the two boxes are less than about a couple of metres apart, a feedback howl will be heard. With the microphone at a distance from the control box, a sound source such as a portable radio placed near the microphone will be heard in LS1. Turning VR1 clockwise should increase the volume.

Remove the sound source. A small amount of hissing may be heard with VR1 fully advanced. Hum was absent on the prototype. Handling the cable will produce noise; for this reason the cable should be firmly secured when the unit is finally fitted.

If all is well the units may be fitted in their respective rooms and can either stand on any flat surface or be mounted on the wall, the latter suiting the microphone, keeping it out of reach. A single "keyhole" cutout on the backpanel will allow single screw fixing.

By a suitable switching arrangement, two microphones and two speakers, the Baby Alarm can be converted to function as a two-way intercom. ⌑

COMPONENTS

Resistors

R1	4·7MΩ
R2	390Ω
R3	10kΩ
R4	100Ω
R5	100kΩ
R6	10kΩ
R7	10kΩ

All ¼W carbon ± 5%

Capacitors

C1	470μF 10V elect.
C2	0·1μF plastic or ceramic
C3	0·1μF plastic or ceramic
C4	47μF 10V elect.
C5	33μF 6V elect.
C6	470μF 10V elect.

Semiconductors

TR1	2N3819 *n*-channel f.e.t.
IC1	741 differential op-amp 8-pin d.i.l.

Miscellaneous

MIC1	crystal microphone insert
S1	d.p. on-off rotary switch
VR1	22 kilohm carbon log. law
SK1	phono socket
LS1	miniature loudspeaker 80Ω 70mm diameter
B1	9V (PP3)
PL1	phono plug

Stripboard: 0·1 inch matrix, 20 strips × 30 holes; PP3 battery connector; knobs (2 off); board mounts; screened cable; grommet; cases (2 off).

See Shop Talk page 742

COMPONENTS approximate cost £4.00 excluding cases and screened cable

BRIGHT IDEAS

SUPER PHOTODETECTOR

It is clear, on looking at prices of photodetectors (photo emissive types, photo transistors, l.d.r.s, etc.) that these devices are by no means cheap; the least expensive component I have found is the 2N5777 photo Darlington at 60p. With a little care, it is possible to produce one's own photo transistors, at a fraction of the cost.

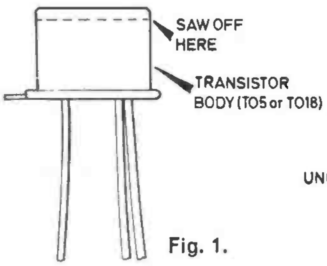


Fig. 1.

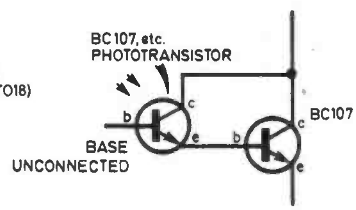


Fig. 2.

Take a transistor in a TO5 or TO18 can, such as a BC107, and, using a fine razor saw carefully remove the top of the transistor, taking care not to squash the can (see Fig. 1). Carefully shake out any particles of metal which may have fallen inside the transistor.

You will find that the innards of the transistor are now exposed to the environment, and if light is allowed to fall onto the chip, you have a photo transistor. If desired, a few drops of cold setting, clear plastic resin may be poured into the can to afford some protection, but this is not essential.

Leaving the base unconnected, in fairly bright sunlight I found that a BC107 would pass 200μA. This sensitivity may easily be increased by using another BC107 transistor, the two being connected as a super-alpha pair (see Fig. 2). There should now be enough sensitivity to drive a relay without further amplification.

By this method, either *npn* or *pnp* silicon photo transistors can be made, much cheaper than the cost of a ready made device. Also, the response is very fast, better than some l.d.r.s.

Peter F. Vaughan, Lynton.

BUTTON STOP

When using twin-core (figure of 8) cable, I bind the separated ends of the cable with a small 4-holed button. This stops the split in the cable from lengthening, see Fig. 1.

A. A. Moore, Preston, Lancs.

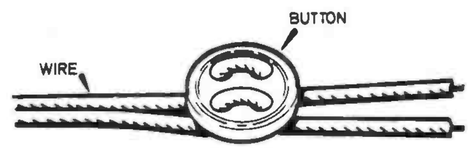


Fig. 1.

NEXT MONTH

MODULATED TONE GENERATOR

Creates a distinctive sound of rapidly changing pitch at power outputs up to 4·5 watts. Applications range from burglar alarms to timers.

LIGHTCALL

A visual indicator for the doorbell.

PLUS SIMPLE NOVELTIES FOR THE FESTIVE SEASON

BURGLAR ALARM

The second project in our *Uniboard* series will protect your home.

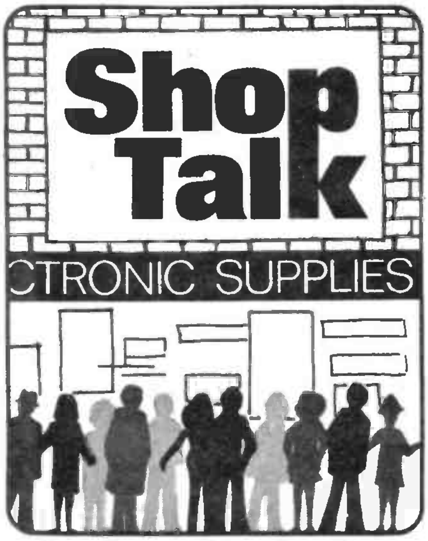
Christmas is Coming —Check your Lights

Tracing a faulty bulb in a string of series-connected bulbs such as those used for decorating a Christmas tree used to be a long, tedious task. NOT any longer! This article describes a quick method of pinpointing the faulty bulb, with hints on extending bulb life and ideas for "electronic" decorations.

There will be a great demand for our December issue so ensure YOUR copy well in advance. See your Newsagent NOW!

Everyday ELECTRONICS

DECEMBER ISSUE ON SALE FRIDAY, NOVEMBER 16 Price 45p

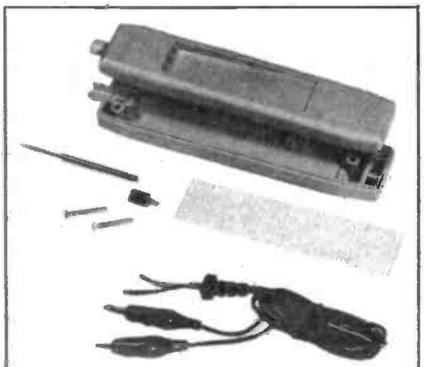


By Dave Barrington

Test Case

Knowing the pride constructors take in the appearance of their finished projects, we make no excuse for returning to the subject of cases again this month.

Ideally suited to housing test gear accessories such as signal injectors, logic probes, small counters, voltage and resistance probes, and continuity checkers, the CTP-1 probe case from Continental Specialties Corporation comes complete with associated hardware.



CTP-1 case kit from Continental Specialities.

Based on the case used in their LPK-1 logic probe kit it is supplied complete with a 3ft length of two-wire connecting lead with a moulded strain reliever and terminated with "croc clips", a nickel-plated screw-in probe tip, a mating tapped hex probe-tip connector, assembly screws, and a cut to size blank printed circuit board.

Also available from CSC is their latest 32-page product catalogue which features their range of circuit breadboarding equipment, logic testing devices and test instrumentation.

Products featured include a range of solderless breadboards and breadboard assemblies, test clips, instrument cases, pulse and function generators, frequency counters and accessories, logic probes, logic monitors and a digital pulser.

Copies of the catalogue and further details of the CTP-1 probe case can be obtained from Continental Specialties Corporation, Dept EE, Shire Hill Industrial Estate, Saffron Walden, Essex, CB11 3AQ.

Teach-In '80

For those readers about to order components for the *EE Tutor Deck* and *Teach-In 80* experiments, we have just heard that due to increase costs Home Radio have had to increase the price of the complete kits of parts for this project and experiments up to Part 6, to £22·50. (List A—£19. B—£4).

However, we understand that Greenweld and A. Marshall (London) Ltd have no plans, at the present time, to increase their published prices. Also, the following advertisers are able to supply complete kits of parts: Ace Mailtronix, Electrovalue, Magenta and Watford Electronics.

Tool sets

More renowned for their top grade soldering equipment, Light Soldering Developments Ltd. are now marketing four handy miniature tool sets.

Each set comes in a plastic case with transparent lid and the tools have chromium plated brass handles. The kits are made up of screwdrivers, open and socket spanners and cross-point screwdrivers.

The set of six instrument screwdrivers (Model. 1113), have hardened and tempered steel blades ranging in width from 0·8 to 3·8mm and retail at £2·93 including VAT. The 19 piece combination set, type 37228, consists of open and socket spanners, 5/64in to 5/16in across flats, socket head, cross head and plain screwdrivers, and a scriber and is priced at £5·12.

A set of five metric box spanners, model 37227, with a tommy bar with hardened and tempered steel ends come in a range of sizes from 3 to 5mm at £2·93. The fourth tool set, (model 37305) comprises two cross point screwdrivers, three hexagonal key wrenches (1·5, 2 and 2·5mm A.F.) and tommy bar at £3·93.

Light Soldering Developments tool sets.

Addresses of nearest stockists can be obtained from Light Soldering Developments Ltd., (Dept. EE), 97-99 Gloucester Road, Croydon, Surrey.

CONSTRUCTIONAL PROJECTS

EE Radio Control System

Our star project this month is part one of the *EE Radio Control System* series and obviously will call for some special components. These will be described fully in the various articles.

Apart from the special electromechanical items, the majority of components should be generally available. The special components are usually stocked by local radio control shops, but any readers experiencing difficulties can order them from S.L.M. (Model) Engineers Ltd., Dept EE, Chiltern Road, Prestbury, Cheltenham, Glos, GL52 5JQ.

3-Function Generator

The only item likely to cause concern in the *3-Function Generator* is the integrated circuit IC1.

We have found that the 8038 is only available from Maplin Electronic Supplies or through R. S. Components dealers.

MW/LW Radio Tuner

For the *MW & LW Radio Tuner*, the slow motion (Jackson 'O' gang type) tuning capacitor is listed in the Maplin, Watford and Home Radio catalogues. However, the specified coils seem to be rare and only stocked by Home Radio Components.

Baby Alarm

The 741 integrated circuit used in the prototype model of the *Baby Alarm* was a TO-5 can type with preformed leads. The 8-pin d.i.l. plastic package is more common and readily available and can directly replace the can type.

Quite a number of readers will already possess a high impedance microphone so therefore the mic. insert could be omitted and SK1 chosen to suit your mic. plug.

The use of a rotary switch for S1 is optional and any double-pole toggle switch will suffice.

Opto Alarm

The first in our *Uniboards* series is a simple *Opto Alarm.*

There are numerous solid state buzzers on the market at the moment and it is worth shopping around for this item as prices seem to vary quite considerably.

The thyristor type MCR102 would appear to be only available from Maplin but the 2N5060, 2N5061 and 2N5062 types are suitable replacements.

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CAPACITORS

Electrolytic Axial Leads — Order Code
−10% to +50% Tol Cap 015+µF+V. d.c.

µF \ V d.c.	16	25	40	63
1·0				9
1·5				9
2·2				9
3·3				9
4·7				9
6·8			9	10
10		8		10
15	8		9	11
22		8		13
33	8		9	
47		8	11	13
68	9			
100		9	13	
150	9	10		31
220	13		26	36
330			30	40
470		23	32	47
680	21	30	39	54
1000	25	30	59	
1500	35	39		
2200	42			

Trimmers — Order Code
250V D.C. Wkg. Film Dielectric, Miniature

1·4 – 4·1pF	20	Cap 808 A
2 – 8pF	20	Cap 808 B
2 – 20pF	22	Cap 808 C
5·5 – 69·5pF	31	Cap 808 D

Electrolytic Radial Leads — Order Code
−10% to +50% Tol. Cap 034 +µF+Volts

µF \ Vd.c.	6·3	10	16	25	35	40	50	63
·47								7
·68								7
1·0								7
1·5								7
2·2								7
3·3								7
4·7						7		8
6·8				7			8	9
10			7			8		9
15			7	8			9	11
22		7	8			9	11	
33			8	9		11		
47		8	9		11			
68			9	11				
100		9	11					
150		11						
220	11							

Electrolytic Can Type — Order Code
High Ripple, IEC Grade 1, Low E.S.R. — Cap HR+µF + Volts
Supplied complete with Vertical Fixing Clip

10000µF	16V	Ripple 5·8A @ 85°C	8·1A @ 50°C	238
22000µF	16V	9·8A	13·7A	370
4700µF	25V	4·6A	6·4A	215
10000µF	25V	8·0A	11·2A	282
22000µF	25V	12·8A	17·9A	469
4700µF	40V	5·6A	7·8A	248
10000µF	40V	9·2A	12·8A	393
4700µF	70V	7·5A	10·5A	403

Miniature Low Value — Order Code
Polystyrene, Axial ±1 Tol., >63V D.C. Wkg — Cap 424
Ceramic Plate, Radial, Low K 100V D.C. Wkg. — Cap 632
Ceramic Plate, Radial, Med K, 100V D.C. Wkg. — Cap 530
Ceramic Plate, Radial, High K, 63V D.C. Wkg. — Cap 629 + Value

pF	424	632	pF	424	632	630	nF	424	629
1			100	18	7		10	27	8
1·2			120	18	9		12	29	
1·5			150	18	9		15	29	
1·8		6	180	18	9		18	31	
2·2		6	220	18	9		22	31	9
2·7		6	270	20	9		27	42	
3·3		6	330	20	9		33	45	
3·9		6	390	20		6	39	50	
4·7		6	470	20		6			
5·6		6	560	20		6			
6·8		6	680	20		6			
8·2		6	820	20		6			
10		6	1000	20		6			
12		6	1200	20		6			
15		6	1500	20		7			
18		6	1800	20		7			
22		6	2200	20		7			
27		6	2700	20		7			
33		6	3300	20		7			
39		6	3900	20		7			
47		6	4700	25		8			
56		7	5600	25					
68		7	6800	25					
82		7	8200	25					

Polyester Radial Leads — Order Code
Dipped Type C280/352 Style — Cap 352
Moulded Type, 10·2mm Pitch — Cap 360 + Value

µF	352	360	µF	352	360
·001		7	·1	7	9
·0015		7	·15	8	10
·0022	6	7	·22	9	11
·0033	6	7	·33	11	
·0047	6	7	·47	14	
·0068	6	7	·68	17	
·01	6	8	1·0	21	
·015	6	8	1·5	30	
·022	6	8	2·2	35	
·033	6	8			
·047	6	8			
·068	7	8			

Tantalum Bead — Order Code
20% Tol. Cap PR+µF+Volts

µF \ V d.c.	10	16	25	35
0·1				11
0·22				11
0·47				11
1				11
2·2		11		13
4·7		12	16	18
10	13	16	18	22
22		18		
47	22			

INTEGRATED CIRCUITS

4000 Buffered C-MOS—High Speed

HEF4000	17	HEF4044	84	HEF4512	110
HEF4001	17	HEF4046	106	HEF4514	250
HEF4002	17	HEF4047	87	HEF4515	299
HEF4006	95	HEF4049	45	HEF4516	101
HEF4007	17	HEF4050	45	HEF4517	382
HEF4008	80	HEF4051	69	HEF4518	94
HEF4011	17	HEF4052	72	HEF4519	55
HEF4012	17	HEF4053	72	HEF4520	94
HEF4013	45	HEF4066	49	HEF4521	188
HEF4014	84	HEF4067	380	HEF4528	99
HEF4015	80	HEF4068	17	HEF4532	120
HEF4016	45	HEF4069	17	HEF4534	510
HEF4017	80	HEF4070	17	HEF4539	110
HEF4018	80	HEF4071	18	HEF4543	155
HEF4019	46	HEF4072	18	HEF4555	78
HEF4020	89	HEF4073	18	HEF4556	78
HEF4021	85	HEF4075	18	HEF4557	386
HEF4022	82	HEF4076	104	HEF4585	97
HEF4023	17	HEF4077	17	HEF4724	171
HEF4024	62	HEF4078	18	HEF40097	90
HEF4025	17	HEF4081	18	HEF40098	73
HEF4026	195	HEF4082	18	HEF40106	62
HEF4027	45	HEF4085	64	HEF40160	119
HEF4028	71	HEF4086	64	HEF40161	119
HEF4029	90	HEF4093	50	HEF40162	119
HEF4030	46	HEF4094	176	HEF40163	119
HEF4031	200	HEF4104	166	HEF40174	119
HEF4035	110	HEF4502	91	HEF40175	119
HEF4040	85	HEF4505	571	HEF40192	140
HEF4041	75	HEF4508	184	HEF40193	140
HEF4042	66	HEF4510	108	HEF40194	119
HEF4043	80	HEF4511	125	HEF40195	119

7400 T.T.L.

N7400N	13	N7444N	92	N74122N	40	N74193N	91
N7401N	14	N7445N	85	N74123N	77	N74194N	73
N7402N	14	N7446AN	85	N74125N	37	N74195N	57
N7403N	14	N7447AN	71	N74126N	37	N74198N	135
N7404N	16	N7448AN	92	N74128N	38	N74199N	122
N7405N	16	N7450N	14	N74132N	38	N74221N	77
N7406N	32	N7451N	14	N74145N	57	N74279N	61
N7407N	32	N7453N	14	N74147N	98	N74298N	71
N7408N	16	N7454N	14	N74148N	86	N74365N	59
N7409N	16	N7460N	14	N74150N	91	N74366N	59
N7410N	14	N7470N	28	N74151N	46	N74367N	59
N7411N	16	N7472N	19	N74153N	43	N74368N	59
N7412N	14	N7473N	28	N74154N	91		
N7413N	23	N7474N	24	N74155N	46		
N7414N	31	N7475N	34	N74156N	46	**74LS**	
N7416N	21	N7476N	30	N74157N	43	N74LS00N	19
N7417N	21	N7480N	32	N74158N	43	N74LS01N	19
N7420N	14	N7483N	63	N74160N	63	N74LS02N	19
N7421N	16	N7485N	80	N74161N	63	N74LS03N	19
N7425N	19	N7486N	25	N74162N	63	N74LS04N	27
N7426N	20	N7490N	40	N74163N	63	N74LS05N	27
N7427N	20	N7491AN	57	N74164N	86	N74LS08N	27
N7428N	23	N7492N	40	N74165N	86	N74LS09N	27
N7430N	14	N7493N	40	N74166N	86	N74LS10N	19
N7432N	20	N7494N	67	N74170N	122	N74LS11N	26
N7433N	23	N7495AN	46	N74173N	77	N74LS12N	26
N7437N	21	N7496N	67	N74174N	77	N74LS13N	48
N7438N	21	N74100N	92	N74175N	55	N74LS14N	74
N7439N	30	N74107N	26	N74180N	57	N74LS15N	26
N7440N	14	N74109N	45	N74181N	205	N74LS20N	19
N7442N	51	N74116N	92	N74182N	57	N74LS21N	26
N7443N	92	N74121N	28	N74192N	91	N74LS22N	26

N74LS28N	35	N74LS138N	99	N74LS253N	117
N74LS30N	19	N74LS139N	99	N74LS257N	117
N74LS32N	27	N74LS153N	88	N74LS258N	117
N74LS33N	35	N74LS154N	138	N74LS260N	29
N74LS37N	35	N74LS155N	93	N74LS261N	321
N74LS38N	35	N74LS156N	93	N74LS266N	54
N74LS40N	27	N74LS157N	93	N74LS273N	143
N74LS42N	60	N74LS158N	97	N74LS283N	117
N74LS51N	27	N74LS160N	129	N74LS290N	117
N74LS54N	27	N74LS161N	117	N74LS293N	119
N74LS55N	27	N74LS162N	144	N74LS298N	149
N74LS73N	35	N74LS163N	117	N74LS365N	121
N74LS75N	44	N74LS164N	119	N74LS366N	121
N74LS76N	46	N74LS170N	220	N74LS367N	121
N74LS78N	39	N74LS173N	132	N74LS368N	121
N74LS83AN	106	N74LS174N	141	N74LS373N	173
N74LS85N	104	N74LS176N	119	N74LS374N	173
N74LS86N	39	N74LS181N	306	N74LS375N	117
N74LS90N	59	N74LS190N	117	N74LS378N	158
N74LS92N	76	N74LS191N	117	N74LS386N	56
N74LS93N	76	N74LS192N	119	N74LS390N	196
N74LS95BN	82	N74LS193N	119	N74LS393N	196
N74LS96N	126	N74LS194N	161	N74LS395N	207
N74LS107N	41	N74LS195AN	119	N74LS490N	143
N74LS109N	45	N74LS196N	132	N74LS670N	239
N74LS112N	45	N74LS197N	132		
N74LS113N	45	N74LS240N	206		
N74LS114N	45	N74LS241N	206		
N74LS125N	53	N74LS242N	206		
N74LS126N	53	N74LS243N	206		
N74LS132N	78	N74LS244N	206		
N74LS136N	49	N74LS251N	117		

LINEAR

CA3046	84	TL081CP	84
CA3080E	77	TL084CN	156
CA3130E	99	UA741CN	20
CA3140E	48	UA741CT	47
CA3189E	293	UA748CN	39
LM301AN	34		
LM339N	78		
LM380N	104		
LM381AN	198		
LM3900N	75		
MC1458N	39	**Voltage Regulators**	
MC3403P	156		
NE531	131		
NE536T	259	LM309DA (K)	119
NE555N	28	UA723CN	42
NE556N	66	UA7805CU	78
NE566N	171	UA7812CU	78
NE570N	486	UA7815CU	78
NE571N	505	UA7912CU	97
RC4136	146	UA7915CU	97
TBA1205	88	UA78L05CS	38
TDA1022	713	UA78L12CS	38
TDA1034B	239	UA78L15CS	38

Zener Diodes
400mW C4V7-C33
BZY88/BZX79 + Voltage 9

CASES—Boss Industrial Mouldings

Small Desk Console—Boss Industrial Mouldings
Slope Front Console. Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
W161, D96, H39 (57)	214	Case BIM1005 OR
W215, D130, H47 (73)	308	Case BIM1006 OR

Plastic Boxes
Moulded Box and Close Fitting Flanged Lid
ABS Box, C/W Brass Bushes, and Lid in Orange

		Order Code
L112 W62 D31	99	Case BIM2003 OR
L150 W80 D50	131	Case BIM2005 OR
L190 W110 D60	223	Case BIM2006 OR

Plastic Boxes with Metal Lids
Recessed Top Box
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
L85 W56 D29	112	Case BIM4003 OR
L111 W71 D42	150	Case BIM4004 OR
L161 W96 D53	208	Case BIM4005 OR

Diecast Boxes
Diecast Box and Flanged Lid
Aluminium Box and Lid in Natural Finish

		Order Code
L113 W63 D31	124	Case BIM5003 NA
L152 W82 D50	215	Case BIM5005 NA
L192 W113 D61	334	Case BIM5006 NA

Small Desk Consoles
Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey
Ventilation Slots in Base

		Order Code
W105 D143 H32 (56)	236	Case BIM6005 OR
W170 D143 H32 (56)	312	Case BIM6006 OR
W170 D214 H32 (82)	431	Case BIM6007 OR

OPTO ELECTRONICS

			Order Code
Light Emitting Diodes, Individual			
·125" (3mm)	Red	16	CQY54
	Green	18	CQY95
	Yellow	20	CQY97
Panel Mounting Clip to suit.		3	LED3 Clip
·2" (5mm)	Red	16	CQY24A
	Green	18	CQY94
	Yellow	20	CQY96
Panel Mounting Clip to suit.		5	LED5 Clip
Photoresistors			
ORP12		95	ORP12
ORP61		95	ORP61
Phototransistors			
OCP71		220	OCP71
BPX25		195	BPX25
BPX29		195	BPX29
Photocoupler			
FCD820		165	FCD820

HARDWARE

D.I.L. Sockets

8 Pin Low Profile Socket Tin	12	DIL SKT 8
14 Pin Profile Socket Tin	14	DIL SKT 14
16 Pin Low Profile Socket Tin	16	DIL SKT 16

Heatsinks

Individual Type for 1 × TO5 50° C/W	12	Sink 5F
Individual Type for 1 × TO66 10·5° C/W	28	Sink TV2
Individual Type for 1 × TO3 7·2° C/W	26	Sink TV3
Individual Type for 1 × TO126 17° C/W	25	Sink TV4
Individual Type for 1 × TO220 17° C/W	26	Sink TV5

P.C.B. Components
Dalo Pen, Blue Ink, Slow Drying 98 Pen 33PC

SWITCHES

		Order Code
Miniature Toggle—Honeywell		
SPDT	67	SW 8A1011
SPDT C/Off	81	SW 8A1021
SPDT Double Bias To Centre	90	SW 8A1041
SPDT Single Bias To Centre	90	SW 8A1051
SPDT Bias	84	SW 8A1061
DPDT	99	SW 8A2011
DPDT C/Off	111	SW 8A2021
DPDT Double Bias To Centre	123	SW 8A2041
DPDT Single Bias To Centre	123	SW 8A2051
DPDT Bias	116	SW 8A2061
Miniature Push—C & K		
SP Push to Make, Momentary	62	SW 8531
SP Push to Break, Momentary	62	SW 8533

MAINS TRANSFORMERS

Order Code
Secondaries may be connected in series or parallel to give wide voltage range
Primaries 0-220, 240V

6VA—Clamp Type Construction 235 ea.
Approx. 18% Regulation. F.C. 54, H36, W35

0-4·5V, 0-4·5V Secondaries	Trans 6VA	45
0-6V, 0-6V		60
0-12V, 0-12V		120
0-15V, 0-15V		150
0-20V, 0-20V		200

20VA—Clamp Type Construction 360 ea.
Approx. 16% Regulation F.C. 70, H48

0-4·5V, 0-4·5V Secondaries	Trans 20VA	45
0-6V, 0-6V		60
0-12V, 0-12V		120
0-15V, 0-15V		150
0-17·5V, 0-17·5V		175
0-20V, 0-20V		200

SEMICONDUCTORS

IN914	5	BC182L	12
IN4001	5	BC184	11
IN4002	5	BC184L	12
IN4004	7	BC212	11
IN4007	9	BC212L	12
IN4148	4	BC214	11
IN5402	15	BC214L	12
2N2218A	31	BC547	13
2N2369	21	BC548	11
2N2646	46	BC549	12
2N2926G	13	BC557	15
2N3053	19	BC558	15
2N3054	55	BCY70	15
2N3055	55	BCY71	16
2N3055 Full ISB Test	95	BD131	39
2N3442	155	BD132	39
2N3702	9	BD139	39
2N3704	9	BD140	39
2N3705	10	BFR90	333
2N3773	297	BFX85	29
2N3819	22	BFY50	17
2N3820	39	BFY51	17
2N3904	9	BFY52	20
2N5457	39	BLX65	262
2N5459	35	BLY93A	2977
40673	88	BRY39	50
AC188	24	BSX20	21
AD161	42	CL8960	2850
AD162	42	MPF102	36
BAW95D	1200	OA91	8
BC107	14	OC28	118
BC108	14	OC35	105
BC108C	18	TIP31A	48
BC109	14	TIP32A	54
BC109B	19	TIP41C	76
BC109C	20	TIP42C	76
BC148	10	TIP2955	75
BC158	10	TIP3055	60
BC177	17	TIS43	36
BC179	20	ZTX109C	16
BC182	11		

RUMMAGING AROUND

with Keith Cadbury

USEFUL SUCKER

One of my main sources of high quality components for stock is the "Goody Bag". Whenever I visit my local electronics shop, I rummage in his "junk" bins and usually select a bag or two of assorted "goodies".

Until recently the various p.c.b.'s that I had collected from these bags of components had been gathering dust. Most of the components on the boards had leads too short to cut, and removing them with a soldering iron proved to be one hell of a laborious task, resorted to only in emergency, when a particular component has been needed that was not available from another source.

A recent acquisition has resulted in all the boards being stripped of 75 per cent of their components, and at a very fast rate. I now have a stock of several hundred close-tolerance resistors, items which have previously been bought only as required.

The acquisition that made it all so easy was a device called a "Soldersucker". A sort of suction device with a Teflon nozzle, it can be primed and discharged with one hand easily, while the other hand is used to apply the soldering iron to the soldered component. The Soldersucker draws away molten solder with fantastic force that has to be seen to be believed, and after repeating the operation at each of the joints, the component can be lifted out, sometimes without the need to heat the "de-soldered" joints again.

So simple and so quick, I just didn't realise how easy its use makes the removal of components. I would not have considered spending over a fiver on the tool, but as I have now had the chance to prove its worth at, relatively speaking, no cost (it was amongst a large "job lot" I was fortunate enough to obtain for a few quid recently) I have no hesitation in recommending its worth.

It would soon cover its cost. I have recovered, in good order, something like eighty pounds' worth of transistors, 1 per cent resistors, integrated circuits and capacitors, with the aid of the Soldersucker!

I dream of an electronic house, where everything is controlled from a central position. Heating, lighting, ventilation, entertainment, security, cooking, washing and so on.

To sit in a Captain Kirk-type of armchair and to be in complete control of one's immediate environment seems to me to be quite possible, given today's State of the Art. And given the time and the money to make it all!

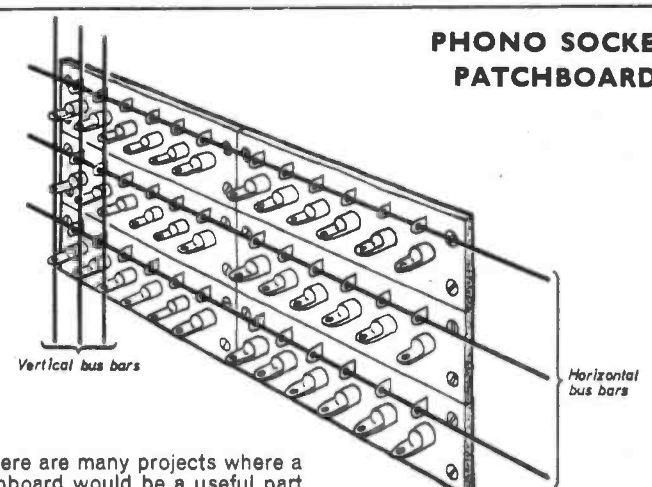
A robot to take the dog for a walk; three VTR's always recording all TV output, recalled by ultrasonic instruction at a moment's notice for replay on one of the many colour televisions around the house; similar audio recorders for five or six radio programme transmissions; automatic tending of the garden. What bliss, but for how long, before the whole caboodle becomes an absolute bore? You would get no exercise ever, and you would possibly die of a heart attack brought about by the effort of rising from your control chair to go to bed.

Nevertheless, those readers who dream of more electronickery will realise the necessity of a patchboard, to alter various parameters that may need adjustment—how long grandma is allowed in the bath before the water automatically drains away; grilling times for the T-bone steaks; securing the fridge and freezer when hungry teenagers go prowling.

Even more modest projects will benefit from a patchboard—it would be an additional item of equipment that could prove very useful to the enthusiast's audio set-up, especially where creative tape-recording is undertaken.

The patchboard described here is adequate for all projects the writer has worked on to date, and can be made at a fraction of the cost of a "bought" item.

PHONO SOCKET PATCHBOARD



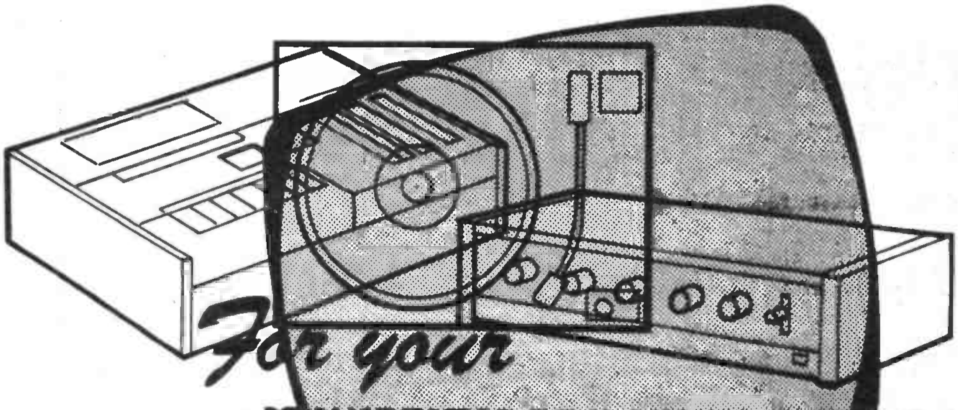
There are many projects where a patchboard would be a useful part of the circuitry—given one hell of a lot of money to spend! For example, the Maplin catalogue price quoted for a 30 × 30 hole patchboard is £88·38p. It seems to me that my-very-cheap alternative would suffice in nine out of ten applications.

Chassis mounting phono sockets are available on Paxolin boards containing numbers of sockets from one to eight, from Maplin, and work out at under 5p per socket in most cases. For example, to make an alternative to Maplin's 10 × 10 hole board costs under a fiver, using twenty of the five-socket boards, compared with £19·55p.

I used single strands of copper wire, about 1½mm thick, from a length of electricians' heavy-duty cable, which was soldered as shown in the illustration. Careful drilling and mounting of the boards is needed to make the finished job look neat—but then care is needed with all electronic work anyway!

And that's not all—the plugs are much less expensive also. Ordinary phono plugs cost under 10p, and can either be shorted out, or small resistors or capacitors can be connected across the terminals, inside the cover. Use plastic plugs (which are the cheapest) and devise your own colour code so that you can tell at a glance whether the connections are shorted or joined through a component. The wireable component plugs listed by Maplin for their 10 × 10 board cost 59p each, compared with 9p for my alternative!

Yer pays yer money and takes yer choice—for me, Mr Hobson dictates, prompted by the bank manager, tax collector, starving children and shoeless wife.



For your ENTERTAINMENT

By ADRIAN HOPE

Wireless Telegraphy Act

The legality of remote and radio control understandably confuses many people. Here are the facts in a nutshell. The Wireless Telegraphy Act prohibits the use of any unauthorised radio station.

This wording covers both transmitters and receivers. So it is not only illegal to transmit any radio frequencies (such as CB radio) without authorisation, it is also illegal to receive them.

It follows that it is also illegal to use a radar speed trap detector in a car. These devices pick up police radar speed check signals and convert them into an audible alarm.

Under the Wireless Telegraphy Act it is also illegal to use a radio controlled model boat, car or aeroplane. But whereas no authorisation and licences are available to transmit pirate radio programmes or receive police radar signals, licences are available for the transmission of non-speech radio remote control signals to models and toys.

The penalty for any illegal transmission or reception, whether Citizens Band chat, radar trap avoidance, pirate radio pop music transmission or radio remote control of a toy, is the same; a fine of up to £400 and/or 3 months in jail. It is, of course, highly unlikely that anyone using a remote control toy would be fined as much as someone transmitting a pirate radio programme, but the penalty is available to a court.

Direct Link

Fortunately, because the Wireless Telegraphy Act covers only radio frequencies, it does not cover the use of ultrasonic, or infra red, or visible light, or laser light, links for remote control or other communication, even of speech and music. Thus it is perfectly legal to use links of this type without a licence. The snag is that such links are far more directional than radio links.

In Japan it is now possible to buy a gramophone turntable that contains a built-in high quality stereo radio transmitter which operates on a v.h.f. f.m. band. The gramophone signal can thus be picked up by a v.h.f. f.m. receiver anywhere in the house. So the user can install a turntable in one room and an amplifier and hi fi system in the other without any cable links. This would be illegal in the UK.

Ultrasonic or infra red links need something close to line-of-sight relationship, so cannot offer a comparable facility. Also infra red links can be disturbed or "broken" by direct sunlight, as the sun emits considerable infra red radiation.

I recall eyewitness tales of an impressive demonstration several years ago which was set up to show off the prowess of a remote controlled fire fighting device. The robot-like gadget was designed to sense the infra red radiation produced by a fire, turn, drive towards it and then loose off the contents of a fire extinguisher.

The demonstration took place out of doors and a can of petrol was duly ignited. It was Summer, but a dull day. Then, just as the petrol burst into a ball of flames, the sun broke through the clouds. The robot's sensor picked up the sun's infra red radiation and latched onto its direction. The gadget stopped dead in its tracks, tilted back and loosed the contents of its fire extinguisher into the sky.

Take-away Car Radio

In-car-entertainment or ICE is now big business. It's easy to pay around £300 for a combined radio and cassette player; and that's excluding loudspeakers, and extras like booster amplifiers, graphic equalisers and exotic aerials.

Understandably many motorists are reluctant to install such expensive equipment because it's akin to leaving several hundred pounds laying in the dashboard pocket ready for a thief to grab. Even worse, the thief will probably smash the door, break a window or slit your sunshine roof to get access.

Burglar alarms are one answer, but by no means 100 per cent. Another answer is that offered by car radio firm Voxson.

The Voxson Tanga range of radios, now being fitted as standard to small Fiat cars, is the very opposite of secure. The radio is a plug-in module that the driver removes every time the car is left unattended.

The really clever part of the scheme is that they have made the removable module small enough to fit into a pouch that hangs on a key ring along with the car keys. A socket is secured to the car dashboard and as this socket contains only a single chip audio amplifier it isn't worth stealing. The tiny plug-in module contains all the r.f. and i.f. circuitry, a tuning control and a volume control. There's a separate colour-coded module for longwave, medium wave and v.h.f. reception.

Provided you remember to pull out the module when you park there's nothing left to encourage a thief.

War on CB

I learned recently how CB helped us win the war in Africa. Of course it wasn't called CB then, but the wavelength, 27MHz was the same.

Before World War II such frequencies seemed unmanageably high. But spurred on by the impetus of war the USA, Japan and Germany all made military equipment to work on this band.

One of the characteristics of "27 meg", and indeed one of the reasons why no one wants it for CB in the UK, is that it can skip across Continents. A signal beams up into the sky bouncing off the upper atmosphere and down to earth again thousands of miles away.

In 1942 an amateur radio enthusiast in the USA heard German conversations on his experimental 27 meg receiver. He brought in a German speaking friend who reckoned the conversation sounded like military chat between tank commanders.

The American army moved in and discovered that the signals were skipping across the world from Rommel's tanks in North Africa. They could only be picked up within a radius of a few miles and night after night the army in the USA monitored the signals from Africa and sent them back to Field Marshall Montgomery in Africa. Thus, although Montgomery was out of range of Rommel's low power 27MHz transmitters, he soon knew everything the "Desert Fox" was saying to his troops.

RADIO WORLD

By Pat Hawker, G3VA

Amateur News Service

For over 24 years, a specialised "broadcast" news service entirely independent of the BBC and IBA has quietly but efficiently existed in the United Kingdom: the RSGB's weekly "GB2RS" bulletins transmitted every Sunday morning from amateur radio stations in different parts of the country. The bulletins provide news and information of interest to all radio amateurs and short-wave listeners.

An important extension to this service has just been introduced: the bulletin now, for the first time, goes out at 1100 hours local time on 7·0475MHz using conventional amplitude modulation and can thus be heard by listeners with run-of-the-mill "all-band" radio receivers.

Previously all GB2RS transmissions have been on 3·5 or 144MHz, often using single-sideband or narrow-band frequency modulation, frequencies and modes seldom available to listeners not equipped with communications receivers designed specifically for radio amateurs.

The 7MHz transmissions will usually come from the station of Gordon Adams, G3LEQ at Knutsford, Cheshire and reception in the UK will depend on the "short skip" conditions to be expected at this stage of the sunspot cycle.

Apart from 7MHz the new schedules include seven transmissions at different times from different sites on 3650kHz (3640 or 3660kHz in Scotland) using ssb or a.m.; eight transmissions on ssb on 144·250MHz; and 19 transmissions on 145·525MHz nbfm, together providing coverage in most parts of the UK.

The service was launched in September 1955 by Frank Hicks-Arnold, G6MB on behalf of the Radio Society of Great Britain. Since then one of the London news-readers, Arthur Milne, G2MI of Bromley, Kent has read the bulletin on more than 1000 Sundays; he can usually be heard making the first transmission on 3·65MHz each Sunday at 0930 local time.

A condition imposed by the Home Office is that the weekly scripts, prepared at RSGB headquarters, have to be vetted by them in advance. Bulletins provide details of national and international happenings and events affecting amateurs, contest results, propagation conditions, news of amateur expeditions ("dxpeditions"), OSCAR satellite orbital predictions and the like.

There is also a weekly bulletin for radio-teleprinting (rtty) enthusiasts transmitted under the call-sign GB2ATG in the 3·5 and 144MHz bands—of course on radio teleprinters.

In these days when there is much interest in the concepts of local and community radio broadcasting, GB2RS provides an interesting example of an alternative concept: that of reaching nationally a relatively small segment of the population. By using their own communications transmitters the radio amateurs have shown a way of doing this at low cost.

Radiation Non-hazards

Events at the Kensington fire station, where in August radiation meters appeared to detect harmful levels of ionizing radiation but where it was shown by staff of the National Radiological Protection Board apparently to have been caused by harmless non-ionizing radiation from the short-wave transmitters of the nearby Israeli Embassy, have underlined once again how difficult it is for the lay public (and even the experts) to judge just what levels and types of radiation are potentially harmful.

Most scientists and engineers accept that the present officially recommended levels for non-ionizing radiation from microwave and other radio transmissions, even though set empirically many years ago, have proved remarkably satisfactory, though there still remain doubts in some minds as to possible biological effects at levels too low to cause appreciable local heating.

Contrariwise there are some grounds for thinking that low levels of h.f. radiation may even have a beneficial, preventive effect in regard to certain diseases.

Microwave Bombardment

Part of the confusion in the public mind was brought about by the much publicised "bombardment" by microwaves of the US Embassy in Moscow some years ago. Many people rushed to the conclusion that this was all a deliberate attempt to affect the health of the American diplomats.

Less well known is that it has become clear since then that the real reason was a Russian attempt to prevent interception of their microwave telecommunications links by receivers in the Embassy, a practice they were themselves doing in the USA. There is considerable evidence that their embassies and consulates contain microwave aerials and receivers which can intercept telephone traffic to and from Government buildings, using computers programmed to select automatically conversations likely to be of interest.

Many embassies, of course, have h.f. radio transmitters that enable the diplomats to communicate directly with their own countries. My daily walk to work through Belgravia takes me past several large and very prominent "log-periodic" h.f. beam arrays, while even a casual look at many of the other diplomatic buildings in the area reveal more modest transmitting aerials. And some countries still favour "disguised" aerials, hidden in flag poles, etc either in deference to environmental considerations or as a relic from the days when diplomatic radio links were virtually a form of under-cover "pirate" operation.

Today it is all highly "legal" under Article 27 of the Vienna Convention on Diplomatic Relations which gives to missions the right of free communication in code or cipher, although still insisting that missions "may install and use a wireless transmitter only with the consent of the receiving state". Occasionally problems arise from the transmitters causing interference to television reception in the area, a matter which has to be handled with diplomacy.

Why So Slow?

Among the reasons why so many hobbyists would welcome a CB system are the difficulties, the delays and the expense of obtaining an amateur radio licence. It takes too long and costs too much for a youngster to acquire a Class A or a Class B amateur licence. It is not just a question of the technical standards but also the administrative delays. Now that the Radio Amateurs Examination is based on "multiple choice" questions, capable of being marked very rapidly, why is it usually September before candidates learn whether they have passed an examination held in May? And why do candidates have to apply to take the examination so long beforehand?

With a sufficiently large pool of multiple choice questions it should surely be possible to arrange that applicants could take the exam at any time, virtually on a walk-in basis, just as those living near a Post Office coast station or Marine Radio Surveyor's Office can take the Morse test at any time of the year. Time seems so very important to a youngster itching to get on the air.

I was fortunate enough, as a schoolboy, to take out my licence before there was such a thing as a technical examination but considerable technical interest in radio communication!

In these days of factory "appliances" there is a lot to be said for checking that applicants do know something about the technology—but nothing at all to be said for putting such long delays into the system.

Further evidence of the value and importance of encouraging amateur radio emerged in the aftermath of the floods in west India and in the path of Hurricane David in Dominica where for a period the only link with the outside world was via an amateur station operating from batteries.

"Just a moment while I get my calculator".

WORKSHOP MATTERS

By Harry T. Kitchen

Marking-Out

Last month I advocated the creating of a drawing, however elementary, of the required marking-out; I also explained the reason for doing this in reverse. Let us now look at marking out, cutting, and bending a fictitious front panel. In real life, of course, you will substitute your own requirements.

Let us agree on a front panel measuring 10in by 6in, and let us work in imperial since so many of us do so in our private lives, whatever measurements we may use at work. Let us also decide that the panel will be secured to the cabinet by means of flanges $\frac{1}{2}$in wide, bent inwards, and at right angles to the panel. Immediately this gives us the overall size of 11in by 7in. We cut this from a larger sheet of aluminium, or obtain it cut to size.

All four sides will, naturally, be absolutely square. We must mark out our datum lines, commencing with the two centre lines. Set the combination square to $5\frac{1}{2}$in and scribe a small line; likewise at $3\frac{1}{2}$in. Using the square, now extend these lines until they intersect, bang in the centre of the panel, dividing the sheet into four exactly equal portions.

The position of every hole, top to bottom, side to side, is, in good engineering practice, referred back to these centre lines, so their exact positioning is critical. So too is every bending line. Errors are thus confined to one reference line.

Now if we happily start at one end and carry on, line to line to line, errors can accumulate, possibly disastrously. Say every line is out by 25 thou., in itself a wide or a narrow limit depending on applied criteria, then six holes, or lines, later on you will be out of position by 0·025in × 6 or 0·150in. That hole or line being out of position could completely ruin the panel.

Fixing Flanges

The fixing flanges require a somewhat different approach. If you mark the panel to precisely 10in by 6in it will not fit. Why? Well, you haven't allowed for the thickness of the metal. For a precision panel you must subtract the thickness of the panel from the bending dimensions.

In round figures let us say the panel is 25 thou. thick. So you set your combination square to 5in and 3in from the centre lines, and then as well as you are able to, you subtract 25 thou. each time, top and bottom, and both sides. Then scribe the bending lines. With decent luck you will achieve a panel that is a perfect fit. When bentl

Now we can set about the holes required. Round holes are easy; at the intersection of appropriate horizontal and vertical datum lines use a centre punch and lightly "pop" the precise point. Then use engineers' dividers to draw the circle required. Square or rectangular holes also use the horizontal and vertical datum lines. Locate the centre of the hole then, halving the width and length scribe its limits above and below, and to either side of the datum lines.

Let me reiterate that these lines will have been scribed on the reverse side of the panel so that the outer side is unblemished when the panel is completed. Got it wrong? So have I before, and I dare say, will again.

Cutting Out Holes

Having a panel marked out, we can commence cutting out the holes. There are various tools on the market designed to facilitate this chore. Let us however confine ourselves to easily and cheaply obtained hand tools. Of inestimable value is the *Abrafile*, available in various diameters. I have had mine for many years, and they range from $\frac{3}{4}$in diameter to some that will fit a fretsaw; just the job for cutting holes in metal panels.

For round holes, drill a starting hole just inside the circumference of the required hole somewhat larger than the *Abrafile*, or other round file you propose using. Insert your file and away you go, all around the hole, just inside the scribed cricle. Enlarge the hole to the required size, and remove all rough edges, by use of a smooth half round or round file. Smaller holes are simply enlarged in size by judicious use of a round file.

Square or rectangular holes are tackled in a similar manner. Again a starting hole is drilled, this time in one corner. Again you set off with your trusty round file, filing away just inside the scribed lines. Finally you square off the corners and straighten up the sides by use of a smooth Hand file or Flat file.

Alternatively, you can, particularly with large holes, drill several holes in a straight line, inside and parallel to each side of the hole. Then you use a padsaw with a length of hacksaw blade in it to cut out the hole. The four sets of holes you drill must, of course, all join up so that the hacksaw blade can be inserted. Finish off as before.

Bending

The scribed bending line must be accurately aligned with the angle iron, and just visible. This degree of visibility is important as it aids repeatability. The angle iron pieces are bolted together and clamped in the vice securely.

Use a piece of hard wood, place it in intimate contact with the aluminium sheet and the angle iron, and bend the sheet in the same direction as the scribed lines until it is flush with the angle iron; hopefully this will be square.

If necessary, tap the hard wood with a mallet, from end to end, and back, slowly and carefully. When the sheet lies on the angle iron, place the hard wood upon it and tap it down firmly to ensure a good tight bend. There should be no signs of damage on the sheet, or ripples; the hard wood used as an inter-face between mallet and sheet is a great aid here as it absorbs local blows.

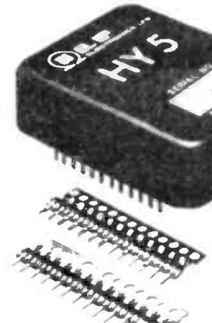
With care, and practice, you will be able to manufacture your own cabinets; cabinets that will compete favourably with commercial products.

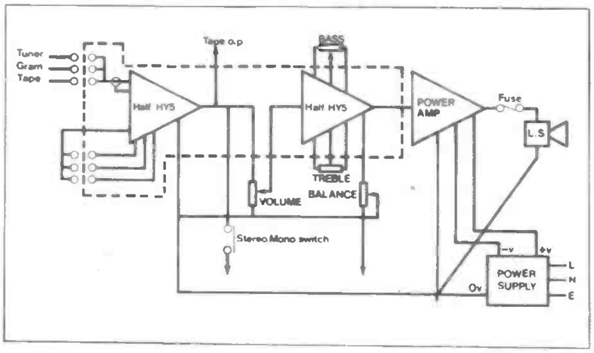
Panels have been dealt with at length since they are the most complex part of a cabinet, but the rest of it can be made in exactly the same way.

and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER

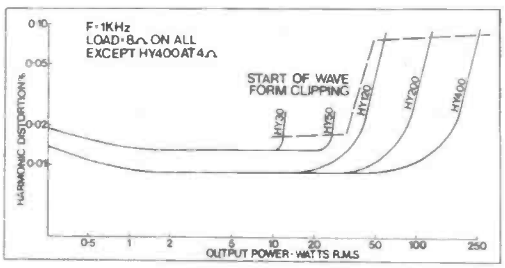




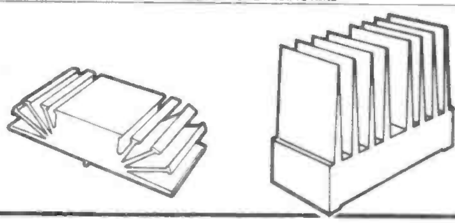
The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz–0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

£4.64 + 74p VAT

THE POWER AMPLIFIERS

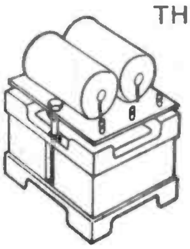


Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0- +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into 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 - 16 Ω
Input sensitivity — all models 500 mV
Input impedance — all models 1·00 K
Frequency response — all models 10Hz - 45KHz - 3dB

THE POWER SUPPLY UNITS



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PSU 50 for 1 or 2 HY50's £8.10 + £1.22 VAT
PSU 70 with toroidal transformer for 1 or 2 HY120's £13.61 + £2.04 VAT
PSU 90 with toroidal transformer for 1 HY200 £13.61 + £2.04 VAT
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MAGENTA ELECTRONICS LTD.

E.E. PROJECT KITS

Make us **YOUR No. 1 SUPPLIER OF KITS and COMPONENTS** for E.E. Projects. We supply carefully selected sets of parts to enable you to construct E.E. projects. Project kits include **ALL THE ELECTRONICS AND HARDWARE NEEDED**—we have even included appropriate screws, nuts and I.C. sockets. Each project kit comes complete with its own **FREE COMPONENT IDENTIFICATION SHEET.** We supply—you construct. **PRICES INCLUDE CASES UNLESS OTHERWISE STATED. BATTERIES NOT INCLUDED.** IF YOU DO NOT HAVE THE ISSUE OF E.E. WHICH CONTAINS THE PROJECT—YOU WILL NEED TO ORDER THE INSTRUCTIONS/REPRINT AS AN EXTRA—39p. each.

CHASER LIGHTS. Sept. 79. £18·95.
VARICAP M.W. RADIO. Sept. 79. £9·45.
SIMPLE TRANSISTOR TESTER. Sept. 79. £5·58.
ELECTRONIC TUNING FORK Aug. 79 £9·21. Suitable microphone & plug £1·61 extra.
WARBLING TIMER. Aug. 79. £5·99
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AUTOMATIC PHASE BOX. Dec. 77. £18·58 inc. p.c.b.
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TREASURE LOCATOR. Oct. 77. £9·65 case extra. £2·55. Less handle, etc.
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SHORT WAVE RECEIVER. Aug. 77. £12·09 case extra £1·64.
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R.F. SIGNAL GENERATOR. Sept. 78. £16·83 less case.
TRANSISTOR TESTER. Oct. 77. £8·98 case extra £3·90.
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ADD-ON CAPACITANCE UNIT. Sept. 77. £4·91.
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VARICAP MW RADIO. Sept. 79. £9·45.

LATEST KITS: S.A.E. OR 'PHONE FOR PRICES

3 BAND SHORT WAVE RADIO

Simple trf design covering 1·2-24MHz. **Covers most amateur bands and short wave broadcast bands.** Five controls-bandset, bandspread, reaction, wavechange and attenuator. Uses an internal 9v battery—very low current consumption. The 3 coils are all mounted on the pcb—selection is by a wavechange switch. Use with headphones or a crystal earpiece. **Kit contains all the components required including the pcb and case.** Instructions are included with this kit. Headphones are not included—we recommend our high impedance mono headphones.

KIT £18·97 **HEADPHONES EXTRA £3·28.**

NEW ELECTRONICS CATALOGUE 1980

MAGENTA'S CATALOGUE HAS BEEN CAREFULLY DESIGNED FOR E.E. READERS. PROOUCT DATA AND ILLUSTRATIONS MAKE THE MAGENTA CATALOGUE AN INDISPENSABLE GUIDE FOR THE CONSTRUCTOR. CATALOGUE INCLUDES CIRCUIT IDEAS FOR YOU TO BUILD.

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MAGENTA gives you **FAST DELIVERY BY FIRST CLASS POST OF QUALITY COMPONENTS & KITS.** All products are stock lines and are new & full specification. We give personal service & quality products to all our customers—**HAVE YOU TRIED US?**

ONE-ARMED BANDIT

OCT. 79. £18·08
CASE EXTRA £3·99

METAL LOCATOR

E.E. JUNE 79.

WE HAVE MADE UP A *COMPLETE* HARDWARE KIT FOR THIS PROJECT. WITH TUBULAR PLASTIC COLLAPSIBLE HANDLE, HAND GRIP, COIL FORMER, AND ALL SCREWS, NUTS, CLIPS, TAPE, FOIL SPACERS etc.

Everything you need for the project **including electronics and case £9·89**
Or separately:
Electronics & Case £5·14
Hardware Kit £4·75

DOING IT DIGITALLY

Complete kit IN STOCK NOW for FAST DELIVERY by FIRST CLASS POST. All top quality components as specified by EVERYDAY ELECTRONICS. Our kit comes complete with FREE TTL & COMPONENT IDENTIFICATION SHEETS. £25·25 for the TTL TEST BED. £4·13 for ADDITIONAL COMPONENTS for first 6 months.

COMPONENTS FOR PARTS 7, 8, 9 & 10. £10·98
includes:— photocells, I.C.'s, Resistors, Capacitors, thermistors, Microphone, speaker, presets, etc.

COMPONENTS FOR PART 11 £2·73

COMPONENTS FOR PART 12 £3·19

TEACH IN 80

NEW SERIES—ALL COMPONENTS IN STOCK NOW FOR FAST DELIVERY. All top quality components as specified by Everyday Electronics: Out kit comes complete with **FREE COMPONENT IDENTIFICATION SHEET.** Follow this educational series and learn about electronics—Start today! **SEND £22·95 for the TUTOR DECK and ADDITIONAL COMPONENTS parts 1-6.** All orders sent by **FIRST CLASS POST.** Out kit contains all these parts:—

TUTOR DECK: METER, BREADBOARD, TRANSFORMER, LEDS, POTENTIOMETERS, SWITCHES, SPEAKER, PLUGS, SOCKETS, BATTERY CLIPS, WIRE, CABLE, FUSES, FUSEHOLDERS, KNOBS. **ADDITIONAL COMPONENTS. PARTS 1-6,** RESISTORS, PHOTOCELL, DIODES, CAPACITORS.

IDEAL SOLDERING EQUIPMENT FOR THE TEACH IN AND ELECTRONICS

ANTEX X25 SOLDERING IRON 25W £4·98
SOLDERING IRON STAND £2·03
SPARE BITS. Small. Standard, Large. 65p each.
SOLDER. Handy size 75p.
DESOLDER BRAID 69p
HOW TO SOLDER BOOKLET 12p
HEAT SINK TWEEZERS 15p.
SOLDER BOBBIN 30p
DESOLDER PUMP £6·98

TEACH IN 80

MULTIMETER TYPE 1. 1,000 o.p.v. with probes. 2" × 3½" × 1". £8·78.
MULTIMETER TYPE 2. 20,000 o.p.v with case and probes. 5" × 3½" × 1¾". £14·25.
ANTEX X25 SOLDERING IRON 25W. Ideal for electronics. £4·98.
SOLDERING IRON STAND. Antex ST3. £2·03.
SPARE BITS. 2·3mm, 3mm, 4·7mm. 65p.
DESOLDER BRAID. 69p.
HEAT SINK TWEEZERS. 15p.
DESOLDER PUMP. Easy to use. £6.98.
F.M. INDOOR AERIAL. 57p.
TELESCOPIC AERIAL. 120 c.m. £2·08.
TELEPHONE PICK-UP COIL. 72p.
CRYSTAL MICROPHONE INSERT. 63p.
SPEAKERS MINIATURE. 8 ohm 87p. 64 ohm 96p. 80 ohm £1·.28
PILLOW SPEAKER. 8 ohm £1·08p.
6" ROUND SPEAKER. 8 ohm, 5W. £2·18.
CABINET SPEAKER. 8 ohm, 5W. 5" speaker. Cabinet 10" × 7" × 4". £7·.43
RE-ENTRANT HORN SPEAKER. 8 ohm S.W. Horn dia. 5½". £8·27.
EARPIECES. Crystal 48p. Magnetic 18p.
STETHOSCOPE ATTACHMENT. Fits our earpieces 69p.
BUZZER. 6V 82p. 12V 85p.
MONO HEADPHONES. 2K. Padded. Superior. Sensitive. £3·28.
STEREO HEADPHONES. 8 ohm. Padded. £4·24.
INTERCOM. 2 Station. Desk. £7·16.
MICROPHONE DYNAMIC. 600 ohm. Cassette type. £1·38.
DENTISTS MIRROR. Adjustable. £2·44.
JEWELLERS EYEGLASS. £1·08p
TRIPLE MAGNIFIER. £1·63.
HAND MAGNIFIER. 3" Lens. £3·43.
SPECTACLE MAGNIFIER. Clips on to spectacle frame. £4·65
ILLUMINATED MAGNIFIERS. 1½" lens £1·09. 3" lens £3·07.
SIGNAL INJECTOR. £5·48.
POCKET TOOL SET. 20 piece. £4·09.
SCREWDRIVER SET. Six piece. £2·18.
Q MAX PUNCH. ⅜" £2·14. ½" £2·30. ⅝" £2·41. ¾" £2·50.
DRILL 12V. Hand or stand use. £10·95. Stand £6 88.
CAPACITANCE SUBSTITUTION BOX. Nine values, 100pF—0·22uF. £3·03.
QUICKTEST. Mains connector. £8·83.
PLUG IN POWER SUPPLY. 6, 7·5-9V d.c. 300mA. £4·05.
SPRINGS—SMALL. 100 Asstd. £1·68.
CROC CLIP TEST LEAD SET. 10 leads with 20 clips. £1·06.
DIMMER SWITCH. 240V. 800W. £4·13.
TRADITIONAL STYLE BELL. 3–8V. 70mm chrome gong. £1.60.
UNDERDOME BELL. 4–10V. Smart. Dia. 70mm. £1·97.
TOWERS INTERNATIONAL TRANSISTOR SELECTOR. New edition. £6·22.
F.M. TUNER CHASSIS. 88-108MHz. 9V d.c. £8·19.
MORSE KEY. High speed. £3·83.
PANEL METERS. 60 × 45mm. Modern style. 50uA, 100uA, 1mA, 1A, 25V d.c. £6·33.
NIGHT LIGHT. Plug type. £1·08.
CONNECTING WIRE PACK. 5 × 5yd. coils. 55p.
VERO SPOT FACE CUTTER. £1·06.
VERO PIN INSERTION TOOL. 0·1" £1·46. 0·15" £1·.45
RESISTOR COLOUR CODE CALCULATOR. 21p.

IT'S FREE

This newsletter brings advance information of new lines, special snips and "too few to advertise" items. We call it "Advance Advertising News". Whenever you want a copy just send a S.A.E. or the subscription rate of £1·50 for 12 issues, which is just about what it costs us to address the envelope and post them second class.

SPECIAL NOTES: The "+" sign after the amount shows the amount of V.A.T. The postage is based upon the amount the article costs to send if the same article forms part of a larger parcel. Would your order be less than £6·00 however, you must send an additional 50p to offset packing and other expenses.

IMPORTANT NOTES:

1. In our July/Aug newsletter we announced a standby heater kit. The heading for this should have read: 5000 watts not 500 watts, and don't forget you can save yourself over £4 by ordering this during September.
2. In some advertisements the Delta siren/bleeper was specified as suitable for A.C. only, it will however work from 6-12 volts D.C. or 12-24 volts A.C.

12v SUBMERSIBLE PUMP
Just join it to your car battery, drop it into the liquid to be moved and up it comes, no messing about, no priming, etc. Suitable for water, paraffin and any non-explosive, non-corrosive liquid. One use if you are a camper, make yourself a shower. Price £6 + 90p. A free gift, first 100 purchasers will get tap with built-in switch and length of plastic tubing.

PRECISION RESISTORS
A fortunate purchase enables us to offer almost a complete range of Mullard metal film precision resistors, 1% tolerance. Values start at 5 r and go right through to 976 k. Most values are available in ½ watt and ¼ watt rating. Price 25p + 3½p each in small quantities, or 20p + 3p each where supplied not less than 10 of a value, 15p + 2½p each not less than 100 of a value.

THIS MONTH'S ELECTRICAL SNIP
Parcel of M.E.M. White flush 13 amp sockets, switches, etc. Total retail value over £56 + vat for only £28 + £4·20. You get 10 double 13 amp sockets and 6 single 13 amp S sockets with neons, 14 power (20 amp dpt switches and spurs some with neons), 20 single ganged one-way, two-way and intermediate switches, and super free gift (worth £3). If not collecting please add £2.

M.E.M. WHITE FLUSH SOCKETS, ETC.
We have picked out the popular items for the snip parcel described above but a list of the other parts available is as follows (makers list Nos.): 220, 224, 240, 242, 244, 711, 712, 813, 1000, 1005, 1010, 1011, 1020, 1021, 1022, 1024, 1025, 1033, 1400, 1400 WH, 1401 WH, 1402, 1402 WH, 1403, 1403 WH, 1404, 1404 WH, 1405, 1405 WH, 1407, 2025, 7092. Electricians and Contractors using these accessories should send for our M.E.M. Electrical List where prices and quantity discounts will be quoted.

VARI-CAP T.V. PUSH BUTTON TUNER
W. German make but fitted to several popular colour T.V.'s, makers Ref. No. 2357 0076. This has 6 push buttons, each of which is in effect a multi turn pot, total resistance is 15k. The buttons are black with chrome metal tops. Price £1 + 15p, post 25p. Good quantity available at usual discount rates.

MULTI TURN POT WITH KNOB
100k lin. 20 turn used in many T.V. receivers, makers ref. 7802 412-00051. Suitable for fine control of resistence in general circuitry. Price 40p + 6p.

T.V. DIPLEXER
On plastic moulding size 2½" × 1½". We are able to offer these at such a low price that they can be used as T.V. aerial sockets only. Price 10 for £1 + 15p.

TRANSDUCERS
As used remote control T.V. receivers. Price £1·50 + 22p.

BURGLAR ALARM
Mains operated new circuit available, this is simple to install and trouble free. Price list and diagram free on request.

ARMY 46 SETS
As made for and used in the Second World War, we have a few of these in mint condition, complete with carrying satchels, headphones, throat mikes and instruction cards. In unopened boxes. Price £30 + £4·50. Post £2.

MUSIC CENTRE COVER
Size 20" × 13½" × 4". Clear plastic £3·50 + 52p, carriage and special packing £2.

25 AMP D.C. METERS
Flush panel mounting, wide angle, extra long, 320° scale made for G.P.O. Really beautiful instrument, brand new in original cartons. Limited quantity only so no discounts. Price £8 + £1·20. (Less than half maker's price.)

BIG BLOWER
Driven by 1/10 H.P. mains motor but compact and quiet running. This is ideal for air conditioning, fume extraction, pressurizing and many other applications. Overall size 10½" × 10½" dia. Outlet size 10½" × 4½". Price £15 + £2·25, carriage £3. Note this is the largest of our 'Snail' shaped blowers, we have smaller ones right down to 10 watt motors with outlets as small as 2" × 2", in fact we can cover almost any application and welcome your enquiries. Prices are from £3 complete with motor.

DOLLS HOUSE SWITCH
Time is fast approaching when you may be thinking of making toys. Small surface mounting switches are often a problem and this is why we are now offering this plastic bodied rotary switch suitable for low voltage applications. Price 10 for £1·50 + 22p.

CASSETTE STORAGE CASE
With dust cover, holds 5 cassettes and comes complete with clip for joining to another, so you can make up in lengths to suit yourself. Price 50p + 7½p + 50p post or ten for £4 + 60p, post £1·50.

TELEPHONE ANSWERING MACHINES
Grade 2 machines are in stock ready for immediate despatch or collection (if coming specially to collect please telephone first). For the benefit of new readers we supply these machines on the understanding they are broken up or at least not used for their original purpose. The machines are secondhand but so far as we can see they are complete and quite possibly in good working order. We do not test them but guarantee to replace any part of the machine should it be missing or faulty, providing we are notified within 7 days of receipt. Prices for the machines are as follows: Grade 2 that is in very good condition £15·50 + £2·25, and Grade 1 which are top grade machines and are our very best almost perfect £20 + £3 each, but there is likely to be one month's wait. To these prices must be added £2·50 to cover carriage.
Mains Power Pack in Plastic Case for Telephone Answering Machine. Price £4·50 + 63p. Post 50p.

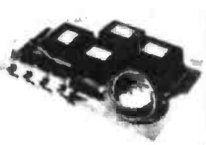
POT CORES
We now have good stocks of Ferrite pot cores. These are ex unused equipment and contain the bobbin and have been opened ready to use.

	Diameter	Thickness	Price	
FX 2243	4·5 cm	3·0 cm	75p + 12p	per pair
FX 2242	3·5 cm	2·3 cm	60p + 9p	per pair
FX 2240	2·5 cm	1·6 cm	50p + 7p	per pair

COMPONENT BOARD 421
Again from unused equipment, major items on these are two power silicon transistors, Motor Rola Ref. SJ 5433, mounted on a heat sink with mica insulators, also behind the panel are two power rectifiers ST NS 1008. Price 90p + 8p.

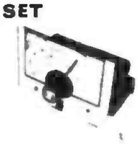
MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone in easy-to-assemble modular form and complete with a pair of speakers this should sell at about £30—but due to a special bulk-buy and as an incentive for you to buy this month we offer the system complete at only £15 including VAT and postage.



SHORTWAVE CRYSTAL SET

Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 10, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts £2·30—crystal earphone 65p including VAT and postage.



RADIO STETHOSCOPE

Easiest way to fault find, traces, signal from aerial to a speaker, when signal stops you've found the fault. Use it on, Radio, TV, amplifier, anything. Kit comprises transistors and parts including probe tube and twin stetho-set £4·60.

WINDSCREEN WIPER CONTROL

Vary speed of your wiper to suit conditions. All parts and instructions to make £4·25.

DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £3·75.

SOUND TO LIGHT UNIT

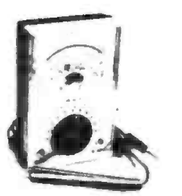
Will proved circuit flashes up to 750 watts of lamps. Complete kit includes S.C.P. mains input leads, all parts and very neat plastic case £4·95.

CASSETTE OUTFITS

Complete mechanisms with record/playback and erase heads—all electronics and speaker £9·75 post and VAT paid. *Note* these are all cased up ready to use but case may be slightly uncomplete, cracked or broken.

VARICAP POCKET RECEIVER
CHASER DISPLAY

To quickly receive parts for these and other E.E. projects, send the approximate cost as shown. Any cash adjustment can be made later.



MINI-MULTI TESTER

Amazing, deluxe pocket size precision moving coil instrument jewelled bearings—1000 opv—mirrored scale.
11 instant ranges measure:—
DC volts 10, 50, 250, 1000
AC volts 10, 50, 250, 1000
DC amps 0-1mA and 0-100 mA
Continuity and resistance 0-150K ohms.
Complete with insulated probes, leads, battery, circuit diagram and instructions.
Unbelievable value only £6·50 + 50p post and insurance.

FREE Amps ranges kit enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly but if you already own a mini tester and would like one send £1·50.

TERMS: Cash with order—but orders under £6 must add 50p to offset packing, etc.
BULK ENQUIRIES INVITED. PHONE: 01-688 1833.
ACCESS & BARCLAYCARD ACCEPTED

J. BULL (ELECTRICAL) LTD

(Dept. E.E.), 103 TAMWORTH RD.,
CROYDON CR8 1SG

HEAVY DUTY 3 CORE APPLIANCES LEAD
15 amp wire 6ft. long, conventional yellow green, brown and blue cores, grey PVC outer, prepared ends, this flex normally sells at 30p per metre, 10 leads for £2·50 + 40p. Post £1·50.

E.H.T. MAINS TRANSFORMER
Output voltage 4·5kv 3mA. These transformers are ex unused P.S.U.'s. Price £2 + 30p, post 40p.

LOUD SPEAKER GRILL
Good quality rigid plastic, ideal for use in car or home extension speakers. Two sizes available: 12" × 12", price 75p × 13p, 18" × 18", £1·50 + 23p.

6 DIGIT COUNTER—RESETTABLE
Coil voltage 48 D.C. or 115v A.C., current 100mA approx. Price £1·95 + 30p.

10 DIGIT SWITCH PAD
Made we believe for G.P.O. push button telephones, each button operates 2 pole switch which returns automatically, panel size 2½" × 3½" × 1½", push buttons with clear plastic protected digits 0-9. Price £1·95 + 30p.

MAINS BLOWER
Real bargain this month is a blower made by Smiths, the mains motor is let right into the turbulator and takes up the minimum of space. Overall size of the blower is 7" dia. × 2½" and the air outlet 1½" × 2½". Price only £2·50 + 33p + p & p 50p.

DIAL INDICATOR
As used in tool making and other precision measuring operations, the famous John Bull accurately shows differences of ·01mm. A beautifully made precision instrument, price in most tool shops would be £12-£15. Price £8 + £1·20

WATERPROOF SWITCH
Ideal for greenhouse or outdoor, plastic body. Price 60p + 9p.

CAR SPEAKER
Elliptical size 7½" × 5", 4 ohm. Price £1·50 + 12p, post 20p + 2p.

7 SEGMENT DIGITAL DISPLAY
TIL 302, l.e.d. com. anode—character size 4" approx. Price £1·15 + 16p.

USEFUL BREAKDOWN UNIT
We do not normally offer second hand equipment for breaking down but this particular item contains so many useful pieces that we have decided to break our rule. The unit is in fact a pocket "bleeper" in a most useful case, size about 2½" wide by ¾" thick by 5½" deep, ideal size to fit into the top jacket pocket. Case comes apart by undoing two screws, inside is printed circuit board upon which are mounted a miniature loud speaker, three rechargeable nicads diac type 150—4 ferrite potted coils, three of which are tunable, 4" ferrite rod. Mercury tilt switch on when case is upright, 4 electrolytic condensors, one micro switch, 8 transistors all with usable length leads, 4 polystyrene capacitors, 2 pin plug for charging batteries without uncasing and approximately 4 diodes and approximately 30 various capacitors and resistors, most of the resistors being ¼ watt type, truly a very useful unit although secondhand, still in reasonable condition. Price £1·50 + 22p.

25 WATT SPEAKERS
Comprising 8" woofer and 3" tweeter with crossover and terminal connection panel, all mounted in good quality non-resonant cabinet. These are extremely good quality units comparable with those selling at twice the price. Cabinet size approx. 20" high, 10½" wide and 8½" deep, heavy cabinet made of thick blockboard. Price £25 + £3·75 the pair, well worth your coming to collect, but if you cannot collect they are still worth this £5 extra for carriage.

TWIN PADDED FLEX
5 amp ideal for some electric irons and appliances that require very flexible lead, 10 metre lengths. Price £1 + 15p. Post 45p.

ROD THERMOSTAT
Suitable for high temperatures up to 550°F. This is adjustable either at the head or remotely by a length of flexible drive. Price £2·50 + 38p.

DRY FILM LUBRICANT
In aerosol can for easy application and for putting lubricant into places where the normal oil-can cannot reach. Offered at about half the original list price. 50p + 7p per can (8 oz) or 12 cans for £4 + 60p. post £1·50. The lubricant is I.C.I. Fluon L169.

V3 MICROSWITCH
Popular switch with 10 amp 250 volt changeover contacts. Price £15 per 100, or £140 per 1000 + VAT. Ditto with 15 amp changeover contacts £20 per 100 or £180 per 1000.

ASSORTED MICROSWITCHES
10 different small, medium and large sizes to suit most projects and repair jobs. Price £1·50 + 22p. If this pack does not contain the one you want, give us a ring, we may have it.

PUSH SWITCHES
That really stand out. Its large dished knob also makes this extra easy to operate, sprung to return to normal when pressure is removed. 10 amp 250 volt changeover contacts. Type 1, 1 c/o 40p + 6p. Type 2, 2 c/o 60p + 9p. Type 3, 3 c/o 80p + 12p.

HFW KIT
Light Tracer and Strobe for disco's or parties. 2 running light patterns and a strobe. Was described with full constructional details in September Everyday Electronics. Our price for complete kit including case £14 + £2·10.

SPRING LOADED ROCKER SWITCH
Made originally for car dash. This is a simple on/off for up to 10 amps. Price 25p + 4p.

DP PANEL SWITCH
Arco made. This is a handsome switch, it has a long flat-ended toggle, black and chrome finish. Rated 2 amps at 250 volts and double-pole on/off. Price 40p + 6p.

PUSH BUTTON SWITCH
Suitable mains, audio or RF. Each switch rated at 250 volts 15 amps. 1st (black push button) closes 2 circuits; 2nd (white push button) operates one changeover; 3rd (white push button) operates one changeover; 4th (white push button) opens one circuit. **Note:** All depressed buttons remain down until cleared by the 5th (red button). **Further note:** It is a relatively easy job to alter the position of the tags, thus making the switches suit your circuit. Fitted with 3 white, 1 red and 1 black button. Price 75p + 11p.

COMBINATION SWITCH
This comprises 12 miniature changeover micro switches joined in banks of 3 and mounted on frame with four digital numbered thumb wheels and a removable lever for locking the thumb wheel, the thumb wheel operates 3 banks. Over 4,000 combinations are possible, by re-wiring the switch connections underneath thousands more variations are possible. If you are making equipment which should not be switched on accidentally or without authority, then this is a switch to consider. It can be used as a coding switch for many other operations. Very neat and compact, measuring approx. 4" × 1½" and 1½" deep. Price £1·75 + 26p.

BALANCE ARMATURE INSERTS
600 ohm impedance, use as either speaker or mike. Price 50p + 7½p.

PHOTO TRANSISTOR
First class maker, will respond to light or infra-red. 5 for £1 + 15p. 100 for £15 + £2·20. 1000 for £125 + £18·75.

CONTACT STAT
This is a skeleton thermostat with control knob calibrated 90°F-190°F. Put it into a box and you have calibrated wall stat or fix its flat base in close contact with the item to be controlled, for instance, bolt it to the casing of an electric motor, heat sink of semi conductor or other device which must not be allowed to overheat or strap it to a water tank, etc., etc. The switch will make and break 15 amps at normal mains voltage. Price £1·50 + 22p.

RST VALVE MAIL ORDER CO. (EE11)

CLIMAX HOUSE, FALLSBROOK ROAD, LONDON SW16 6D

SPECIAL EXPRESS MAIL ORDER SERVICE

SEMICONDUCTORS

Type	Price	Type	Price	Type	Price	Type	Price
AA119	0·12	ASY26	0·46	BC159	0·12	BCY71	0·20
AAY30	0·31	ASY27	0·46	BC167	0·14	BCY72	0·15
AAY32	0·40	ASZ15	1·44	BC170	0·13	BCZ11	1·72
AAZ13	0·21	ASZ16	1·44	BC171	0·12	BD115	0·52
AAZ15	0·39	ASZ17	1·44	BC172	0·12	BD121	1·38
AAZ17	0·31	ASZ20	1·72	BC173	0·14	BD123	1·38
AC107	0·69	ASZ21	2·30	BC177	0·17	BD124	1·50
AC125	0·23	AU110	1·96	BC178	0·10	BD131	0·46
AC126	0·23	AU113	1·96	BC179	0·10	BD132	0·44
AC127	0·23	AUY10	2·30	BC182	0·13	BD135	0·39
AC128	0·23	BA145	0·15	BC183	0·12	BD136	0·39
AC141	0·29	BA148	0·15	BC184	0·13	BD137	0·40
AC141K	0·40	BA154	0·10	BC212	0·15	BD138	0·46
AC142	0·23	BA155	0·12	BC213	0·14	BD139	0·49
AC142K	0·35	BA156	0·10	BC214	0·17	BD140	0·51
AC176	0·23	BAW62	0·06	4BC237	0·10	BD144	2·30
AC187	0·23	BAX13	0·07	BC238	0·14	BD181	1·26
AC188	0·23	BAX16	0·10	BC301	0·38	BD182	1·36
AC17	0·66	BC107	0·14	BC303	0·38	BD237	0·46
ACY18	0·92	BC108	0·14	BC307	0·12	BD238	0·63
ACY19	0·86	BC109	0·15	BC308	0·12	BDX10	1·05
ACY20	0·80	BA113	0·14	BC327	0·23	BDX32	2·38
ACY21	0·86	BC114	0·15	BC328	0·21	BDY20	1·44
ACY39	1·72	BC115	0·10	BC337	0·21	BDY60	1·72
AD149	0·80	BC116	0·17	BC338	0·20	BF115	0·29
AD161	0·52	BC117	0·20	BCY30	1·15	BF152	0·21
AD162	0·52	BC118	0·12	BCY31	1·15	BF153	0·23
AF106	0·52	BC125	0·10	BCY32	1·15	BF154	0·20
AF114	0·40	BC126	0·23	BCY33	1·04	BF159	0·26
AF115	0·40	BC135	0·16	BCY34	1·04	BF160	0·10
AF116	0·40	BC136	0·17	BCY39	3·45	BF167	0·28
AF117	0·40	BC137	0·17	BCY40	1·15	BF173	0·23
AF139	0·46	BC147	0·10	BCY42	0·29	BF177	0·20
AF186	1·38	BC148	0·09	BCY43	0·29	BF178	0·28
AF239	0·52	BC149	0·10	BCY58	0·18	BF179	0·29
AFZ11	3·16	BC157	0·10	BCY70	0·17	BF180	0·35
AFZ12	3·10	BC158	0·09			BF181	0·35
						BF182	0·35
						BF183	0·29

Type	Price	Type	Price	Type	Price	Type	Price
BF184	0·29	BY126	0·10	OA70	0·35	OC82	0·74
BF185	0·29	BY127	0·17	OA79	0·35	OC83	0·74
BF194	0·10	BZX61	0·21	OA81	0·35	OC84	0·74
BF195	0·10	Series		OA85	0·35	OC122	1·73
BF196	0·12	BZY88	0·15	OA90	0·09	OC123	2·02
BF197	0·14	Series		OA91	0·09	OC139	2·59
BF200	0·31	CRS/140	0·69	OA95	0·09	OC140	3·16
BF244	0·23	CRS/340	0·66	OA200	0·10	OC141	3·74
BF244	0·32	CRS/360	1·04	OA202	0·10	OC170	1·15
BF257	0·28	GEX66	1·73	OA211	1·15	OC171	1·15
BF258	0·30	GEX541	2·02	OAZ200	1·15	OC200	1·73
BF259	0·37	GJ3M	0·86	OAZ201	1·15	OC201	2·02
BF336	0·35	GJ5M	0·86	OAZ206	1·15	OC202	2·02
BF337	0·35	GM0378	2·02	OAZ207	1·15	OC203	2·02
BF338	0·30	KS100A	0·52	OC16	2·30	OC204	2·88
BFS21	4·56	MJE340	0·92	OC20	2·88	OC205	2·88
BFS28	2·56	MJE370	1·35	OC22	2·88	OC206	2·88
BFS61	0·23	MJE371	0·71	OC23	3·16	OC207	2·02
BFS98	0·23	MJE520	0·60	OC24	3·45	OCP71	1·44
BFW10	0·74	MJE521	0·63	OC25	1·05	ORP12	1·15
BFW11	0·74	MJE295	1·44	OC26	1·04	R2008B	2·02
BFX84	0·25	MJE305	0·66	OC28	2·30	R2009	2·58
BFX85	0·26	MPF102	0·35	OC29	2·30	R2010B	2·02
BFX87	0·24	MPF103	0·35	OC35	1·73	T1C44	0·35
BFX88	0·24	MPF104	0·35	OC36	1·73	T1C226D	1·38
BFY50	0·30	MPF105	0·35	OC41	0·92	T1L209	0·23
BFY51	0·30	MPSA06	0·28	OC42	0·96	T1P29A	0·47
BFY52	0·30	MPSA56	0·30	OC43	2·59	T1P30A	0·48
BFY64	0·30	MPSU01	0·41	OC44	0·69	T1P31A	0·51
BFY90	1·44	MPSU06	0·53	OC45	0·63	T1P32A	0·55
BSX19	0·24	MPSU56	0·56	OC71	0·63	T1P33A	0·70
BSX20	0·23	NE555	0·52	OC72	0·63	T1P34A	0·84
BSX21	0·23	NKT401	2·30	OC73	1·15	T1P41A	0·72
BT106	1·44	NKT403	1·99	OC74	0·74	T1P42A	0·81
BTY79/40	3·07	NKT404	1·99	OC75	0·74	T1P2955	0·77
BU205	2·02	OA5	1·09	OC76	0·63	T1P3055	0·64
BU206	2·59	OA7	0·63	OC77	1·38	T1S43	0·52
BU208	2·30	OA10	0·74	OC81	0·74	ZS140	0·20
BY100	0·52	OA47	0·10	OC81Z	1·38	ZS170	0·24
						ZS178	0·62

Type	Price	Type	Price	Type	Price
ZS271	0·26	2N697	0·20	2N3055	0·81
ZS278	0·05	2N698	0·35	2N3440	0·69
ZTX107	0·13	2N705	1·38	2N3441	0·92
ZTX108	0·12	2N706	0·17	2N3442	1·26
ZTX109	0·14	2N708	0·23		
ZTX300	0·14	2N930	0·30	2N3614	1·73
ZTX301	0·15	2N1131	0·30	2N3702	0·13
ZTX302	0·17	2N1132	0·30	2N3703	0·15
ZTX303	0·20	2N1302	0·40	2N3704	0·15
ZTX304	0·22	2N1303	0·40	2N3705	0·15
ZTX311	0·14	2N1304	0·52	2N3706	0·15
ZTX314	0·23	2N1305	0·52	2N3707	0·15
ZTX500	0·15	2N1306	0·58	2N3708	0·12
ZTX501	0·10	2N1307	0·58	2N3709	0·15
ZTX502	0·18	2N1308	0·63	2N3710	0·12
ZTX503	0·20	2N1309	0·63	2N3711	0·12
ZTX504	0·23	2N1613	0·29	2N3771	2·02
ZTX531	0·23	2N1671	1·73	2N3772	2·30
ZTX550	0·18	2N1893	0·29	2N3773	3·45
1N914	0·06	2N2147	2·02	2N3819	0·41
1N916	0·08	2N2148	1·89	2N3820	0·52
1N4001	0·07	2N2218	0·20	2N3823	0·63
1N4002	0·07	2N2219	0·28	2N3866	0·83
1N4003	0·08	2N2220	0·21	2N3904	0·15
1N4004	0·08	2N2221	0·21	2N3905	0·15
1N4005	0·09	2N2222	0·21	2N3906	0·15
1N4006	0·09	2N2223	3·10	2N4058	0·18
1N4007	0·10	2N2368	0·20	2N4059	0·12
1N4009	0·07	2N2369A	0·24	2N4060	0·14
1N4148	0·07	2N2484	0·23	2N4061	0·14
1N5400	0·15	2N2546	0·63	2N4062	0·15
1N5401	0·15	2N2904	0·29	2N4124	0·17
1S44	0·05	2N2905	0·29	2N4126	0·17
1S920	0·06	2N2906	0·24	2N4286	0·23
1S921	0·08	2N2907	0·24	2N4288	0·25
2G301	1·15	2N2924	0·24	2N4289	0·26
2G302	1·15	2N2925	0·25	2N5457	0·45
2G306	1·27	2N2926	0·16	2N5458	0·40
2N404	1·15	2N3053	0·29	2N5459	0·46
2N696	0·20	2N3054	0·58		

VALVES

Type	Price	Type	Price	Type	Price	Type	Price
AZ31	1·26	ECC83	1·01	EL32	1·73	KTW63	2·02
CBL31	2·30	ECC84	1·36	EL33	4·02	MU14	1·73
CL33	2·30	ECC85	1·38	EL34 (Thorn)	2·53	N78	10·35
CY31	1·15	ECC88	2·07	EL34 Mullard	2·57	OA2	1·76
DAF91	0·48	ECC91	0·72	EL41	1·44	OB2	1·44
DAF96	1·15	ECC189	1·00	EL42	2·02	OC3	2·20
DF91	0·46	ECF80	1·24	EL81	1·26	OD3	2·20
DF96	1·15	ECF82	1·38	EL84	1·15	OZ4	1·84
DK91	1·21	ECH35	2·30	EL86	2·48	PC86	1·61
DK92	1·44	ECH42	1·32	EL91	7·44	PC88	1·61
DK96	1·26	ECH81	1·38	EL95	1·51	PC97	1·38
DL92	1·26	ECH83	1·44	EL360	6·32	PC900	1·38
DL94	1·38	ECH84	1·47	EM34	5·75	PCC84	1·15
DL96	1·26	ECL82	1·15	EM80	1·26	PCC88	1·38
DY86/7	0·73	ECL83	1·73	EM81	1·15	PCC89	1·58
DY802	0·90	ECL86	1·38	EM84	1·15	PCC189	1·61
E80CC	0·27	EF37A	4·02	EM85	1·44	PCF80	1·15
EABC80	1·38	EF39	3·16	EM87	1·73	PCF82	1·15
EAF42	1·44	EF40	1·32	EN91	2·04	PCF86	1·84
EAF801	2·02	EF41	1·38	EY51	2·02	PCF87	1·84
EB41	2·30	EF42	2·30	EY86	0·96	PCF200	2·82
EB91	1·01	EF50	1·73	EZ40	1·44	PCF201	2·45
EBC33	2·02	EF80	0·92	EZ41	1·44	PCF801	1·84
EBC41	1·44	EF83	2·02	EZ80	0·96	PCF802	1·82
EBC81	1·26	EF85	0·92	EZ81	0·96	PCF805	1·84
EBC90	0·97	EF86	1·74	EZ90	1·38	PCF806	1·84
EBF80	0·58	EF89	1·84	GZ32	1·44	PCF808	1·84
EBF83	1·44	EF91	2·07	GZ33	4·00	PCL82	1·18
EBF89	0·97	EF92	6·03	GZ34	2·18	PCL83	1·82
EBL31	2·85	EF98	1·44	KT61	4·02	PCL84	1·15
ECC40	1·44	EF183	0·92	KT66	7·18	PCL85	1·24
ECC81	1·01	EF184	0·96	KT88	8·20	PCL86	1·24
ECC82	0·82	EH90	1·61	KTW61	2·02	PCL805/85	1·24
				KTW62	2·02	PD500	4·24
						PFL200	2·07

Type	Price	Type	Price	Type	Price	Type	Price
PL36	1·38	UBF89	1·38	5Z4GT	1·75	6BN6	1·69
PL81	1·38	UCC84	1·20	6-30L2	1·70	6BQ7A	4·14
PL81A	1·38	UCC85	1·38	6AB7	1·73	6BR7	4·60
PL82	1·38	UCF80	1·32	6AC7	1·61	6BR8	2·02
PL83	2·55	UCH42	1·30	6AF4A	1·84	6BS7	4·66
PL84	1·24	UCH81	2·07	6AG7	2·30	6BW6	4·66
PL504/500	1·61	UCL82	1·20	6AH6	5·52	6BW7	1·75
PL508	2·07	UCL83	1·66	6AK5	3·98	6BX7GT	5·70
PL509	3·45	UF41	1·15	6AK6	2·81	6BZ6	2·62
PL519	3·73	UF80	1·66	6AL5	1·01	6C4	1·01
PL801	1·27	UF85	1·66	6AM4	2·65	6CB6A	2·76
PL802	3·40	UF89	1·66	6AM5	4·43	6CD6GA	5·84
PY33	0·92	UL41	2·88	6AM6	2·07	6CG7	2·55
PY81	0·81	UL84	1·38	6AN5	0·12	6CH6	7·48
PY82	1·01	UM80	1·15	6AN8A	3·80	6CL6	4·12
PY83	2·07	UY41	1·44	6AQ5	1·10	6CW4	8·33
PY88	1·01	UY85	1·20	6AR5	1·84	6D2	1·01
PY500A	2·07	Z803U	9·09	6AS6	6·42	6DK6	2·59
PY800	0·87	1B3GT	2·58	6AS7GA	7·78	6DQ6B	4·40
PY801	0·87	1R5	1·21	6AT6	0·98	6EA8	3·31
QQV02-6	13·16	1S5	0·46	6AU5GT	4·81	6EB8	2·44
QQV03-10	5·44	1T4	0·46	6AU6	1·24	6EW6	1·73
QQV03-20A	20·13	2AS15	11·50	6AV5GA	4·35	6F6	2·02
QQV06-40A	40·25	2D21	2·04	6AV6	0·98	6F23	1·84
R17	1·89	3A5	1·55	6AX5GT	3·57	6F28	1·33
R19	1·38	3CX100A	23·00	6B7	1·73	6H2N	1·21
R20	1·66	3S4	1·20	6B8	2·02	6H3N	1·21
U18-20	2·88	4CX250B	22·53	6BA6	1·15	6H6	1·73
U25	1·33	5R4GY	2·30	6BA7	5·89	6J4	0·10
U26	1·66	5U4G	4·35	6BA8A	4·31	6J6	0·21
UABC80	1·44	5U4GB	2·60	6BC4	4·27	6J7	0·04
UAF42	1·44	5V4G	1·75	6BE6	1·24	6K4N	1·44
UB41	1·44	5Y3GT	0·98	6BH6	1·75	6K6GT	1·50
UBC41	1·73	5Z3	1·72	6BJ6	1·24	6K7	1·73
		5Z4G	1·75	6BK4	4·84	6K8	2·02
				6BL6	07·25	6KD6	7·08
				6BL7GT	4·44	6L6G	2·86

Type	Price	Type	Price	Type	Price
6L6GA	1·73	12AU6	2·83	92AG	0·15
6L6GT	2·24	12AU7	0·83	92AV	0·15
6L6GC	2·24	12AV6	2·30	95A1	5·98
6L7	2·30	12AV7	3·98	150B2	2·78
6N2P	1·21	12AX7	1·01	150B3	5·00
6N3P	1·21	12AY7	5·24	150C2	1·73
6N7	1·73	12B4A	3·50	150C4	2·19
6P25	4·14	12BA6	2·42	211	0·90
6Q7	2·53	12BE6	2·55	723AB	40·25
6R7	2·07	12BH7	1·29	807	2·30
6SA7	1·67	12BY7	3·01	811A	0·78
6SC7	1·73	12E1	8·17	812A	0·60
6SF7	1·84	19H4	28·75	813	30·60
6SH7	1·73	30C15	1·84	833A	86·25
6SJ7	1·84	30C17	1·84	866A	6·61
6SK7	1·50	30C18	1·84	872A	16·81
6SL70T	3·06	30F5	1·83	931A	14·08
6SNG7	1·84	30FL1/2	1·28	2050	0·06
6SQ7	1·50	30FL12	2·07	5642	6·05
6SR7	1·73	30FL14	1·84	5654	4·05
6SS7	2·07	30L1	1·15	5651	2·07
6U5G	2·30	30L15	2·07	5670	5·29
6U8	0·92	30L17	2·07	5814A	4·81
6U84	3·24	30P4	1·06	6060	7·88
6V6GT	1·84	30P19	1·38	6146A	5·80
6X4	1·38	30PL1	1·52	6146B	6·42
6X5GT	0·07	30PL13	2·07	6159	9·18
7B7	1·00	30PL14	1·83	6973	4·05
7C5	2·02	30PL15	2·07	7586	13·09
7C6	1·44	35W4	0·69	7587	22·54
7H7	2·30	50C5	0·81	7868	4·53
7R7	1·73	85A2	2·19	8068	0·33
7S7	2·59	90AG	0·18	8136	2·81
7Y4	1·84	90AV	0·16	4CX 250B	5·76
7Z4	2·13	90C1	2·24		
12AT6	1·38	90CG	15·73		
12AT7	1·01	90CV	15·30		

* Tested ex equipment

INTERGRATED CIRCUITS

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	0·18	7410	0·10	7428	0·49	7450	0·21	7483	1·04
7401	0·18	7412	0·30	7430	0·20	7451	0·21	7484	1·15
7402	0·18	7413	0·37	7432	0·35	7453	0·21	7486	0·40
7403	0·18	7416	0·37	7433	0·41	7454	0·21	7490	0·60
7404	0·20	7417	0·37	7437	0·37	7460	0·21	7491	0·92
7405	0·18	7420	0·20	7438	0·37	7470	0·46	7492	0·69
7406	0·46	7422	0·23	7440	0·21	7472	0·38	7493	0·66
7407	0·46	7423	0·37	7441AN	0·97	7473	0·41	7494	0·92
7408	0·23	7425	0·35	7442	0·83	7474	0·46	7495	0·83
7409	0·23	7427	0·35	7447AN	1·04	7475	0·62	7496	0·92
						7476	0·46	7497	3·45
						7480	0·63	74100	1·73
						7482	0·86	74107	0·52

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
74109	0·81	74132	0·81	74156	0·97	74191	1·73	TAA700	4·50	TBA920Q	3·34
74110	0·58	74136	0·63	74157	0·86	74192	1·55	TBA480Q	2·12	TBA990Q	3·34
74111	0·81	74141	0·92	74159	2·42	74193	1·55	TBA520Q	2·65	TCA270Q	3·34
74116	2·02	74142	2·65	74170	2·05	74194	1·44	TBA530	2·28	TCA760A	1·59
74118	1·16	74143	2·88	74172	5·06	74195	1·15	TBA540Q	2·65		
74119	1·73	74144	2·68	74173	1·01	74196	1·38	TBA550Q	3·70		
74120	0·95	74145	1·04	74174	1·73	74197	1·26	TBA560C	3·70		
74121	0·40	74147	2·30	74175	1·04	74198	2·59	TBA673	2·52		
74122	0·69	74148	2·02	74176	1·26	74199	2·59	TBA700	1·75		
74123	1·15	74150	1·84	74178	1·44	76013N	2·02	TBA720Q	2·65		
74125	0·63	74151	0·97	74179	1·44	LM309K	1·73	TBA750Q	2·38		
74126	0·63	74154	2·02	74180	1·32	TAA570	2·65	TBA800	1·38		
74128	0·69	74155	0·97	74190	1·73	TAA630S	4·02	TBA920	3·34		

BASES

Type	Price
B7G unskirted	0·17
B7G skirted	0·35
B9A unskirted	0·17
B9A skirted	9·35
NUVISTOR	0·86
Int Octal	0·29
Loctal	0·63
8 pin DIL	0·17
14 pin DIL	0·17
16 pin DIL	0·20

Valve screening cans all sizes 0·35

CRT'S

Type	Price	Type	Price	Type	Price
1CP31	35·65	5ADP1	40·25	VCR517B*	11·50
2AP1*	9·78	5BP1*	11·50	VCR517C*	11·50
2BP1*	10·35	5CP1*	11·50		
3BP1	9·20	5CP1A	46·00		
3DP1*	8·75	5FP15A	17·25		
3EG1*	8·05	5UP7	18·10		
3FP7	0·00	DG7-5	20·70		
3GP1	0·00	DG7-32	41·40		
3JP1*	9·20	DH3-91	35·65		
3JP2*	0·20	DH7-11	76·26		
3JP7*	11·50	VCR97*	13·80		
3KP1*	17·25	VCR138*	11·50		
3RP1*	40·25	VCR138A*	14·38		
3WP1*	23·00	VCR139A*	9·20		
		VCR517A*	11·50		

Tube Bases
* = Surplus 0·86

Mu-Metal Screens 3·45

REFERENCE BOOKS

BP1	First Book of Transistor Equivalents & Substitutes	0·80
BP2	Handbook of Radio, TV and Industrial & Transmitting Tube and Valve Equivalents	0·60
BP7	Radio and Electronic Colour Codes & Data Chart	0·25
BP14	Second Book of Transistor Equivalent & Substitutes	1·10
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BP41	Linear I.C. Equivalents & Pin Connections	2·78
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202	Handbook of Integrated Circuits (I.C.'s) Equivalents & Substitutes	1·00
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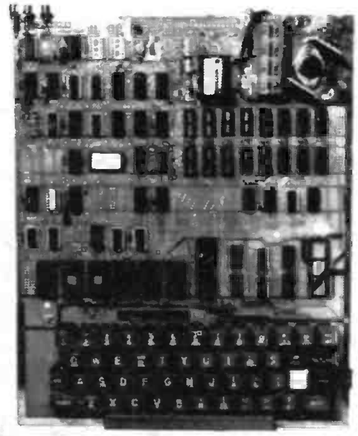

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STATEMENTS

CLEAR DATA	DEF	DIM	END	FOR
GOTO GOSUB	IF GOTO	IF THEN	INPUT	LET
NEXT ON GOTO	ON GOSUB	POKE	PRINT	READ
REM RESTORE	RETURN	STOP		

EXPRESSIONS

OPERATORS

+ - * / ↑ NOT AND OR > < <> > = < = RANGE 10^{-32} to 10^{+32}

VARIABLES

A,B,C ... Z and two letter variables
The above can all be subscripted when used in an array. String variables use above names plus $ e.g. A$

*8K Microsoft Basic means conversion to and from Pet, Apple and Sorcerer easy. Many compatible programs already in print.

SPECIAL CHARACTERS

@ Erases line being typed, then provides carriage return, line feed.
← Erases last character typed.
CR Carriage Return — must be at the end of each line.
: Separates statements on a line.
CONTROL/C Execution or printing of a list is interrupted at the end of a line. "BREAK IN LINE XXXX" is printed, indicating line number of next statement to be executed or printed.
CONTROL/O No outputs occur until return made to command mode. If an Input statement is encountered, either another CONTROL/O is typed, or an error occurs.
? Equivalent to PRINT

FUNCTIONS

ABS(X)	ATN(X)	COS(X)	EXP(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)
FRE(X)	INT(X)		
SGN(X)	SIN(X)		
USR(I)			

STRING FUNCTIONS

ASC(X$)	CHR$(I)	FRE(X$)	LEFT$(X$,I)
RIGHT$(X$,I)		STR$(X)	
LEN(X$)	MID$(X$,I,J)		
VAL(X$)			

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