

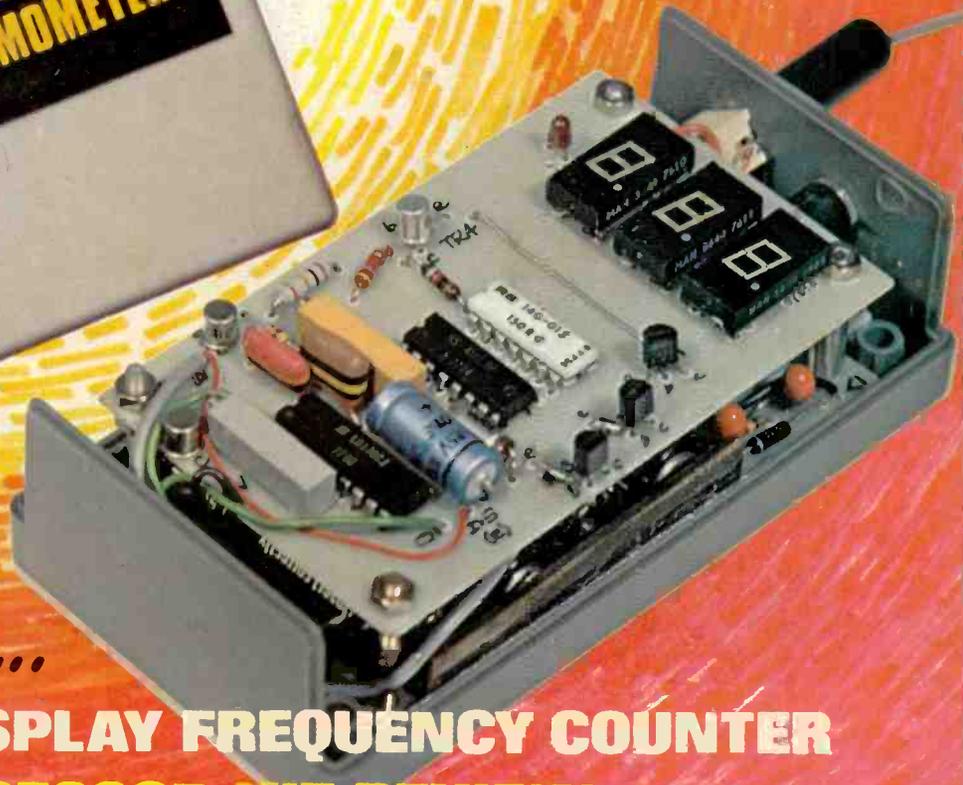
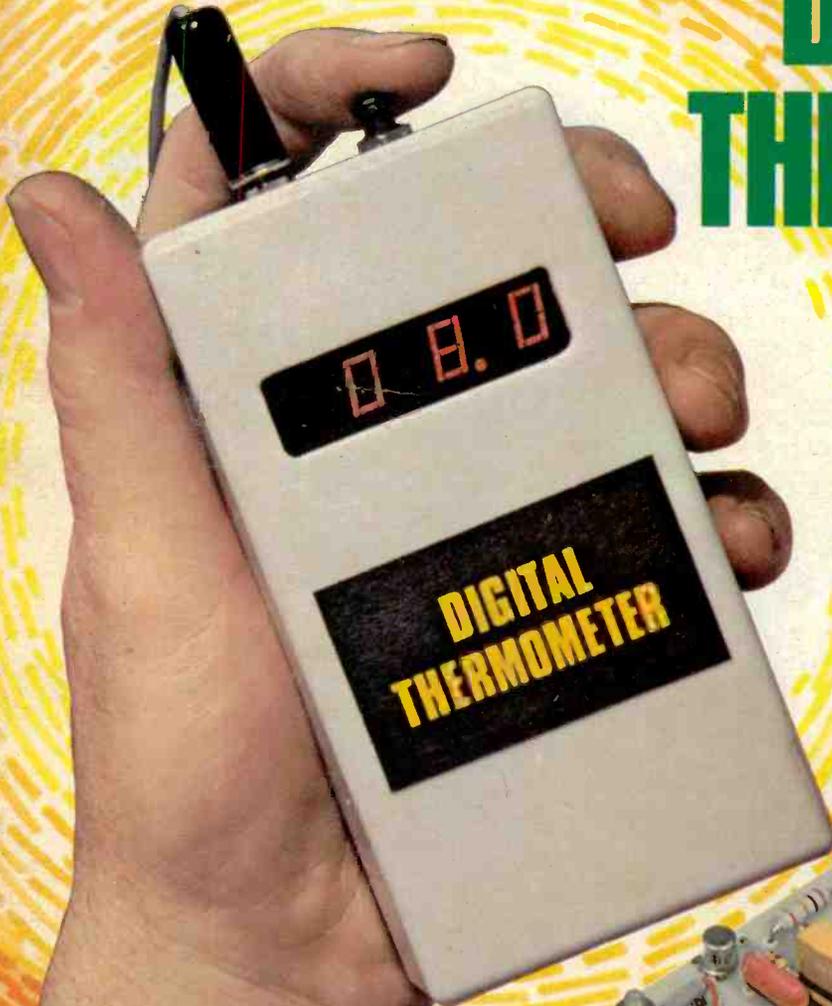
PRACTICAL

# ELECTRONICS

AUGUST 1978

45p

## DIGITAL THERMOMETER



*Also inside...*

**CONSTANT DISPLAY FREQUENCY COUNTER**  
**MICROPROCESSOR KIT REVIEW**

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# PRACTICAL ELECTRONICS

VOLUME 14 No. 12 AUGUST 1978

## CONSTRUCTIONAL PROJECTS

<b>TOUCH SWITCH</b> <i>by G. Davis</i> Direct replacement for a mains light switch	890
<b>P.E. TV GAME CENTRE—2</b> Concludes with construction and setting up	892
<b>DIGITAL THERMOMETER</b> <i>by M. Plant</i> Measurement range of $-99.9^{\circ}\text{C}$ to $+99.9^{\circ}\text{C}$ . Single LSI chip simplifies construction	896
<b>MOTOR SPEED CONTROLLER</b> <i>by R. F. Mack</i> You set the speed which the controller maintains irrespective of loading	916
<b>12V CONVERTOR</b> <i>by D. J. Bradbury</i> Enables a 24V iron to be powered from a car battery	924
<b>CONSTANT DISPLAY FREQUENCY METER</b> <i>by J. Becker</i> Monitors frequency without flicker	934

## GENERAL FEATURES

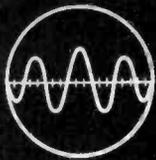
<b>MICROPROCESSOR REVIEW—AMICOS</b> <i>by P. Birnie</i> Kit review of this 6800 system	906
<b>P.C.B. ASSEMBLY JIGS</b> <i>by W. English</i>	909
<b>MAKING P.C.Bs</b> <i>by A. R. Damper</i>	910
<b>INGENUITY UNLIMITED</b> Envelope Shaper—pH Meter—Touch Sensitive Keyboard—Calculator—Decade Counter— CMOS Doorbell—Trace Multiplier—L.e.d. Flasher	920
<b>SEMICONDUCTOR UPDATE</b> <i>by R. W. Coles</i> A look at some recently released devices	930
<b>MICROBUS</b> <i>by D.J.D.</i> A bi-monthly focus on micro's for the home constructor	932

## NEWS AND COMMENT

<b>EDITORIAL</b>	889
<b>SPACEWATCH</b> <i>by Frank W. Hyde</i> Out of the Ecliptic, Sun Shivers, Uranus, Landsat, Halley's Comet	901
<b>NEWS BRIEFS</b> Heat Pipe device—Eagle's Launch—New Microprocessors— Ink Jet System	902 905
<b>MARKET PLACE</b> Interesting new products	912
<b>READOUT</b> A selection of readers' letters	918
<b>BOOK REVIEWS</b> Selected new books we have received	918
<b>PATENTS REVIEW</b> Thought provoking ideas on file at the British Patents Office	919
<b>INDUSTRY NOTEBOOK</b> <i>by Nexus</i> What's happening inside industry	931
<b>POINTS ARISING</b> Linear Capacitance Meter	938

Our September issue will be on sale Friday, 11 August 1978  
(for details of contents see page 929)

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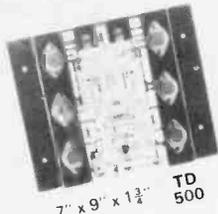
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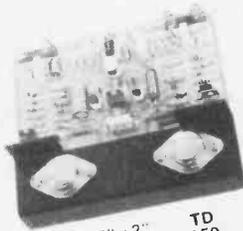
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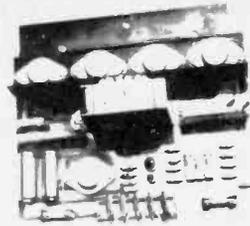
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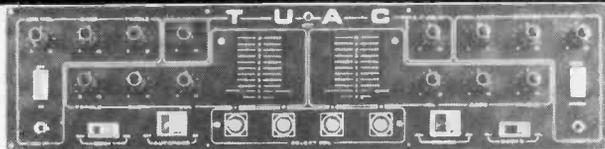
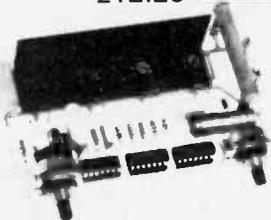
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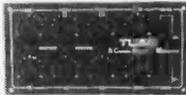
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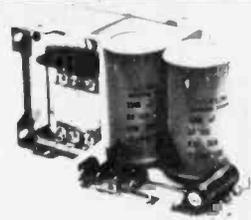


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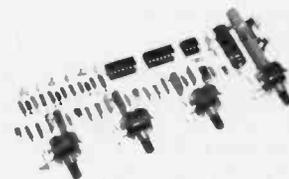
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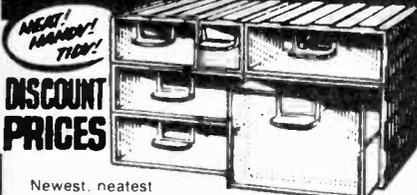
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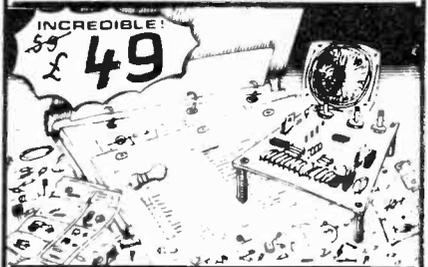
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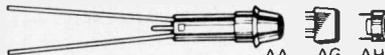
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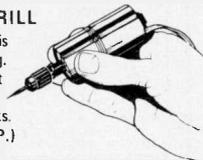


Red, Amber, Clear, Opal  
Green

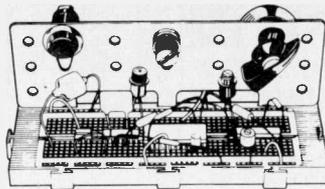
AA AG AH  
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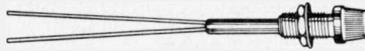
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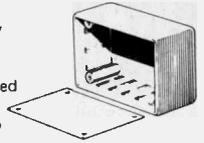
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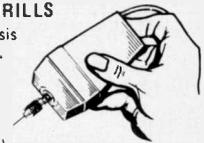


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AA130	0-15	BCZ11	1-50	*MPSU56	0-45	1N916	0-07	7405	0-28
AAZ13	0-25	BD115	0-60	NKT401	2-00	1N4001	0-06	7406	0-55
AAZ15	0-31	BD121	1-50	NKT403	1-73	1N4002	0-07	7407	0-55
AAZ17	0-25	BD123	1-50	NKT404	1-73	1N4003	0-08	7408	0-28
AC107	0-75	BD124	1-30	NE555	0-45	1N4004	0-09	7409	0-28
AC120	0-25	BD131	0-51	OA5	0-75	1N4005	0-13	7410	0-20
AC126	0-35	BD132	0-54	OA7	0-55	1N4006	0-15	7412	0-26
AC127	0-25	*BD135	0-35	OA10	0-55	1N4007	0-15	7413	0-45
AC128	0-25	*BD136	0-36	OA47	0-14	1N4009	0-15	7416	0-40
AC141	0-20	*BD137	0-37	OA70	0-30	1N4148	0-07	7417	0-40
AC141K	0-35	*BD138	0-40	OA79	0-30	1N5400	0-14	7420	0-25
AC142	0-20	*BD139	0-43	OA81	0-30	1N5401	0-18	7422	0-25
AC142K	0-35	*BD140	0-47	OA85	0-30	1S44	0-06	7423	0-35
AC176	0-25	BD144	2-00	OA90	0-08	1S920	0-08	7425	0-35
AC187	0-25	BD181	1-38	OA91	0-08	1S921	0-08	7427	0-35
AC188	0-25	BD182	1-48	OA95	0-08	2G301	1-00	7428	0-50
ACV17	0-85	BD237	0-80	OA200	0-10	2G302	1-10	7430	0-20
ACV18	0-85	BD238	0-85	QA202	0-11	2G305	1-10	7432	0-36
ACV19	0-85	BDX10	0-75	QA210	0-75	2N404	0-60	7433	0-37
ACV20	0-85	BDX32	2-25	QA211	0-75	2N696	0-25	7437	0-42
ACV21	0-85	BDY20	1-42	QAZ200	0-65	2N697	0-16	7438	0-37
ACV39	1-25	BDY60	0-75	QAZ201	0-65	2N698	0-30	7440	0-22
AD149	0-70	BF115	0-39	QAZ206	0-65	2N705	0-80	7441AN	0-92
AD161	0-75	BF152	0-25	QAZ207	0-65	2N706	0-12	7442	0-78
AD162	0-75	BF153	0-25	OC16	1-25	2N1305	0-11	7443AN	1-20
AF106	0-45	BF154	0-25	OC20	2-00	2N930	0-26	7450	0-20
AF114	0-25	BF159	0-35	OC22	2-50	2N1131	0-26	7451	0-20
AF115	0-25	BF160	0-30	OC23	2-75	2N1132	0-26	7453	0-20
AF116	0-25	BF167	0-39	OC24	3-50	2N1302	0-37	7454	0-20
AF117	0-25	BF173	0-39	OC25	0-90	2N1303	0-37	7460	0-20
AF139	0-40	BF177	0-38	OC26	0-90	2N1304	0-45	7470	0-35
AF186	1-50	BF178	0-48	OC28	2-00	2N1305	0-50	7473	0-36
AF239	0-45	BF179	0-48	OC29	2-00	2N1306	0-50	7473	0-36
AF211	2-75	BF180	0-45	OC35	1-50	2N1307	0-50	7474	0-40
ASV26	0-45	BF181	0-45	OC36	1-50	2N1308	0-60	7475	0-59
ASV27	0-45	BF182	0-45	OC41	0-50	2N1309	0-60	7476	0-42
ASV28	0-50	BF183	0-45	OC42	0-50	2N1613	0-33	7480	0-60
ASZ15	1-25	BF184	0-39	OC43	1-50	2N1671	0-50	7482	0-85
ASZ16	1-25	BF185	0-37	OC44	0-50	2N1893	0-33	7483	0-00
ASZ17	1-25	*BF194	0-12	OC45	0-50	2N2147	1-40	7484	1-00
ASZ20	0-75	*BF195	0-11	OC71	0-45	2N2148	1-65	7486	0-40
ASZ21	1-50	*BF196	0-13	OC72	0-45	2N2218	0-33	7490	0-52
AU110	1-70	*BF197	0-14	OC73	1-00	2N2219	0-42	7491AN	0-85
AU113	1-70	BF200	0-32	OC74	0-50	2N2220	0-35	7492	0-60
BA145	0-15	*BF224	0-20	OC75	0-50	2N2221	0-50	7493	0-85
BA148	0-10	*BF244	0-35	OC76	0-50	2N2222	0-25	7494	0-80
BA154	0-10	BF257	0-37	OC77	1-20	2N2223	2-75	7495	0-80
BA155	0-12	BF258	0-42	OC81	0-75	2N2368	0-17	7496	0-90
BA156	0-13	BF259	0-45	OC81Z	1-00	2N2369A	0-21	7497	3-67
BAW62	0-05	*BF336	0-50	OC82	0-75	2N2484	0-21	74100	1-75
BAX13	0-07	*BF337	0-50	OC83	0-55	2N2646	0-50	74107	0-45
BAX16	0-07	*BF338	0-55	OC84	0-60	2N2904	0-65	74109	0-86
BC107	0-18	BFS21	2-27	OC122	1-50	2N2905	0-35	74110	0-57
BC108	0-12	BF228	1-38	OC123	1-55	2N2906	0-25	74111	0-86
BC109	0-13	*BFS61	0-25	OC139	2-25	2N2907	0-21	74116	1-89
*BC113	0-15	*BFS98	0-25	OC140	1-95	*2N2924	0-15	74118	0-95
*BC114	0-18	BFW10	0-30	OC141	2-25	*2N2925	0-17	74119	2-00
*BC115	0-19	BFW11	0-30	OC170	0-75	*2N2926	0-13	74120	1-10
*BC116	0-19	BFX84	0-48	OC171	0-75	2N3053	0-25	74121	0-45
*BC117	0-22	BFX85	0-41	OC200	1-00	2N3054	0-50	74122	0-60
*BC118	0-16	BFX87	0-35	OC201	1-50	2N3055	0-65	74123	1-00
*BC125	0-18	BFX88	0-32	OC202	1-50	2N3440	0-60	74125	0-80
*BC126	0-25	BFY50	0-28	OC203	1-75	2N3441	0-80	74126	0-80
*BC135	0-15	BFY51	0-26	OC204	1-25	2N3442	1-20	74128	0-80
*BC136	0-19	BFY52	0-26	OC205	1-75	2N3525	0-50	74132	0-68
*BC137	0-10	BFY64	0-30	OC206	1-75	2N3614	1-20	74136	0-80
*BC147	0-10	BFY90	1-32	OC207	1-25	*2N3702	0-15	74141	0-85
*BC148	0-10	BSX19	0-34	OC207	1-25	*2N3703	0-15	74142	3-00
*BC149	0-13	BSX20	0-34	ORP12	0-83	*2N3704	0-15	74143	3-00
*BC157	0-12	BSX21	0-32	*R2008B	2-25	*2N3705	0-15	74144	3-00
*BC158	0-11	BT106	1-25	*R2009	2-25	*2N3706	0-14	74145	2-45
*BC159	0-13	*BTY79/400R	3-19	*R2010B	2-25	*2N3707	0-18	74147	2-00
*BC167	0-18	*BU205	2-25	T1C44	0-36	*2N3708	0-14	74148	2-45
*BC170	0-16	*BU206	2-25	T1C226D	1-30	*2N3709	0-15	74150	1-75
*BC171	0-14	*BU208	2-50	T1L209	0-25	*2N3710	0-14	74151	0-90
*BC172	0-13	BY100	0-45	*T1P29A	0-50	*2N3711	0-15	74154	2-00
*BC173	0-15	BY126	0-15	*T1P30A	0-60	2N3711	1-60	74155	0-90
BC177	0-19	BY127	0-15	T1P31A	0-52	2N3712	1-70	74156	0-90
BC178	0-18	BZK61	0-20	T1P32A	0-75	2N3713	2-65	74157	0-90
BC179	0-18	Series		T1P33A	1-00	*2N3819	0-36	74159	2-50
*BC182	0-11	BZY88	0-13	T1P34A	1-20	*2N3820	0-46	74170	2-60
*BC183	0-11	Series		T1P41A	0-70	*2N3823	0-60	74172	5-00
*BC184	0-12	CRS1105	0-45	T1P42A	0-90	2N3866	1-00	74173	1-75
*BC212	0-14	CRS1140	0-60	T1P2955	1-00	*2N3904	0-21	74174	1-57
*BC213	0-14	CRS3005	0-45	T1P3055	0-50	*2N3905	0-22	74175	1-00
*BC214	0-17	CRS340	0-75	*T1S43	0-35	*2N3906	0-22	74176	1-10
*BC237	0-17	CRS360	0-90	*ZS140	0-25	*2N4058	0-20	74178	1-65
*BC238	0-12	GEX66	1-50	*ZS170	0-12	*2N4059	0-15	74179	1-65
BC301	0-45	GEX541	1-75	*ZS178	0-54	*2N4060	0-20	74180	1-65
BC303	0-60	GJ3M	0-75	*ZS271	0-22	*2N4061	0-17	74190	1-48
BC307	0-20	GSM	0-75	*ZS278	0-56	*2N4062	0-18	74191	1-48
BC308	0-18	GMO378A	1-50	*ZTX107	0-11	*2N4124	0-17	74192	1-25
BC327	0-22	*KS100A	0-40	*ZTX108	0-10	*2N4126	0-17	74193	1-25
BC328	0-18	MJE340	0-58	*ZTX109	0-12	*2N4286	0-20	74194	1-25
BC337	0-19	MJE370	0-65	*ZTX300	0-12	*2N4288	0-25	74195	1-10
BC338	0-18	MJE371	0-81	*ZTX301	0-13	*2N4289	0-25	74196	1-20
BCY30	1-00	MJE521	0-75	*ZTX302	0-17	*2N4517	0-35	74197	2-25
BCY31	1-00	MJE2955	1-25	*ZTX303	0-17	*2N4548	0-35	74198	2-25
BCY32	0-90	MJE3055	0-75	*ZTX304	0-19	*2N4549	0-35	74199	2-25
BCY33	0-90	*MPF102	0-30	*ZTX311	0-12	3N125	1-75	*76013N	1-75
BCY34	0-90	*MPF103	0-30	*ZTX314	0-20				
BCY39	3-00	*MPF104	0-30	*ZTX500	0-13				
BCY40	1-25	*MPF105	0-30	*ZTX501	0-14	INTEGRATED			
BCY42	0-30	*MPSA06	0-25	*ZTX502	0-16	CIRCUITS			
BCY43	0-32	*MPSA56	0-25	*ZTX503	0-17	7400	0-20		
BCY58	0-18			*ZTX504	0-20	7401	0-20		
BCY70	0-18			*ZTX531	0-20	7402	0-20		

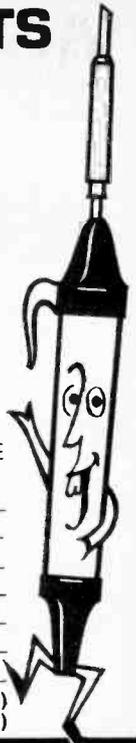
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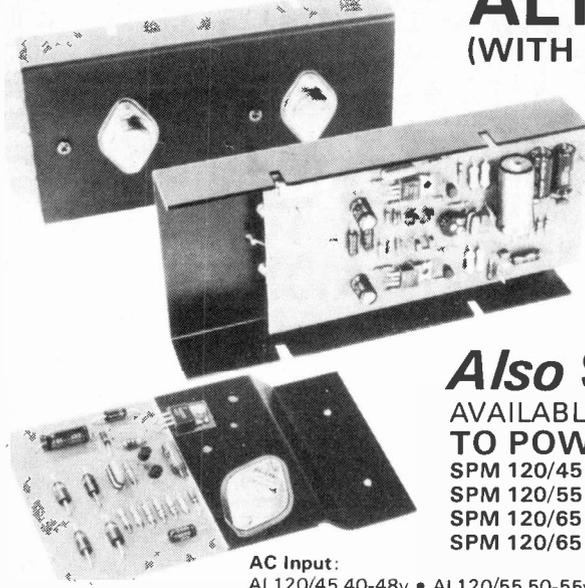
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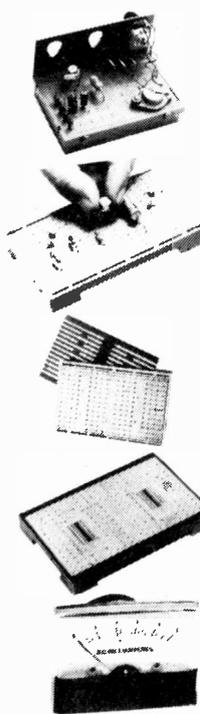


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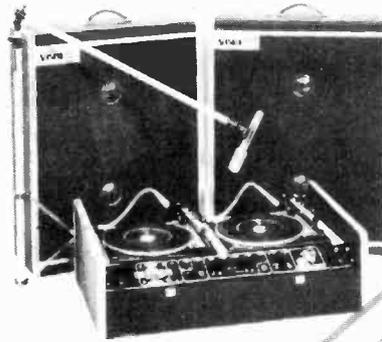


Illustration shows GXL Centaur System

These systems feature full mixing for two decks tape & mic with monitoring facilities – override and are supplied complete with sound to light sequencer, display, speaker leads etc.

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### D.I.Y. MODULES FOR ALL DISCO/P.A. AMPLIFIERS

SA308 30W 8 ohms 45V	£9.95*	SUPPLY FOR TWO MODULES	£10.90*
SA604 60W 4 ohms 50V	£13.25	SUPPLY FOR TWO MODULES	£13.50
SA608 60W 8 ohms 65V	£14.25	SUPPLY FOR TWO MODULES	
SA1204 120W 4 ohms 75V	£15.95	SUPPLY FOR ONE MODULE	£22.50
SA1208 120W 8 ohms 95V	£21.00	SUPPLY FOR TWO MODULES	
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0.2% Distortion, 30Hz 20, KHz – 2dB, Fully Short/Open Circuit proof input sensitivity 240 mV to suit most mixers – D.C. & Output Fuses fitted



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Available complete and ready to plug in or as an easy to connect module with all controls except monitor switch already fitted – full instructions supplied.

FEATURES INCLUDE:  
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Stereo module	£33.50
Panel	£3.95
(Set of knobs/sockets etc)	£5.50
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Mono 18V	£39.50
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Plus channel controls	Panel £2.95



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Super Strobe 2-3 Joules £22.50  
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	£15.50	Large 2 x 12"	£28	1 x 18"
			£29.50	

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Bubble machines (aptikinetics) £36.50

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**FULL RANGE OF RE-AN PRODUCTS IN STOCK  
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(As fitted to our package PA system)

Direct from Motorola Inc., USA at an UNBEATABLE PRICE

No crossover required 4kHz – 30kHz rated 75W/8 ohms 150W/4 ohms use two per 100W amplifier – Full instructions supplied.



**AND**

# PACKAGE P.A. SYSTEMS (2 Year Guarantee)

Complete with PIEZO horn columns fitted with 100 watt units (100 watt system illustrated)

**100 Watt £149.50**

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12 Months @ £12.91 or 24 Months @ £7.20

Includes 4 Channel 100 Watt Amplifier with Treble, Bass and Master Controls plus Leads and Twin Piezo Horn Columns (shown on right)

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2x 100 Watt Mixed Inputs plus Three Sets of Bass and Treble Controls plus Slave Output and Master Control.

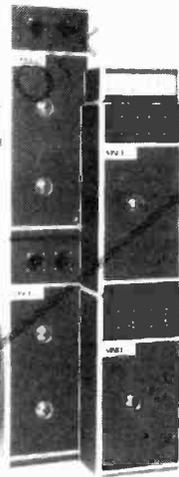
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A high quality Cassette Tape Echo Unit giving long tape life, infinitely variable echo depth and speed control. Suitable for all mics. and instruments.

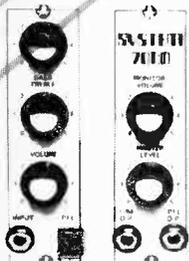
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Input Stages Up to 20	Mono PCB	£5.95	Mono C/W panel etc.	£8.95
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	Stereo PCB	£9.50	Stereo C/W panel etc.	£12.50
Power supply for up to 20 channels		£9.50	Blank panel	£1.00

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Four mixing inputs - 100W into 4 ohms  
Wide range boss & treble controls  
- master - Twin outputs

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Type	No.	Price	Type	No.	Price
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1/4in OBA	840	£0.75	1/4in 4BA	847	£0.25
1/4in 2BA	842	£0.65	1/4in 6BA	848	£0.40
1/4in 2BA	843	£0.45	1/4in 6BA	849	£0.21
1/4in 2BA	844	£0.52	1/4in 6BA	850	£0.25
1/4in 4BA	845	£0.44			

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

Type	No.	Price	Type	No.	Price
OBA	855	£0.72	4BA	857	£0.30
2BA	856	£0.48	6BA	858	£0.24

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Type	No.	Price	Type	No.	Price
OBA	859	£0.14	4BA	861	£0.12
2BA	860	£0.12	6BA	862	£0.12

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Type	No.	Price	Type	No.	Price
OBA	851	£0.40	4BA	853	£0.22
2BA	852	£0.28	6BA	854	£0.22

## SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0.11*
DPDT standard slide	1974	£0.14*
Toggle switch SPST 1/2 amp 250V a.c.	1975	£0.33*
Toggle switch DPDT 1 amp 250V a.c.	1976	£0.42*
Rotary off mains switch	1977	£0.50*
Push switch — Push to make	1978	£0.13*
Push switch — Push to break	1979	£0.18*

ROCKER SWITCH	Colour	No.	Price
A range of rocker switches SPST — moulded in high insulation. Material available in a choice of colours ideal for small apparatus.	RED	1980	£0.30*
	BLACK	1981	£0.30*
	WHITE	1982	£0.30*
	BLUE	1983	£0.30*
	YELLOW	1984	£0.30*
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Description	No.	Price
Miniature SPST toggle, 2 amp 250V a.c.	1958	£0.50*
Miniature SPST toggle, 2 amp 250V a.c.	1959	£0.55*
Miniature DPDT toggle, 2 amp 250V a.c.	1960	£0.70*
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	£0.85*
Push button SPST, 2 amp 250V a.c.	1962	£0.78*
Push button SPST, 2 amp 250V a.c.	1963	£0.83*
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Single-bank wafer type — suitable for switching at 250V a.c. 100mA or 150V d.c. in non-reactive loads make-before-break contacts. These switches have a spindle 0.25in dia. and 30° indexing.

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Plastic button gives simple 1 pole change over action. Rating 10 amp 250V a.c.

Order No.	Price
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Panel mounting 20mm	509	£0.20*
Panel mounting 1 1/2in	510	£0.30*

QUICK BLOW 20mm					
Type	No.	Type	No.	Type	No.
150mA	611	6p	1A	615	5p
250mA	612	5p	1.5A	616	6p
500mA	613	5p	2A	617	5p
800mA	614	7p	2.5A	618	6p

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

QUICK BLOW 1 1/2in					
Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634
All 7p each					
Type	No.	Type	No.	Type	No.
1A	635	2.5A	638	5A	642
2A	637	3A	639		

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No.	Length	Width	Height	Price
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156	11in	6in	3in	£2.12
157	6in	4 1/2in	1 1/2in	£1.30
158	9in	5 1/2in	2 1/2in	£1.76

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No.	Length	Width	Height	Price
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160	4in	4in	1 1/2in	62p
161	4in	2 1/2in	1in	62p
162	5 1/2in	4in	1 1/2in	70p
163	4in	2 1/2in	2in	64p
164	3in	2in	1in	44p
165	7in	5in	2 1/2in	£1.04
166	8in	6in	3in	£1.32
167	6in	4in	2in	86p

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C26	4 pieces 8" x 3 1/4" (approx.) Single-sided fibreglass	80p
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**MINIATURE MAINS Primary 240V**

No.	Secondary	Price
2021	6V-0-6V 100mA	90p*
2022	9V-0-9V 100mA	90p*
2023	12V-0-12V 100mA	95p*

**MINIATURE MAINS Primary 240V with two independent secondary windings**

No.	Type	Price
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2025	MT150-0-12V, 0-12V RMS	£1.50*

**1 AMP MAINS Primary 240V**

No.	Secondary	Price	
2026	6V-0-6V 1 amp	£2.50*	P & P 45p
2027	9V-0-9V 1 amp	£2.00*	P & P 45p
2028	12V-0-12V 1 amp	£2.60*	P & P 55p
2029	15V-0-15V 1 amp	£2.75*	P & P 66p
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**STANDARD MAINS Primary 240V**

Multi-tapped secondary mains transformers available in 1 amp, 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50V.

Volts available by use of taps: 4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25-0-25V.

No.	Rating	Price	
2031	1 amp	£5.50*	P & P 86p
2032	1 amp	£6.60*	P & P 86p
2033	2 amp	£8.40*	P & P £11.10

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107	FM Indoor Ribbon Aerial	£0.60*
113	3.5mm Jack plug to 3.5mm jack plug. Length 1.5m	£0.75*
114	5 pin DIN plug to 3.5mm. Jack connected to pins 3&5. Length 1.5m	£0.85*
115	5 pin DIN plug to 3.5mm. Jack connected to pins 1&4. Length 1.5m	£0.85*
116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	£1.10*
117	AC mains connecting lead for cassette recorders & radios. 2 metres	£0.68*
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131	5 pin DIN plug to 3 pin DIN plug. 1&4 and 3&5. Length 1.5m	£0.83*
132	2 pin DIN plug to 2 pin DIN socket. Length 1.0m	£0.98*
133	5 pin DIN plug to 2 phono plugs. Connected pins 3&5. Length 1.5m	£0.75*
134	5 pin DIN plug to 2 phono sockets. Connected pins 3&5. Length 23cm	£0.68*
135	5 pin DIN socket to 2 phono plugs. Connected pins 3&5. Length 23cm	£0.68*
136	Coiled stereo headphone extension lead. Black. Length 6m	£1.75*
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+ 12½% VAT



The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, simply by changing the settings of the pre-set controls. Features include FET input stage. Vari-Cap diode tuning. Switched AFC LED Stereo Indicator.

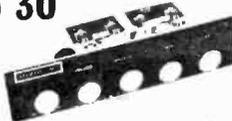
FREQUENCY RANGE	88-108 Mhz
SENSITIVITY	3.0 µV
BANDWIDTH	250 kHz
SPIRIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22.5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm x 110mm x 32mm

## Stereo 30

**COMPLETE AUDIO CHASSIS**

**£18.95**

+ 40 p&p  
+ 12½% VAT



7 + 7w R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, main switch, fuse and fuse holder and universal mounting brackets.

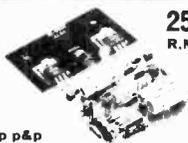
OUTPUT POWER	7 Watts RMS
LOAD IMPEDANCE	8 ohms
TOTAL HARMONIC DISTORTION	Less than .5% (Typically .3%)
FREQUENCY RESPONSE	50 Hz to 30 kHz ± 3dBs
TONE CONTROL RANGE	± 12 dBs at 100Hz and 10kHz
SENSITIVITY	190 mV for full output
INPUT IMPEDANCE	1 M ohms
TRANSFORMER REQUIREMENTS	22 V. A.C. rated at 1 A
DIMENSIONS (Less controls and panel)	200mm x 130mm x 33mm

## AL60

**AUDIO AMPLIFIER MODULE**  
25 Watts RMS

**£4.55**

+ 25p p&p  
+ 12½% VAT



25w R.M.S.

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25 RMS with distortion levels below 0.1%.

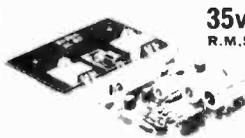
OUTPUT POWER	25 Watts RMS
SUPPLY	30-50 V
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz x 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm x 64mm x 15mm

## AL80

**AUDIO AMPLIFIER MODULE**

**£7.15**

+ 25p p&p  
+ 8% VAT



35w R.M.S.

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W with distortion levels below 0.1%.

OUTPUT POWER	35 Watts RMS
SUPPLY	40-60 V
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz x 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm x 64mm x 15mm

## AL250

**POWER AMPLIFIER**

**£17.25**

+ 40p p&p + 8% VAT



125w R.M.S.

This unit, designated AL250, is a power amplifier providing an output of up to 125W RMS, into a 4 ohm load.

OUTPUT POWER	125 Watts RMS continuous
OPERATING VOLTAGE	50-80 V
LOADS	4-16 ohms
FREQUENCY RESPONSE	25 Hz 20 kHz measured at 100 Watts
SENSITIVITY FOR 100 WATTS O/P AT 1 kHz	450 mV
INPUT IMPEDANCE	33 K ohms
TOTAL HARMONIC DISTORTION 50 WATTS into 4 ohms	0.1%
50 WATTS into 8 ohms	0.06%

## AL30A

**AUDIO AMPLIFIER MODULES**

**£3.75**

+ 25p p&p  
+ 12½% VAT



10w R.M.S.

These low cost 5 and 10 watt modules offer the utmost in reliability and performance, whilst being compact in size.

MAXIMUM SUPPLY VOLTAGE	30 V
POWER OUTPUT for 2% THD	10 Watts RMS
TOTAL HARMONIC DISTORTION	Less than .25%
LOAD IMPEDANCE	8-16 ohms
INPUT IMPEDANCE	100 K ohms
FREQUENCY RESPONSE	50 Hz-25 kHz ± 3 dBs
SENSITIVITY	75 mV for full output
DIMENSIONS	74mm x 63mm x 28mm

## SPM80

**STABILISED POWER SUPPLY**

**£4.25**

+ 25p p&p  
+ 12½% VAT



Designed to power two AL60s at 15 Watts per channel simultaneously. Circuit Techniques include full short circuit protection.

INPUT A.C. VOLTAGE	33-40V
OUTPUT D.C. VOLTAGE	33 V nominal
OUTPUT CURRENT	10 mA-1.5 amps
OVERLOAD CURRENT	1.7 amps approx.
DIMENSIONS	105mm x 63mm x 30mm

## PA100

**STEREO PRE-AMPLIFIER**

**£15.80**

+ 40p p&p  
+ 12½% VAT



A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution to the front end requirements of stereo amplifiers or audio units. The six push button selector switch gives a choice of inputs together with two filters for high and low frequencies.

FREQUENCY RESPONSE	20 Hz to 20 kHz x 1 dB
TOTAL HARMONIC DISTORTION	Less than .1% (Typically .07%)
SENSITIVITY	100 mV/100 K ohms } For an
INPUTS	2. RADIO TUNER } output
	3. MAGNETIC P.U. } 250 mV
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
BASS CONTROL RANGE	± 15 dBs at 75 Hz
TREBLE CONTROL RANGE	+ 10-20 dBs at 15 kHz
SIGNAL/NOISE RATIO	Better than 65 dBs (All inputs)
INPUT OVERLOAD	Better than 26 dBs (All inputs)
SUPPLY	20 to 40 V
DIMENSIONS	300 x 90 x 33mm (less controls)

## MPA30

**MAGNETIC CARTRIDGE PRE-AMPLIFIER**

**£2.95**  
+ 25p p&p  
+ 12½% VAT

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the MPA30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.

SENSITIVITY	3.5 mV for 100 mV output
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
INPUT IMPEDANCE	50 K ohms
SUPPLY	18 to 30 V—re earth
DIMENSIONS	110 x 50 x 25mm (inc DIN socket)

## PA12

**STEREO PRE-AMPLIFIER**

**£7.10**  
+ 30p p&p  
+ 12½% VAT

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

FREQUENCY RESPONSE	20 Hz-20 kHz (—3dB)
BASS CONTROL	± 12 dB at 60 Hz
TREBLE CONTROL	± 14 dB at 10 kHz
INPUT IMPEDANCE	1 Meg. ohm
INPUT SENSITIVITY	300 mV
CROSSTALK	—60 dB
SIGNAL/NOISE RATIO	—65 dB
OVERLOAD FACTOR	± 20 dB
TAPE OUTPUT IMPEDANCE	25 K ohms
DIMENSIONS	152mm x 84mm x 25mm

## PS12 POWER SUPPLY

Designed for use with the AL30A S.450 and MPA30 in conjunction with transformer T538.

INPUT VOLTAGE	17-20V AC	<b>£1.30</b> + 25p p&p + 12½% VAT
OUTPUT VOLTAGE	27-30V DC	
OUTPUT CURRENT	800mA	
SIZE	60mm x 43mm x 26mm	

## GE 100 NINE CHANNEL MONO-GRAPHIC EQUALIZER

The GE100 has nine 1 octave adjustments using integrated circuit active filters. Boost and Cut limits are ± 12dB. Max. Voltage handling 2 V RMS, T.H.D. 0.05%, input impedance 100K. Output impedance less than 10 K. Frequency response 20 Hz-20 KHz (3dB). The nine gain controls are centred at 50, 100, 200, 400, 800, 1,600, 3,200, 6,400 and 12,800 Hz. The suggested gain controls are 10 K LIN sliders (not supplied with the module) See Paks S31 and 16192. **£22.00** + 25p p&p + 12½% VAT

**SG30 POWER SUPPLY BOARD** for GE100 15-0-15 VOLT **£5.50** + 12½% VAT + 25p p&p

## SIREN ALARM MODULE

American Police screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer breakdown and other security purposes. Order No. S15. No. BP124. **Only £3.50** + 8% VAT + 25p p&p

## MA60 HI-FI AMPLIFIER KIT

Build your own top quality amplifier, save yourself pounds. The MA60 kit comprises the following BI-PAK modules, 2 x AL60 amps, 1 x PA100 pre-amp, 1 x SPM80 stab. power supply, 1 x BMT80 transf. giving 17 watts RMS per channel STEREO. All modules covered by the BI-PAK satisfaction or money back guarantee. Details of the above modules are in this ad. **Price £32.00** + 12½% VAT + 62p p&p.

## TC60 KIT

A beautifully designed genuine TEAK WOOD veneered cabinet to put the professional touches to your home built amplifier. Full set of parts incl. Front & Back Panels, Knobs, Chassis, Fuses, Sockets, Noen, etc. Ideal for the MA60. Size: 425mm x 290mm x 95mm. **Price £19.95** + 12½% VAT + 86p p&p

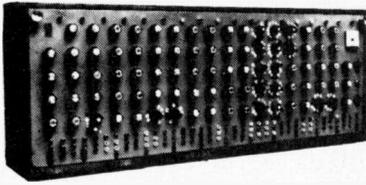
## TRANSFORMERS

T538 For use with S.450 AL30A MPA30  
Order No. 2036 Price: **£3.20** + 55p p&p + 12½% VAT  
T2050 For use with Stereo 30  
Order No. 2050 Price: **£3.25** + 55p p&p + 12½% VAT  
BMT80 For use with AL60 SPM80  
Order No. 2034 Price: **£5.40** + 86p p&p + 12½% VAT  
BMT250 For use with AL250  
Order No. 2035 Price: **£6.35** + £1.10 p&p + 12½% VAT

# BI-PAK

DEPT. PE8, P.O. Box 6, Ware, Herts

# KITS FOR SYNTHESISERS, SOUND EFFECTS



**COMPONENTS SETS** include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, keyboards, etc. are not included but most of these may be bought separately. Fuller details of kits, PCBs and parts are shown in our lists.

**CIRCUIT AND LAYOUT DIAGRAMS** are supplied free with all PCBs unless "as published".

**PHOTOCOPIES** of all P.E. texts for most of the kits are available—prices in our lists.

# PHONOSONICS

MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET.

## P.E. MINISONIC Mk. 2 SYNTHESISER

A portable mains-operated Miniature Sound Synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser the functions offered by this design give it great scope and versatility. Consists of 2 log VCOs, VCF, 2 envelope shapers, 2 voltage controlled amps, keyboard hold and control circuits, HF oscillator and detector, ring modulator, noise generator, mixer, power supply.

Set of basic component kits from **£62.23**  
Set of printed circuit boards **£9.94**

## P.E. SYNTHESISER (P.E. Feb. 73 to Feb. 74)

The well acclaimed and highly versatile large-scale mains-operated Sound Synthesiser complete with keyboard circuits. Other circuits in our lists may be used with the Synthesiser to good advantage.

**The Main Synthesiser:** PSU, 2 linear VCOs, 2 ramp generators, 2 input amps, sample hold, noise generator, reverb amp, ring modulator, peak level circuit, envelope shaper, voltage controlled amp.

Set of basic component kits **£83.03**  
Set of printed circuit boards **£13.20**

**The Synthesiser Keyboard Circuits** (can be used without the Main Synthesiser to make an independent musical instrument): 2 logarithmic VCOs, divider, 2 hold circuits, 2 modulation amps, mixer, 2 envelope shapers and PSU.

Set of basic component kits **£48.18**  
Set of printed circuit boards **£7.66**

## GUITAR EFFECTS PEDAL (P.E. July 75)

Modulates the attack, decay and filter characteristics of an audio signal not only from a guitar but from any audio source, producing 8 different switchable effects that can be further modified by manual controls. Possibly the most interesting of all the low-priced sound effects units in our range. Circuit does not duplicate effects from the Guitar Overdrive Unit.

Component set with special foot operated switches **£7.59**  
Alternative component set with panel switches **£4.96**  
Printed circuit board **£1.43**

## SOUND BENDER (P.E. May 74)

A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice-operated fader, automatic fader and frequency doubler.

Component set for above functions (excl SWs) **£7.84**  
Printed circuit board **£1.81**

Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce jangle-drum rhythms.

Component set (incl. PCB) **£2.88**

## PHASING UNIT (P.E. Sept 73)

A simple but effective manually controlled unit for introducing the phasing sound into live or recorded music.

Component set (incl. PCB) **£2.87**

## PHASING CONTROL UNIT (P.E. Oct 74)

For use with the above Phasing Unit to automatically control the rate of phasing.

Component set (incl. PCB) **£4.48**

## SOPHISTICATED PHASING AND VIBRATO UNIT

A slightly modified version of the circuit published in "Elektor", December 1976, and includes manual and automatic control over the rate of phasing and vibrato.

Component set **£17.69**  
Printed circuit board **£2.33**

## WAH-WAH UNIT (P.E. Apr 76)

The Wah-Wah effect produced by this unit can be controlled manually or by the integral automatic controller.

Component set (incl. PCB) **£3.55**

## AUTOWAH UNIT (P.E. Mar 77)

Automatically produces Wah-pedal and Swell-pedal sounds each time a new note is played.

Component set, PCB, special foot switches **£7.27**  
Component set and PCB, with panel switches **£4.83**

## P.E. JOANNA PLUS ORGAN VOICING

The basic five octave electronic piano (P.E. May/Sept 75 and Sound Design) has switchable alternative voicings for Honky-Tonk, ordinary piano, and Harpsichord or a mixture of any of these three, together with facilities including fast and slow tremolo, loud and soft pedal switching, and sustain pedal switching. The modification retains all the circuitry associated with the piano but in addition provides an organ-voice envelope facility with 5 switchable pitches, variable attack and sustain, phasing and vibrato.

Set of components (excl switches) for PSU, Frequency generator, Pitch and Note Divider, Envelope Shapers, Voicings, and Control circuitries. (Order as KIT 71-5) **£109.75**  
Set of PCBs (Order as PCB SET 71-6) **£29.18**

## SYNTHESISER TUNING INDICATOR (P.E. July 77)

A simple 4-octave frequency comparator for use with synthesisers and other instruments where the full versatility of the P.E. Tuning Fork is not required.

Component and PCB (but excl sw.) **£7.45**

## GUITAR FREQUENCY DOUBLER (P.E. Aug 77)

A modified and extended version of the circuit published.

Component set and PCB **£4.22**

## GUITAR SUSTAIN (P.E. Oct 77)

Maintains the natural attack whilst extending note duration.

Component set, PCB and foot switches **£4.90**  
Component set, PCB and panel switches **£3.48**

## WIND AND RAIN UNIT

A manually controlled unit for producing the above-named sounds.

Component set (incl. PCB) **£3.72**

## GUITAR OVERDRIVE UNIT (P.E. Aug 76)

Sophisticated, versatile Fuzz unit, including variable and switchable controls affecting the fuzz quality whilst retaining the attack and decay, and also providing filtering. Does not duplicate the effects from the Guitar Effects Pedal and can be used with it and with other electronic instruments.

Component set using dual slider pot **£6.86**  
Component set using dual rotary pot **£6.20**  
Printed circuit board **£1.62**

## FUZZ UNIT

Simple Fuzz unit based upon P.E. "Sound Design" circuit.

Component set (incl. PCB) **£2.05**

## TREMOLO UNIT

Based upon P.E. Sound Design circuit.

Component set (incl. PCB) **£3.64**

## TREBLE BOOST UNIT (P.E. Apr 76)

Gives a much shriller quality to audio signals fed through it. The depth of boost is manually adjustable.

Component set (incl. PCB) **£2.40**

## P.E. TUNING FORK (P.E. Nov 75)

Produces 84 switch-selected frequency-accurate tones. A LED monitor clearly displays all beat note adjustments. Ideal for tuning acoustic or electronic musical instruments.

Main component set (incl. PCB) **£15.59**  
Power supply set (incl. PCB) **£7.03**

SEE OTHER PAGE FOR KEYBOARDS, AND OUR LISTS FOR OTHER COMPONENTS AND ACCESSORIES STOCKED

## P.E. SYNCHRONOME (P.E. Mar. 76)

An accented-beat electronic metronome, providing dupe, triple and quadruple times with full control over the beat rate. Can also be used as a simple drum-beat rhythm generator. Includes power supply.

Component set (incl. loudspeaker) **£11.62**  
Printed circuit board **£2.04**

## TAPE NOISE LIMITER

Very effective circuit for reducing the hiss found in most tape recordings. All kits include PCBs.

Standard tolerance set of components **£2.96**  
Superior tolerance set of components **£3.76**  
Regulated power supply (will drive 2 sets) **£4.69**

## ENVELOPE SHAPER WITHOUT VCA (P.E. Oct. 75)

Provides full manual control over attack, decay, sustain and release functions, and is for use with an existing voltage controlled amplifier.

Component set (incl. PCB) **£4.86**

## ENVELOPE SHAPER WITH VCA (P.E. Apr. 76)

This unit has its own voltage controlled amplifier and has full manual control over attack, decay, sustain and release functions.

Component set (incl. PCB) **£6.88**

## TRANSIENT GENERATOR (P.E. Apr. 77)

An envelope shaper, without VCA, having the usual attack, decay, sustain and release functions, and in addition it also provides a Repeat Effect enabling a synthesiser to be programmed to imitate such instruments as a mandolin or banjo.

Component set **£4.52**  
Printed circuit board **£1.82**

## WAVEFORM CONVERTER

Slightly modified from a circuit published in "Elektor". Converts a saw-tooth waveform into four different waveforms: sine-wave, mark-space saw-tooth, regular triangle form, and squarewave with an externally variable mark-space ratio.

Component set (incl. PCB but excl. sw/s) **£8.19**

## VOLTAGE CONTROLLED FILTER (P.E. Dec. 74)

Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.

Component set (incl. PCB) (Order as Kit 65-1) **£8.22**

## RING MODULATOR (P.E. Jan 75)

Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.

Component set (incl. PCB) (Order as Kit 59-1) **£5.50**

## NOISE GENERATOR (P.E. Jan. 75)

Part of the P.E. Minisonic now released as an independent kit for use with other synthesisers.

Component set (incl. PCB) (Order as Kit 60-1) **£3.35**

## SOPHISTICATED POWER SUPPLIES

A wide range of highly stabilised low noise power supply kits is available—details in our lists.

## MICROPHONE PRE-AMP (P.E. Apr. 77)

Component set (incl. PCB) **£3.78**

## VOICE OPERATED FADER (P.E. Dec. 73)

For automatically reducing music volume during talk-over—particularly useful for Disco work or for home-movie shows.

Component set (incl. PCB) **£3.97**

## DYNAMIC RANGE LIMITER (P.E. Apr. 77)

Automatically controls sound output to within a preset level.

Component set (incl. PCB) **£4.58**

**EXPORT ORDERS** are welcome, though we advise that a current copy of our list should be obtained before ordering as it also shows Export postage rates. All payments must be cash-with-order, in Sterling and preferably by International Money Order or through an English Bank. To obtain list send 50p.

## POST AND HANDLING

U.K. orders—under £15 add 25p plus VAT, over £15 add 50p plus VAT. Keyboards £2.00 plus VAT. Optional insurance for compensation against loss or damage in post, add extra 50p for cover up to £50, £1.00 for £100 cover, £2.00 for £200 cover. Eire, C.I., B.F.P.O., and other countries are subject to Export postage rates.

## DON'T FORGET VAT!

Add 12½% (or current rate if changed) to full total of goods, post and handling. (Does not apply to export orders).

PHONOSONICS · DEPT. PE68 · 22 HIGH STREET · SIDCUP · KENT DA14 6EH MAIL ORDER AND C.W.O. ONLY SORRY BUT NO CALLERS PLEASE

# AND OTHER PROJECTS

**PHOTOGRAPHS** in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

**LIST**—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components

**OVERSEAS** enquiries for list Europe—send 20p; other countries—send 50p.



## KIMBER-ALLEN KEYBOARDS AND CONTACTS

Kimber-Allen Keyboards as required for many published circuits. The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C, the keys are plastic, spring-loaded, fitted with actuators, and mounted on a robust aluminium frame.

3 Octave (37 notes)	£25-50
4 Octave (49 notes)	£32-25
5 Octave (61 notes)	£39-75

**Contact Assemblies** (gold-clad wire) for use with the above keyboards (1 required for each note):

Type GJ: Single-pole change-over	each 24p
Type GB: 2 pairs of contacts, each pair normally open	each 27p
Type GC: 3 pairs of contacts, each pair normally open	each 36p
Type GE: 4 pairs of contacts, each pair normally open	each 45p
Type GH: 5 pairs of contacts, each pair normally open	each 57p
Type 4PS: 3 pairs of contacts plus single-pole changeover	each 53p

**Printed Circuit Boards** for use with GJ, GB and 4PS contacts (thus eliminating much interwiring) are available. Details in our lists.

### RHYTHM GENERATOR

15-Rhythm Tempo, Timing and Logic control unit (excl. sw's but incl. PCB)	£12-90
10-Instrument Effects circuits	£13-56
PCB for Effects circuits	£4-25
Power Supply incl. PCB	£12-00

### 128-NOTE TUNE-PROGRAMMABLE SEQUENCER

(P.E. Nov/Dec 77)

Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythmic pattern are externally variable. (Please use order codes quoted in brackets.)

Main Circuit (Nov) excl. sw's (KIT 76-1)	£20-60
Power Supply (KIT 76-3)	£6-05
Trigger Inverter and Alt. Output (KIT 76-2)	£1-35
LED Counter (KIT 76-4)	£2-45
PCB (as published) for KITS 76-1 & 3 (PCB 76A)	£2-61
PCB for KITS 76-2 & 4 (PCB 76B)	£2-54

### P.E. STRING ENSEMBLE (PE Mar-July 78)

The new keyboard string-instrument synthesiser.

<b>Basic component sets:</b>	
Power Supply (KIT 77-1)	£9-22
Tone Generator (KIT 77-2)	£14-93
Diode Gates (KIT 77-3)	£19-78
Chorus Generator (KIT 77-4)	£19-06
Voicing System (KIT 77-5)	£9-38

**Printed Circuit Boards:**

Double-sided PCB for Power Supply, Tone Generator & Diode Gates with most of the Matrix wiring as printed tracking (PCB 77L/R)	£18-40
PCB for Chorus Generator (PCB 77C)	£2-65
PCB for Voicing System (PCB 77D)	£2-62

Fuller details of kits & PCBs are in our lists.

### FORMANT SYNTHESISER (Elektron 1977/78)

Very sophisticated music synthesiser for the advanced constructor who puts performance before price. Details in our lists.

### DISCOSTROBE (P.E. Nov. 76)

4-channel light-show controller giving a choice of sequential, random, or full strobe mode of operation.

Basic component set	£18-19
Printed circuit board	£3-45

### BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)

Multi-function circuits that, with the use of other external equipment, can serve as lie-detector, alphaphone, cardiophone etc.

Pre-Amp Module Components set (incl. PCB)	£4-22
Basic Output Circuits—combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lampdriver circuits.	£6-59
Audio Amplifier Module Type PC7	£7-75

### 10% DISCOUNT VOUCHER (PE68)

**TERMS:** Correctly costed, C.W.O., U.K. orders over £50 goods value. Valid until end of month on cover of P.E. This voucher must accompany order.

### TRANSISTORS

AC128	28p
AC175	28p
BC107	14p
BC108	14p
BC109	14p
BC109C	15p
BC177	14p
BC184	12p
BC187	25p
BC204	14p
BC209C	14p
BC213	15p
BC214	15p
BC262	25p
BC415	16p
BC473	29p
BD131	44p
BD132	54p
BF244A	24p
BF245A	24p
BSY95A	22p
MD8001	172p
OC71	30p
OC72	30p
RPY5BA	48p
TIS43	60p
ZTX108	9p
ZTX301	13p
ZTX384	16p
ZX4501	15p
2N2219	27p
2N2646	50p
2N2905	35p
2N2905A	36p
2N2906	22p
2N2907	22p
2N3054	66p
2N3055	60p
2N3702	12p
2N3704	12p
2N3819	35p
2N3820	64p
2N3823E	39p
2N5459	45p

### INTEGRATED CIRCUITS

301 8-pin DIL	48p
318 8-pin DIL	230p
320-15	55p
324 14-pin DIL	87p
341-15	195p
709 8-pin DIL	48p
723 T05	105p
723 14-pin DIL	56p
726 T05	98p
741 8-pin DIL	32p
748 8-pin DIL	63p
4024 14-pin DIL	46p
4069 14-pin DIL	18p
4136 14-pin DIL	126p
7805 T0220	205p
7806 T0220	205p
7808 T0220	205p
7812 T0220	205p
7815 T0220	205p
7818 T0220	205p
AY10212 16-pin DIL	650p
AY1672 1/6	195p
CA3046 14-pin DIL	90p
CA3080 8-pin DIL	82p
CA3084 14-pin DIL	209p
M252 16-pin DIL	680p
MC3340 8-pin DIL	150p
MCM6810 24-pin DIL	670p
SG3402N 14-pin DIL	262p
STK025	595p
TDA1022 16-pin DIL	672p
XR2207 14-pin DIL	420p
ZN425E 16-pin DIL	375p

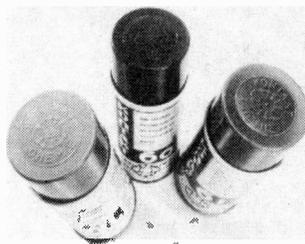
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7404	.19	7473	.30	4014	.85	4502	.95
7406	.36	7474	.30	4015	.85	4508	2.09
7407	.36	7475	.40	4016	.52	4510	1.51
7408	.19	7476	.35	4017	.85	4511	1.75
7410	.14	7486	.35	4018	.85	4514	2.98
7413	.36	7493	.35	4023	.19	4516	1.09
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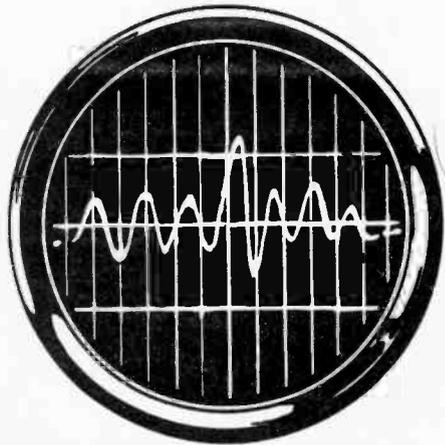
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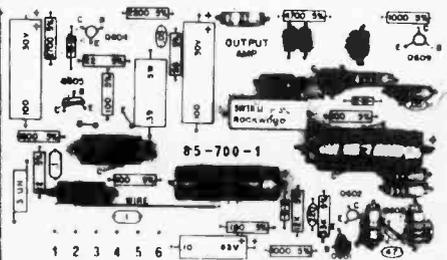
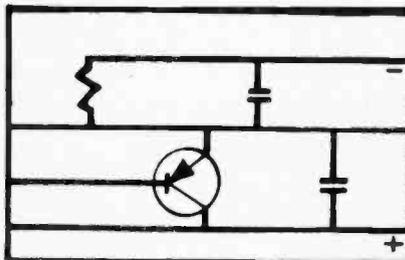
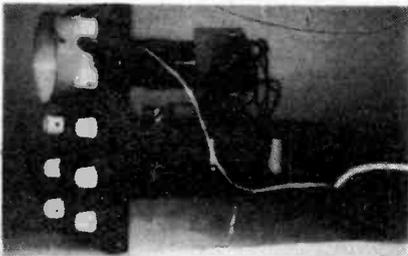
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## FAST MOVING?

RECENT news of the development of further advanced passenger trains capable of 150 m.p.h. has triggered interest from overseas governments. The Japanese are known to have a particular interest in the systems used to tilt the trains by up to nine degrees on curves; this is an electro-hydraulic system, the design of which interests the Japanese Government. Let us hope that we can sell these systems, or at least the technology, to them rather than once again allow others to capitalise on our inventiveness.

## INFORMATION

We have also noted one or two other improvements—the installation of “travel computers” at main line stations being one of particular interest.

A simple unit that quickly provides all train times and other general information at the push of a few buttons is a great boon to many travellers. The unfortunate part is that one must be at the station to use the computer. With the now inadequate telephone information system, one can spend a whole day trying to obtain

train times, etc. as anyone who has tried recently in the London area will know.

With the widespread use of Viewdata still a good few years away, it is a problem which would appear to require an interim solution—perhaps the installation of a Viewdata terminal at all stations would assist!

## ROBOTS

These are just two minor areas where we are seeing the immediate application of “the new electronics” and it is being widely reported that the advance of technology will change the whole face of industry and society. With approximately 70,000 industrial “robots” already in use in Japan is it any wonder that they are able to produce many items cheaper than Western countries. Although we in Britain are employing robots in increasing numbers, we are generally rather behind other industrial countries in this area, for a variety of reasons.

The knowledge that a revolution is about to commence is said to be partly behind the NEB plan to set up a micro-electronics company in partnership with a group of engineers. This controversial scheme has rocked the

established companies in this country—few of which have made the necessary capital investment to enable them to compete with i.c. manufacturers in America and Japan.

The business of chip production was recently referred to as “silicon printing” by Dr. Ed. Sack of General Instrument Microelectronics, one of the few companies producing chips in Britain. It is sad to note that GIM was set up by a group of British engineers with American backing about 10 years ago to design and sell chips for the communications industry. However, many of its products are now selling well abroad but not in Britain because the technology employed is in advance of the British systems.

GIM see the next boom as being in games—particularly hand held ones—and toys. They have developed a remote control system for toy cars which employs two m.p.u.'s. GIM are also active in programmable TV games and have joined forces with EMI who will be selling software in cassette form. Perhaps their recent Queen's Award for export achievement will be augmented by a rapidly expanding home market!

Mike Kenward

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**T**HIS touch switch can be used to directly replace an ordinary household light switch without the need for either additional wiring or fixing. The unit is capable of handling a mains load of up to 300 Watts and if the quadrac CSR1 (a diac and triac combined) is mounted on a suitable heatsink this figure can be increased to 750 Watts.

### CIRCUIT DESCRIPTION

The complete circuit diagram of the Touch Switch is shown in Fig. 1. Gates "a" and "b" of IC1 are connected as a bistable multivibrator with gates "c" and "d" used as a buffer stage.

When the switch is off the output from the buffer stage (pins 10 and 11) is high and the transistor TR1 is on. Because TR1 is connected across the diode bridge D1 to D4, when it is on the capacitor C4 is prevented from charging. As the quadrac is switched on by a rising voltage across C4, when the transistor TR1 is on the quadrac and consequently the lamp are both off.

If when the lamp is off a finger is placed against the "ON" plate this capacitively grounds the plate due to the high input impedance of the stage and a voltage is developed across R1 and R2. This voltage takes the input of gate "b" high which results in the output of the bistable being switched from the low to the high state. This high state output from the bistable is inverted by the buffer stage to a low state and TR1 is turned off.

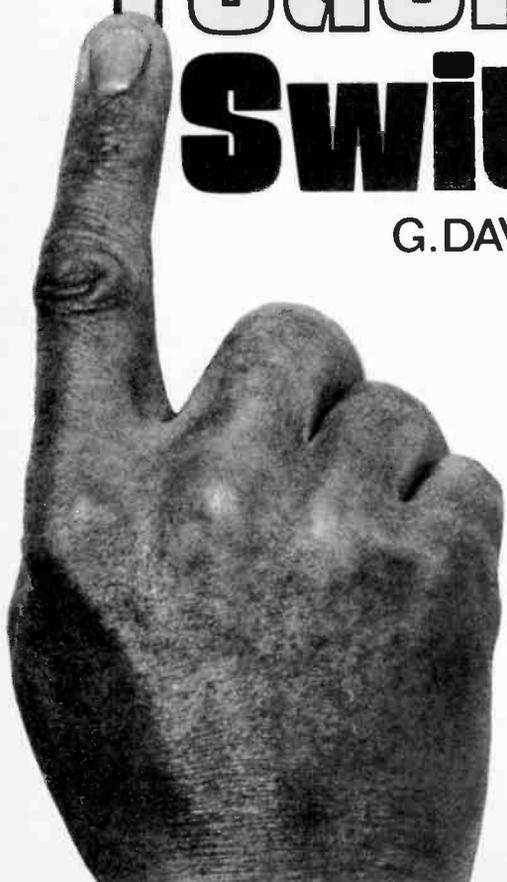
With the transistor off, capacitor C4 is no longer prevented from charging via R7 and the voltage across the capacitor increases. When this charging voltage reaches approximately 33V the quadrac switches the lamp on.

When the switch is off the "ON" touch plate is illuminated to enable the switch to be easily located in the dark.

The capacitors C1 and C2 filter any voltage spikes that may occur from motor starting surges elsewhere in the house, such as when a fridge or freezer is turning on. These spikes could cause false triggering of the switch.

# Touch Switch

G. DAVIS



### CONSTRUCTION

The p.c.b. design for the Touch Switch is shown in Fig. 2 with Fig. 3 showing the layout of the components. Note that where R1 is joined to R2 and R3 is joined to R4 the components are not soldered to the board.

As the plain side of the printed circuit board is used as the frontplate for the switch (with all the components being mounted on the copper track at the rear of the board) only four drilled holes are necessary in the p.c.b.; two for fixing the switch to the wall and one in the middle of each touch plate.

After the holes have been drilled the p.c.b. can be sprayed the desired colour and then dry cellotape should be placed on the front panel over the two touch plate holes. If the board is then turned over clear epoxy resin can be used to fill the "ON" plate hole while the "OFF" plate hole should be filled with black epoxy resin. When both resins have set the cellotape can be removed.

The components should then be soldered onto the board keeping the leads as short as possible.

### TESTING AND MODIFICATIONS

The "lamp" wire from the touch switch should be connected via the lamp to the neutral lead. If the power is turned on and a finger placed over each touchplate in turn the light should go on and off. Care should be taken to ensure the live and lamp wires are connected correctly otherwise the switch will not operate satisfactorily.

If the switch is to be used to drive a fluorescent light the circuit should be modified as shown in Figs. 4 and 5.

By incorporating the CR Network shown in Fig. 6 the light will remain on for a preset time period determined by the value of the CR network, i.e. if  $C = 22\mu\text{F}$  and  $R = 10\text{M}\Omega$  the delay is  $22\mu\text{F} \times 10\text{M}\Omega = 2 \text{ mins}$ . ★

## COMPONENTS . . .

### Resistors

R1, R3	10M $\Omega$ (2 off)
R2, R4	4.7M $\Omega$ (2 off)
R5, R7	100k $\Omega$ $\frac{1}{2}$ W (2 off)
R6	100k $\Omega$
R8	220k $\Omega$
All 5% $\frac{1}{2}$ W carbon unless otherwise stated	

### Capacitors

C1	150pF 50V Ceramic
C2	47pF 50V Ceramic
C3	22 $\mu\text{F}$ 16V Tantalum
C4	10nF 100V Polyester

### Semiconductors

D1-D4	1N4148 (4 off)
D5	6.2V 400mW Zener
D6	1N4004
TR1	ZTX304
IC1	CD4001
CSR1	400V 6.5A Quadrac

### Miscellaneous

Miniature wire ended neon RS type 586-015

### CONSTRUCTOR'S NOTE

All the components including the p.c.b. can be obtained from G.J.D. Electronics, 105 Harper Fold Road, Radcliffe, Manchester.

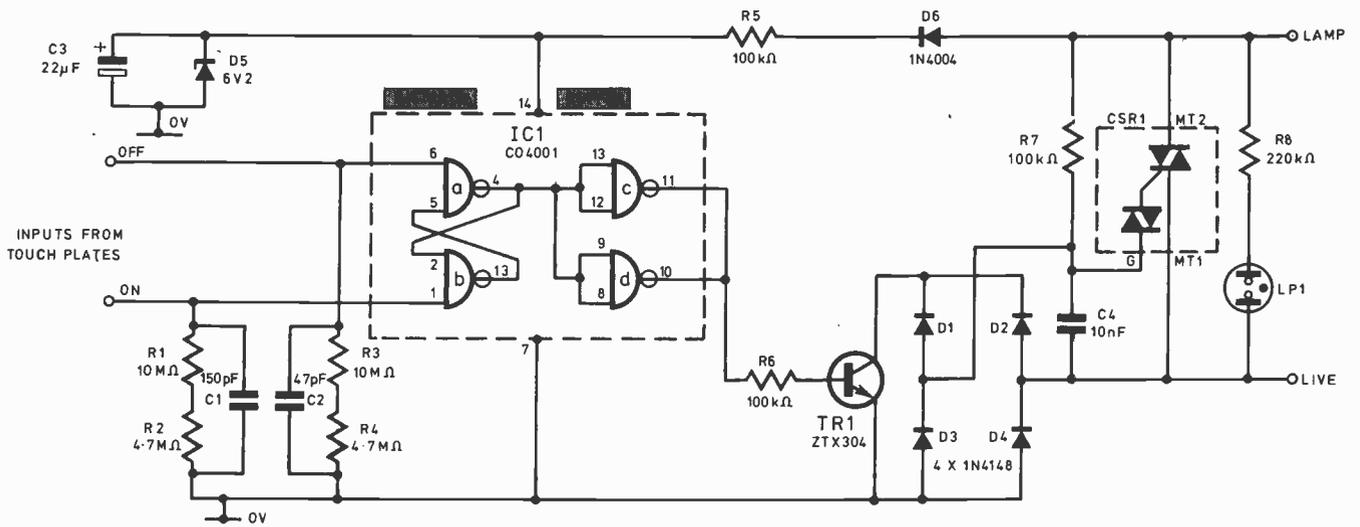


Fig. 1. Complete circuit diagram of the Touch Switch

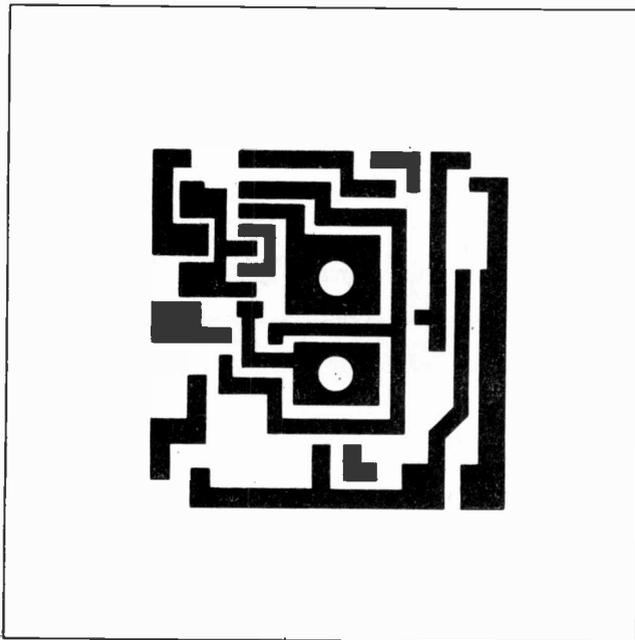


Fig. 2. Printed circuit board design

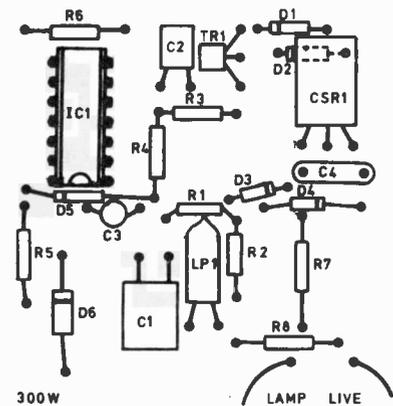


Fig. 3. Component layout for p.c.b.

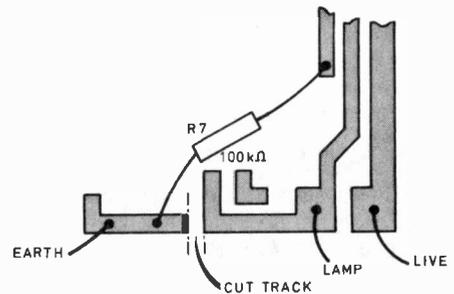


Fig. 5. Modification required to p.c.b. design for switching a fluorescent light

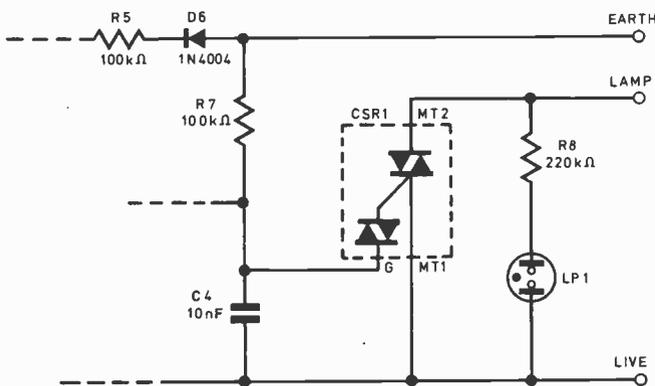


Fig. 4. Modification necessary for switching a fluorescent light

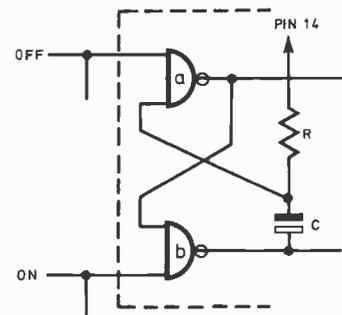
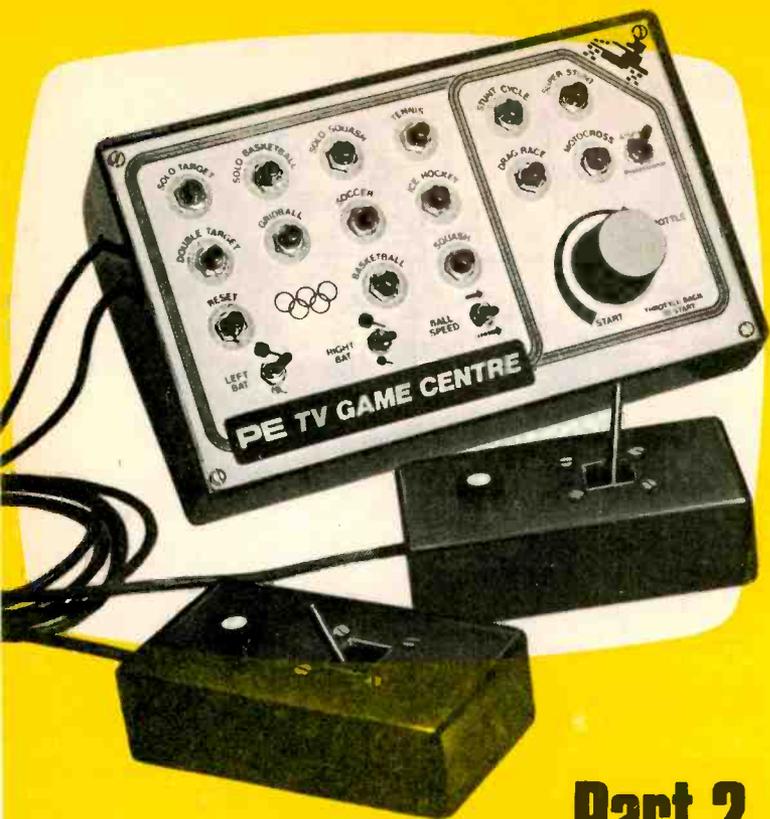


Fig. 6. Modification for obtaining a preset "ON" time period



*four motorcycle games  
ten ball games  
see last month's P.E.  
for how to play them*

## Part 2

# PE TV GAME CENTRE

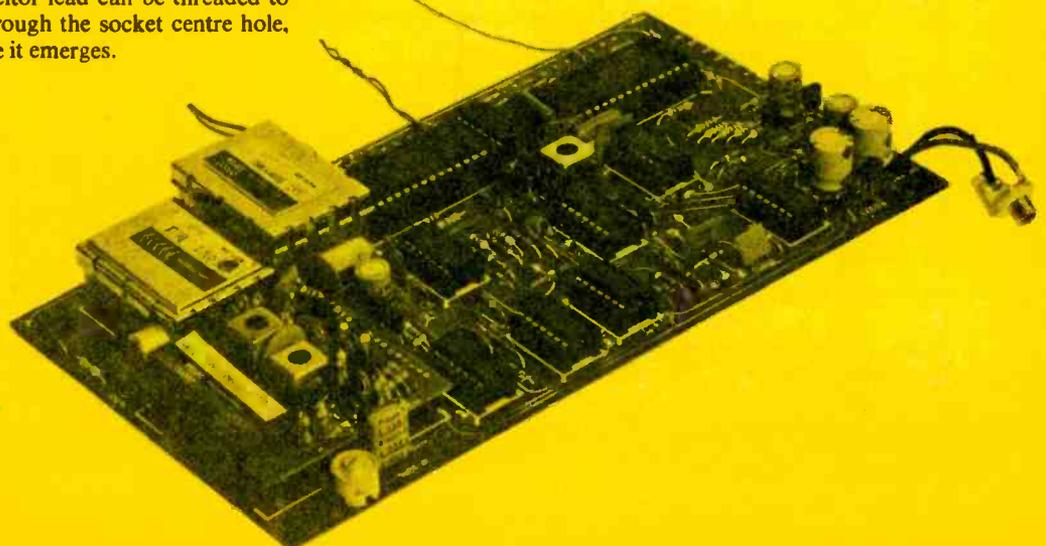
### CONSTRUCTION

Mount all the switches and the potentiometer on the front panel and wire them up as shown in Fig. 2.1, using ribbon cable but leaving the p.c.b. end of the ribbon unconnected.

Insert the i.c.s lastly when assembling the p.c.b., removing them from the conductive foam packing only at the moment necessary. The games chips themselves (IC1 and IC2) should be inserted last of all. Some earthed tin foil laid out on the worktop surface will help to reduce the possibility of damage due to static electricity. It would be advisable to mount the modules early on so that the remaining component space is more apparent. On the UM1263 (sound modulator) it is necessary to remove the lid and solder a 100pF capacitor (C5) between the coaxial socket centre-pin and the p.c.b. The capacitor lead can be threaded to the inside of the modulator box through the socket centre hole, and then soldered at the point where it emerges.

*board powered from  
external power pack*

*minimal  
setting-up  
procedure*



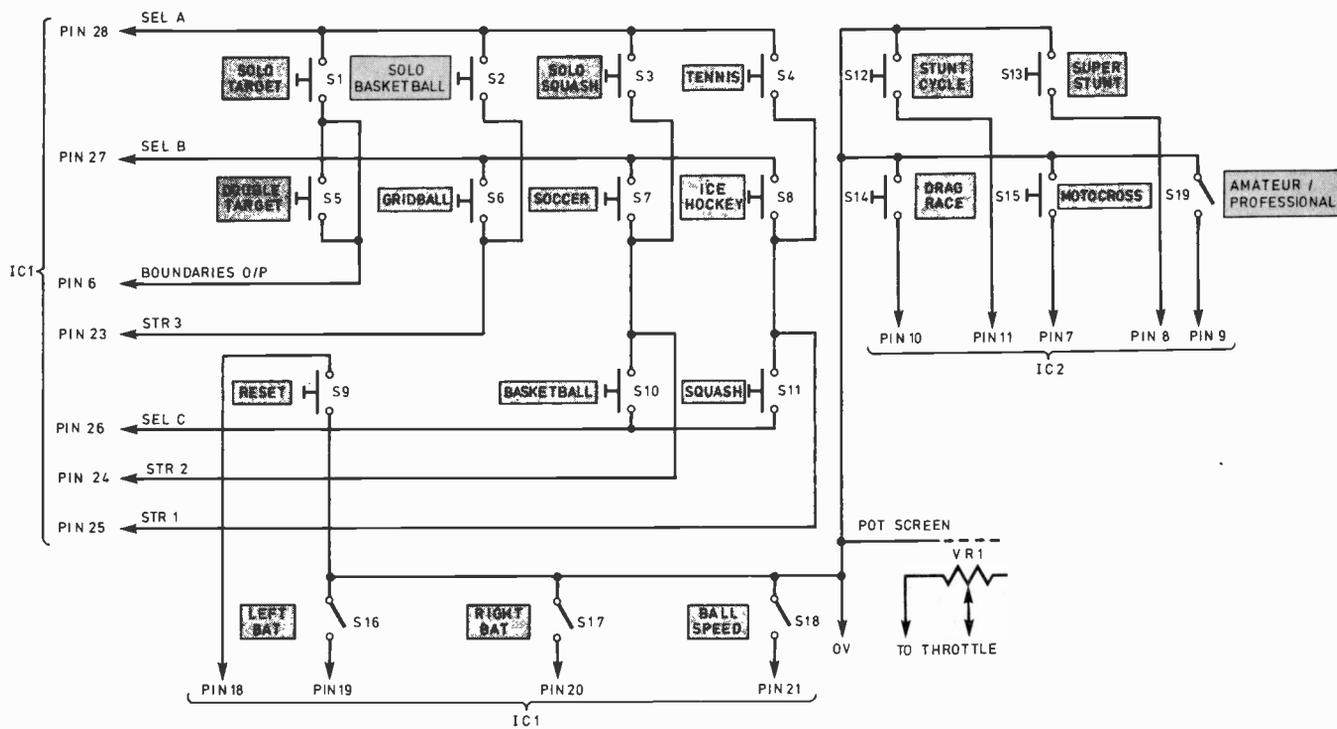
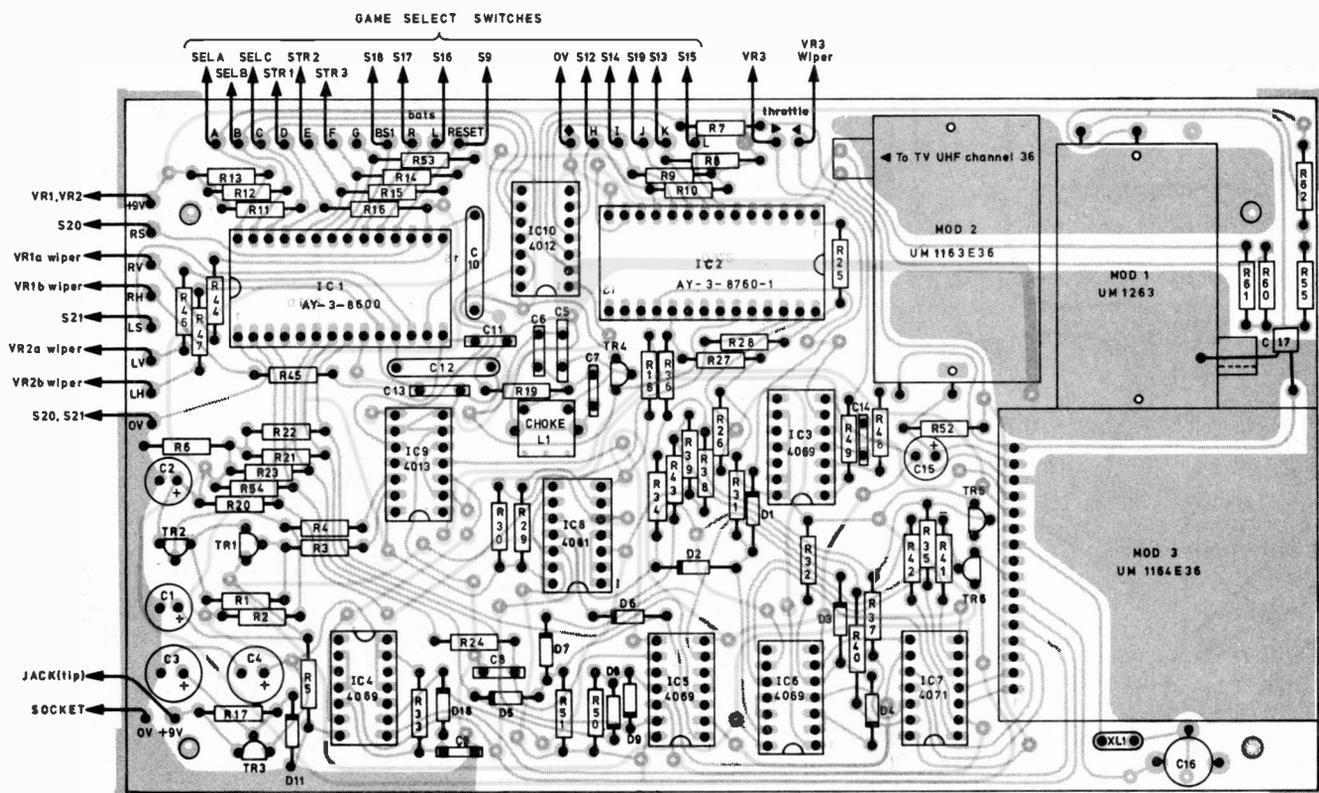


Fig. 2.1. Switch panel wiring diagram. This matrix wiring system was referred to in Part 1, Fig. 1 (wrongly as Fig. 10)

Fig. 2.2. Component board layout. Note that C17 couples the Sound Modulator output socket to the p.c.b.



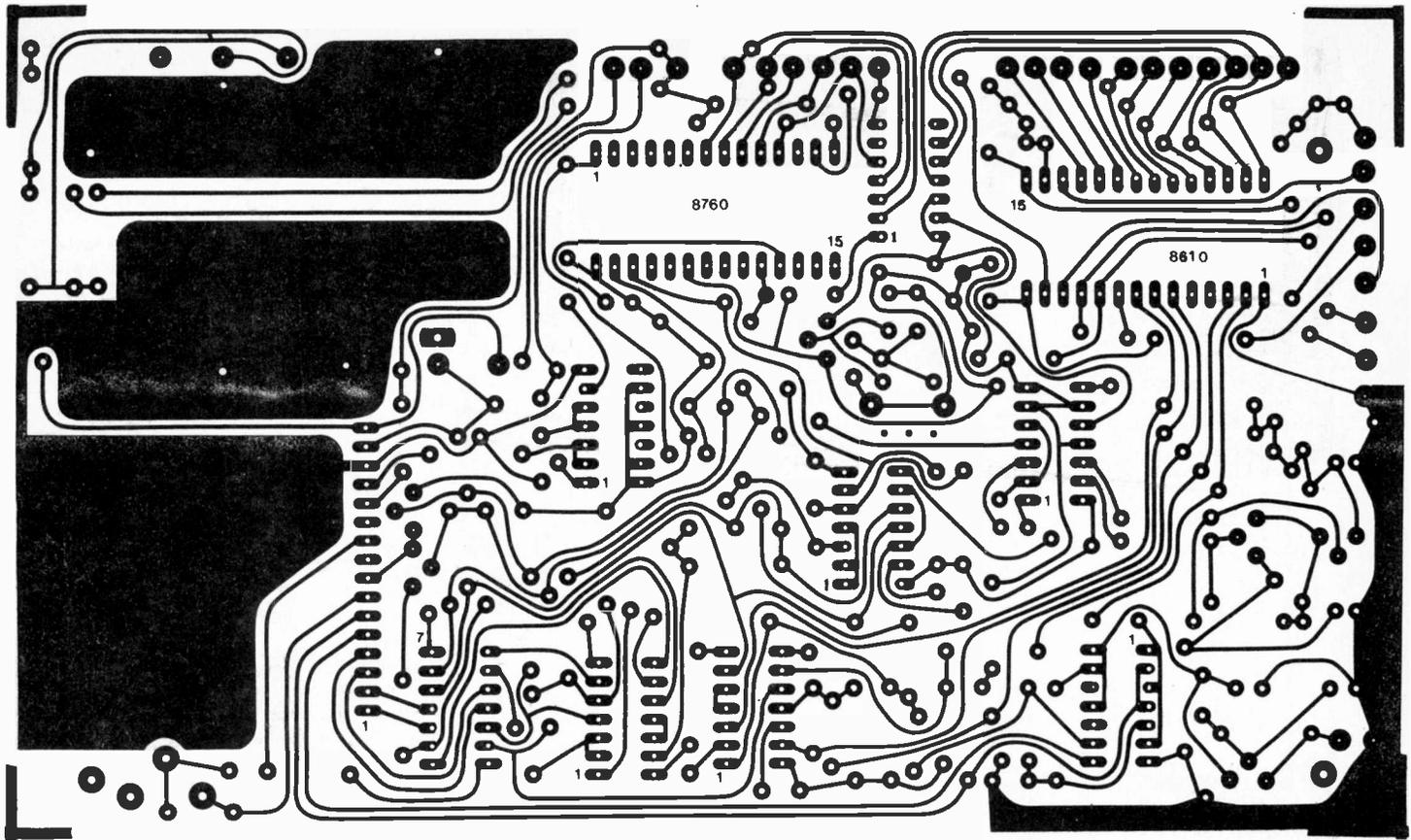
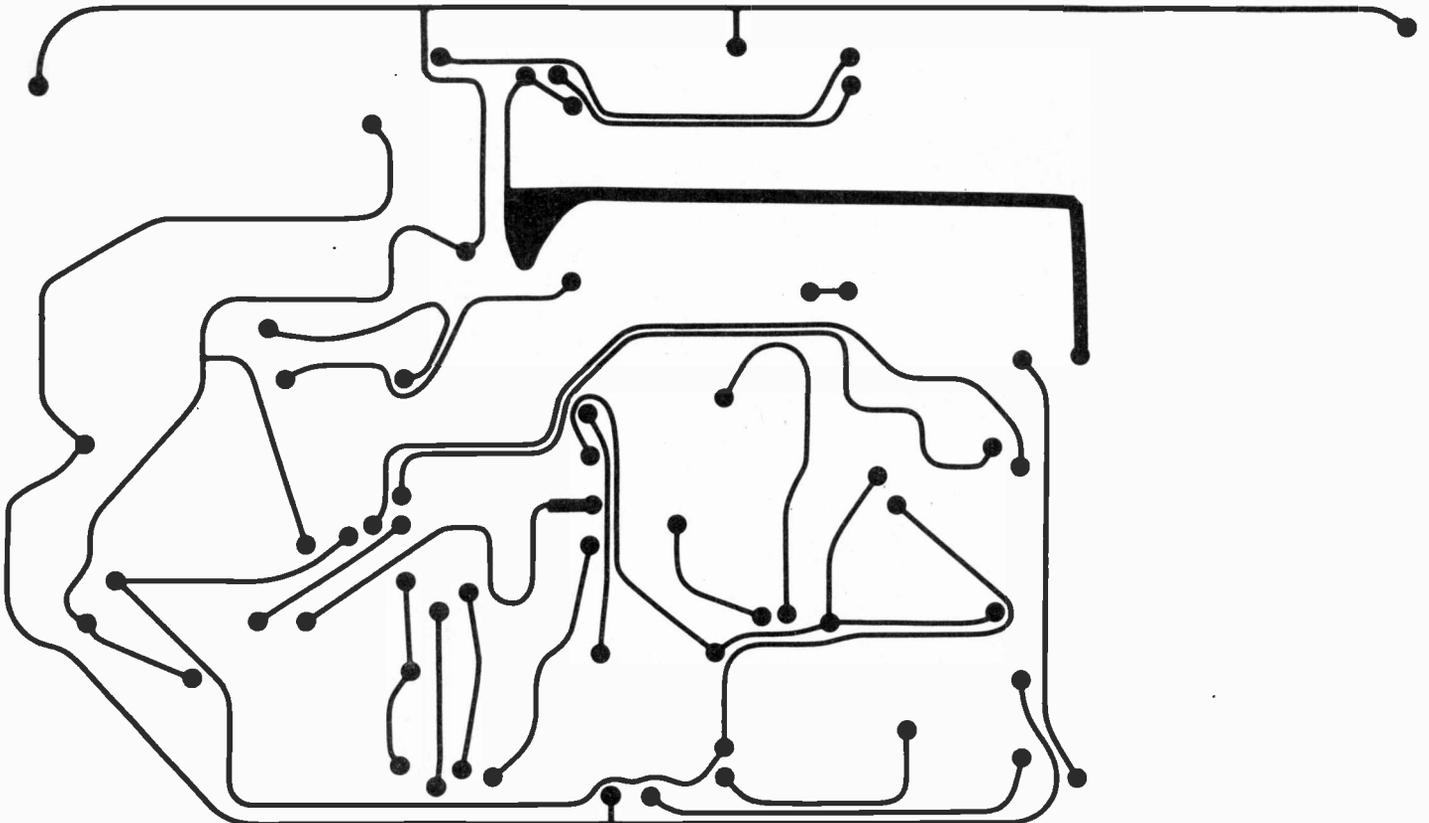
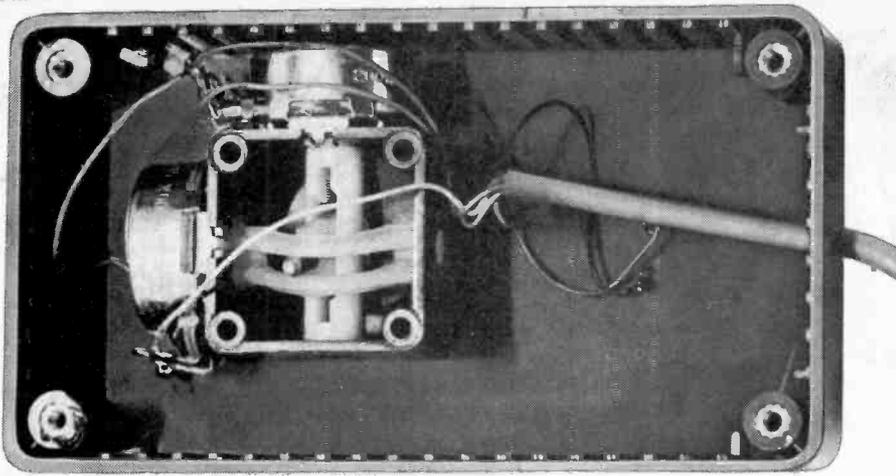


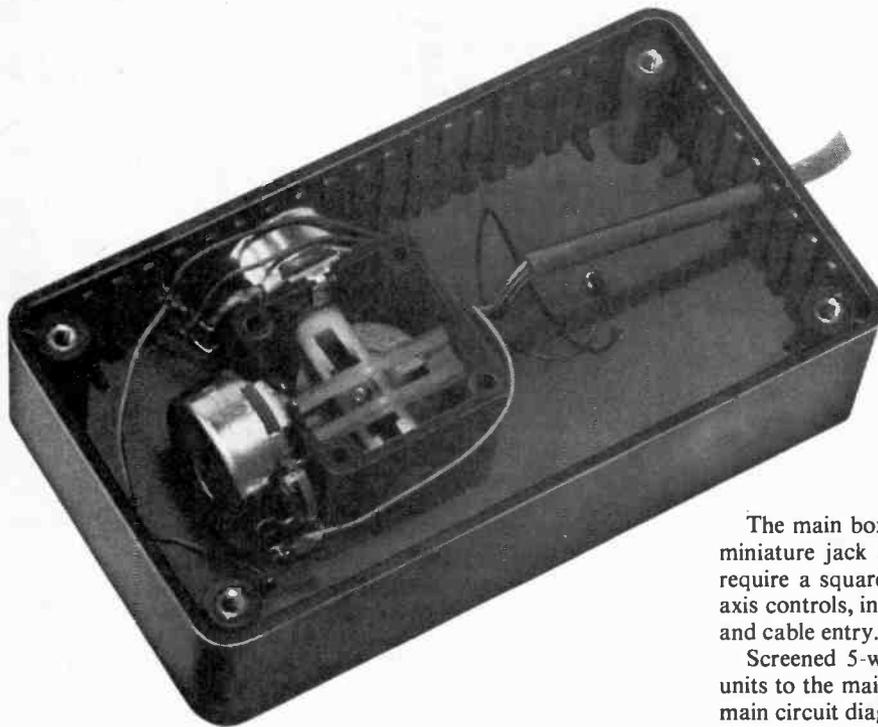
Fig. 2.3. Printed circuit layout (actual size)

Fig. 2.4. Component side p.c.b. (actual size)





The hand-held units (shown here with lid removed), contain dual-axis potentiometers for movement of the bat both up and down, and left and right across the television



The serve buttons supplied by Teleplay are mounted on the outside surface of the box, with only the connection tags passing through the lid

The main box should be cut for cable entry holes, and for the miniature jack socket (d.c. supply input). The hand-held units require a square hole of  $15 \times 15\text{mm}$  to accommodate the dual axis controls, in addition to further drillings for the push buttons and cable entry.

Screened 5-way cable is necessary to connect the hand-held units to the main box, and the wiring of these can be seen in the main circuit diagram.

Once all the switches and potentiometers are mounted and wired up, the p.c.b. can be fixed into the main box using self-tap screws, and then wired to the various controls. Low loss coaxial lead should be used for the aerial input signal to the television set, the other end of which is connected to the UM1163E36 vision modulator coaxial output socket.

The system is now ready to check out, but first look over the p.c.b. and wiring for possible dry joints, and ensure that all diodes and electrolytic capacitors are connected in the right polarity.

#### SETTING-UP

All modules supplied by Teleplay should be pre-tuned, but it may be necessary to adjust the oscillator frequency using L1, to lock the picture onto the screen. This should be done with the unit powered up and the television tuned to Channel 36. Fine tuning of the PAL colour encoder crystal is achieved by trimming XL1 (4.4336MHz).

The unit is powered by a mains adaptor unit which plugs straight into a 13A socket, and jacks into the Game Centre via a low tension lead (jack tip + Ve). ★

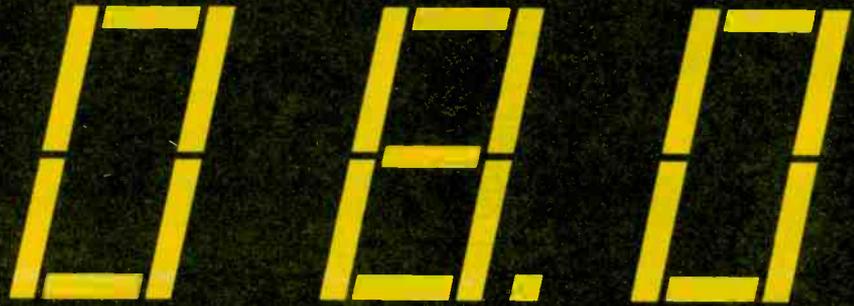
#### CORRECTIONS TO PART ONE

In part one, capacitors C10 and C12 were marked in the components list as  $0.8\mu\text{F}$ . This should read  $0.18\mu\text{F}$ .

TR1-TR3 are BC337 transistors, and the tunable choke should be  $40\mu\text{H}$  R17 is  $100\Omega$  and *not*  $1\text{K}\Omega$ .

It is also necessary to add the following resistors to the components list:

R38, R39	$8.2\text{K}\Omega$
R53	$5.6\text{K}\Omega$
R54	$2.2\text{K}\Omega$
R55	$222\text{K}\Omega$
R60, R61	$6.8\text{K}\Omega$
R62	$100\Omega$
C17	$100\text{pF}$ silvered mica



# DIGITAL THERMOMETER

M. PLANT

In order to provide a BCD to seven segment display of an analogue quantity, analogue-to-digital circuitry is required. Formerly this meant the use of a large number of discrete and integrated circuit devices which posed problems for the constructor of electronic instruments making use of these digital techniques. The availability of the Siliconix LD130 CMOS i.c. now enables the analogue to digital conversion to be performed with the one device plus a handful of additional components. Sophisticated instrumentation functions can now be obtained with a few components: the LD130 lends itself to the measurement of temperature, voltage, current, resistance, sound intensity, rotational speed, for example, indeed any physical quantity which lends itself to conversion into a voltage change which can then be processed digitally.

In this article the construction of a digital thermometer is described which has the following specifications:

<b>Range</b>	-99.9°C to +99.9°C
<b>Transducer</b>	pn junction diode
<b>Display</b>	3 digit 7 segment
<b>Resolution</b>	0.1°C
<b>Over-and-under range indication</b>	flashing display
<b>Minus sign</b>	illuminated l.e.d.
<b>Power supply</b>	6V (4 x 1.5V—HP7)

Initially the circuit was assembled on Veroboard and gave satisfactory results but a printed circuit board assembly produced improved performance.

## THE LD130

Details of the internal operation of the LD130 will not be described here but are covered in the relevant Siliconix application note. As Fig.1 shows the LD130 is an 18 pin dual-in-line package which features the low power

consumption of all CMOS devices: 25mW at  $\pm 5V$  power supply. The lower limit of the supply voltages is  $\pm 4.3V$  and the upper limit is  $\pm 8V$  (60mW consumption). The twin supply voltages must be matched to within 1.5V for correct operation of the device.

Internal counting is achieved through an oscillator which becomes functional when a single capacitor C4 is connected between pin 14 and ground. This capacitor and C1 together determine the sampling rate of the circuit. In use the i.c. samples the analogue voltage and displays its value in digital form at a sampling rate of  $f_{osd}/6144$ .

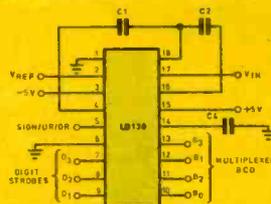


Fig. 1. Pin identity for the LD130

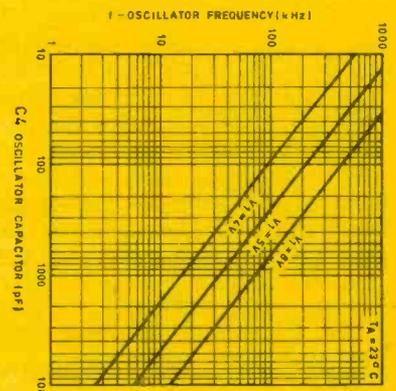


Fig. 2. Graph of frequency related to capacitor choice

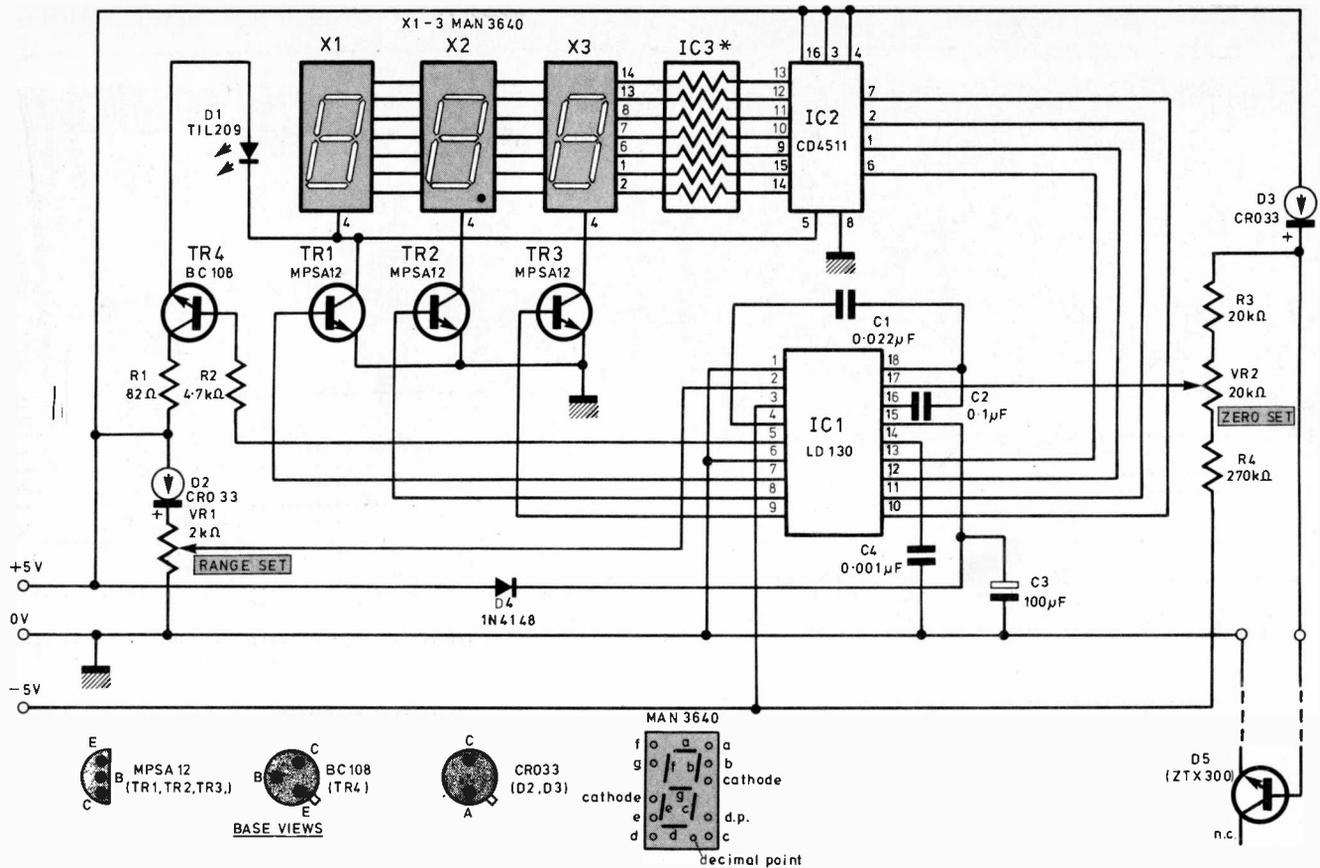


Fig. 3. Thermometer circuit

The oscillator frequency as a function of C4 is shown in Fig. 2 for various values of the positive supply voltage V1. Thus at V1 = 5V and C4 = 0.001μF, f<sub>osc</sub> is about 30kHz. Therefore the sampling rate is about 5Hz.

The value of the integrator capacitor C1 must be chosen according to the equation  $C1 = (10^3/f_{osc})\mu F$  approximately, that is, C1 should be of the order of 0.02μF. The value of the auto zero capacitor should be 0.1μF.

The sign and under-and-over range signal appears at pin 5. The analogue input is applied to pin 17 and a reference voltage (V<sub>ref</sub>) is required at pin 2. The multiplexed outputs from pins 10 to 13 and the digit scanning signals from pins 7, 8 and 9 are connected as shown in Fig. 3.

### CIRCUIT ACTION

The complete digital thermometer circuit omitting the power supply circuitry is shown in Fig. 3. The reference voltage V<sub>ref</sub> for the LD130 is provided by the current regulator diode D2 in series with the potentiometer VR1, the wiper of which is connected to pin 2. This particular current regulator has a zero temperature coefficient and therefore VR1 is able to provide a stable voltage—V<sub>ref</sub>.

The digits of the seven segment display are scanned by the LD130 pins 7, 8 and 9 via the npn Darlington current buffer transistors TR1, TR2 and TR3.

High gain Darlington transistors were used ( $\beta = 50,000$ ) although the constructor may use discrete pairs of npn transistors to obtain the same function. The l.e.d. D1, indicating the negative sign of the temperature, is driven by transistor TR4.

The digit segments of the common cathode displays X1-3 are driven from IC2 through the current limiting resistors of IC3. For increased brightness these resistors may be reduced to 100 ohms and, of course, individual 0.25W resistors may be used.

### TRANSDUCER

Provided the forward current is much greater than the reverse saturation current, the voltage across a pn junction diode biased with a constant current varies by about -2.2mV/°C and thus provides a linear temperature-to-voltage transducer—D5. A proportion of the temperature dependent voltage across this sensor is selected by R3, VR2, and R4 voltage divider, one end of which is connected to the negative supply voltage in order that VR2 may be able to set the zero of the temperature scale.

For correct and stable operation of the thermometer, the LD130 must be provided with a short term stable positive supply voltage. As you will see from Fig. 2, any variation in the supply voltage produces a marked change in the oscillator frequency f<sub>osc</sub> which in turn leads to jitter of the display reading. This variation in positive supply voltage as seen by the LD130 is liable to be caused by the variable and high currents drawn by the display. These currents can vary from 4mA, when a digit is blanked, to about 100mA assuming say 12mA per segment for a display of 8.

These currents, flowing through the battery impedance and the copper tracks on the circuit board, cause the voltage seen at pin 15 of the LD130 to vary. Some a.c. decoupling at this pin is therefore provided by means of the diode D4 and the capacitor C3.

Note that this provides a positive supply voltage for the LD130 of 0.6V less than the battery e.m.f. The second circuit design feature which ensures display stability is the return of the analogue ground pin 1 of the LD130 direct to the ground connection of the power supply, i.e. the battery negative.

Rather than use a separate battery to supply the negative voltage with respect to analogue ground required by the LD130, an inverter is used to provide a -5V supply relative

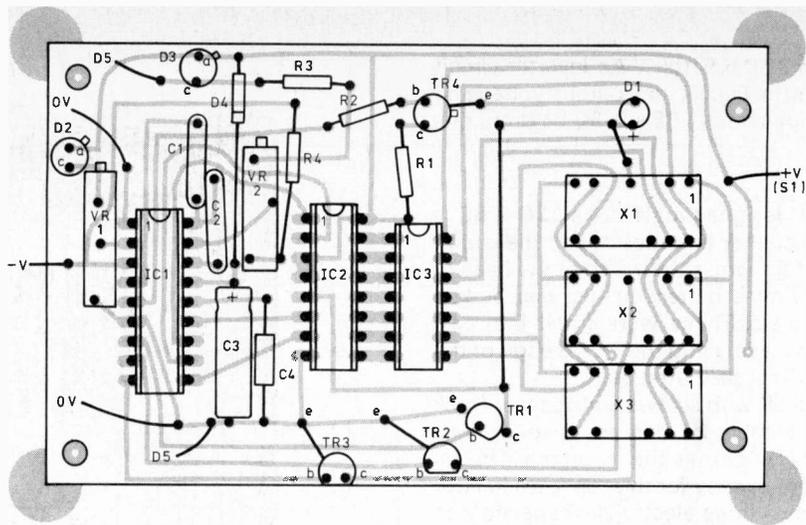


Fig. 4. Main board component layout

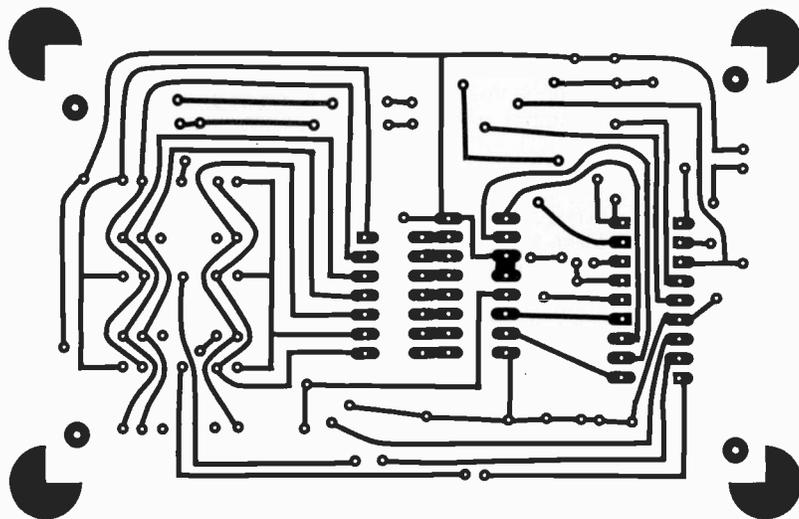


Fig. 5. Etching detail of main board

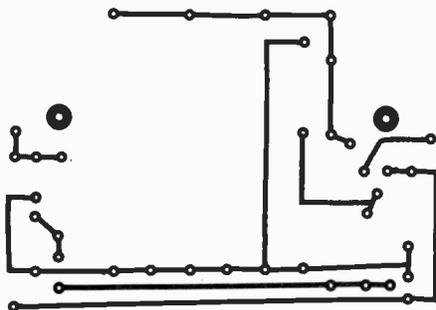


Fig. 6. Inverter p.c. detail

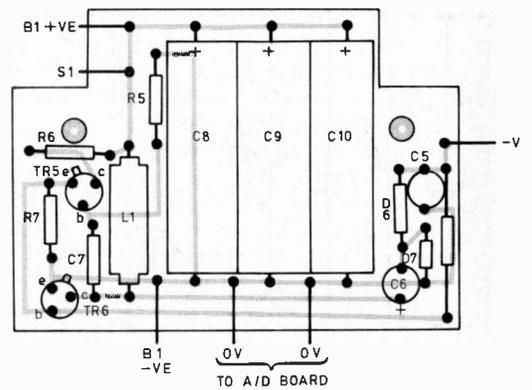


Fig. 7. Component layout

to the zero volts terminal of the battery. An inverter circuit suitable for this is shown in Fig. 8, the output voltage of which is D8's Zener voltage minus TR8's 0.6V be drop, that is 5.6V.

### ASSEMBLY

The circuit boards were designed to fit into a 120 x 65 x 40mm box. Four 1.5V calculator batteries power the circuit and display and these just fit across the width of the base of the box. A four pack HP7 type battery holder was broken apart to obtain the terminals. These were fitted into two pieces of SRBP glued into place along the inside edge of the box. This provided a tight fit for the batteries.

The main board is stood off with screws and spacers. Track layout and component assembly for this are given in Figs. 4/5. The base of the box also carries the inverter p.c.b. the track layout and component overlay for this is shown in Figs. 6/7. This board also contains three electrolytic capacitors to soak up any voltage variation on the wires to the LD130 caused by large display current variations as explained above.

A twin power supply leaves the inverter board for the A/D p.c.b.; the negative lead going to pin 3 of the LD130, and 0V to the analogue ground connection pin 1 with the battery positive to pin 15 of the LD130 via diode D4.

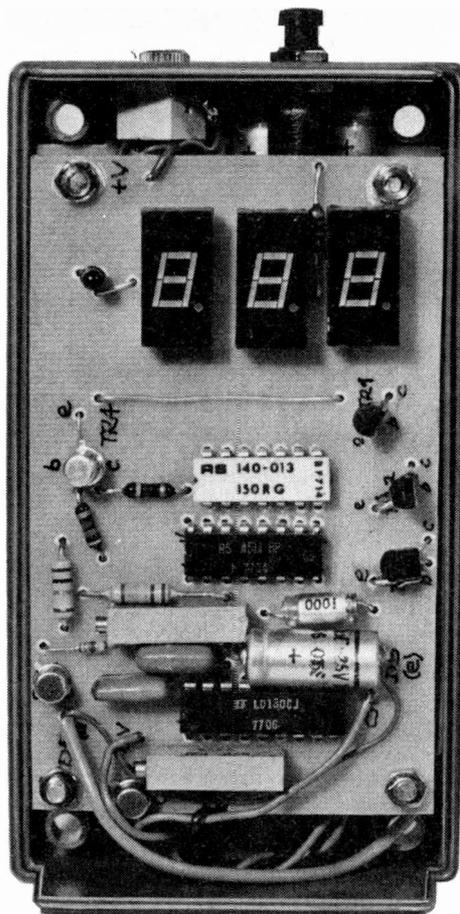
It is recommended that a d.i.l. holder be used for the i.c.s so that they may be reused unless the constructor has the facilities for desoldering i.c.s in the event of failure. IC1 and IC2 are CMOS devices and need the usual care when handling them, in particular do not solder components in place when power is supplied to the board and do not insert or remove these i.c.s when power is supplied.

### SENSOR

The *pn* junction temperature sensor is the base-emitter junction of any general purpose silicon bipolar transistor. Both the BC107 series metal can TO18 style and the ZTX300E line types were found suitable.

Using the ZTX300, the collector lead was cut off close to the encapsulation leaving only the base and emitter leads. Single core screened cable, core to base and screen to emitter was soldered to these transistor leads. One connection must be sleeved to avoid shorting.

Quick setting Araldite mixture was smeared over the sleeved and bared connections and the screened cable then threaded through a piece of nylon tubing or similar until the transistor sits tight against one end of the tube. The excess



Araldite was then wiped off so that when the remaining was set it formed a water tight seal against the effects of moisture when the probe is in use.

The other end of the screened cable is terminated in a 2.5mm plug so that it can be plugged into a socket in the box at the side of the push switch. However to save expense the plug and socket can be dispensed with and the lead taken directly to the circuit board.

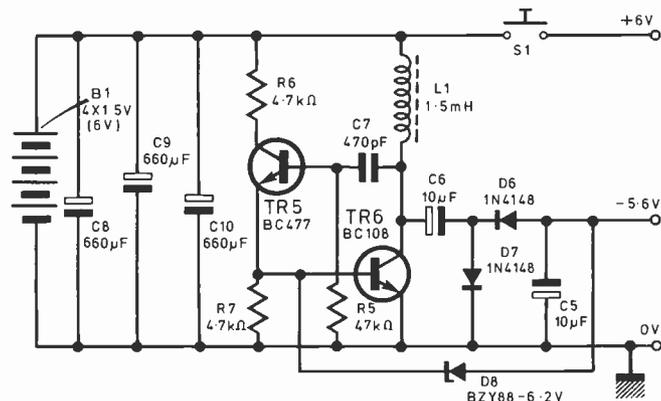
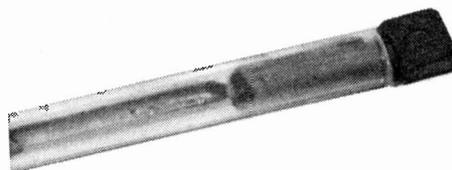


Fig. 8. Inverter circuit



The sensor

## COMPONENTS . . .

### Resistors

R1	82Ω
R2	4.7kΩ
R3	20kΩ
R4	270kΩ
R5	47kΩ (2 off)
R6-R7	4.7kΩ
All ¼W carbon	

### Capacitors

C1	0.022μF polyester
C2	0.1μF polyester
C3	100μF elect. 25V
C4	0.001μF polystyrene
C5-C6	10μF elect. 25V (2 off)
C7	470pf
C8-C10	660μF elect. (3 off)

### Potentiometers

VR1	2kΩ cermet 20 turn variable
VR2	20kΩ cermet 20 turn variable

### Inductor

L1	1.5mH
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### Semiconductors

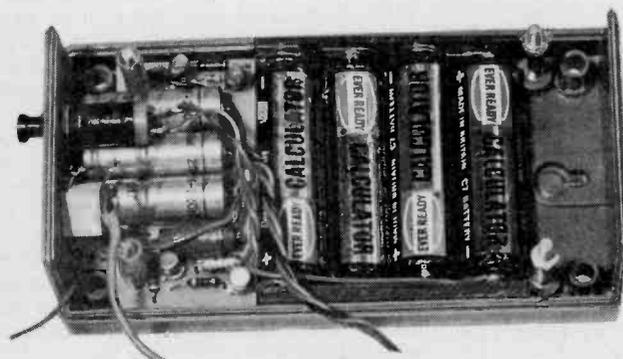
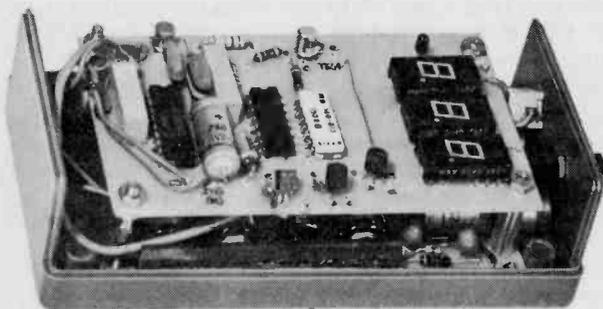
TR1-TR3	MPSA12 Darlington's (3 off)
TR4	BC109
TR5	BC477
TR6	BC108
D1	TIL209
D2-D3	CRO33 current regulator diode (Siliconix)
D4	1N4148
D5	Sensor diode; ZTX300 (base/emitter only)
D6-D7	1N4148 (2 off)
D8	BZY88 6.2V
X1-X3	MAN3640 (Monsanto) (3 off)
IC1	LD130 (Siliconix)
IC2	CD4511
IC3	7 x 150Ω thick film resistor array (Stock No. 140-013—R.S.)

### Miscellaneous

S1—on/off switch, 94 x 57mm (main board)  
42 x 57mm (inverter board), B1-6V (4 x 1.5V)  
2.5mm plug and socket, polystyrene case  
65 x 20 x 40mm.

## EXTRACTING THE DIGIT

Constructors should note that if resolution is not required to the nominal accuracy of 0.1°C, X3 in Fig. 3 can be omitted and the associated driver transistor TR3. Resolution is then to 1°C giving a steadier display which is more restful on the eye and slightly easier on the pocket!



## CALIBRATION

When the boards have been assembled in the box, and all connections checked, the push switch may be pressed whereupon the display will do one of the following:

- Does not light: Check the operation of the switch and all circuit connections.
- Lights and all digits flash on and off rapidly. Adjust VR1 (Range) so that the voltage at pin 2 of the LD130, relative to ground, to 0.35V. This may bring the reading to a steady value, excepting rapid updating of the third digit. If not, adjust VR1 until the display is steady. Place the sensor body in some water at a steady temperature of say 25°C making sure base/emitter leads are not short circuit. Adjust VR1 until the display reads this value.

Note that due to the operation of the LD130 the display will not stabilise at a precise tenth of a degree reading but will range by as much as 0.3°C around the true reading. With experience it will be possible to estimate the temperature to the nearest tenth. Heat some water in another container to say 75°C and place the sensor in it applying the same precautions as before and adjust the range potentiometer until the display reads 75°C. Return the probe to 25°C and readjust VR1 until the display reads this value. Repeat the procedure until the correct temperatures are displayed.

Finally check that the l.e.d. indicating negative temperature lights up when the sensor is in the fridge.

## COMPONENTS

All components are readily available except for the i.c.s and current regulators. Both the LD130 and the CRO33s can be obtained from **Semiconductor Specialists (UK) Ltd.**, Premier House, Fairfield Road, Yiewsley, West Drayton, Middlesex. The Darlington pair MPSA12 driver transistors can be obtained from **Technomatic Ltd.**, 54 Sandhurst Road, London NW9. ★



**FRANK W. HYDE**

### OUT OF THE ECLIPTIC

All spacecraft till now have operated close to the plane of the ecliptic, the plane in which the planets of the Solar System revolve around the Sun. In order to study the higher latitudes of the heliosphere, that is, the environment around the Sun, it is necessary to leave the thin disc of this environment occupied by the planets.

Most of the planets have orbits quite close to the plane of the ecliptic. These are at different angles ranging from approximately  $7^\circ$  for Mercury to  $0^\circ$  for the earth. The exception is Pluto which has an inclination of just over  $17^\circ$ . Thus with this one planet as an exception, the planets are contained in the narrow space at right angles to the plane of the ecliptic of  $14^\circ$ .

Since the Sun is in an oblate spheroid, it follows that much of what can be directly viewed is subject to angular distortion, when the observing point is confined to a narrow angle. It is of paramount importance, in an attempt to understand the astrophysics of our own star, that a spacecraft is put in an orbit at right angles, or nearly so, to the ecliptic plane.

To this end the European Space Agency's first deep space mission will be set up, for a launch in 1983, of two spacecraft simultaneously. The launch will be a joint operation with NASA. Designated Out of Ecliptic (OOE) by the European Space Agency and Solar/Polar by NASA, these two spacecraft weighing some 300kg each will be directed toward Jupiter. It is necessary to use the "sling shot" technique to achieve the orbits required. As the two craft near Jupiter, the trajectories will diverge.

One spacecraft will go round Jupiter from north to south and the other from south to north and then toward the Sun, one toward the southern hemisphere and the other to the northern hemisphere. They will be in the vast unknown volume of space round the Sun.

Under certain conditions, the Sun, in addition to the solar wind, emits particles of

very high energy. Streams of such particles are capable of producing "blast" waves in the solar plasma. Lethal gamma-ray bursts could be produced in this manner. It will be possible, it is hoped, to measure the amount of protection that the solar wind provides in inhibiting the intrusion of particles and radiation from galactic sources. From the data acquired by the vehicles it will be possible to discover the precise values for the loss of mass and energy of the Sun. The changes in the acceleration of the Solar Wind can be recorded and related to the other scientific measurements.

The effects of Novae and super Novae are already known in relation to the environment. Recently Hoyle and Wickramasinghe have written on the subject of debris and cometary matter bringing hostile organisms into the Earth's environment. The protection afforded by the high activity of the Sun is a direct effect. An examination of the effects on both Man and the environment can be correlated with the weather and health. This alone would justify the mission of the two spacecraft.

A total of eight experiments will be put aboard each of the spacecraft. One of these is an entirely British package. Dr. Peter Hedgecock of Imperial College is the principal investigator of the project involving a sensitive magnetometer. It is designed to measure the interplanetary magnetic field drawn out from the Sun by the plasma flow. The measurements will be used to provide a map of the Sun's magnetic field in the heliosphere. This will also help to show how lethal radiation is deflected from Earth by the solar magnetic field.

### THE SHIVERS OF THE SUN

In April this year there was a European Conference on Solar Physics at Toulouse. It is remarkable that these conferences suddenly serve as a reminder that, matters obvious, are frequently shrouded in mystery.

The mystery is usually provided by the assessment of the mechanism involved. Yet by the very nature of the body, many photographs and films of the surface show violent and continual activity. Perhaps this is an elaborate way of saying that seeing is not necessarily believing. So it is implied that corroboration is a necessity.

In the matter of the "Shivering Sun" it seems obvious that the internal activities at the temperatures of the elements involved, would lead to a disturbed state. To the three groups of astronomers, who independently came to similar conclusions in this matter some time ago, there must at least have been some considerable satisfaction that their position was unscathed.

It must be said that one of the observers only, saw physical and direct changes. It is certain that more will be heard of this. To be more serious, the phase measurements made by Hill at various frequencies do at least give some clue as to the "ringing" of the Sun.

### URANUS

Another star occultation by the rings of Uranus has disclosed that there are in fact, 8 ring systems around this remarkable planet. This observation also disclosed that one of the rings varies in width. At the point where the

ring is nearest to the planet it is narrower than at the point farthest from Uranus. This ring also appears to precess. These observations were made with the 2.5 metre du Pont telescope at Campas Observatory in Chile by Eric Persson of Hale Observatories. The rings are very tenuous for until a star is occulted by them it is not possible to see them with any certainty.

### LANDSAT 3

The first pictures from Landsat 3 show considerable improvement over those of the first two Landsats. The type of imaging on Landsat 3 is different from that on the previous vehicles. The Return Beam Vidicon (RBV) system has now been accepted as a useful tool for the purpose required. Disappointment with Intelstats 1 and 2 was partly due to the system used and also to a degraded camera system. Landsat 3 was launched in March this year and has vindicated the Intelstat project. The RBV system does have a higher order of resolution than the MSS (Multispectral Scanning) system previously used.

The pictures from Intelstat 3 show that objects of 50 metres in length can be resolved and areas of 0.25 hectare. This higher resolution is also accomplished by two cameras instead of four. The two cameras image two adjacent areas of 99 kilometres square. The spectral band width is  $0.5-0.75\mu\text{m}$ . Further improvements in resolution were obtained by doubling the focal length of the lens systems on the cameras. Such items as roads, railways and areas like lakes and reservoirs are clearly seen and provide useful information for both Earth resources scientists and resources surveyors.

There seem to be one flaw in the whole matter and that is the objections from the armed services. They seem to fear that too much information is being revealed by way of maps and other means, which may reach unauthorised persons. It is a sad reflection on the integrity of technology when equipment is deliberately degraded in the interest of the services. It seems quite illogical, since what one nation can do another can do also, especially in the matter of observation where the altitudes involved are around 900 kilometres.

### HALLEY'S COMET

In previous SPACEWATCH reports Halley's comet has been the object of assessment for a special mission. After the fiscal set-back which seemed likely to kill it years ago there are now second thoughts. NASA has now accepted that it would be a valuable mission. Because of the heavy commitments to EXOSAT and the Large Space Telescope, there may be some hard bargaining.

The new mission is for a two in one project designed to widen the scope of the experiments. A flight past Halley's Comet would be followed by a swing by the Earth and a show flyby of another comet Tempel-2, in 1988. This project would be the first to use solar-electric propulsion, to attain the high velocity which can match the speed of the comets. It is thought that there is a likelihood of the mission now getting under way.

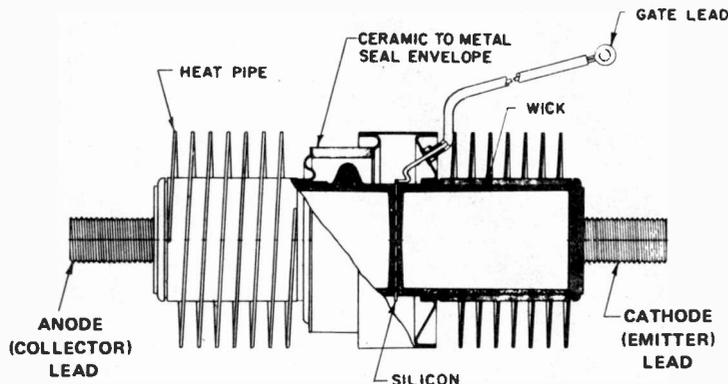
# News Briefs

## HEAT IN THE PIPELINE

ONE could only *guess* what it would be called, but it *had* to come, and RCA brought it onto the electronics scene. It's called the "transcendent" device, and it's a new class of power semiconductor which uses heat pipes to cool off hot junctions.

These lightweight devices feature integral heat pipes bonded directly to large silicon wafers capable of handling currents of hundreds of amperes. The first devices available include rectifiers, thyristors and transistors.

The integral heat pipes in these devices minimise thermal resistance and increase radiator fin efficiency, thereby permitting RCA to produce semiconductors significantly smaller and lighter than conventional semiconductor/heatsink assemblies of similar power ratings. Typical size reduction is by a factor of four, and weight reduction by a factor of seven.



Transcendent thyristor construction

Other advantages of RCA's heat-pipe/integral-fin construction technique include improved resistance against overloads and high-current surges, and the opportunity either to reduce the silicon-junction temperature for enhanced reliability, or to operate at full ratings at high ambient temperatures.

Installation is also simplified by the elimination of separate heatsinks.

The first RCA transcendent devices available are the P95000EB Series of 250A, 500W rectifiers with blocking voltages up to 1,200V, the P95400EB Series of 400A, 500W thyristors with blocking voltages up to 1,200V, and the P95200EE4 100A, 500W n.p.n transistor.

The rectifiers and thyristors use compact radiator structures resulting in a weight of only 340g, and a volume of less than 230 cubic centimetres. The transistor uses a different radiator structure with a dissipation capability of 500W, yet the device weighs less than 1kg and occupies a volume of less than 1,100 cubic centimetres.

Any of these devices can be supplied with radiator structures to accommodate either air or liquid cooling. Thermal resistances are of the order of 0.1 to 0.2°C/W, and operating ambient temperatures at full ratings range up to 50°C.

The transcendent device is appropriate for a wide range of commercial and military applications involving fixed, mobile or aerospace equipment. Typical uses are in welders, electro-chemical platers, power conversion and distributing systems, motor-speed controls, military-vehicle drives, radar power supplies and aircraft power systems.

## EAGLE'S LAUNCH

ON May 21 Eagle International unveiled over 132 new editions to its range of consumer and industrial electronics products, including new hi-fi, public address, security, business and educational equipment. The biggest ever launch in Eagle's history.

Many of these new products are being displayed at the 1978 Radio Show, where the Eagle International stand is in the Piccadilly Hotel, Piccadilly.

The centre piece of the range of consumer products is 20 new hi-fi separates including five loudspeakers, four amplifiers, three receivers, two tuners, two turntables and a front-loading cassette deck. Eagle are also introducing a number of audio products and accessories, such as headphones, cartridges, table radios, and ribbon aeriels. Important additions to the public address range with new disco and group PA systems have also been made.

Among the new products in the security field are domestic burglar and fire alarm equipment, including one single-zone combined fire/intruder panel, suitable for private homes and smaller offices or industrial premises.

Eagle is also introducing five test equipment products including multimeters; three emergency lighting products, two headsets specifically designed for educational purposes, and eight intercoms.

## NEW MICROPROCESSORS

A NEW 16-bit microcomputer, the Intel 8086, has been formally introduced, and is Intel's highest performer yet, being seven to twelve times faster than the 8080 at program execution. It joins the 8085A and 8048 industry standard micro families, and employs the same software development tools as MCS-80 and MCS-85. To protect the customers' software investment, the 8086 is source code compatible with the 8080A and 8085 via a translator package.

The 8086 provides all the previous features with 16-bit arithmetic, signed 8- and 16-bit arithmetic dynamically relocatable programs; design features multi-processor configuration support, and it can address a megabyte of memory. The standard clock rate is 5MHz (8MHz optional).

The Intel HMOS process has put 29,000 transistors on a chip only 225mm<sup>2</sup> which is better than the average home constructor can manage!

Another new device from Intel is the 8022, and this will be of much more interest to the amateur because it is the first micro with an on-board analogue to digital converter! This most useful addition to the microprocessor is accompanied by an input port which can be directly connected to a "touch-panel" keyboard.

The 8022 has twice the program memory (2 kilo bytes) as that of the 8021. With a dual input A to D converter, variable threshold 8-bit input port of 100mV sensitivity, zero-crossing capability, and an extra test pin for conditional jumps, this microprocessor has to be a device we shall hear a lot more of.

The A to D converter is of the successive approximation type accepting inputs up to 5V, and requires an external voltage reference source.

Machine code instructions select which input is to be used, whilst the converter runs continuously, updating a results register every 40µs. This speed of conversion allows multiplexing of the two analogue inputs, to provide many analogue channels without complex hand-shaking, or converter stop/start instructions.

Test pin 1 of the 8022 will detect sinewave zero crossing, so that when used in conjunction with mains control, the system can switch power via triacs, etc. at the optimum time for minimum generation of electrical noise. This "symmetrical" zero-crossover switching is also preferred by the Electricity Generating Board.

The 8022 is housed in a 40-pin package, and has an internal clock generator which requires one external component—a crystal or resistor. There are also two high current drive outputs.

# The Proto-Board®

Now circuit designing  
is as easy as  
pushing a lead  
into a hole.

No soldering.  
No de-soldering.  
No heat-spilt components.  
No manual labour.  
No wasted time.



With a Proto-Board you can hook  
your circuit together as quickly as you can  
think.

And you can have second thoughts, and third  
thoughts, equally quick and easy, till you've got the whole thing  
right.

Then you can solder up if you want to, but most engineers don't because the  
Proto-Board push-fit connectors are highly reliable.

And everything is visible, come back next week and you 'read' the circuit  
immediately.

Contact terminals are arranged in sets of five, each  
connected across the back, and in the Model 203A  
illustrated you get 1770 contacts, in six rows of 59 x 5,  
plus four double power rails, each with 100 contacts  
connected lengthwise and two horizontal power units  
with 40 contacts each. Many other models; see chart.  
Proto-Board breadboards will accept transistors, ICs,  
LSI packages, resistors, capacitors, LEDs, trimmers,  
relays etc.; most plug straight in.

**Try one. You'll wonder how you ever  
managed without it.**

Model Number	No. of Solderless Tie-points	IC Capacity (14-pin DIP's)	Unit Price	Postage & Package	VAT	Total Price	Other features
PB-6	630	6	£ 9.20	£1.00	£0.82	£11.01	Kit—10 minute assembly
PB-100	760	10	11.80	1.00	1.02	13.82	Kit—with larger capacity
PB-101	940	10	17.20	1.25	1.48	19.93	8 distribution buses, higher capacity
PB-102	1240	12	22.95	1.25	1.94	26.14	Large capacity, moderate price
PB-103	2250	24	34.45	1.50	2.88	38.83	Even larger capacity; only 1.73 pence per tie-point
PB-104	3060	32	45.95	1.50	3.80	51.25	Largest capacity; lowest price per tie-point
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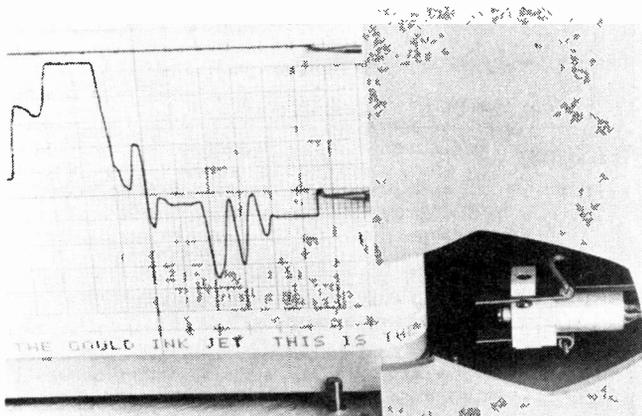
# News Briefs

## CHARGED AND ARRESTED

**A**N ingenious system for printing has been employed to produce a unique device for depositing alphanumeric characters on moving chart recorder paper, by Gould Instruments Division.

Primarily intended as an add on unit for their standard "continuous stream" ink chart recorders, Gould have developed this improved system (pictured below) whereby ink is virtually "shocked" into a set of minute uniform particles, and charged to a high potential so that it can be electrostatically deflected along one axis. The position on the paper at which a particular ink particle is arrested will depend upon the potential of the deflector plates at that time.

The characters are described as "highly readable" and are formed on a 5 x 7-dot matrix. They appear along the edge of the oscillograph paper to allow annotations concerning relevant parameters *whilst the recording is being made*. In some cases this can allow event triggered recording, to save chart paper, with the nature of each trace and event details in juxtaposition. The "ink jet" device is instructed with ASC11 words which can originate from a manually operated keyboard or perhaps a minicomputer system for fully automatic monitoring.



The mechanism works like this: the basic impulse jet consists simply of a glass capillary tube with an orifice at one end, a coaxial piezoelectric driver, and a plastics supply line leading to an unpressurised ink reservoir. The piezoelectric driver is pulsed, and the shock waves squirt a metered amount of ink through the jet, just like a tiny microscopic valve-less pump. This art of obtaining ink particles of consistently equal masses and velocities is important for the next step; which is to charge the particles and electrostatically deflect them with a staircase waveform, and know for certain where they are going to be headed for afterwards.

As the paper advances under the head, the deflection staircase waveform builds up each character in raster fashion (5 rows of 7 dots), the pump "spitting" out (or missing out) ink at the appropriate times, controlled by the electronics.

Some of the statistics are: character width held constant over a 1,000:1 chart speed range (from 0.05mm/s to 50mm/s), achieved through paper/character generator speed synchronisation. The mechanism is silent, and could print on almost anything without damage. A single 10<sup>3</sup>cm cartridge will print over two million characters.

A real-time clock modulé is also available for time scale print-out along the oscillograms.

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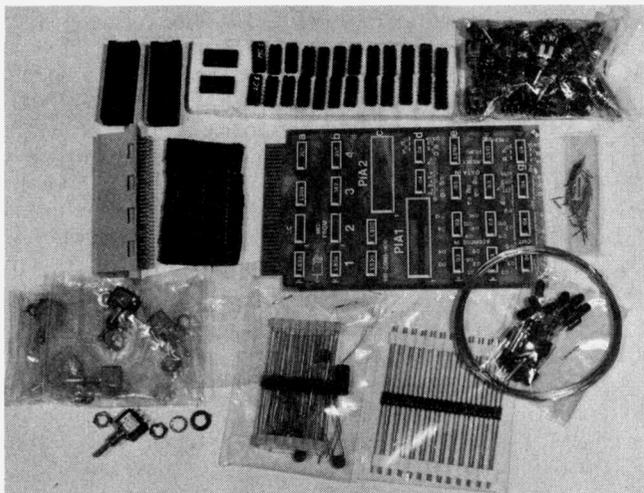
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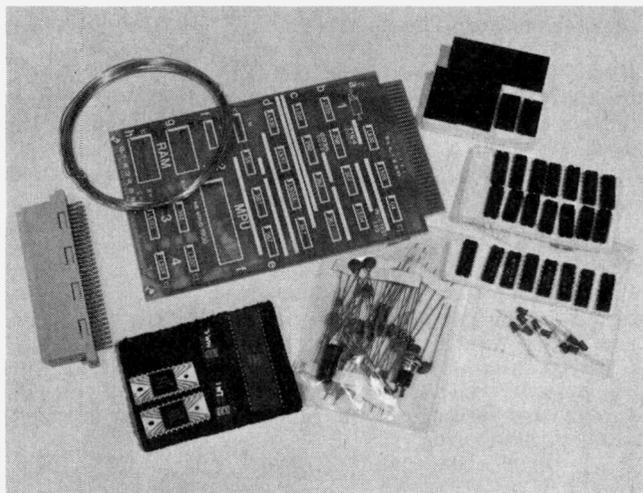
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# MICROPROCESSOR

## Kit Review... By P. A. Birnie



Contents of the CON-COS box as supplied in the kit.



MAIN-COS components as supplied in the kit.

THE APPEARANCE in the market-place of a bewildering number of microprocessors has sparked off the home computer industry—first in the U.S.A. and later in the U.K.—and has resulted in an equally bewildering number of “systems” for the amateur. These range from the simplest “keys and lamps” systems, which are more useful as teaching aids than as home computers, through the hex. keypad/hex. display systems to the keyboard and v.d.u. systems running in BASIC and capable of performing the most sophisticated of computing tasks.

Recent months have seen the emergence of several “keys and lamps” systems from such firms as Ritro and Newbear Computing, and these are designed primarily as a means of “getting started” in home computing while at the same time offering the facility of later expansion to virtually any level of system complexity. The system reviewed here is the Ritro AMI-COS system, which is 6800 based and when operational allows the user to run programs entered by means of keys in hex. machine code, and read out the “answers” on two l.e.d. arrays, i.e. it is intended primarily as a cheap means of getting into microprocessor computing.

As can be seen in the photograph, an array of 16 l.e.d.s and 16 switches allows the address bus to be monitored on l.e.d.s and have addresses entered onto itself by keys. A similar array of 8 l.e.d.s and 8 switches performs the same functions on the data bus. Other switches allow single step or clocked operation, automatic address increment when inputting data, access to the 6800 register, interrupts and other functions. In other words, access is given to all parts of the system to allow the basic principles of microprocessor operation to be rapidly learned and later applied to the solution of problems by relatively simple programs.

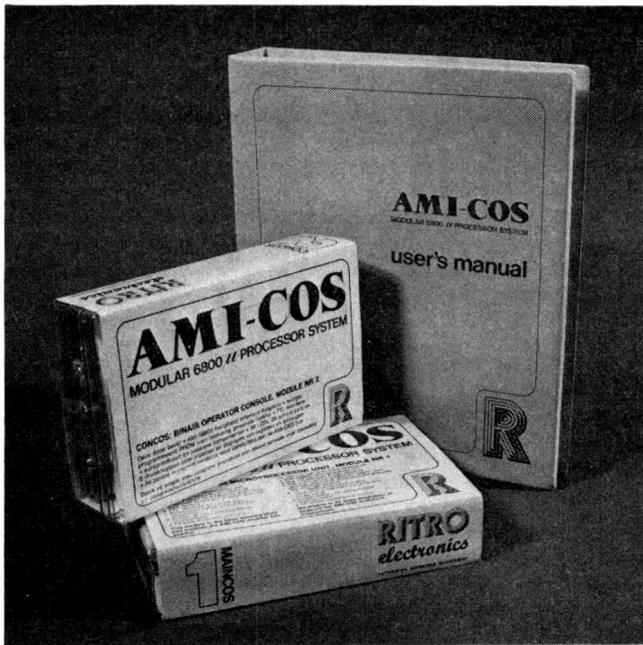
### THE HARDWARE

The kit of parts consists of two plastic boxes containing MAIN-COS and CON-COS and a large thick instruction manual—MAIN-COS being the name given to the circuit module containing the 6800 microprocessor and peripheral circuitry, CON-COS, on the other hand, is a circuit module which interconnects the operation panel and MAIN-COS. Both modules are impressively packed in the appropriate conducting foam or polystyrene packaging and each plastic box is slipped into a sleeve which outlines the contents and overall function of that module, and it is at this point that a problem, which was to recur, came to light. The MAIN-COS sleeve is printed in Dutch and English, but the CON-COS sleeve is printed only in Dutch, which proves no problem with such words as “processor”, but rather more tricky when one is confronted with “drukknoppen” (pushbuttons?).

The manual consists of an A.4 sized loose-leaf book about 25mm thick with sections on construction of the MAIN-COS and AMI-COS modules, theory of the 6800, sample program derivation and general background of the devices used in the system. Unfortunately, the manual contains only about 50 pages of actual constructional information, about one half of its total being devoted to a reprint of device data sheets—very useful background, but few constructors will need or want to plough through this material. A section devoted to a very clear explanation of the 6800 instruction set is very well produced and the author found the information was more easily understood than that given in the Motorola Programming Manual.

A further section deals with program writing and associated flow-diagram production; the explanations are very clear and two programs are written from flow diagrams through to machine code listing. These programs, an 8 bit binary to three

word BCD convertor and a "running light" program, are subsequently handy as an easy way of checking on correct function of the system when completed. The shortest section of the manual is entitled "General Mounting Directions", and is intended to give guidance on constructional techniques. The advice given is at a very basic level and is obviously translated from some other language, which has caused some amusing "directions" to be given—mentioning a "soldering rod", and requesting that a joint should be kept still "during the hardening process" (please see the footnote concerning the construction section of the manual).



Presentation of the kit including the complete manual.

### CONSTRUCTING MAIN-COS

The circuit board used for MAIN-COS is a simple eurocard size double-sided fibre glass board *without* plated through holes and thus the first task is to make a number of through board connections using the 0.8mm wire supplied. The manual says to cut 149 pieces and link as shown in a photograph of the board. Unfortunately, due to the poor quality of this photograph, it requires considerable care to link all the required holes and not link holes subsequently to be occupied by i.c. legs or component leads, particularly as the figure of 149 seems to be excessive—137 links being used in this prototype. While completing this task, ample opportunity is given to examine the circuit board, which is to a very high quality with a gold-plated double-sided 64 way edge connector and relatively high packing density of i.c.s and a few discrete passive components.

The next activity involves inserting a 7404 inverter package and a "test i.e.d." and probe. This assembly is extensively used during construction, in conjunction with "forcing wires" or earth-connected wires, to de-bug the system as it is assembled. This allows the experimenter, without even a multimeter, to confidently construct the kit—a very helpful idea. Assembly of the board is performed in several stages, each stage being followed by a comprehensive test routine using tables which instruct one to monitor with the test i.e.d. and "force" with forcing wires at specified points, thus checking each i.c. and its interconnections step by step.

The construction of the clock generator in microprocessor systems is frequently a cause for concern, but the AMI-COS module simply uses two back-to-back monostables (74123) with fixed resistors and capacitors, resulting in the prototype constructed by the author, in a clock frequency of 750kHz and a mark/space ratio of about 1:1. This frequency and mark/space ratio can, of course, only be checked using an oscilloscope, so, if the constructor requires a given clock ratio to allow real-timing in software, then he will need to have access to such an instrument.

The final stage in construction involves inserting the 6800 microprocessor and two ROM chips and applying a + 5 volt supply, at which point the processor board *tests itself out* using a diagnostic program contained in the ROM's. A set of eight small i.e.d.s flashes-through a defined sequence, testing, among other things, data and address lines, RAM locations and the presence of other modules. Failure of any test results in the appropriate i.e.d. being lit, allowing relatively easy debugging of the MAIN-COS module—a very neat solution to the problem of testing microprocessor systems in general, and all the more remarkable for its appearance in a basic system such as this. Assuming the manual has been followed, then the MAIN-COS board should function correctly, and may be set aside pending the construction of CON-COS; Fig. 1 shows a block diagram of MAIN-COS.

### CONSTRUCTING CON-COS

CON-COS occupies a second eurocard which again has to have a number of through holes linked, the number given in the manual—92—being correct this time. Again, the picture

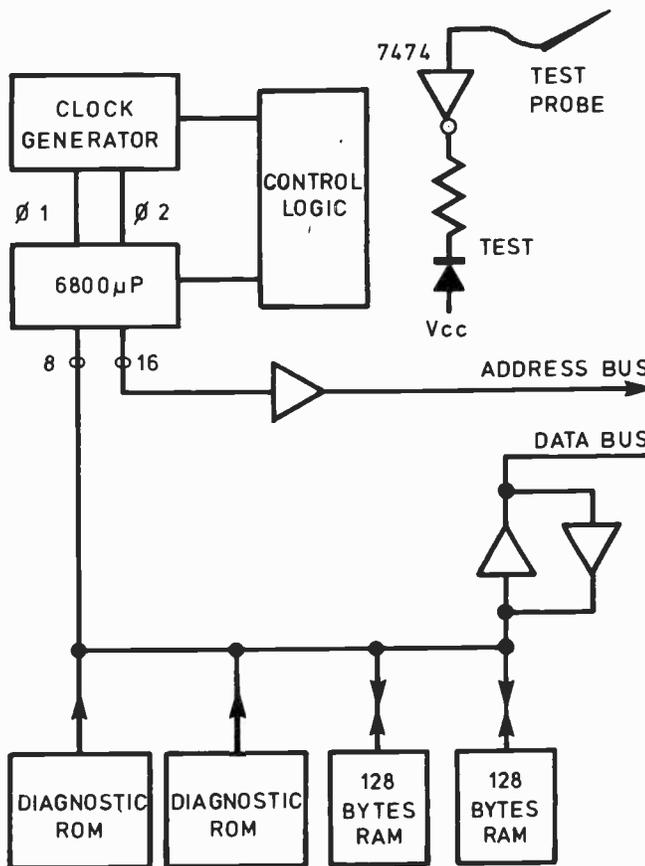
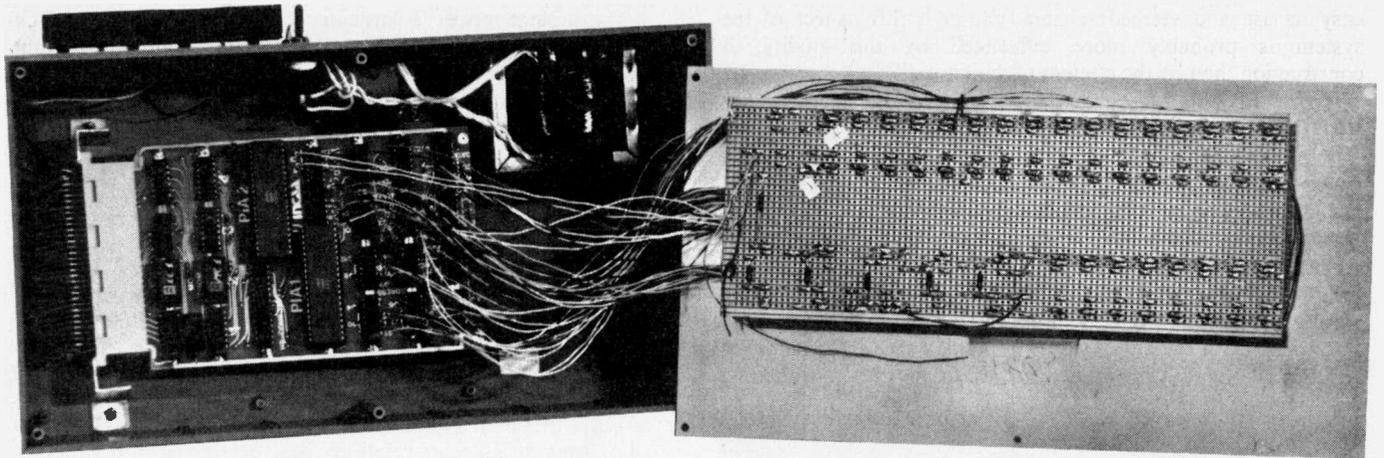


Fig. 1. MAIN-COS block diagram.



Construction of the kit in the Desko case. Veroboard was used for switch and l.e.d. wiring.

showing the positions of the holes is of very poor quality and a diagram would have been much more useful. Construction continues in stages, a test schedule allowing a thorough check to be made of all devices and interconnections. At any rate, this is the intention, but this part of the constructional information is bad, having many errors, causing much cross-reference to the circuit diagrams (see footnote). If the constructor has sufficient ability to overcome these problems, then construction and testing of the board is relatively straightforward and results in a module which controls the interface between MAIN-COS and a front panel—Fig. 2 shows the block diagram of CON-COS.

The final part of construction consists of mounting the switches and l.e.d.s in the CON-COS kit of parts on a panel, or, as was done by the author, on the front plate of a Desko, sloping front case (TEK 364 from West Hyde Developments).

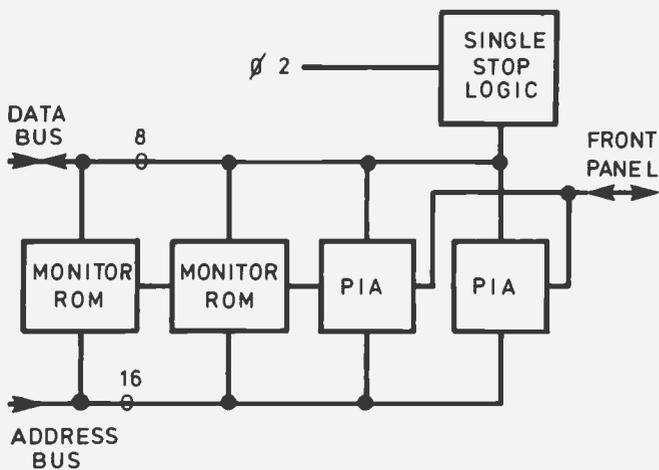


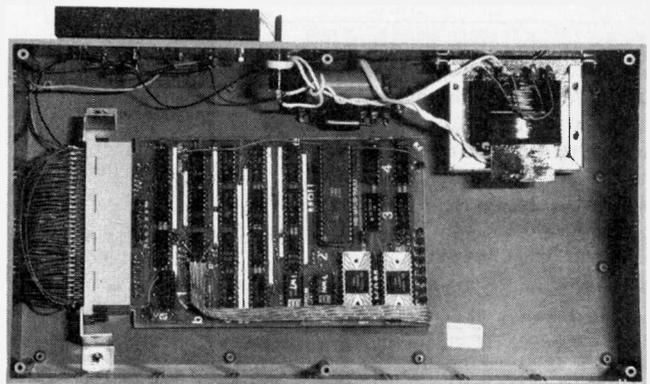
Fig. 2. Block diagram of CON-COS.

The switches and l.e.d.s can either be mounted on a sheet of Veroboard or a printed circuit board which can be obtained as an optional extra from Ritro. The front panel must be connected to CON-COS using insulated wires which are soldered direct on to the board rather than connecting via the edge connector, effectively tying the panel and CON-COS together by a harness of 61 wires. A simple power supply giving 2 amps at + 5 volts must be provided by the constructor to drive the MAIN-COS and CON-COS modules.

## TESTING AND PROGRAMMING

Testing of the completed system is carried out in two parts. Firstly, the test program in the two ROMs in MAIN-COS is used in conjunction with the RESET key to check out the system using the eight test l.e.d.s on MAIN-COS. This test program also clears the front panel displays and prepares the system for the second part of the test. This final test is probably best performed using the “running lamp” program—an 18 hex. byte program which causes all l.e.d.s to light except for one, which “runs” along the data and address displays at a rate which can be varied by making small changes to the program.

The program can be stepped through one instruction at a time or at full system clock rate to allow an easy check of the system performance. The author’s attempts were rewarded in success, after several “hiccups” caused by errors in the front panel circuit



MAIN-COS and power supply construction.

diagram, which effectively caused some switches to be “upside down” on the panel, so that, for instance, the switch which selects either program counter or index register was inverted when connected “as diagram”. In practise, this prevents one easily entering a program as the RAM address of the program bytes is not displayed on the front panel and apparently indicates that the auto-increment of the program counter is not working—all very confusing and the source of several hours of head scratching!

Having sorted out these problems, the system proved very easy to use and seemed reliable, although this aspect of the system is probably more influenced by the quality of construction than by the content of the kit itself.

## VERDICT

The purpose of any "keys and lamps" microprocessor system must be primarily to introduce the *newcomer* to microprocessors to the intricacies of what is a complex subject. In this respect, AMI-COS, as presented to us, cannot be said to be a complete success. The circuit boards and hardware are all top quality and the concept of step by step checking, using a built-in test i.e.d., is excellent. The use of the microprocessor to check itself and the system out with the aid of test programs in ROM is similarly a very well thought-out concept, and yet all this good engineering

is spoiled by a poor set of assembly instructions.

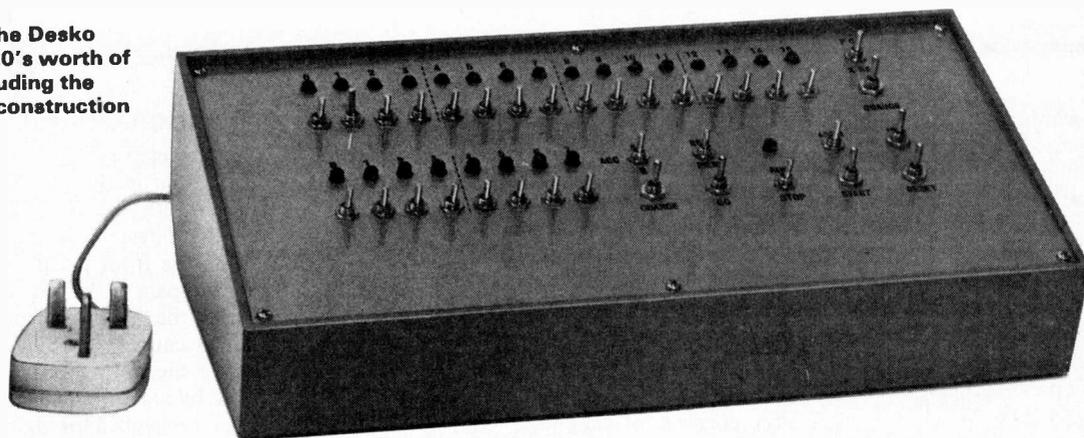
The system, once constructed, is excellent as a "tutor" in microprocessors, when used in conjunction with the relevant sections of the manual, but, at a price of £166.50 plus VAT, seems expensive when, for only small additional outlay, a system running on keyboard and TV set-v.d.u. could be obtained.

For more information contact Ritro Electronics (UK) Ltd., Grenfell Place, Maidenhead, Berkshire.

## FOOTNOTE

As a result of our kit construction and findings concerning the manual, Ritro and Mr. P. Birnie have got together and the construction section of the manual has now been completely rewritten. ★

The completed unit in the Desko case. Approximately £20's worth of extra components (including the case) were used in the construction of this unit.



# P.C.B. ASSEMBLY JIGS

W. ENGLISH

ONE of the main problems involved in soldering p.c.b.s and stripboard is being able to hold the boards in an accessible position to enable a satisfactory joint to be made.

The two assembly jigs described here show how this can be accomplished with both large and small boards.

## CONSTRUCTION (TYPE 1)

A very simple but effective jig for holding small pieces of board is shown in Fig. 1. It consists of a piece of 12mm plywood 130 × 130mm onto which is glued a wedge shaped piece of 15mm softwood cut to an angle of 30 degrees.

To complete the device, a spring clothes peg with the jaws modified as shown below is glued to the slope of the wedge.

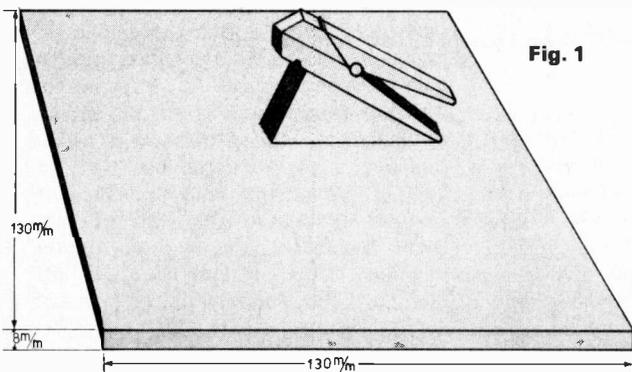


Fig. 1

## CONSTRUCTION (TYPE 2)

The assembly jig shown in Fig. 2 is capable of accepting boards up to 300 × 140mm. If larger sizes are to be used, then the relevant dimensions can be scaled up.

The board to be soldered is gripped in slots cut into two bars, one of which is movable to take boards as narrow as 20mm. A self-tapping screw through the metal band at each end of the movable bar enables it to be clamped so that the board is held firmly. A detail of this is given in Fig. 3.

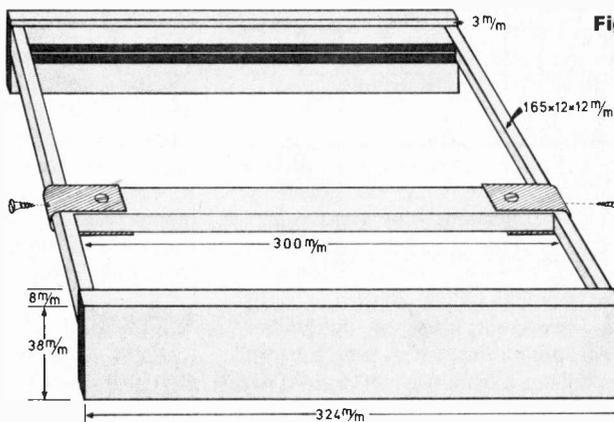


Fig. 2

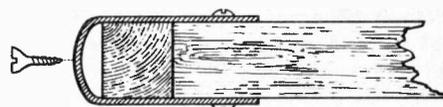


Fig. 3



# P.C.B.s

*A. R. Damper*

**M**ANY readers of P.E. are newcomers to the construction of electronic circuits, and will most probably construct simple projects on tagstrips or Veroboard. It will not have escaped their notice that most large published projects give details of a printed circuit layout. The reason is simply that printed circuit boards (p.c.b.s) are simple to make (once you know how!), and provide a much neater and professional looking end-product. Smaller published circuits often give a Veroboard layout or no constructional details at all. This article is intended to be a guide for those wishing to make p.c.b.s from circuit diagrams for the first time. Single-sided boards only will be considered. Double-sided boards are mostly used in more complex projects, and when published in magazines, can usually be obtained ready made.

There are two main types of board material to choose from, SRBP and glass-fibre. In general applications either may be used, the SRBP being cheaper but not as strong as glass-fibre. In higher quality applications where maximum isolation between tracks is essential, glass-fibre boards are preferable. For small general projects SRBP is quite adequate.

## AN EXAMPLE

The object of the exercise is to produce a conductor network on the board by covering, or masking the areas where copper is to remain, and then dissolving away the remaining areas. However, before the tracks can be marked onto the board the layout must be determined from the circuit diagram. A simple circuit (one stage amplifier), provides an example. See Fig. 1.

The circuit is a simple one with no interconnections to other parts of a complex design, enabling the layout on the board to follow the layout of the diagram. Now see how this circuit can be

transformed into a finished p.c.b. The points marked with an "O" represent the need for a hole in the board to take a component lead. At point "A" there are four holes necessary; one for a capacitor lead, two for resistors, and one for the transistor base lead. If the components were now to mystically vanish, Fig. 2 results, and the Os indicate where the holes are to be drilled. This is the general layout and only gives a guide to the track layout.

The resistors are probably low-wattage and can therefore be mounted vertically; consequently the distances between the two holes for Rs need only be about 6mm. However, C2 is an electrolytic capacitor, and for an amplifier having a low pass characteristic, may be of large value, hence large size. The holes for C2 may need to be 50mm apart. So from Fig. 2, Fig. 3 is produced taking into account the component sizes. It is therefore very important that the components are obtained prior to building the board if their size is unknown. Figure 3 still shows the track from the *component side of the board* and must be reversed to give the layout as it will be etched. To ensure that the input and output are isolated, it is always best to fill in large otherwise empty spaces with conductor, and earth it making sure there is one continuous path to earth. This gives the final full size layout as in Fig. 4, the shaded area being the "filled-in" portion carried out after the main track is applied.

## METHOD

There are quite a few different types of etch resists on the market. In the author's opinion the best board is produced by a combination. Until recently the resist used was painted onto the board (enamel paint and nail-varnish being common), but these did not lend themselves to small scale work such as integrated circuit con-

nections. Then etch-resist pens appeared which enabled the circuit to be drawn directly onto the board, and although they sound fine, the author has found that they often "run" to produce very thick lines unsuitable for fine work. Without running these pens down, the dry transfer system seems the cleanest and simplest method. It is also fairly cheap, and if a mistake is made, the offending line can be scraped off. So, the author recommends that for the main track, dry transfers are used whilst the larger filled-in areas are covered with nail varnish, paint or etch-resist ink.

## MAKING THE BOARD

Having worked out the final layout as in Fig. 4 the board can be prepared. Firstly cut from a larger sheet, a piece of copper-clad board of the required size, using a hack-saw with a *fine* blade and then file the edge smooth. The surface of the copper must now be thoroughly cleaned to remove all grease, dirt and finger-marks. A good method is to rub the surface *gently* with a cloth after sprinkling a little "Ajax" or similar cleanser onto the board. This is very effective and no trouble whatever has ever been experienced with the fine scratches produced. The board is then rinsed in fresh water and dried.

Dry transfer systems are sold by many P.E. advertisers and complete packs consists of ten sheets, each carrying a different symbol such as lines, drilling points, transistor and i.c. sockets, etc. whilst extra individual sheets are usually available also. It is advisable to buy extra sheets of lines, as these are most frequently used. The author once used Letraset sheets of symbols and line rules, before this system became available, and in certain circumstances such as when fine lines are needed, Letraset is still handy. However, these sheets are more

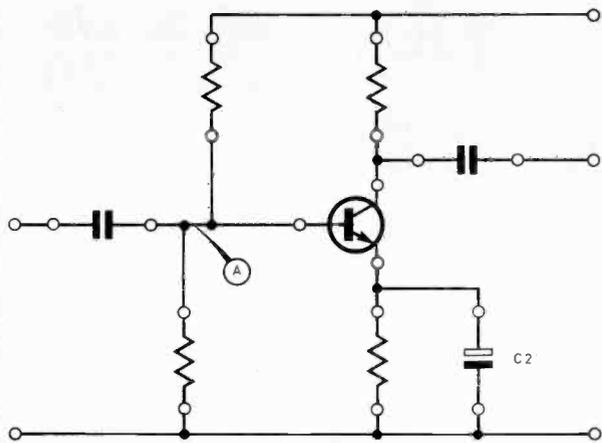


Fig. 1

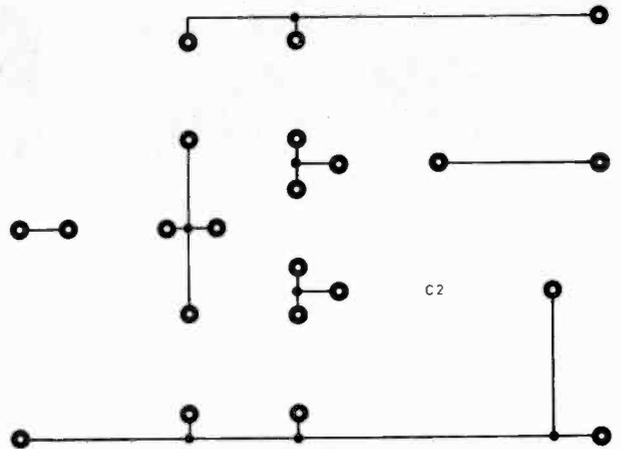


Fig. 3

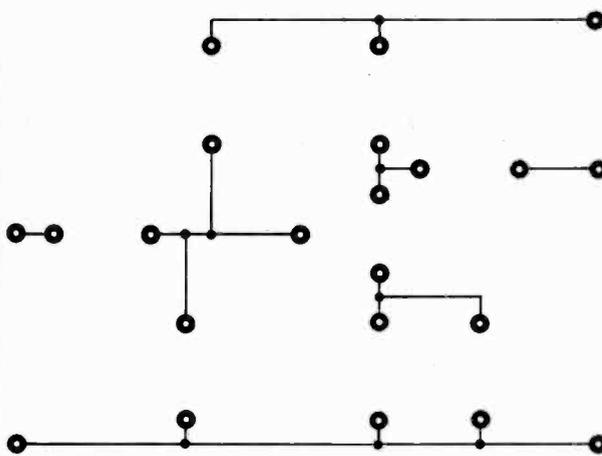


Fig. 2

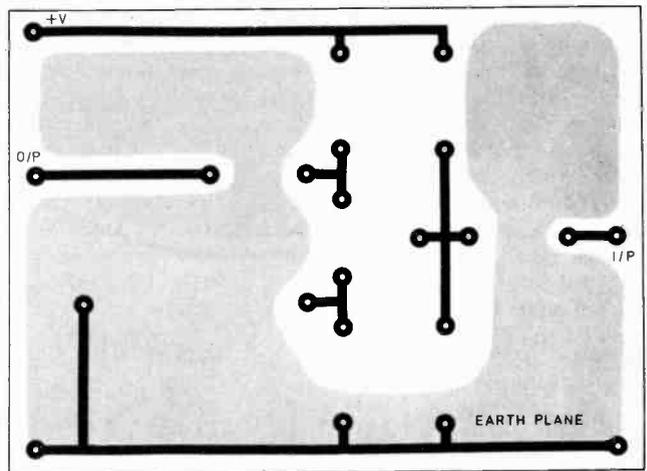


Fig. 4

expensive and therefore only used when necessary. Letraset is useful for applying lettering to the board to identify component positions. If Letraset is included in the masking the etchant should be reduced to around half the normal concentration, as this type of transfer may start to loosen. The p.c.b. transfer system is of course unaffected by the full strength solution.

Working from the layout, the transfers should be applied by placing the required symbol face down on the board and rubbing the backing sheet gently with a bluish pencil. When transference is complete, the backing sheet is carefully peeled away and the remaining transfer symbol gently pressed onto the copper to secure it. Clean hands are necessary for this operation. Should something go wrong, the transfer can be removed by scraping it off with a finger-nail or blunt instrument.

When all the lines (as in Fig. 4) have been applied, the larger shaded area can

be filled in with etch-resist ink or paint. The board should then be left to dry.

### ETCHING

The etching solution used is ferric chloride, which is also obtainable from advertisers in this magazine. The solution is made up as follows. For each pound weight of ferric chloride, one pint of cold water should be added, and placed in a plastics container (a plastics orange juice bottle with the top sawn off is ideal). The ferric chloride should then be added slowly, stirring all the time with a piece of wood or plastics rod. Don't add too much at a time because the solution gets hot, and it becomes necessary to stop and let it cool. *Never add water to the crystals*, because the heat generated is enormous and the steam produced might shower you with hot ferric chloride, or melt the plastics container. If any ferric chloride gets on your skin, wash the area thoroughly with water. Store the solution in a plastics container with a secure

stopper.

To etch the board, pour some of the etchant into a shallow plastics or glass tray and lay the board face down on the solution. This allows any by-product from the etching process to fall away from the surface of the board. If the board sinks, or you would rather see what's going on, lay the board face-up in the bottom of the container, but keep the solution moving by gently rocking the container. When etching is complete, remove the board with non-metallic tweezers and rinse in cold water. After drying, the resist can be removed by rubbing the surface with medium or fine grade "wet and dry" paper obtainable at d.i.y. shops. The holes can then be drilled with a 0.8mm drill. Some components will have larger diameter leads and the appropriate drill should be at hand. To give the drill a start, it is useful to mark the position with a centre-punch, but be *very gentle* otherwise the board may crack. ★

# Market Place

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

## GETTING STARTED

Delta Distribution is a very new company initially concentrating on power supply transformers, regulators and common i.c.s. Good, fast service is their intention and they are at present setting up mail order and telephone credit services with Access and Barclaycard.

The product range will be expanded as soon as possible and the current price list is available from **Delta Distribution Co., 75 Willowtree Ave., Gilesgate Moor, Durham, DH1 1DZ (0385 62760).**

## SOUND ON VISION

An all British invention, the Videograph, has recently been announced. It converts sound from a record, tape, organ or synthesiser into a display on a domestic colour or black and white TV screen.

Two inputs allow direct display of stereo sound as independent left and right channels, or alternatively a mono signal may be used to feed, for example, low frequencies to one channel and high frequencies to the other.

When used with a colour TV the waves are orange and blue, while the background performs an eight stage colour cycle.

Connection to the TV is directly via the aerial socket.

The Generator Kit costs £12 and the UHF Colour Modulator Kit is £6.95. Cabinet and controls cost £6.95 + £1 p&p.

Ready built units are available at £39.95. All prices include VAT.

**William Stuart Systems Ltd., Dower House, Herongate, Brentwood, Essex.**

## AMERICAN COMPUTER BITS

Another supplier of computer bits and pieces has arrived on the scene; Interam Computer Systems Ltd, who are geared up to service both the hobbyist and small businesses.

As we move further into the "software age" more of these suppliers are sure to pop up, with all sorts of novel odds and ends. Among the literature sent for our perusal by Interam were details of such things as the Cybernetic Systems 1000 Speech Synthesiser. This p.c.b. can be programmed to talk, using standard English and American phonemes, callable using ASCII characters. It is described as a real conversation piece!

Then there is the Newtech Model 6 Music Board which is S-100 bus compatible, and with built-in audio amp and loudspeaker can be programmed to produce melodies, rhythms, sound effects, morse code, touch-tone synthesis, and much more.

And yet another American product available from Interam, is the George Risk 753 ASCII Keyboard module with 53 keys on the popular ASR-33 format and 3 user definable keys.

What is PROROM? This is an 8K EPROM memory board with on-board programming circuitry intended to make high programming charges a thing of the past, and made by Mountain Hardware (USA).

Much much more is available from Interam; disk systems, optical tape readers, a Z80 c.p.u. system, software, and many American books and magazines.

More details are obtainable from **Interam Computer Systems Ltd, 59 Moreton Street, Victoria, London SW1.**

## ONE-CHIP TV SOUND SYSTEM

The TDA 1190 is a 12-pin silicon monolithic i.c., mounted in a "batwing" plastic power package. The device which performs all the functions needed for a TV sound system has an audio output power of typically 4.2 watts into a 16Ω load with a supply voltage of +24V. The TDA 1190 is particularly suited to use with 5.5MHz (PAL) sound systems.

The package provides a FM IF amplifier and detector of high sensitivity which only requires the addition of few extra components and a single tuned coil. AM rejection is excellent; figures of 55dB being typical. An active low pass filter is used to attenuate IF harmonics. Other features include an on-chip audio power output stage and a d.c. volume control.

Although primarily intended for use in TV sets the device can be used in inexpensive FM radios and other FM receiver applications at IF frequencies up to 10.7MHz.

For further information contact **Fairchild Camera and Instruments (UK) Ltd, 230 High Street, Potters Bar, Herts.**

## SOLDERING TOOLS

For many years the name Adcola has been synonymous with soldering irons. "Adcola '78" is a very well produced booklet about the other products manufactured by "The soldering equipment people".

Perhaps initially written for volume production solderers this booklet makes useful reading for any hobbyist.

The advantages of thermostatically controlled "soldering stations" are well documented. Their main improvement over the commonly used "thermal balance" iron is a more rapid rise to operating temperature and an ability to maintain a set temperature during repetitive working.

Among the numerous sizes and profiles of plain copper and iron plated bits is an 80° p.c.b. tip. Iron plated bits oxidise much less quickly than plain copper and are claimed to have a ten times greater working life.

Of particular interest to project builders is a desoldering bit for 14 or 16 pin i.c.s although it does require to be used in a 27-30 watt iron. Adcola also supply an i.c. puller. This is a simple spring loaded extractor used to withdraw i.c.s from a board after a desoldering bit has melted the surrounding pin solder.

Other desoldering aids are a heated tip with suction bulb, a desoldering gun and various sizes of desoldering braid.

For quick access to both sides of a rigidly held p.c.b. Adcola's Variclamp deserves consideration. This is a lightweight portable holding device which can hold items in any preset position.

The right tools make the job easier and help towards a good finish. The range of cutters, nippers, pliers, shears and strippers gives the craftsman constructor the means of achieving professional quality boards.

Copies of "Adcola '78" and a full price list may be obtained from **Adcola Products Ltd, Adcola House, Gauden Road, London SW4.**

### TRISTATE L.E.D.

A light-emitting diode which produces red or green emission according to the polarity of the applied voltage is now available from Distronic. Known as the Xciton XC5491, the device uses a back-to-back double-diode configuration which produces red or green light of equal intensity for both colours.

The forward bias is typically 2.2V at a current of 10mA with a dynamic resistance of 25Ω. The maximum continuous forward current is 25mA for both colours and the operating temperature is -55°C to +85°C.

The XC5491 is supplied in a T-1-3/4 package measuring 0.2in diameter x 0.34in height, and is supplied with wire-wrappable leads.

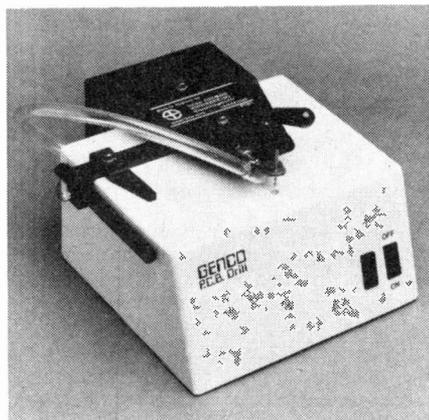
For further information contact **Distronic Limited, 50-51 Burnt Mill, Elizabeth Way, Harlow, Essex.**

### CHUCKLESS P.C.B. DRILLING MACHINE

A p.c.b. drilling machine operating on a new design system allows inexperienced operators to drill perfect p.c.b.s immediately.

The unit has no chuck and does not require guide bushes for turbo shank tungsten carbide drills.

The drill bits run in vee-blocks at the end of the drill arm allowing extremely accurate running at 15,000 r.p.m. Belt idler pulleys run on ballraces and the mains motor is silent running.



An integral vacuum attachment for efficient swarf removal will optionally accept standard Hoover vacuum cleaner attachments if required.

The ultra lightweight drill arm can be easily raised and lowered to allow modifications to p.c.b.s where components are already in place. The machine will accept drills from 0.35mm to 2mm diameter.

Standard fitments include back stop and side gauge—fully adjustable in both X and Y axis, and a jig to ensure accurate location when fitting drill bits.

The unit cost £140 with accessories and is available from **P.B. Electronics (Scotland) Ltd, 9 Radwinter Road, Saffron Walden, Essex.**

### STORAGE SCOPE

The new oscilloscope available from Gould Advance, is a general purpose two channel digital storage oscilloscope and waveform digitizer which features several new facilities, including an X-Y display and a sensitivity of 100μV/cm combined with isolation from earth to avoid hum and ground loop problems.

It is based on an 8-bit analogue/digital converter operating at a 1MHz sampling rate into a 1k bit store to provide a -3dB bandwidth up to 600kHz.

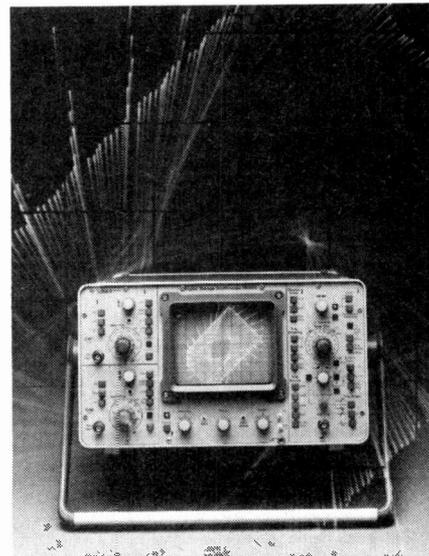
In addition to facilities for displaying the sum or difference of the input signals, the instrument has a comprehensive range of signal conditioning and trigger facilities, including a "trigger-window" feature which is unique in oscilloscopes. In this mode, trigger occurs whenever the input goes outside either of two levels, symmetrically spaced above and below the original trigger level.

Internal trigger sensitivity is equivalent to 2mV of signal at frequencies from d.c. to 1MHz, and external sensitivity is better than 100mV up to 1MHz. Trigger coupling allows selection of d.c. or a.c. with high-frequency and/or low-frequency rejection if required.

An important feature of the digital storage system is a signal delay switch, which inserts a quarter scan length delay into the digital signal path, so that events happening prior to the trigger event may be viewed on the screen.

An 18-position rotary switch varies the speed rate over a very wide range, 100μs/cm to 50s/cm, while an X-expand control offers the facility of expanding the display horizontally, even after storage has taken place.

In addition to the normal dual-channel form of display against a time axis, channel 1 can



be displayed against channel 2 in the X-Y mode.

A split-trace facility is incorporated; in the single-trace mode, alternate samples of the input signal are frozen, so that an image of the signal may be stored and superimposed on the display of the current input waveform.

The digital storage system incorporated in the Gould Advance OS4100 offers considerable advantages over conventional tube-storage oscilloscopes incorporating expensive limited-life storage tubes. The X-Y facility means that the instrument is ideally suited for looking at transients where more than one variable is involved.

For further information including price contact **Gould Instruments Division, Roebuck Road, Hainault, Essex.**

### RADIOCODE CLOCK

A clock which has been specifically designed to receive the time and date information which is transmitted by the National Physical Laboratory from Rugby on MSF 60kHz is available from Circuit Services.

By decoding the Rugby signals the clock can set itself automatically within two minutes of being switched on and displays either the time or the date. No subsequent adjustments are necessary because the clock is capable of accounting for both leap years and BST.

Its estimated range is around 1,000 miles and for continental use the clock has an add-on-hour facility or alternatively, a modified version can be supplied which receives a similar signal from the DCF77 transmitter at Mainflingen, West Germany. This allows the clock to be used in Eastern Europe where the MSF transmission may be weak.

The unit can be supplied with an alarm/timer module which enables the clock to control other equipment at certain times for precise periods. A record/replay unit can also be supplied which allows the time or date to be recorded on one track of a conventional tape recorder while the other tracks monitor instrument outputs, transients, etc. On replay the recorded time is shown on the Radiocode Clock display. In this mode the clock operates



exactly as if it was receiving a normal transmitted signal. Once the tape has been started on replay, the clock circuitry requires around two minutes to synchronise with the code. After synchronisation has taken place any events recorded on other tracks of the same tape will be timed to within approximately 10mS of their occurrence.

Another advantage of this system is that if the Rugby transmitter should happen to break down during an important recording period, the back up crystal clock will take over and provide an accurate time reference.

For further information contact **Circuit Services, 6 Elmbridge Drive, Ruislip, Middx.**

## HONEY AT 2.50?

The Casio F-100 digital chronograph can display time, calendar, or a stopwatch function. The 1/100th second stopwatch measures net and lap times and can record 1st and 2nd place times.

Timekeeping is  $\pm 15$  seconds per month and gains or losses of up to 30 seconds are easily adjusted by pressing two buttons and zeroing in on a time signal. A complete setting of hours, minutes and seconds takes a little longer.

The calendar display is similarly easy to set, and looks after itself with only the 29th February to contend with.

Although water resistant the watch should not be subjected to swimming, bathing or even car washing. The manufacturers say the display may disappear if kept under constant sunlight but will reappear after normal temperature resumes. Battery life is approximately 18 months.

It is not understood why the function buttons on the watch are coloured grey, yellow, brown and green whereas the user's guide refers to them as B.L.C. and A.

If you want to brush up on your watch knowledge in German, French, Spanish or Italian then Casio's user's guide serves as a miniature Hugo's. Soon, perhaps, the average music centre will have Stoppuhrfunktion: Travail buttons; oxido de plata batteries; and interfaced Luce shows.

The English language and the traditional clock face are disappearing into an oriental



sunset. The last two lines of The Old Vicarage, Grantchester by Rupert Brooke survived the attack by Peter Sellers' cafe waitress but what hope have they against the digital time display.

*Stands the church clock at ten to three?*

*And is there honey still for tea?*

F-100, £19.95, Tempus, 19-21 Fitzroy St., Cambridge, CB1 1EH.

## DAWN CHORUS DEVICE

Aptly named the Wren, this new quartz movement miniature alarm clock by Smith's Industries is a mere 59mm high.

The hands and hour positions are luminous and the moulded case is available in white with a black or gilt dial, or brown with a gilt dial.

The recommended retail price is £12.90.

## AMPLIFONE

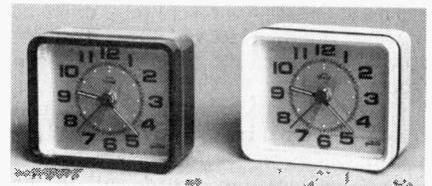
This telephone amplifier fits nearly under a standard instrument and not having any wiring to the telephone can be installed instantly.



Dialling and ringing tones and voices are amplified enabling the caller to hear incoming sound "hands off". The flight deck is simplified to one combined On/Off switch and volume control.

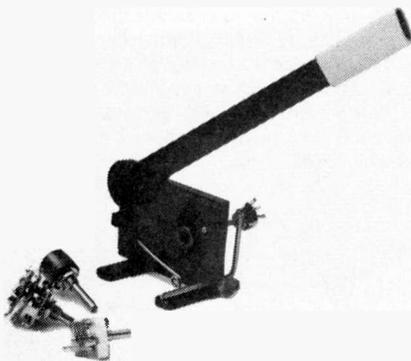
Posted and packed price is £10.

Southern Developments, 120 High Street, Billingshurst, Sussex, RH14 9QS.



## SHAFT SHEAR

Manufactured from hardened Swedish tool steel, this guillotine-type tool will cut copper, aluminium, mild and stainless steel, and plastics rod of the following diameters:  $\frac{1}{16}$ ,  $\frac{1}{8}$  and  $\frac{1}{4}$ in, and 3, 4, 5, and 6mm.



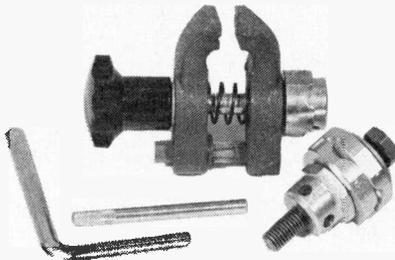
Shock and vibration have caused problems when the spindles of sensitive components have been sewn or cut on a lathe; but the Telpro Shaft Shear may be used to cut the spindles of even delicate helical potentiometers, since it does not transmit shock or vibration.

A further advantage is that it gives such a clean, smooth cut that no filing or other finishing operation is needed before control knobs are fitted.

Manufacturers are Tele-Production Tools Ltd., Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9Nw.

## MINI VICE

This, Design Centre selected vice, needs only a  $\frac{1}{8}$  inch clearance hole in a work bench to give an infinitely positionable third hand. It is an ideal addition to the Home Radio Electronic Workshop (below) and is also supplied by them, at £5.50 + 8 per cent VAT and 85p postage, but post free if supplied with an Electronic Workshop.



## TRAVEL

If you have ever been evicted from the kitchen table just as you were getting your project into a "critical" mode you will understand the marketing theory behind The Electronic Workshop. At the first sign of an approaching ketchup bottle the self contained unit can up and away to the safety of the cupboard under the stairs.

The working surface is two feet wide and 20 inches deep. Rubber mat covers the centre area and formica protects the side portions. Pieces of pine  $1\frac{1}{2}$  inches high form the outer edges and also double as tool holders.

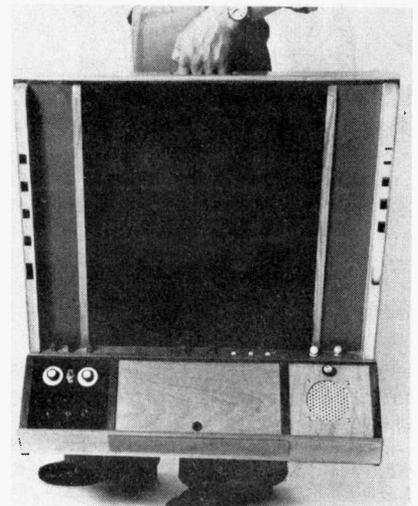
At each end of the back section is a flush 13A shuttered mains socket. The right hand

compartment contains a power pack, giving 0-20V at 1A. The left hand compartment houses a small 35Ω speaker and volume control. The centre compartment acts as a tool box and dispenser for reels of solder, plain wire and tinned copper which feed out of three holes into the work area.

The price of the workshop complete, but for wiring up, is £45. Ready wired, £54. VAT and carriage, £4.56.

Home Radio (Components) Ltd. 240 London Road, Mitcham, Surrey CR4 3HD.

Please note that the photograph shows a mark one version which had AC and DC controls on the power supply. The present workshop has a single control.





## DIGITAL THERMOMETER REVIEW

There are many different types of digital thermometer now available which cover a very wide temperature range.

The hand-held types use CMOS technology to ensure low power consumption with either l.e.d. or l.c.d. indication.

The shape and type of sensor depends on the particular application for which the unit is required, i.e. medical, surface, liquid, powder or gas measurements.

### 800 SERIES

This series incorporates twelve different models with a wide variety of thermocouples to cover the temperature range from  $-150^{\circ}\text{C}$  to  $1,750^{\circ}\text{C}$ .

To ensure maximum life is obtained from the internal batteries a three position switch: momentary-off-on is used. This facility enables the instrument to be either switched on only for the instant at which it is required, or maintained continuously on. HP7 batteries are included with the unit and rechargeable cells with a charger are available as an optional extra.



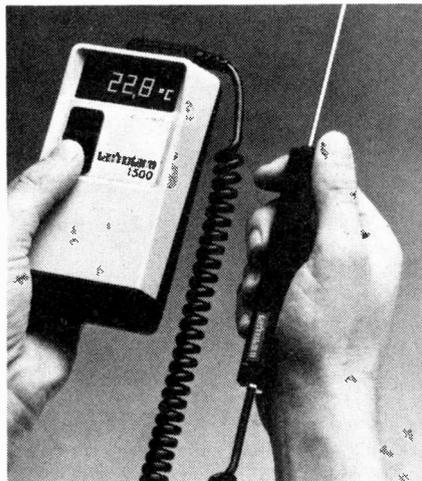
The 8000 series vary in price from £94.00 to £125.00 subject to the temperature range and resolution required.

Further details can be obtained from Channel Electronics Ltd., PO Box 58, Seaford, Sussex.

## THERMISTOR PROBES

The Technoterm 1500 uses precision thermistors with negative temperature coefficients in their probes. This enables response times of between 6 and 10 secs to be achieved over a temperature range of  $-40^{\circ}\text{C}$  to  $140^{\circ}\text{C}$ , depending on the type of probe chosen.

A wide range of probes is available to suit most applications. Accessories include nickel cadmium batteries, recharger and a handy dispenser for silicone paste which reduces the response times on rough surfaces.



The Technoterm 1500 is priced at £169.00 and is available from Thermographics Ltd., 16 Canal Street, Congleton, Cheshire.

### CLINICAL TYPE

The 4755 has been designed specifically for medical and environmental measurements and is available in two ranges,  $33^{\circ}\text{C}$  to  $42.9^{\circ}\text{C}$  (clinical) and  $1^{\circ}\text{C}$  to  $48^{\circ}\text{C}$  (environmental).

The medical unit is capable of retaining the highest temperature detected within a patient and to prevent cross infection both the instrument and the sensor can be sterilised. To avoid the need for sterilisation after each test disposable sheaths for the sensor are supplied with the unit. The response time of the thermometer is 15 secs with rechargeable cells as an optional extra.



The Digitron 4755 is available priced £92.00 from Digitron Instrumentation Ltd., Mead Lane Industrial Estate, Hertford, Herts.

## TEMPSTIK

The Tempstik thermometer has been designed to meet the low cost instrument need and is capable of measuring a temperature range of  $-100^{\circ}\text{C}$  to  $200^{\circ}\text{C}$  with reasonable accuracy.

The instrument has a liquid crystal display and is powered from a PP3 battery which is not included.



The Tempstik which is priced at £73.00 is available from Process Measurement Ltd., 8 High Street, Littlehampton, West Sussex.

### BENCH TYPE

The 7000 series was designed for bench or rack mounted applications and is mains operated. The temperature is indicated on three or four 14mm Sperry gas discharge displays. Thirteen models are available for the temperature range  $-100^{\circ}\text{C}$  to  $1,800^{\circ}\text{C}$ .

All the models in this series can be fitted with an alarm circuit which consists of two totally independent alarm points each having its own relay and front panel l.e.d. The relay contacts which are rated at 240V 2A provide normally open, common and normally closed outputs at the rear of the unit.



The price of the 7000 series is between £109.00 and £149.00 depending on the temperature range chosen.

For further information contact Jenway Ltd., 26 Broomhills Industrial Estate, Rayne Road, Braintree, Essex.



# MOTOR SPEED CONTROL

R.F. MACK

**T**HIS circuit was developed to control the speed of a small model vehicle driven by a permanent magnet electric motor, and provides the following features:

1. A wide range of continuous speed control down to about 200 r.p.m. motor speed.
2. Substantially constant speed despite changes in mechanical resistance due to inclines, cornering, or surface variation—carpet to lino, for example.
3. Substantially constant speed despite changes in electrical resistance—varying track length in a model railway, for example.
4. Economical low-speed operation, unlike some op-amp based controllers.

## PRINCIPLE OF OPERATION

The controller makes use of the fact that when the permanent magnet motor is temporarily disconnected from the drive battery, it acts as a generator driven by the wheels of the free-wheeling vehicle, with the generated voltage representing the actual speed of the vehicle.

The controller compares this generated voltage with a voltage selected to represent the desired speed, and when the vehicle speed is less than the desired speed the controller momentarily reconnects the battery to the motor.

This process is repeated continuously, resulting in the motor being fed with a stream of fixed magnitude pulses, with a repetition rate governed by the external conditions, as shown in the waveform diagram.

## CIRCUIT DESCRIPTION

A voltage representing the desired speed is fed to terminal A. This voltage may be derived in various ways, the potential divider VR1 being shown as an example. Transistor TR1 compares this voltage with the generated voltage from the motor via filter components R9, C3, and switches on TR2 when the actual speed is less than the desired speed. Monostable M1 then produces a fixed magnitude pulse at

## COMPONENTS . . .

### Resistors

R1	10k $\Omega$
R2	10k $\Omega$
R3	39k $\Omega$
R4	39k $\Omega$
R5	470 $\Omega$
R6	1k $\Omega$
R7	10 $\Omega$ 2W
R8	1k $\Omega$
R9	39 $\Omega$
R10	1k $\Omega$

( $\frac{1}{4}$ W carbon except where otherwise stated)

### Capacitors

C1	0.022 $\mu$ F plastic
C2	0.1 $\mu$ F plastic
C3	0.047 $\mu$ F plastic
C4	0.01 $\mu$ F ceramic
C5	0.01 $\mu$ F ceramic
C6	0.01 $\mu$ F ceramic

### Semiconductors

TR1	BC107	TR4	AD142
TR2	BC157	D1	AA12 (see text)
TR3	BFY50	IC1	SN74123

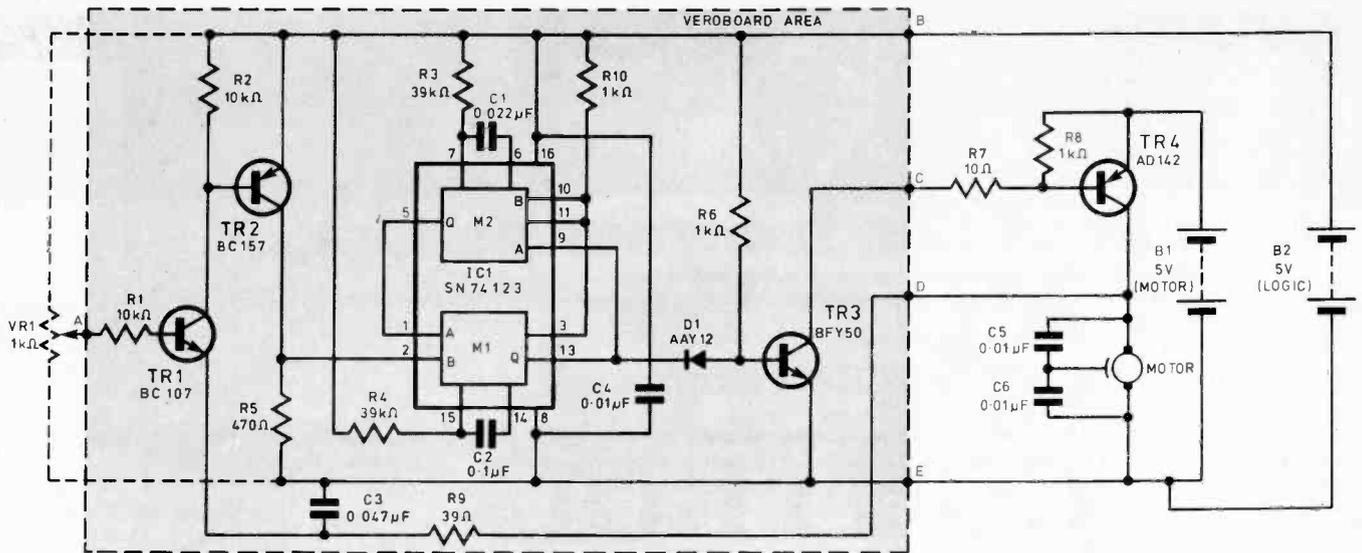
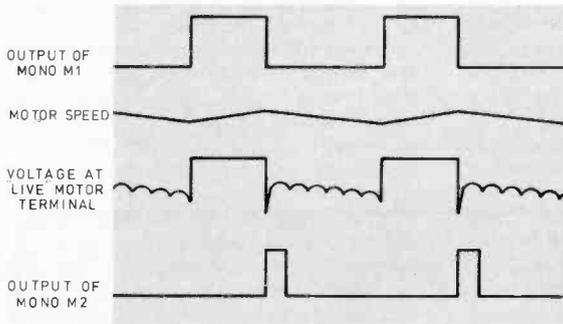


Fig. 1 (above). Circuit diagram; Fig. 2 (below) waveforms



pin 13 of the i.c. and applies power to the motor via TR4, which is an AD142, chosen for its low saturation voltage at high current levels.

Diode D1 is provided to prevent the monostable output terminal from being held low by the base-emitter junction of TR3, and must be a gold bonded germanium component to ensure that TR3 turns off adequately when required.

When the power is removed from the motor inductive effects cause a negative voltage spike at the motor terminal D, as shown in the waveform diagram, so monostable M2 is provided to prevent re-operation of M1 until this back-e.m.f. has decayed and the voltage across the motor truly represents the vehicle's speed.

Separate Nicad batteries were used to avoid interference problems caused by the large surges of motor current and the sensitivity of the TTL monostables.

### MONOSTABLES

The 74123 is a dual retriggerable, resettable monostable multivibrator providing an output pulse whose duration and accuracy is a function of external timing components.

There are two inputs per function, one active low and one active high. This permits triggering on either the positive going leading edge or negative going trailing edge of a pulse. Triggering is independent of input transition time or pulse width.

Since the switching voltage requirement for silicon is higher than the germanium with no pulse output from M1, D1 conducts and TR3/TR4 remain off.

With a pulse output, D1 is blocked and TR3 conducts so that TR4 provides current to the motor.

To prevent the pulse period being extended with the appearance of the inductive spike, Q output is routed back

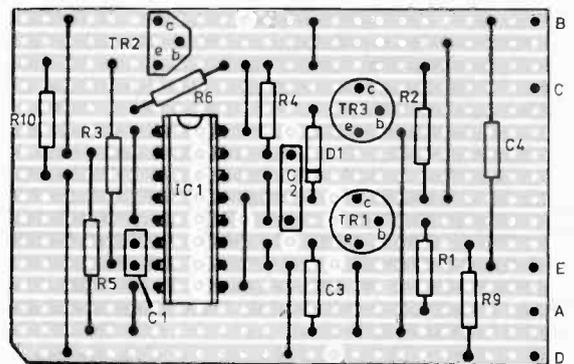


Fig. 3. Board layout

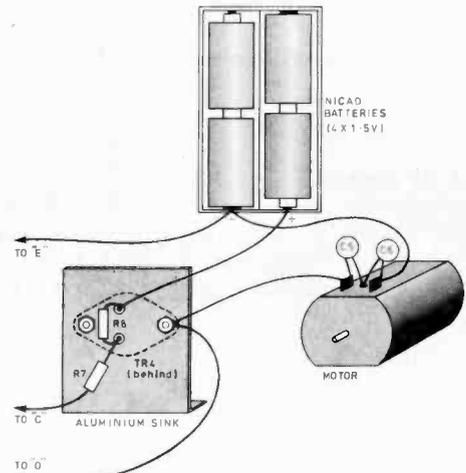


Fig. 4. Component connections to board

to M2 producing a high output at pin 5 which inhibits the Q output of M1.

As can be seen from the waveform diagrams the pulse widths at M1 and M2 outputs have been preset by choice of R4-C2 and R3-C1 respectively, the pulse period being a function of the product of these.

### CONSTRUCTION

All components except TR4, R7, R8, C5 and C6 are mounted on a piece of 0.1in x 0.1in Veroboard as shown. ★

# readout

## ... a selection from our postbag

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

### Audio compass

Sir—A number of compasses have been, and are being, adapted to provide an audible signal for use by blind yachtsmen. However, none of these provide all the facilities that I, as a blind helmsman, would like to have incorporated into one device.

The device that I want would comprise the following: a unit which will generate an electronic signal indicating the boat's direction, detected by the strength and/or direction of the compass's magnetic field; a calculator-type keyboard to be used to enter desired courses and alterations to them; an audio output stage; and, at the heart of it all, a microprocessor to control and coordinate everything.

I have a good knowledge of programming and a basic knowledge of electronics. But I need help to design and construct this device. If you would like to help me with this, please contact me, preferably by telephone, 01-591 5491 (home) or 01-432 6277.

Kenneth C. Knowles,  
3 Sheringham Drive,  
Barking, Essex,  
IG11 9AL.

### CB v TV continued

Sir—I read with interest your article "CB Radio" under Industry Notebook in the May edition of *Practical Electronics*.

While one is delighted at the content of the article with regard to the recognition of the TV receiver front end problem and the development of better systems, it is a pity that your last paragraph, re interference, is typical of the uninformed and hysterical comment in the electronic/radio press concerning CB Radio. Over the last year comments like this have caused concern to laymen and authority alike.

Of course the great mass of population would not take kindly to TV interference caused by CB Radio and rightly so. But before you spread alarm and despondency a little investigation on your part would have revealed that interference (or prevention of it) stood high on the list of priorities produced by the CB pressure groups. Indeed their call was for VHF/UHF spectrum with low power (2W) FM. Not the AM/SSB kilowatts on 27 MHz

which has been responsible for the interference problem in other countries.

A. J. Cawthorne,  
T.ENG(CEI), FSERT, G3TDJ,  
Bude, Cornwall.

*Nexus comments: "As a licenced amateur Mr Cawthorne will be aware of the problems of TVI and of controlling abuses of radio usage however well the regulations are framed and policed. We all start off with good intentions. If, in fact, CB users with kilowatt outputs do exist this proves the point. There is no reason to suppose that British CB enthusiasts, once they catch the bug, will be content with 2 Watts or even 20 Watts. Mr Cawthorne will also be aware that his fellow fully-licenced amateurs, supposedly responsible, are often tempted to abuse their conditions of licence. We cannot assume that CB enthusiasts with on-demand permits, no RAE, and no signed log-books, will be better behaved."*



## BOOK REVIEWS

### IC 555 PROJECTS

By E. A. Parr

Published by Bernard Babani Ltd

141 pages 180 × 115mm. Price £1.45

ONE of the most versatile i.c.s available to constructors in recent years has been the 555 timer. This book explains the operation of the timer in detail and then describes the basic circuits that can be built around it.

Specific applications for the device are a collection of designs which have appeared in P.E. and other magazines and are given under four headings; model car, model railway, alarm and general circuits.

Variations of the 555, namely the 556, 558 and 559 which are the dual and two quad versions available are also briefly covered. Practical notes are given on how to construct the circuits with tables to determine the values of the timing capacitors. Many readers will find this book useful both for constructing the circuits and as a handy pocket reference book on the 555 timer.

D.J.S.

### OP-AMPS; THEIR PRINCIPLES AND APPLICATIONS

By J. B. Dance

Published by Newnes Technical Books

88 pages, 135 × 215mm. Price £2.25.

SO MANY books published have been along the same lines as this, and indeed on exactly the same subject, that it is perhaps better to stick to the bare facts.

The book has been written for the non-specialist engineer and home constructor. A non-mathematical approach has been adopted, and internal workings of devices area not discussed in any depth; only applications.

The initial three chapters are devoted to the 741 i.c., followed in Chapter 4 by external frequency compensation. Chapter 5 covers f.e.t. input op-amps, and the last two chapters go into i.c.s for audio applications. At the end of the book there is a glossary of op-amp terminology.

Although the original concept of operational amplifiers was that of performing mathematical operations, no devices for performing mathematical functions are included, as part of the author's aim of keeping the book at a simple practical level. There are clear and well printed working circuit diagrams throughout, each with component values given, and anyone seeking to understand operational amplifiers could do worse than read this material, which is an updated version of the *Electronics Australia* series "Op-Amps Without Tears."

M.A.



# PATENTS REVIEW...

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

## SIGNAL CLIPPING INDICATOR

The Sony Corporation has already patented (BP 1 439 241) protective circuit for shutting down an audio amplifier when the impedance value at its output falls below a preset value, for instance due to short-circuiting of the driven loudspeaker. Now, in BP 1 458 857, Sony describes a circuit which will indicate clipping of the output signal as, for instance, may follow from over driving the amplifier into distortion.

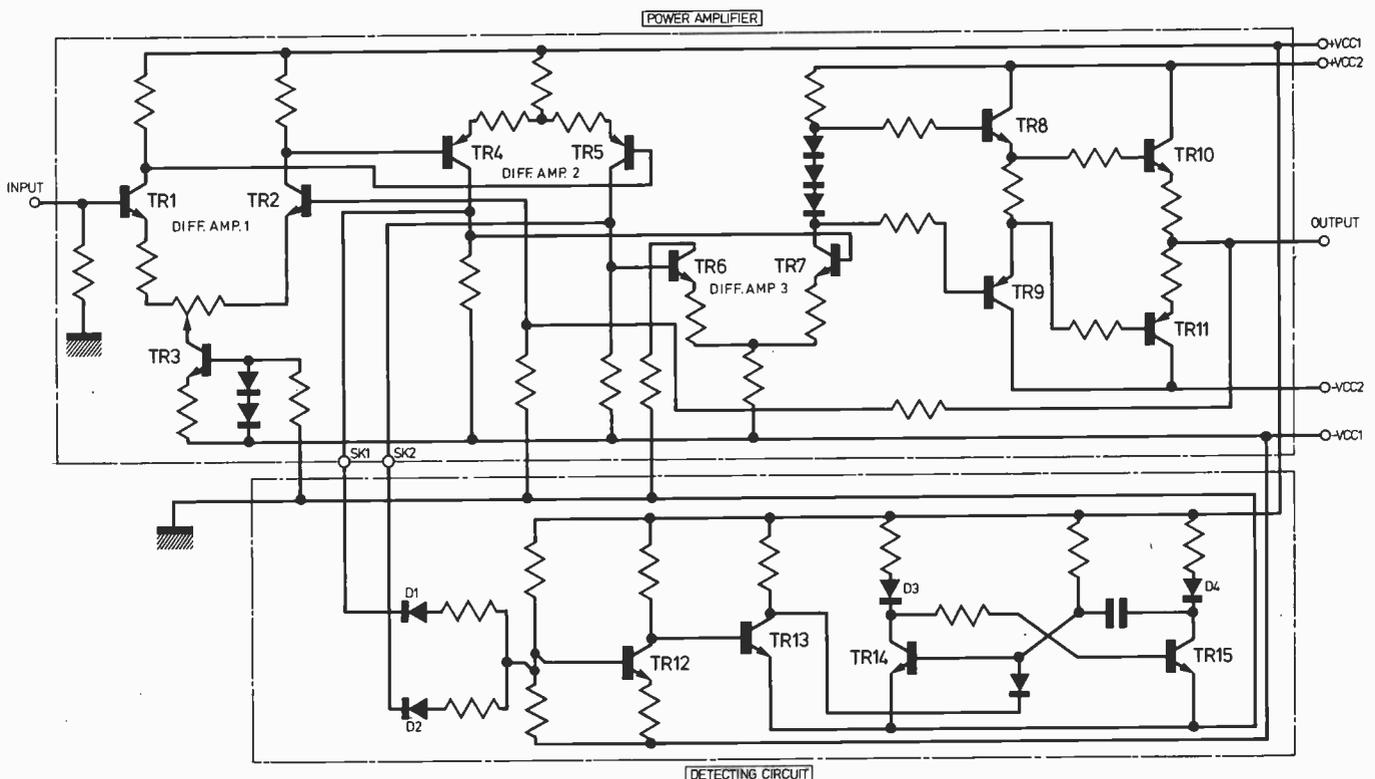
The circuit shows a power amplifier with three differential amplifiers (Diff. Amp. 1, 2, 3) and a push-pull output. The signal path

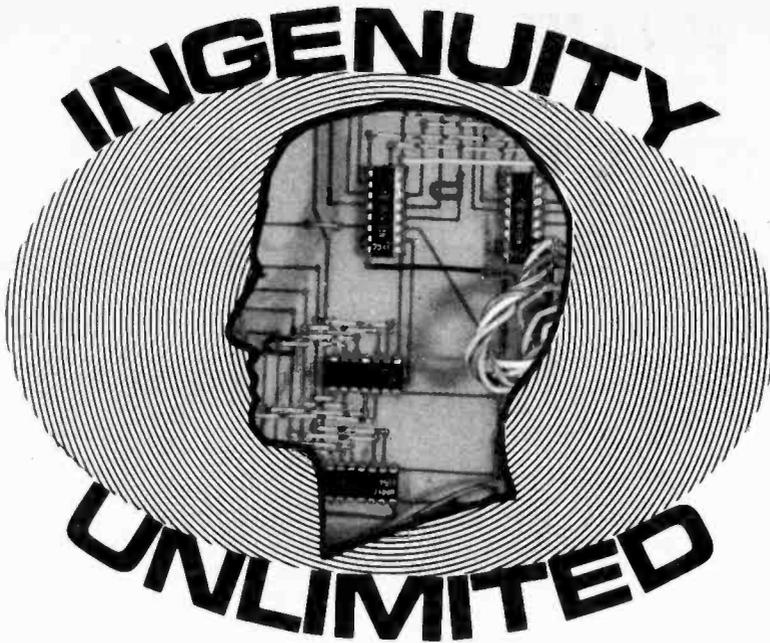
from the output to the base of TR2 forms an in-phase negative feedback loop. Detecting terminals SK1 and SK2 are connected to the collectors of TR4, TR5 respectively of differential amplifier 2.

In normal operation, similar signals of a few volts are delivered to detecting terminals SK1 and SK2. Transistor TR12 of the detecting circuit is conductive, and hence TR13 is non-conductive. This causes TR14 of the monostable multivibrator to be conductive, and transistor TR15 non-conductive. As a result, the light emitting

diode D3 is energised to emit green light which indicates that the power amplifier is operating normally.

When the amplifier is subjected to excess load or the load is short-circuited or the output signal is clipped, the voltages at terminals SK1, SK2 approach that of the voltage source  $-V_{CC1}$  for the differential amplifiers. As a result, D1 or D2 is biased to  $-V_{CC1}$ , TR12 goes non-conductive and TR13 conductive. D3 extinguishes and the red l.e.d. D4 illuminates, to indicate overload or clipping.



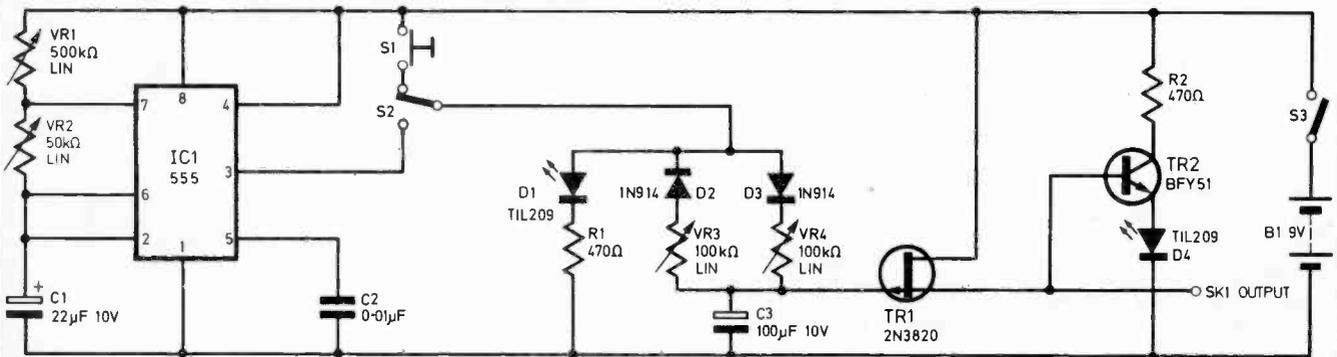


A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

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



## ENVELOPE SHAPER

THE circuit shown above is for an attack/release envelope shaper with automatic triggering.

IC1 is a 555 timer connected in the astable mode with VR1 controlling the duration and VR2 the width of a pulse. No series resistors are used to enable maximum span and flexibility of operation. Automatic triggering is obtained by S2 with S1 used for manual triggering.

The pulse from the output of IC1 (pin 3) is fed via S2 through D3 and VR4 (which controls the attack time) and charges C3 which in turn switches on TR1.

When the pulse is finished C3 is

discharged through VR3 and D2 to D1 and R1. The purpose of D1 and R1 is to form a discharge path for C3 and to indicate when a pulse is applied to C3. The discharge time of C3 depends upon the setting of VR3. As C3 gradually discharges TR1 is turned off.

The cycle of the envelope shaper is monitored by D4 which in turn is controlled by TR2.

To operate, the circuit requires 100 to 200mA and can be driven either by a 9V PP3 battery or a separate power supply unit.

Stephen Trowse,  
Australia.

## pH METER

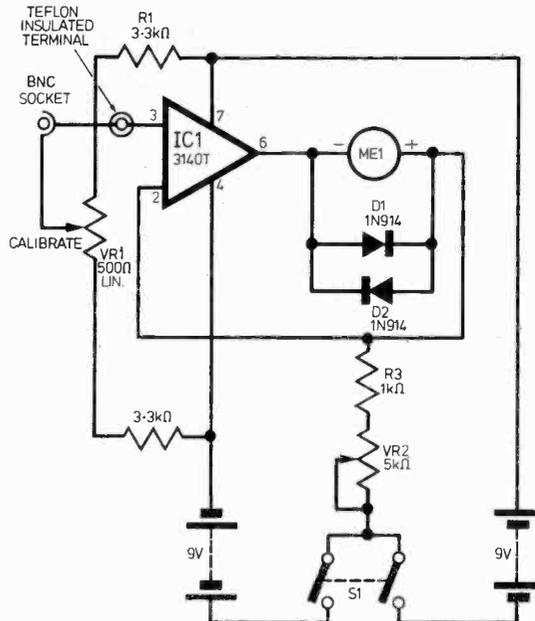
With only a few components, a modern pH meter (acid/alkali level) can be built using the relatively new RCA 3140T operational amplifier.

Stripboard is not suitable because of the close proximity of the tracks, and so the TO5 style op amp should be used with its leads spread out and terminated on a good quality p.c.b. with lead 3 of the i.c. soldered to a teflon insulated terminal. From there, a stiff bare copper wire should connect to the input socket.

The meter ME1 can be a cheap  $\pm 100\mu\text{A}$  movement and it should be easy to re-mark the scale from 2 to 12pH, with 7pH at the centre (being neutral), or from 0 to 14pH. The unit can be powered from two PP3 9V batteries.

With the electrode in a pH7 solution (distilled water will do) adjust VR1 for a reading of 7. Now place the electrode in a buffer solution of pH4 (acidic solution for calibrating) and adjust for a reading of 4. An alkaline buffer solution (above pH7) could be used instead. The instrument is now calibrated. See P.E. March and April 1977 for pH theory.

Walter Hediger  
Switzerland



## TOUGH SENSITIVE KEYBOARD

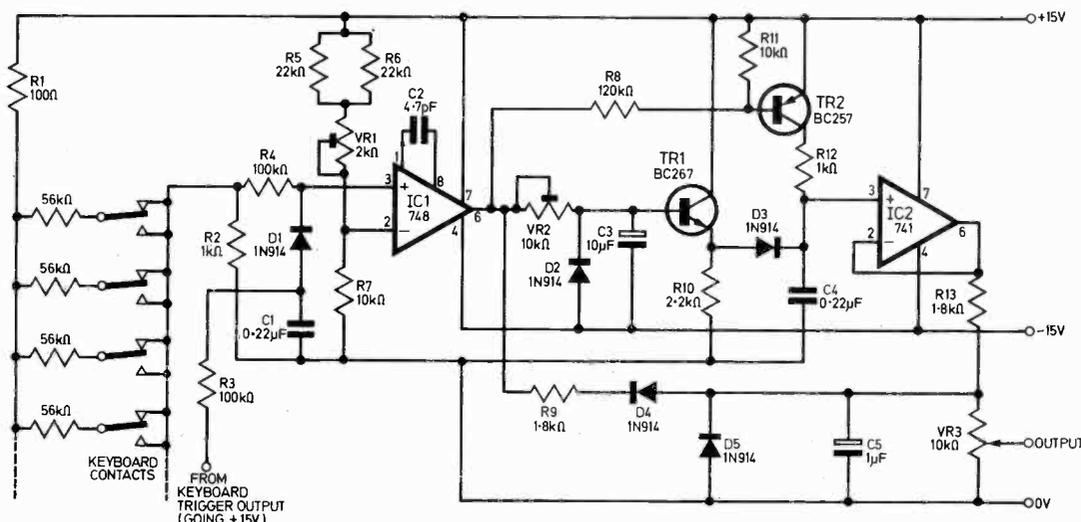
THE circuit described here was designed to provide a synthesiser keyboard with an additional control voltage output, whose magnitude is proportional to the velocity at which a key is struck. This voltage can, for example, be used to control the maximum amplitude which a note attains during the attack time to give the keyboard a piano-like feel, in that it is sensitive to how "strongly" the music is played.

The circuit, shown below, requires an extra set of changeover contacts on the keyboard. IC1 detects when

any contact spring is touching neither of its contacts. Thus the output of IC1 will switch negative for a duration which is inversely proportional to the key velocity. During this time, capacitor C3 is discharged through VR2 to a voltage proportional to the key velocity. TR2, in switching on, charges C4 to a voltage governed by the charge on C3. The output is prevented from going positive at this time by D4 and D5. When the contacts remake, TR2 shuts off preventing any further charge on C4, whose voltage is now buffered by IC2 and passed to the out-

put. C3 now re-charges ready for the next cycle. This sequence of events is prevented from re-occurring when the key is released by the keyboard trigger signal, which inhibits IC1 during this time. VR1 sets up the key detection circuit, and should be adjusted so that the output of IC1 gives a negative pulse when a key is pressed slowly. VR2 sets up the velocity/voltage relationship, and is adjusted to give the required output voltage range.

P. R. Williams,  
Stevenage,  
Herts.



# CALCULATOR-DECADE COUNTER

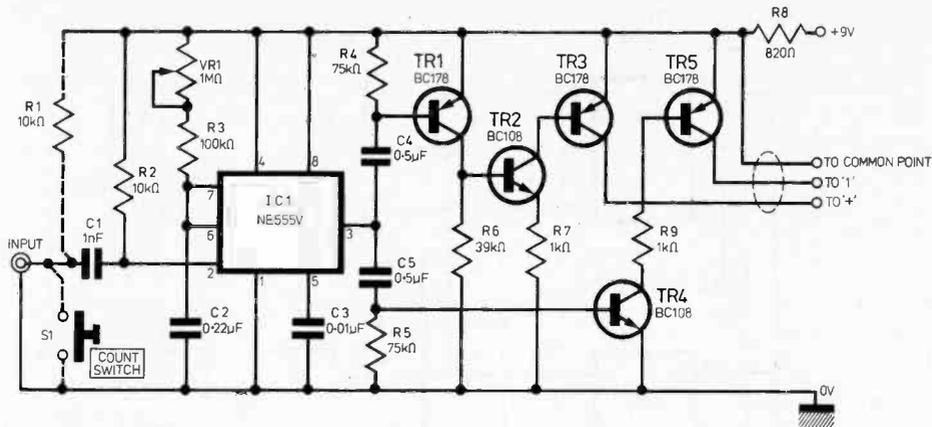


Fig. 1

A conventionally-built decade counter can be rather costly and complicated compared to a calculator with the same digit capability. However, by using the adding function, a calculator can be converted into a decade counter by entering the key sequence 1+, 1+, 1+, 1+, ... etc. electronically. The corresponding display will then be 1, 2, 3, 4, ... etc. The given circuit is designed for adding on to the CBM SR 7919D calculator, with part of the calculator circuit board shown, showing the three take-off points required (Fig. 2).

The circuit essentially consists of a monostable multivibrator driving two switching circuits. This circuit operates on an independent supply and it is advised not to decouple the supply with an electrolytic capacitor. When the monostable receives an input, it generates an output pulse of a given duration. The leading edge of this pulse triggers the "1" input while the trailing edge triggers the "+" input, forming the "1+" sequence for a single input.

The time delay of the monostable is made variable by VR1 so that it can be set just above the minimum duration at which the calculator counter will operate. Even then the time delay (time between the "1" and "+" input) shows to be quite high which means that the maximum frequency input is low. In fact in my set-up, the maximum counting rate is only about 4 per second!

This counter can be used in applications where low and extremely low counting rate suffices when the time out signal feature of the calculator can be utilised.

For example, by feeding a crystal derived 1Hz input, the counter can be used as a precision seconds timer. Similarly it can be used as a counter for registering the number of people entering a building, etc. by adding the resistor and switch as shown in dotted lines in the diagram.

Furthermore the calculator-counter may be connected to a conventional counter to increase its counting capacity. In this way the inherent low counting rate of the calculator-counter can be compensated. For example, the unit digit of the calculator-counter will become the thousand digit if appropriately connected to a conventional 3 digit counter.

Pek Yaw Kee,  
Sarawak,  
East Malaysia.

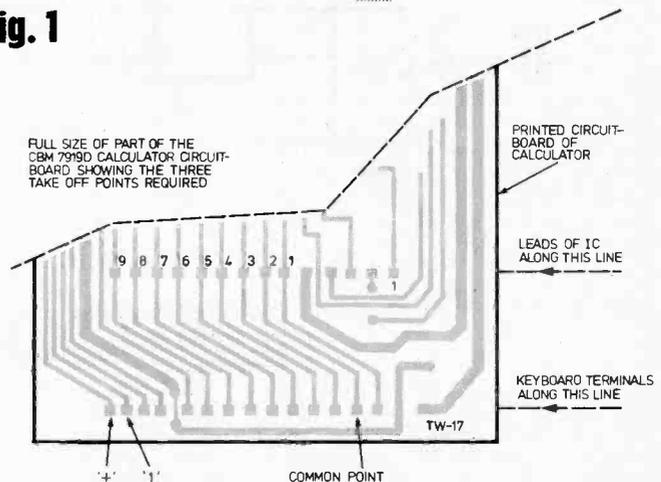


Fig. 2

## CMOS DOORBELL

This i.c. doorbell is built around a CD4011 NAND gate package, using only a handful of readily available components, and forms two oscillators.

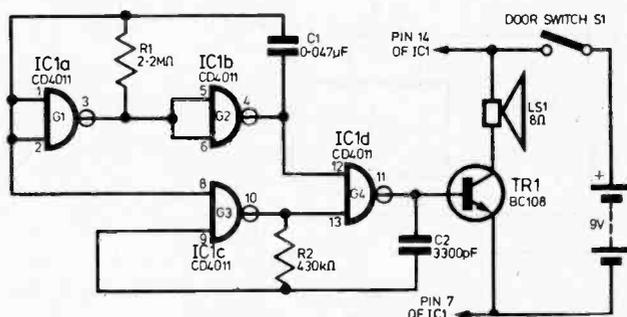
The basic tone for the bell is produced by the high frequency oscillator (G3, G4, R2 and C2), and is interrupted by the low frequency oscillator (G1, G2, R1 and C1). These component values can of course be varied to produce different interrupt rates or basic tone.

The output is fed to a BC108 tran-

sistor which drives an 8Ω loudspeaker, and a PP3 battery can be used to power the circuit. The prototype was

housed in a plastics case measuring 116 × 80 × 35mm.

A. W. Cunningham, Glasgow.



# TRACE MULTIPLIER

Fig. 1

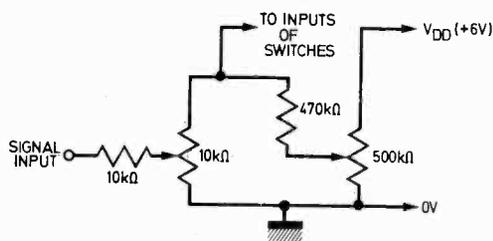
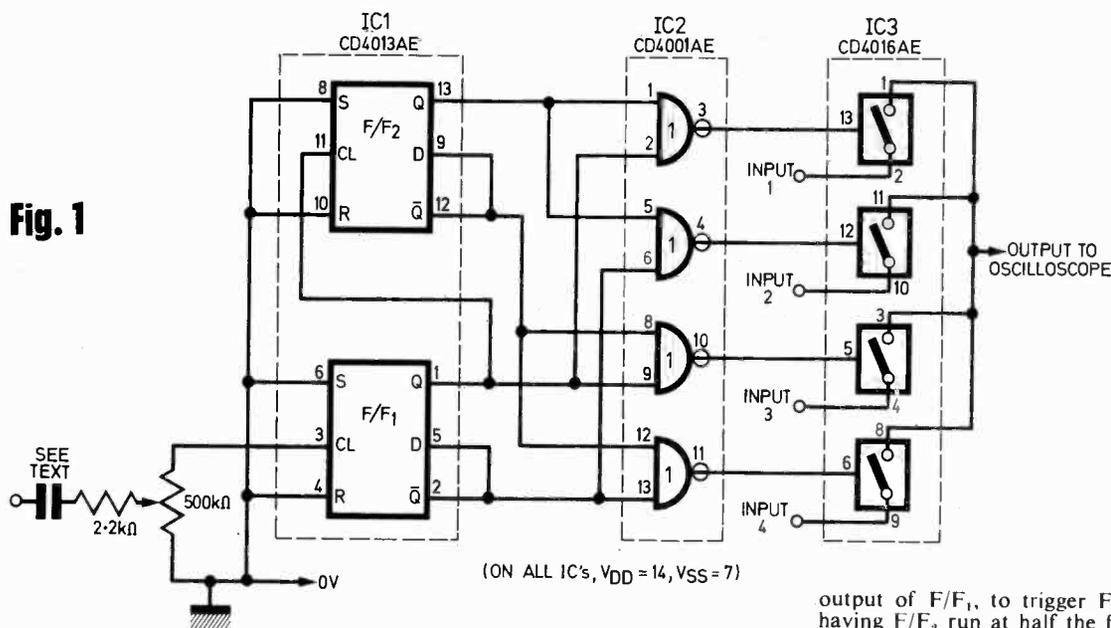


Fig. 2

output of F/F<sub>1</sub>, to trigger F/F<sub>2</sub>, thus having F/F<sub>2</sub> run at half the frequency of F/F<sub>1</sub>. Then the Q and  $\bar{Q}$  outputs of both flip-flops are connected to the inputs of four NOR gates as shown, whose output only goes high when both inputs are low. The outputs of the four gates therefore go high in sequence and trigger the electronic switches which allow the four inputs into the oscilloscope one by one.

Each input, before reaching the switches must be attenuated to a useful amplitude relative to the others, and also must be given a different height on the screen to the other traces. This is achieved by the circuit in Fig. 2, which must be repeated for each input. For this reason, it is best to use preset potentiometers as eight normal potentiometers would cost more than the CMOS circuitry itself.

It may be necessary to use a different capacitor on the input from the oscilloscope's sweep output, but this depends on the voltage range of the output. We have found that a 0.02μF 200V capacitor works admirably where the sweep output is 100V peak-to-peak.

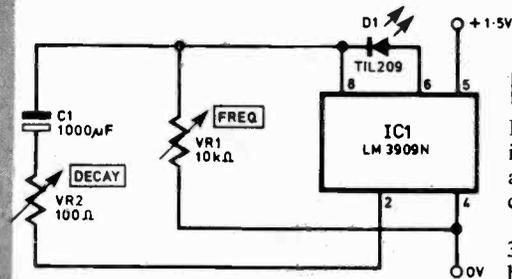
A. Hetherington,  
Nevilles Cross,  
Durham.

THIS circuit, while using only three common CMOS i.c.s allows four separate signals to be displayed on a single beam oscilloscope with independent vertical position and amplitude controls. Instead of using an internal free-running oscillator, this circuit employs the sweep output of the oscilloscope to trigger the switches and therefore displays the first trace on the whole of the screen before displaying

the second in the same way, the switch being triggered by the negative going pulse of the sawtooth wave from the sweep output as it moves back to the other side of the screen.

As the sweep output of most oscilloscopes often exceeds 50V, a series capacitor, series resistor and potentiometer are used to modify the wave and trigger flip-flop. Four sequential outputs are obtained by using the Q

# LED FLASHER



FLASHING i.e.d. indicators are most often used to indicate a hazard. But there are times when a rather less insistent winking indication, would be appreciated, indicating to proceed with caution.

This circuit which uses an LM 3909N i.e.d. Flasher/Oscillator i.c., has a pulse frequency that can be varied by VR1, from 10-60 pulses per minute.

With the decay control VR2 set to zero, the time of each pulse of light from the i.e.d. corresponds to the discharge time of C1, this discharge time can be lengthened, by increasing the resistance by means of VR2, between the positive of C1 and pin 2 of the i.c. So that each pulse of light fades away instead of switching abruptly "off".

Decay time of up to 1 second can be obtained with the components shown. It should be noted that a long decay is not possible with a fast frequency.

M. Miller,  
Reading,  
Berks.

# 12v CONVERTER

## for Weller TCP 1&2 Irons

D. J. BRADBURY

WHEN working on an automobile electrical system it can be very useful to have a soldering iron that will operate from the vehicle's battery. This relieves both the inconvenience and possible hazards involved in arranging external supplies such as a main extension lead.

The unit described in this article is a 12V to 24V d.c. converter designed to supply Weller TCP1 and TCP2 temperature controlled soldering irons from a standard car battery. The converter is housed in a small die-cast box which will also serve as a stand for the iron when it is not in use.

### CIRCUIT DESCRIPTION

A 24V Weller iron consists of a 45 to 48W heating element in series with a magnetic "Curie" effect temperature switch. Because of this switch the iron only takes current when the soldering bit falls below its correct operating temperature. Thus to work efficiently the converter circuit must be able to supply 50W to the soldering iron and yet take minimal quiescent current when its load is open circuit.

The circuit shown in Fig. 1 achieves both these aims, operating at an efficiency of over 80 per cent whilst the iron is warming up and taking only micro-amps when the iron reaches its correct temperature.

When the circuit is connected to a battery and the soldering iron plugged in, bias current is fed to the base of TR1 via the transformer T1, diodes D1, D2 and the iron. This starts to turn TR1 on, causing its collector voltage to fall, enabling the transformer to increase the voltage applied to the load. The load thus biases TR1 on harder until the transistor finally saturates, giving a peak voltage of approximately 28V across the soldering iron.

While the transformer has a voltage across its windings, a magnetising current slowly builds up until the ferrite transformer core is saturated; it then rises rapidly as the core loses its high relative permeability. When the collector current of TR1 reaches about 10A, the transistor no longer receives sufficient base drive to remain saturated and so its collector voltage begins to rise. This causes the load voltage to fall, reducing the base drive of TR1 which further reduces the load voltage and by this feedback action the transistor is turned off.

When TR1 is turned off, its collector voltage rises rapidly above the supply due to the magnetising current flowing in the transformer. Also the output voltage of the transformer goes negative, reverse biasing diodes D1 and D2, so isolating the transformer from the load. The magnetising current causes the unloaded transformer to 'ring' for half a cycle at a frequency mainly determined by its inductance and the value of C1. The high voltage half cycle 'ring' reverses the flow of the magnetising current and as a result defines the length of time for which TR1 does not conduct.

This period must be kept short if the converter is to be efficient. However, the shorter the time the higher the voltage required across T1 to reverse the magnetising current. Since part of this voltage appears across TR1 a compromise was chosen for the converter that gives the

### COMPONENTS . . .

#### Resistors

R1 1Ω 2.5W wirewound

#### Capacitors

C1 0.047μF polyester

C2 150μF 16V elect.

#### Semiconductors

D1, D2 ZS271 (2 off)

D3 1N5401

TR1 BD243B

#### Transformers

Length of 22 s.w.g. enamel covered copper wire

Bobbin (type DT2205, ITT Part No 52352E)

Ferrite pot core (type FX 2241, ITT Part No 52707B)

#### Miscellaneous

\*4mm banana sockets (2 off)

\*3 pin 1.5A Bulgin P430 socket

Diecast box 120 x 95 x 30mm

Support spring (Weller SK185, ITT Part No 66304X)

Funnel (Weller SK1527, ITT Part No 18668E)

FS1 Fuseholder Bulgin F55 with 5A fuse

\*See text



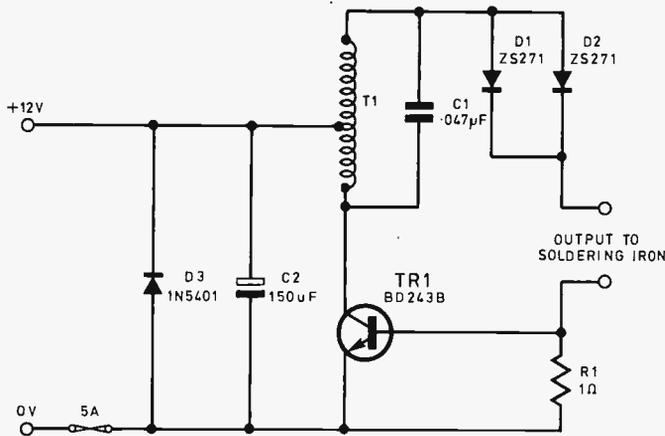


Fig. 1. Circuit diagram of the Converter

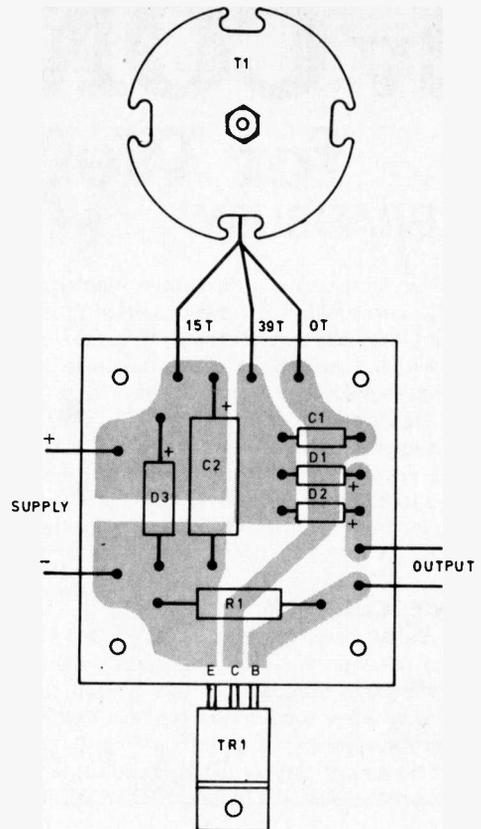


Fig. 2. Printed circuit board design

Fig. 3. Component layout and wiring diagram

transistor a peak collector-emitter voltage of 55V during its off period which lasts for about 25 per cent of the full oscillation cycle.

When the magnetising current flowing in T1 is finally reversed, the output voltage of the transformer swings positive and turns TR1 on again thus starting another cycle. The converter continues to oscillate in this manner, feeding 24V r.m.s. to the soldering iron until its working temperature is reached and the magnetic switch opens.

As the bias for TR1 is supplied through the load, when the temperature switch opens the converter ceases to oscillate. In this condition the only current taken by the circuit is the leakage in TR1, C2 and D3, the sum of which is very small.

When the iron cools, the magnetic switch will close, and so the converter will reheat the bit. The unit will thus operate intermittently, maintaining the soldering iron at its correct working temperature.

The diode D3 has been included in the circuit to protect the converter against reverse polarity connection to the battery. Normally the diode is reverse biased and so it draws little current from the circuit. However, if the supply connections are accidentally reversed the diode will take a heavy current and blow the 5A fuse before the converter circuitry is damaged. Although a series diode would have the advantage of saving the protection fuse if the battery polarity is wrong, it was not used in this case as it would have to pass a current of 5A under normal operating conditions and so for a silicon device would nearly double the power losses of the converter.

### CONSTRUCTION

The prototype was constructed using the printed circuit board layout in Fig. 3 with the component overlay shown in

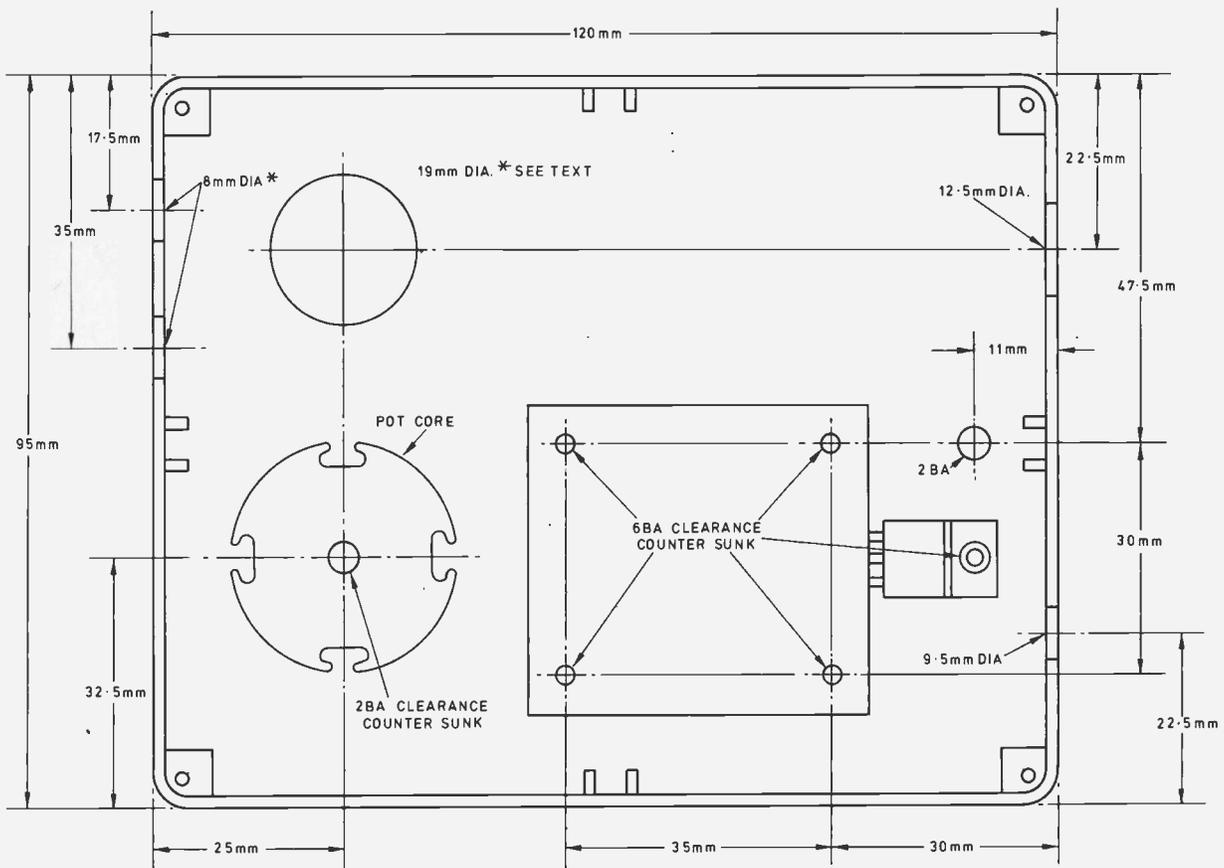
Fig. 4. If the printed circuit board is to be traced, constructors should remember that the copper tracks will carry high currents and so it is recommended that the diagram is followed closely, keeping the tracks as wide as possible.

Once the board has been etched, cleaned and drilled, the components and lead out wires may be soldered. The supply input leads should be fitted with large crocodile clips for making connections to the battery. Although the power dissipation in TR1 is not very high, it is necessary to mount the transistor on the converter box to keep the device within its temperature ratings. To facilitate this, the transistor is soldered to the back of the printed circuit board with its leads left long so that they can span the gap between the box and the circuit.

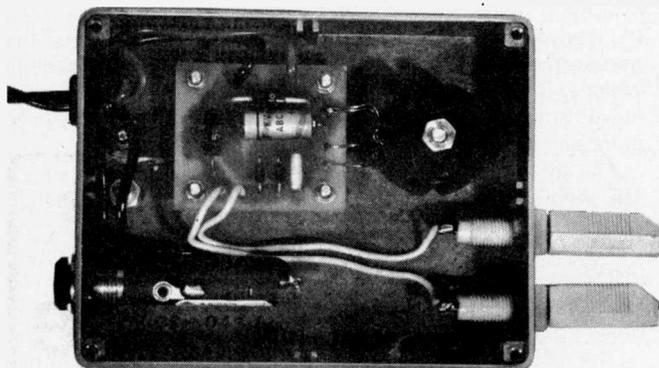
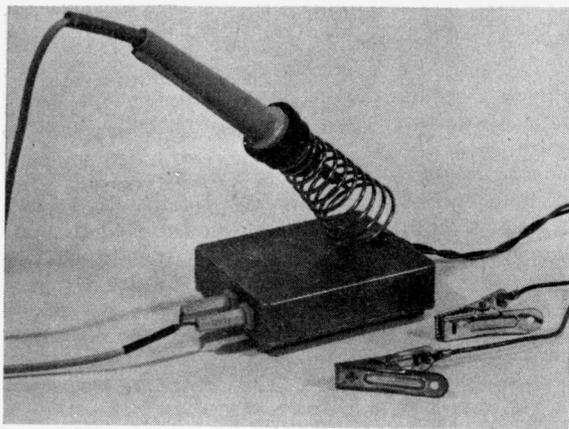
The transformer for the converter consists of a 39 turn coil wound with 0.71mm dia. (22 s.w.g.) enamel covered copper wire mounted inside a 30mm dia. ferrite pot core. The coil should be neatly wound in layers on the plastic bobbin with a tapping taken 15 turns from the start of the winding. As the converter oscillates at a frequency of about 4kHz, the transformer can be the source of an annoying audible whistle. To minimise this, when assembling the pot core halves smear a thin layer of grease on the mating surfaces to dampen core vibrations.

The transformer is fastened to the converter box using a 1in. long countersunk 2BA bolt with nut and spring washer. The spring washer should be placed between the box and the transformer as in this position it acts as a vibration insulator. Do not overtighten the retaining nut as no advantage is gained by doing so and it could result in breaking the brittle ferrite cores.

The 120 x 95 x 30mm die-cast alloy box used to house



**Fig. 4. Case drilling and mounting details**



the converter was drilled to the dimensions shown in Fig. 4. Since the two Weller irons have different connector arrangements the diagram includes the holes for both types of sockets.

The position of the hole to mount TR1 is not given in the diagram as it will depend on how the transistor was soldered to the printed circuit. The correct location can be found by placing the component board in position inside the box and marking the hole through the transistor tab after having checked that the device is lying flat. When the transistor is mounted it should be electrically insulated from the box by using a mica washer and plastic bush.

#### TESTING

Having completed the converter and checked its wiring, plug in the soldering iron and connect the unit to a 12V battery, being careful to observe the correct polarity. The converter should emit a soft whistling sound and the following voltages may be measured from the negative end of C2 using a moving coil voltmeter. TR1 collector +12V, TR1 base +0.8V, soldering iron output +20V.

If there are any serious discrepancies in the voltage readings, disconnect the battery and recheck the converter for faulty components, dry joints and wiring errors. In cases where the converter cannot be heard to oscillate and all the voltage readings are zero, check the fuse and the battery polarity. Never use fuses rated at more than 5A or those with "slow blow" characteristics as they may result in damage to D3 or TR1 under fault conditions.

If the converter is operating correctly it should oscillate for between 1 and 1½ minutes from switch-on, after which time the soldering iron will have reached its working temperature and the soft whistle will cease. The converter may be occasionally heard as it reheats the bit.



# MK14-the only low-cost keyboard-addressable microcomputer!

## The new Science of Cambridge MK14 Microcomputer kit

The MK14 National Semiconductor Scamp based Microcomputer Kit gives you the power and performance of a professional keyboard-addressable unit - for less than half the normal price. It has a specification that makes it perfect for the engineer who needs to keep up to date with digital systems or for use in school science departments. It's ideal for hobbyists and amateur electronics enthusiasts, too.

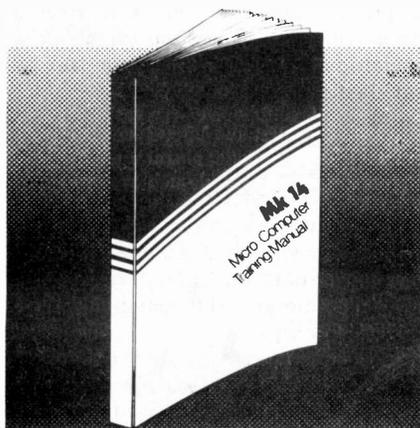
But the MK14 isn't just a training aid. It's been designed for practical performance, so you can use it as a working component of, even the heart of, larger electronic systems and equipment.

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### Free Manual

Every MK14 Microcomputer kit includes a free Training Manual. It contains



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Phil Pittman, Wireless World, Nov. 1977.

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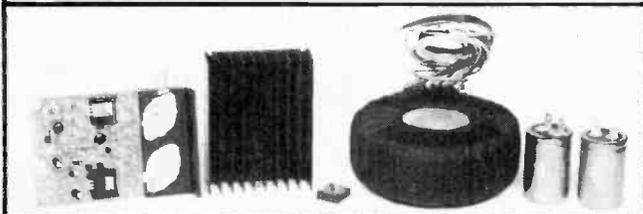


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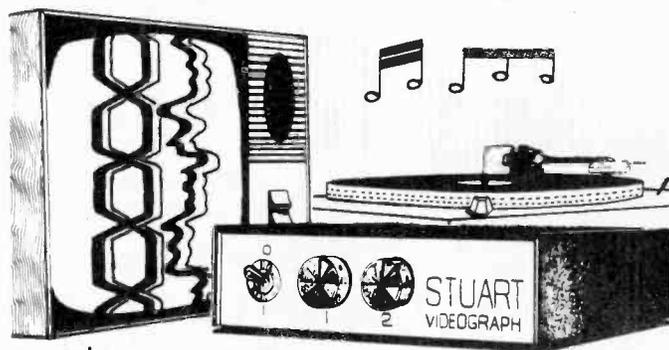
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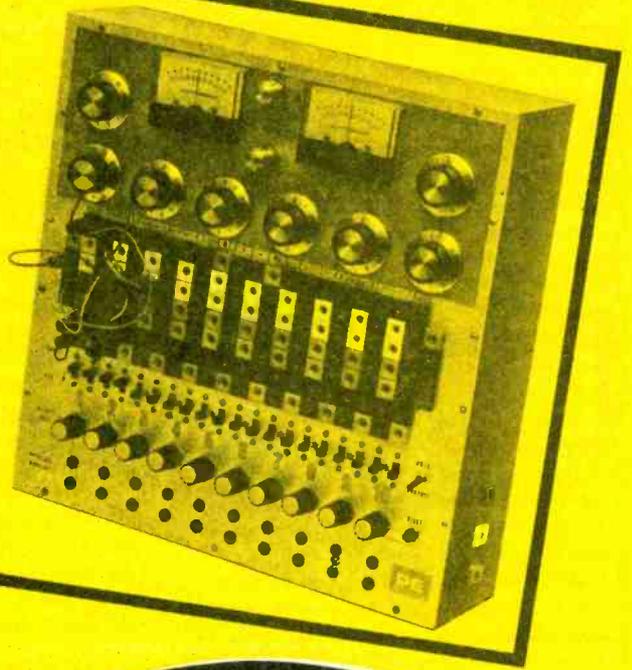
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# NEXT MONTH!

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PRACTICAL

# ELECTRONICS

OUR SEPTEMBER ISSUE WILL BE ON SALE FRIDAY, 11 AUGUST, 1978

# Semiconductor UPDATE...

FEATURING **MD4301 AD3500** **R.W. Coles**

## ALARMING DEVELOPMENT

One of the problems of using modern large scale integrated circuits is that we, the users, have become obliged to surrender a lot of our design independence to the semiconductor manufacturers.

To ensure volume sales of their chips, the manufacturers tend to build devices which are aimed at the widest possible market, and we, as willing customers, have had to forego some of the "oddball" applications that we could indulge in when using discrete transistors and individual amplifiers or logic gates.

Of course, a ray of hope *is* visible in the shape of the microprocessor, but unless you happen to be a confirmed "Micro-nut" there are still many fearsome obstacles to deflect you from *that* path, not least the cost of it all.

When you think about it, the bastions of the LSI industry are calculators, clocks, microprocessors, voltmeters, and TV games, and precious little else. Not exactly a fertile ground for the amateur who wants the benefits of LSI but who can cope with only so many variations on the digital clock theme before trading the whole lot in for a pair of beam-tetrodes and a 50-Watt soldering iron!

The point I am trying to make is that any *original* large scale integrated circuits that do turn up deserve a rousing welcome from our beleaguered band, and this month I have managed to turn up a beauty!

I refer to the **MD4301**, from the Canadian firm of Mitel, (no—don't groan, you can get them from Rastra Electronics Limited!), which is unassumingly labelled a "CMOS Alarm Circuit." Inside its tiny fourteen pin plastic package, the MD4301 has an amazing array of odds and ends which enables it to act as, among other things, a complete fire alarm system with all the practical bits and pieces you would design in yourself, given the chance.

There is a comparator circuit, which will trigger an alarm condition for a 150mV voltage differential between its two inputs.

There is an audio oscillator which is turned on by an alarm condition, a 300mA switch output to drive a horn or siren, and a

separate pulsed l.e.d. driver for local power-on indication.

There is also a "low-battery" detector which gives an unobtrusive but hard to ignore output of 50 milliseconds each minute on all alarm outputs when the battery voltage gets too low for comfort, (which shouldn't be too often, because the standby battery drain is a miserly 25 microamps!)

There is an alarm trigger "in" and "out" which allows any number of MD4301 circuits to be cascaded so that any one active unit can trigger all the others for a full scale fire alert, and other variations and options too numerous to mention.

To use the MD4301 in a self contained fire alarm system, you need only hook it up to an ion chamber smoke detector cell, a nine volt battery, a horn or siren and a few discrete components. A much more exciting and useful prospect than building yet *another* digital clock!

## 3½ IS TWICE AS GOOD AS 3

Some time ago I featured a 3 digit single chip voltmeter device in this column, and suggested that the traditional moving coil meters with their inherent fragility and accuracy limitations would soon be losing ground to the newcomer. A new chip from National brings the demise of springs and jewelled bearing even closer. They have managed to cram a complete 3½ digit voltmeter system on to a single LSI chip, a system which up to now had taken at least two chips, and usually many more, to implement.

A 3½ digit display is actually twice as

good as a 3 digit display because you get a full scale output of 1999 instead of 999, double the dynamic range and precision of earlier single chip systems.

The new chip is coded **AD3500** and it contains not only the digital conversion circuitry but also the l.e.d. segment drivers, the system clock and the analogue "front end".

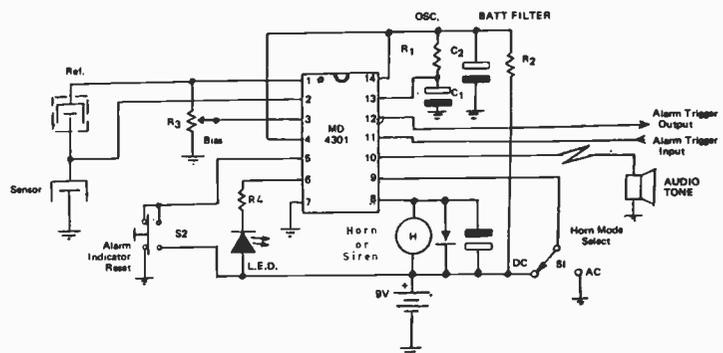
The chip uses low consumption CMOS technology and runs from a single plus five volt supply, so building a digital multimeter with the AD3500 should be child's play!

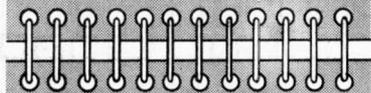
To build a complete voltmeter all you need to add (apart from some kind of power source) is an l.e.d. display, a low cost 75492 digit driver, a voltage reference, and a handful of discrete resistors and capacitors—the whole thing could be fitted on to a circuit board about 8cm square.

The addition of a range switch and a few extra resistors would allow a full complement of voltage and current ranges, and with a constant current source added, resistance ranges would be possible.

If you wanted to be really cunning, you could use the over-range outputs provided by the AD3500 to control an auto-ranging system which did the range changing for you using reed relays or solid state analogue switches, very useful for hands-free trouble shooting!

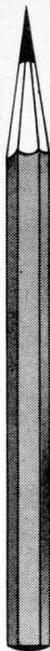
In terms of accuracy, the new device beats the moving coil meter hands down with a  $\pm 0.05$  per cent specification. You will probably degrade that figure with your external components of course, but the traditional meter is hard pressed to deliver even 2 per cent accuracy!





# INDUSTRY NOTEBOOK

By Nexus



## The Pay-Off

Further to my recent reports on overseas investment, especially in the United States, it is worthy of note that Racal has now formed a Data Communications Group headed up by D. Leighton Davies. Leighton, a B.Sc.(Hons) graduate from the University of Wales, was ten years with Solartron and in senior positions with GEC Computers and Automation, and STC, before becoming managing director of Racal-Milgo Ltd in 1969, then a tiny UK operation owned 50/50 by Racal in the UK and Milgo Inc in the USA. It was virtually a marketing company set up to exploit Milgo products outside the Americas.

First-year turnover was in the tens of thousands of pounds. Now, less than ten years later, Leighton heads up a wholly British-controlled data communications group of world standing with a predicted £75 million profitable turnover in the current financial year and operating from manufacturing, systems engineering and marketing bases in Reading, Frankfurt, Tokyo, Miami and Sunnyvale, and through an associated company in Rio de Janeiro and Brazilia. The present huge boost in turnover came from Racal's recent acquisition of Milgo Inc and Vadic Inc in the USA and further acquisitions are being sought.

Just one example explains what overseas investment is all about. Racal-Milgo Inc, Miami, Florida, has just signed a contract with Eastern Airlines for a System 200 Management Centre to streamline Eastern's data network covering 300 locations in North America and the Caribbean. As well as the Management Centre (which monitors and controls a network of up to 16,256 communications devices and modems on as many as 64

channels) the Eastern Airlines contract includes orders for hundreds of high-speed modems. No British company confined to a UK base would have been considered for such a contract, let alone win it. The Eastern Airlines contract plus many others in the US is a pay-off for Britain.

It works in reverse, too. North Thames Gas would not have bought £120,000 of equipment to improve its data links from a company based solely in Miami, Florida. But North Thames Gas were very happy to contract with Reading-based Racal-Milgo with its full local engineering support, even though a percentage of the equipment is built by the now British-owned Racal-Milgo in the USA. For this type of business you need to be on the spot.

## Outlook

Public opinion polls are not invariably reliable but a recent poll of electronics goods manufacturers has shown a downturn in optimism (as distinct from downright pessimism) on future prospects, especially in exports in the capital goods sector where a number of respondents are clearly suffering the effects of stronger foreign competition. Paradoxically, except for the hard-pressed consumer sector, the great bulk of returns showed increased business and general buoyancy. Best sector of all is automatic test equipment (ATE) with a boom in the home market, perhaps because of the shortage of good test engineers as well as their cost, and of course it is much easier to introduce labour-saving equipment into the progressive electronics industry than into moribund industries where job protection is a worker obsession, perpetuating out-moded processes.

*Apropos* my remarks in earlier paragraphs on overseas investment, there is still plenty of movement at home too. Racal, already mentioned, is spending £1.5 million on microelectronics development, Pye has just completed a £5 million complex housing 1,200 workers for mobile radio, Decca Communications has acquired the whole of the h.f. radio business of Granger Associates of California, and English Electric Valve has added 100,000 sq. ft. of manufacturing space through purchase of the former Marconi-Elliott i.c. plant at Witham, Essex.

## Poland Buys British

The controversial Polish order for British shipyards, heavily subsidised by the taxpayer, has turned up trumps for Redifon who landed the contract for all the electronics packages on the 22 ships involved. Redifon has undertaken to plan and commission all the equipment, together worth many millions. For starters Redifon will supply 44 of their new R1000 Series communications receivers worth,

possibly, £5,000 or more each, and this is just the fringe.

Decca Marine has also done well in the Polish market recently by contracting £330,000 worth of Decca Navigator receivers and plotters to the Polish fishing fleet operating in the Baltic. There are now some 500 Polish ships fitted with the Navigator. The Japanese have also recently contracted to expand their Decca Navigator coverage with new chain stations so that all four major Japanese ports will now have Decca coverage.

## Employment

I note that the IEE Annual Report comments on the scale of recruitment advertising in the past year, so high that special recruitment supplements had to be issued with the Institution journals. Anticipated revenues from situations vacant adverts were handsomely exceeded and a total of £1,000 a day was received in the year from this source.

The shortage of engineers is tending to push up salaries and I notice far more firms offering posts in the £5,000-£7,000 bracket than formerly. But is this enough when one reads that a London bus driver can make £6,000 a year plus perks like free travel? Glancing through the ads the cash plums are still overseas provided you can put up with the climate and general conditions. Up to £21,000 in Libya, £20,000 in Iran, £18,000 (tax free) in Saudi Arabia.

Such salaries are only for senior people with long experience on major products but even scaled down to average engineer level it seems overseas salaries in the Middle East are still more than twice that which can be earned at home and nearly all carry tax concessions.

More of the gentle sex are entering engineering but it is still a mere trickle. Of 190,000 chartered engineers registered in the UK there are only 200 women, less than half of whom work in industry. Of the women I note that the three senior ladies on the secretariat of the Electronic Engineering Association are all designated in the Annual Report as Ms whereas none of the men, not even the Director, is dignified by Mr.

## More on Mats

The French company Thomson-CSF is also in the field of mobile automatic telephones (MATS) and claims to have 8,000 subscribers world-wide using their equipment linked to public or private telephone exchanges. Their new microprocessor-controlled car telephone has a capacity of 16 pre-programmable numbers of up to 24 digits each. There is clearly going to be keen competition for this fast-growing business.

# MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus will present ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data books. The most original ideas will probably come from readers working on their own microcomputer systems, and payment will be made for any contribution featured here. This is also the place to air your views, in general, on this new technology, so let's be hearing from you!

## SCOPE FOR GRAPHICS

**O**SCILLOSCOPES were used for troubleshooting with the earliest computers, and so it is hardly surprising that they soon became permanently connected as a convenient way of displaying drawings produced under computer control. Since then the CRT has remained the most widely used peripheral for high-speed graphical output.

An oscilloscope can only display a single point at a time, so to present a line or a picture it is necessary to refresh the scope by repeating the same sequence of movements of the spot over and over again; at least 30 times a second if the picture is to be seen without flicker. There are two main ways of controlling the spot from a computer, and both will be covered here. One is to store the co-ordinates of every point to be displayed in memory, and use these to drive the display. The other method is to generate the individual point co-ordinates as they are to be displayed from a "display file" which contains shorthand commands for drawing lines, circles, characters, etc. A program illustrating

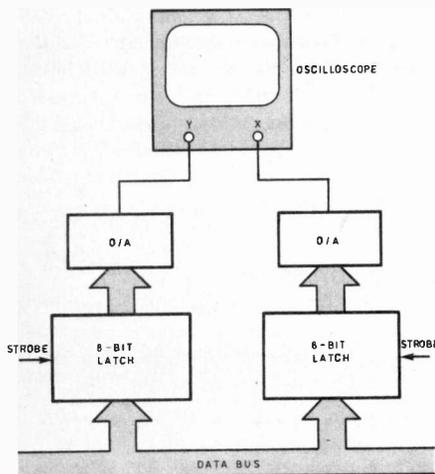


Fig. 1. Block diagram showing the circuitry needed for a microprocessor-controlled graphics display using an oscilloscope.

this approach will show how lines can be generated given the co-ordinates of their endpoints.

## SCOPE INTERFACE

The configuration needed to control a CRT from a computer is shown in Fig. 1. The two D/A converters determine the number of possible point positions; with two 8-bit D/A converters one can display any point on a 256 x 256 grid. The outputs of the D/A converters drive the X and Y inputs of the scope, and these should be d.c. coupled. Since there is no need for timebase circuitry or for sensitive input amplifiers it should be possible to construct a suitable display quite simply. The prototype used two Ferranti ZN425E 8-bit D/As, and these were interfaced to the microprocessor by two 8-bit latches and some addressing circuitry; alternatively a MC6820 PIA could have been used.

The program in Fig. 2, which is for the M6800 micro, illustrates the method of generating a display from the co-ordinates of

```
          NAM      DRAW
          * DISPLAY COORDINATE PAIRS FROM MEMORY *
      8100 XAXIS EQU $8100 D/A OUTPUT
      8101 YAXIS EQU $8101 PORTS
          *
0000 0002 NEWPR RMB 2
          *
0002 CE 0018 DRAW LDX $BUFFER
0005 A6 00 NEXT LDA A 0,X
0007 E6 01 LDA B 1,X
0009 B7 8100 STA A XAXIS
000C F7 8101 STA B YAXIS
000F 08 INX
0010 08 INX
0011 BC 0022 CPX $BUFFEND
0014 27 EC BEQ DRAW
0016 20 ED BRA NEXT
          *
0018 00 BUFFER FCB 0,0,1,1,2,2,3,3,4,4
0022 0022 $BUFFEND EQU $
          END
```

Fig. 2. Program for the M6800 which displays co-ordinate pairs from memory.

every spot position. BUFFER is the address of the list of co-ordinates, and with the list shown the program will display a short diagonal line from (0,0) to (4,4). In this and the next program the D/As are assumed to be located at addresses \$8100 and \$8101. If a

PIA is used to interface them with the micro a few instructions will have to be added at the start of the programs to configure it correctly.

## INTERPOLATION PROGRAM

This method of storing the co-ordinates of every spot position really eats up memory; to draw a square border around the screen would require about 2k bytes of memory (1,022 co-ordinate pairs). It has the advantage that any arbitrary drawing can be displayed; however most graphs and diagrams can be broken down into a number of straight line segments, so a far more economical approach is to store only the co-ordinates of the endpoints of the lines in memory, and generate the points in between as they are needed. Lines other than diagonals or horizontals and verticals cannot be exactly represented on a square lattice, so the program must generate the best approximation.

The program of Fig. 3 does just this—given the two endpoints of a line it generates the intermediate points. It has the feature that it needs no division or multiplication operations, so it can be used to generate fairly complex displays in real time. With the co-ordinate pairs shown at FIRST the program will draw a triangle between the points (0,0), (7,3), and (0,6). The first side of this triangle is shown in detail in Fig. 4: the approximated line is composed of three diagonal moves, (1,1), and four horizontal moves, (1,0).

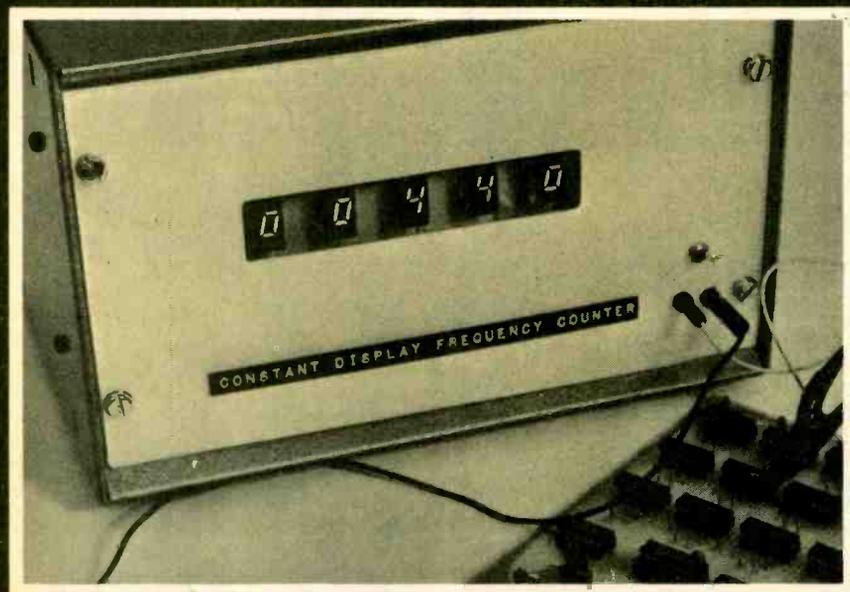
## PROGRAM FLOWCHART

The flowchart of Fig. 5 shows how the program works, and will help those unfamiliar with the M6800 to implement the algorithm on another micro. First of all the two unit vectors DIAGAB and SINGAB are calculated; some combination of these will make up the required approximation to the line. Each point of the line is generated from the previous point by adding either the diagonal move vector, DIAGAB, or the horizontal/vertical move vector, SINGAB. The choice of which to add is determined by the test variable TEST.



# Constant Display FREQUENCY METER

J. BECKER



AN ELEMENTARY  
PIECE OF  
WORKSHOP OR  
LABORATORY  
EQUIPMENT

It is often undesirable to engage an oscilloscope or other versatile apparatus to merely monitor frequency, and to this end the "Constant Display Frequency Counter" specification has been kept simple. The unit is not crystal controlled, but uses an elementary low frequency oscillator which necessitates far less dividing down circuitry, the whole unit thus comprising just a few readily available components. This would be an encouraging project for the beginner.

## CLOCK GENERATOR

The 1Hz clock signal is produced by IC1a (see Fig. 1), whose rate depends upon C1, VR1 and R1. The pulse width generated is about 45ns, and this enables the system to "read" the count almost instantaneously.

The monostable IC1b is repetitively triggered by the output from the multivibrator to produce pulses of about 70ns, controlled by C2 and R2, and which in fact occurs fractionally afterwards due to propagation delay in the i.c. of about 20ns. This second pulse is used to reset the counter at the end of each cycle.

## DECADE COUNTERS AND LATCHES

The input pulses to be counted are amplified and shaped by TR1 and fed to a series of decade counters (IC2-6), each of which successively divides the signal by 10. Each group of four outputs from each of the decade counters is taken, BCD fashion, to the Data inputs of the quad-latch i.c.s, IC7-11.

When the clock inputs of the latch i.c.s are held at a logic zero, the outputs remain in their previous logical states, but at the clock input positive excursion to logic 1, the outputs follow the logic states of the Data inputs. Consequently the outputs

from IC2-6 will effectively be ignored by IC7-11 until they receive the "read" pulse from IC1a, at which time, and for the duration of the pulse, the latch outputs will follow the logical states of the decade counters. Upon cessation of the "read" pulse the gate outputs will hold their new logical states and ignore further changes at their Data inputs—until they receive the next "read" pulse!

## DECIMAL DECODERS AND DISPLAYS

Following the latches, IC12-16 are decoders providing outputs suitable for the numeric displays X1-5. The outputs from the decoders logically follow the outputs of IC7-11 and will only change state when these change state, thus each indicator will continue to display a particular number until the latches alter outputs.

The decade counters are reset at the start of each cycle by the arrival of the pulse from IC1b approximately 20ns after the "read" pulse from IC1a. The result is that if the same number of pulses is counted by a particular decade stage in two or more consecutive sampling cycles, then the relevant display will not change its number, and will only do so if a consecutive count is different from the previous one. Thus if the frequency stays the same the display will appear to be static even though the sampling is still continuing once a second.

## POWER SUPPLY

The a.c. voltage from transformer T1 is rectified by D1-4, and the d.c. ripple is reduced by C4. IC17 reduces and stabilises the main power rail to a nominal 5V. d.c. It is internally protected against thermal or current overloading, and if overloaded will automatically shut itself off until the cause is

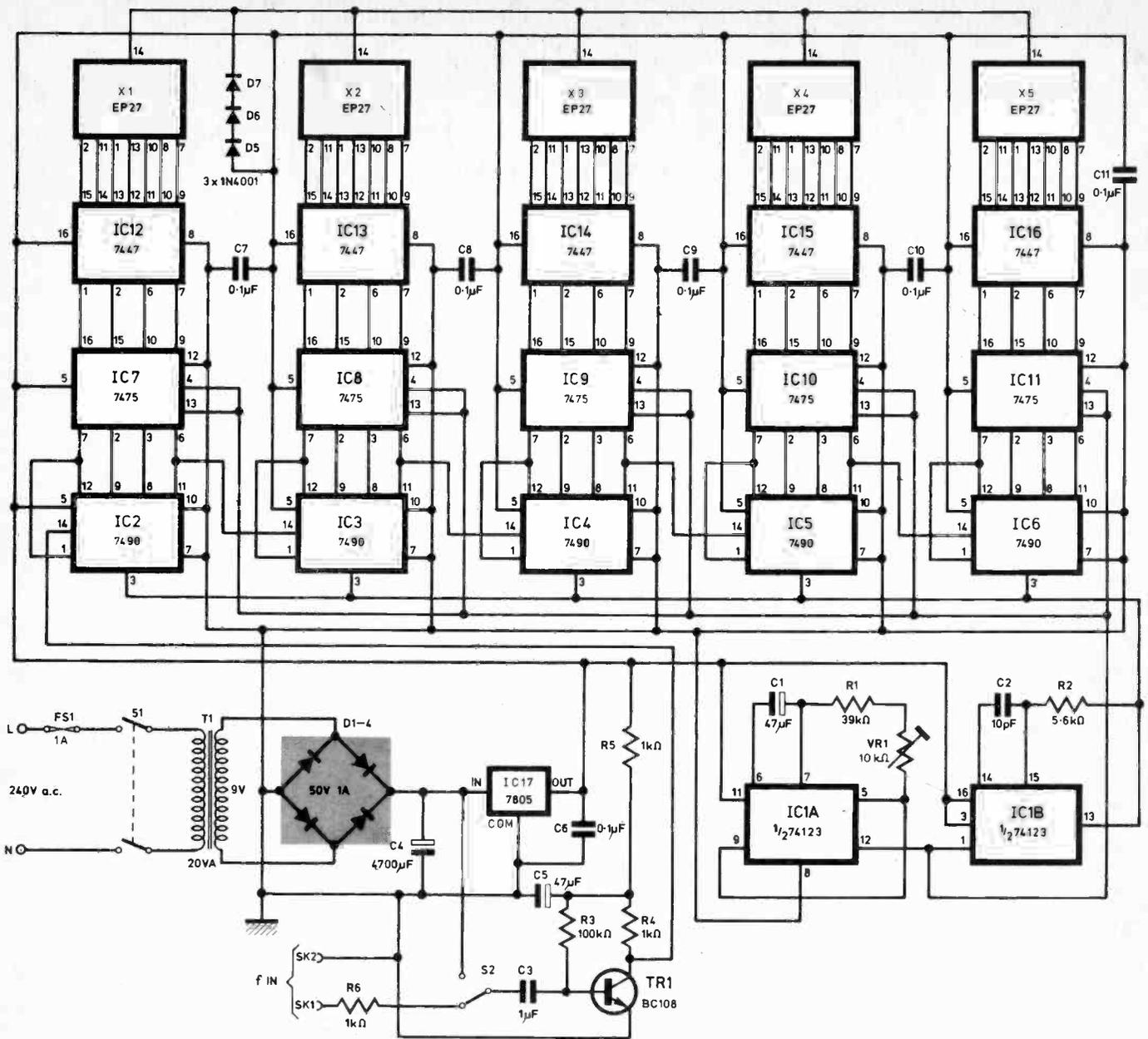
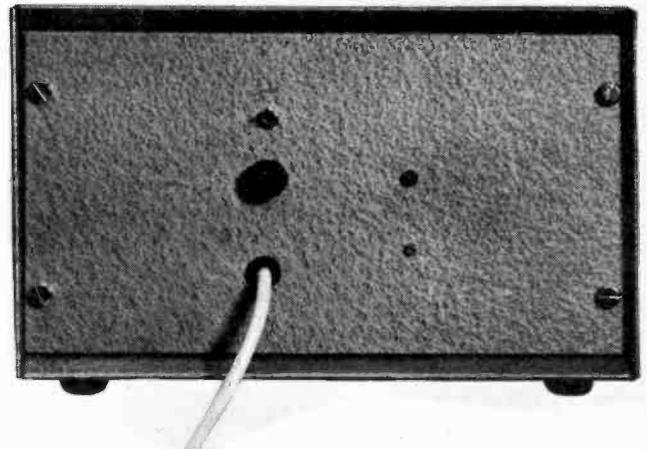
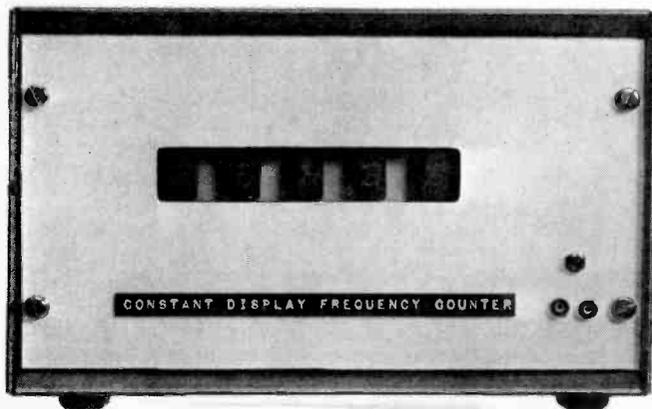


Fig. 1. Full circuit diagram of Frequency Counter



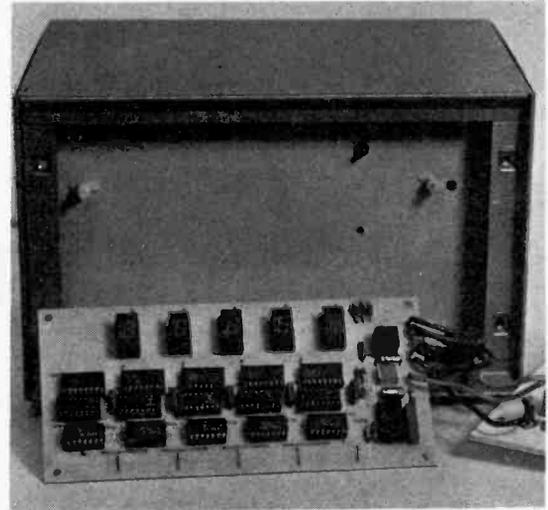
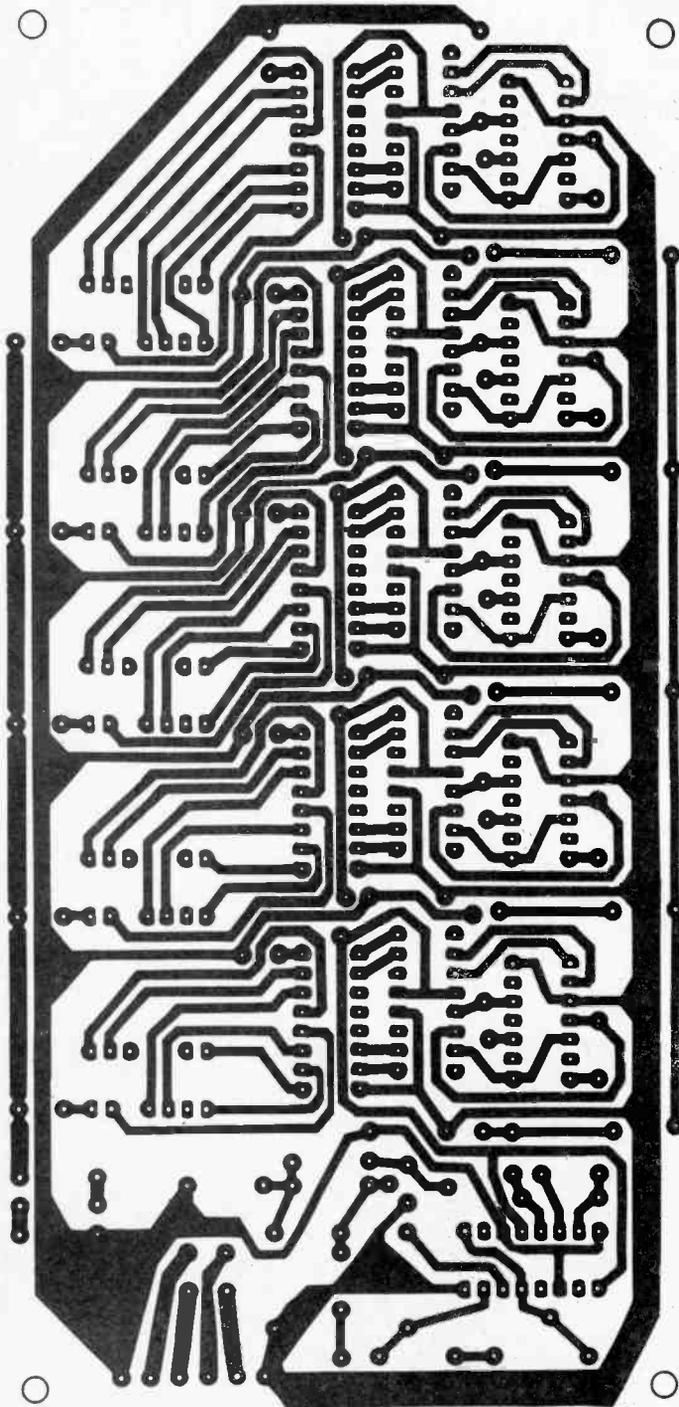
removed, whereupon it will revert to normal operation. In this particular unit it is essential that it is bolted to the metal case in order to provide an adequate heat sink, as it is being used close to its specified limits. The displays have an acceptable voltage range of 2.2V to 3.4V, and are driven from the regulated supply via three IN4001 diodes, each of which reduce the voltage by about 0.7V to provide a supply line of about 3V. Because of the high currents flowing (nearly 1A), the power line connections between the p.c.b., IC17 and C4 must be made using fairly heavy duty wire, and only in the manner shown. Failure to do so could result in unreliable performance of the counter, and "jittery" triggering of the clock generator.

## CONSTRUCTION

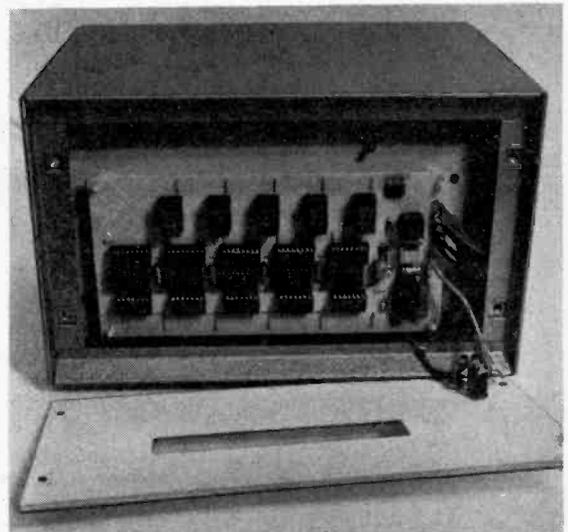
The original front panel is re-mounted internally on two blocks of wood fixed to the side panels, and with the p.c.b. mounted on it. This assembly is set back just enough for the displays to level with the front panel mounting-flange of the box. A clear perspex sheet is used as the new front panel, and should be painted on the inside with emulsion (white on the prototype), after masking off the viewing window and lightly sandpapering the remaining surface area.

The mains switch, panel mounting fuse holder, transformer and reservoir capacitor are mounted in the rear section of the box. It is also advantageous to fix a tag strip on the back panel

Fig. 2. Printed circuit board full size



The original front panel is re-mounted internally in the box to provide a base on which to mount the p.c.b. A new front panel is then made of clear perspex and painted, leaving a display window.



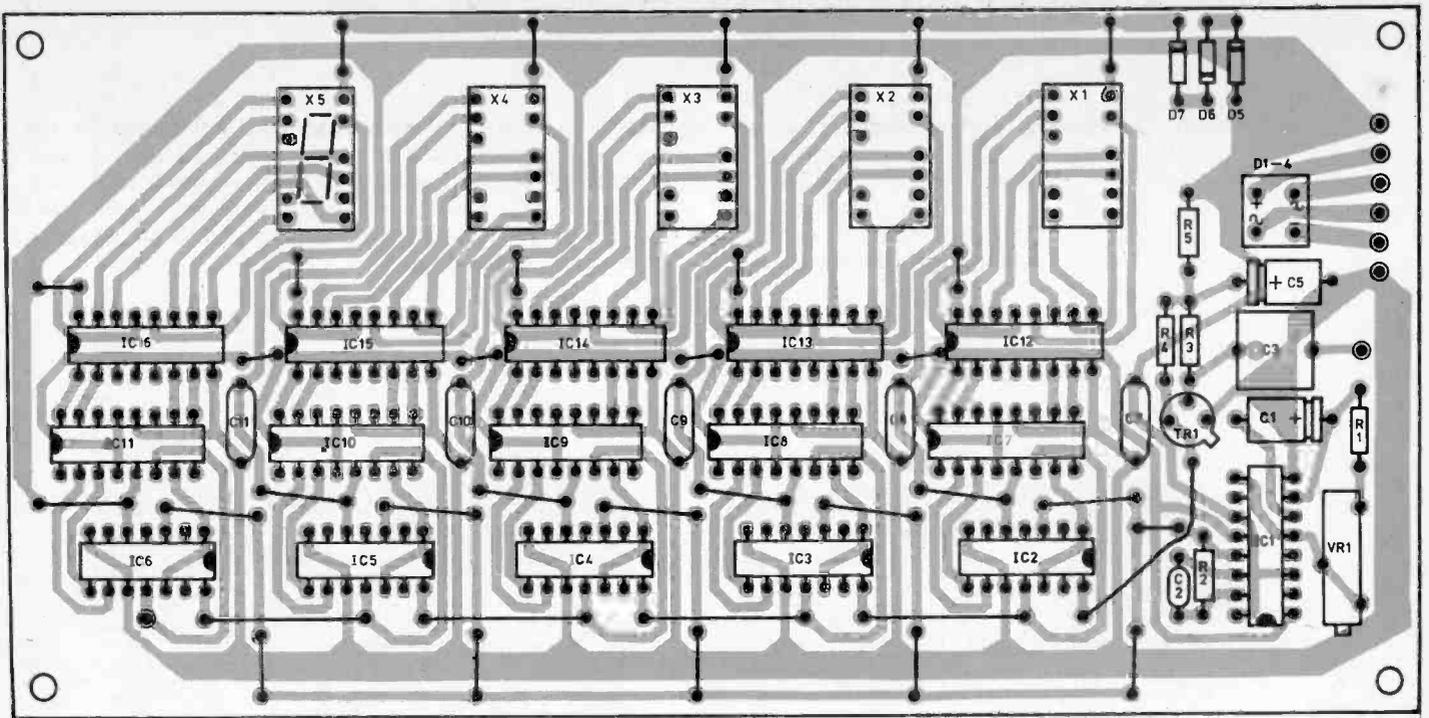
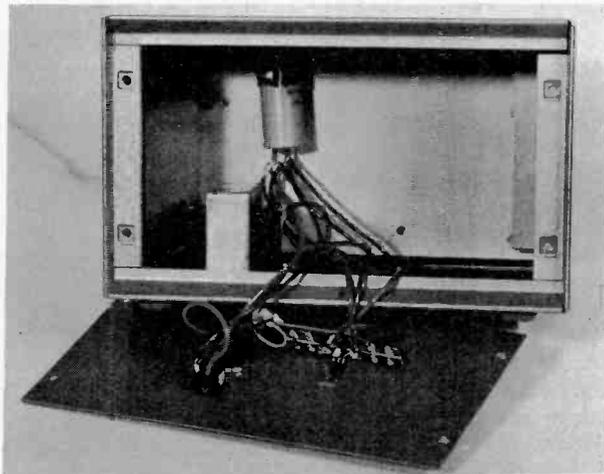


Fig. 3. Component layout (not full size)



along with switch and fuseholder, to facilitate the necessary low tension wiring junctions.

The p.c.b. is shown in Fig. 2, and the component layout of this is shown in Fig. 3.

### SETTING-UP

Following the usual checks for short circuits between tracks, preferably with a magnifying glass, and for possible assembly errors, the unit should be switched on and allowed to warm up for a few minutes. Then a known frequency can be fed in, and VR1 adjusted so that the display read-out is correct for that frequency. A hole is provided in the case immediately below VR1 to provide screwdriver access. In the absence of a good signal generator, the 440Hz of "Concert A" of a musical instrument, or the note of a mechanical tuning fork of the same frequency, can be fed into the counter via a microphone and suitable preamplifier. Alternatively the residual 100Hz ripple on C4 can be fed in, and a switch is included to enable this, but the

## COMPONENTS . . .

### Resistors

R1	39k $\Omega$
R2	5.6k $\Omega$
R3	100k $\Omega$
R4-R6	1k $\Omega$ (3 off)

All resistors  $\frac{1}{4}$ W 5% carbon film

### Potentiometers

VR1	10k $\Omega$ 15-turn cermet preset
-----	------------------------------------

### Capacitors

C1, C5	47 $\mu$ F electrolytic (2 off)
C2	10pF polystyrene
C3	1 $\mu$ F min polyester
C4	4700 $\mu$ F 25V electrolytic
C6-C11	0.1 $\mu$ F polyester (6 off)

### Semiconductors

IC1	74123
IC2-IC6	7490 (5 off)
IC7-IC11	7475 (5 off)
IC12-IC16	7447 (5 off)
IC17	7805 5V 1A regulator
TR1	BC108 or BC109
X1-X5	EP27 7-seg display (5 off)
D1-D4	50V 1A rectifier stack
D5-D7	IN4001

### Miscellaneous

S2	S.P.D.T. toggle switch
S1	D.P.S.T. toggle switch (mains)
F1	1 amp fuse and holder
SK1-2	2mm sockets (red and green)
T1	0-4.5V 0-4.5V 20VA transformer (Type R.S. 207-122)

Printed circuit board, capacitor clip for C4, tag strip, probe leads, metal case (RS 509888)

All components including p.c.b. are available from **Phonsonics**

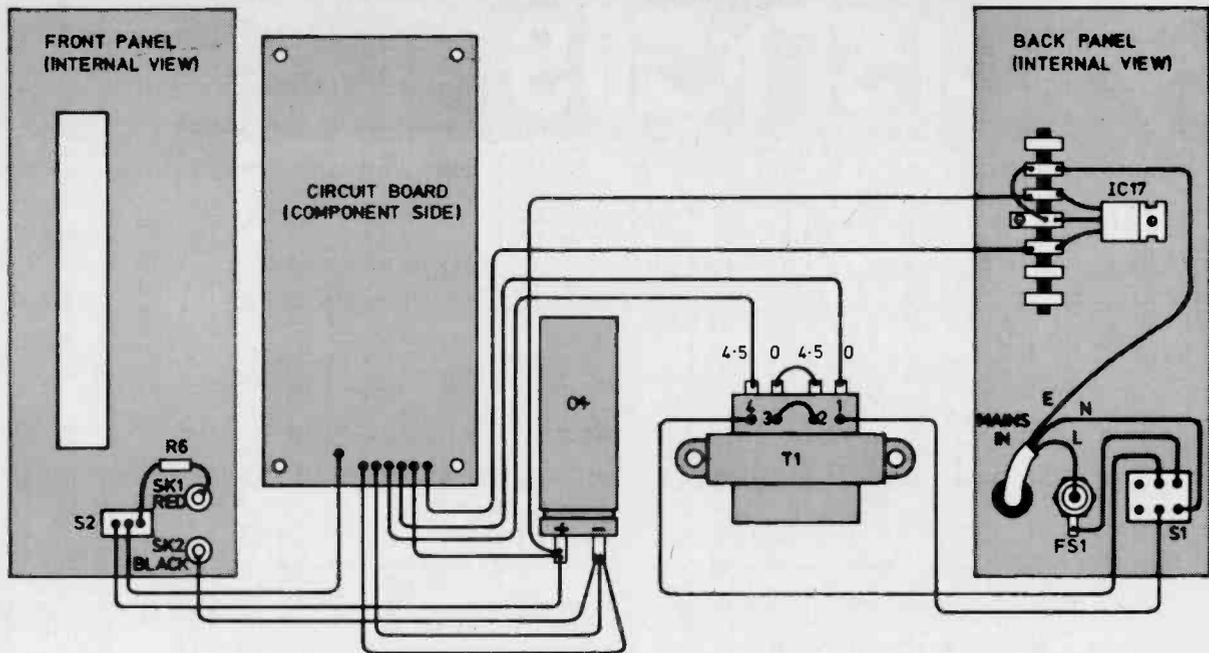


Fig. 4. Wiring diagram. Use either double wires or heavy gauge wire when connecting up C4

higher the calibration frequency the greater the potential accuracy. However, beware that many oscillators can be far less stable than the counter; indeed with the prototype the most stable oscillator tested was the Tone Generator of P.E. Joanna, but even that was found to drift when checked against a mechanical tuning fork.

#### ALTERNATIVE SAMPLING RATES

If a sampling rate other than 1Hz is required, C1 may be increased or decreased without limit, but the resistance total of R1 and VR1 must be kept within the limiting range of 5kΩ to 50kΩ unless additional circuitry is used. Also if an external potentiometer is contemplated in place of VR1, the fixed resistor (of at least 5kΩ) must also be kept physically close to IC1.

The clock rate frequency to be expected from changes to C1 may be approximated by assuming that doubling the capacitance will double the frequency count, and halving it will halve the count. However, in practise the actual count time is

likely to vary from that calculated due to component tolerances and capacitor leakage currents, especially with electrolytic capacitors. In respect of tolerances, the actual values obtained from a nominal value can vary by as much as ±5% for R1, ±20% for VR1, and -10% to +50% for C1. Capacitor leakage currents will depend, of course, upon the specific types used.

#### STABILITY

The unit was checked by the author against the frequencies generated in the P.E. Joanna, which itself was kept in tune against a mechanical tuning fork, and after the initial warm-up period the counter was found to be stable within about 1 pulse per thousand, although the clock rate of IC1a was found to be slightly dependent upon ambient temperature. However, although a more accurate clock pulse might be achieved by making use of the 100Hz ripple available from C4, it was felt that the extra components required did not justify the marginal improvement. ★

## POINTS ARISING

#### LINEAR CAPACITANCE METER (June 1978)

Note that in Fig. 2, resistor R9 in series with S3 (run switch) should be marked R19.

In Fig. 4, the underside link (dotted) should go to IC1 pin 7 and not pin 6. An extra wire link is necessary between IC7 pins 12 and 5.

Do not miss out the track cut on Fig. 4, which lies to the right of the junction of R1 and R2, and which has not shown up very clearly in print.

The common line between B1 and B2 should be wired to 0V on the component board (not shown in Fig. 4). Also link pin 5 to pin 12 on IC7. A track break is necessary to isolate S2a wiper from IC5 pin 4.

See Market Place, July 1978 for 1 per cent components.

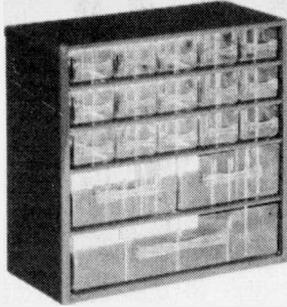
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#### P.E. CHAMP (April and June 1978)

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7407 40p	7440 15p	7489 250p	74132 65p	74161 90p	74189 350p
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7411 20p	7446 85p	7493 40p	74138 125p	74165 125p	74193 120p
7412 20p	7447 75p	7495 60p	74139 100p	74166 125p	74194 100p
7413 30p	7448 70p	7496 70p	74141 80p	74167 325p	74195 100p
7414 60p	7450 15p	74100 95p	74142 270p	74170 200p	74196 100p
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7417 30p	7453 15p	74105 40p	74144 270p	74174 100p	74198 185p
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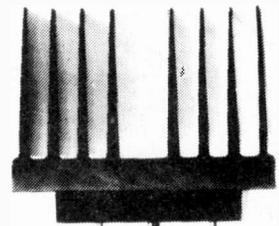
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**APPLICATIONS:** hi-fi, high quality disco, public address, monitor amplifier, guitar and organ.

**SPECIFICATION:** Input Sensitivity—500mV. Output Power—60W R.M.S. into 8 $\Omega$ . Load Impedance—4–16 $\Omega$ . Distortion—0.04% at 60W at 1kHz. Signal/Noise Ratio—90dB. Frequency Response—10Hz–45kHz – 3dB. Supply Voltage— $\pm$  35V. Size—114 x 50 x 85mm

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## HY200 120W into 8 $\Omega$

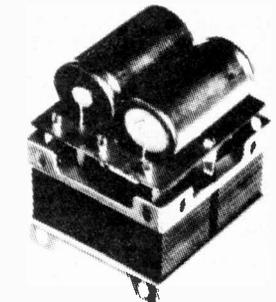
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**FEATURES:** thermal shutdown, very low distortion, load line protection, integral heatsink, no external components.

**APPLICATIONS:** hi-fi, disco, monitor, power slave, industrial, public address.

**SPECIFICATION:** Input Sensitivity—500mV. Output Power—120W R.M.S. into 8 $\Omega$ . Load Impedance—4–16 $\Omega$ . Distortion—0.05% at 100W at 1kHz. Signal/Noise Ratio—96dB. Frequency Response—10Hz–45kHz – 3dB. Supply Voltage— $\pm$  45V. Size—114 x 50 x 85mm.

Price  $\pounds$ 23.32 +  $\pounds$ 1.87 VAT. P. & P. free



## HY400 240W into 4 $\Omega$

The HY400 is I.L.P.'s 'Big Daddy' of the range producing 240W into 4 $\Omega$ ! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

**FEATURES:** thermal shutdown, very low distortion, load line protection, no external components.

**APPLICATIONS:** public address, disco, power slave, industrial.

**SPECIFICATION:** Output Power—240W R.M.S. into 4 $\Omega$ . Load Impedance—4–16 $\Omega$ . Distortion—0.1% at 240W at 1kHz. Signal/Noise Ratio—94dB. Frequency Response—10Hz–45kHz – 3dB. Supply Voltage— $\pm$  45V. Input Sensitivity—500mV. Size—114 x 100 x 85mm.

Price  $\pounds$ 32.17 +  $\pounds$ 2.57 VAT. P. & P. free

**POWER SUPPLIES:** PSU36—suitable for two HY30s  $\pounds$ 5.22 + 65p VAT. P. & P. free. PSU50—suitable for two HY50s  $\pounds$ 6.82 + 85p VAT. P. & P. free. PSU70—suitable for two HY120s  $\pounds$ 13.75 + 1.10 VAT. P. & P. free. PSU90—suitable for one HY200  $\pounds$ 12.85 +  $\pounds$ 1.01 VAT. P. & P. free. PSU100—suitable for two HY200s or one HY400  $\pounds$ 23.10 +  $\pounds$ 1.85 VAT. P. & P. free.

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# WIRE WRAPPING CENTRE



**HOBBY WRAP**  
Model BW 630

Battery  
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Wrapping  
Tool  
Complete  
with Bit  
and Sleeve.



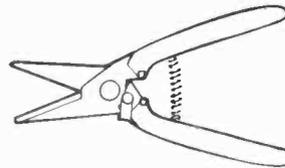
**NEW**

A£24-77 B£29-58 C£2-61 D£6-89

### WIRE-WRAPPING TOOL

For .025" (0.63mm) sq. post "MODIFIED" wrap, positive indexing, anti-overwrapping device.

A	For AWG 30	BW-630
B	For AWG 26-28	BW-2628
C	Bit for AWG 30	BT-30
D	Bit for AWG 26-28	BT-2628

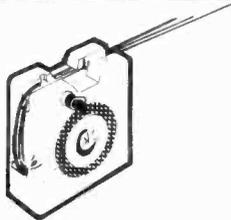


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3136 £3-20



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New wire dispenser cuts and strips three different colours of wire. Quick and easy to use pocket size. Wire sizes 30 AWG. 50ft Red, Blue & White, Kynar insulated.

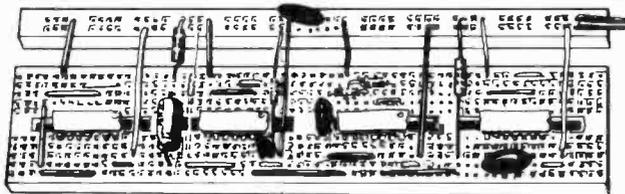
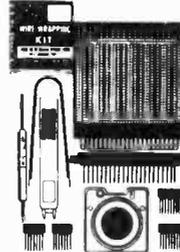
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### WIRE-WRAPPING KIT

Contains: Hobby Wrap Tool WSU-30 M, Wire Dispenser WD-30-B, (2) 14 DIP's, (2) 16 DIP's, Hobby Board H-PCB-1, DIP/IC Insertion Tool INS-1416 and DIP/IC Extractor Tool EX-1.

Wire-Wrapping Kit	WK-4B (Blue)
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£17-80



FROM 75p

### TERMINAL AND DISTRIBUTION STRIPS

Bread boarding building blocks with universal matrices of solderless plug-in tiepoints.

Facilitate quick, solderless circuit build-up and check-cut on universal .1" x .1" matrix.

- Are offered in ten configurations.
- Accept all components with leads up to .032" diameter.
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### HOBBY WRAP TOOL

Wire-wrapping, stripping, unwrapping tool for AWG 30 on .025 (0.63mm) Square Post.

Regular Wrap	WSU-30	£4-39
Modified Wrap	WSU-30M	£4-69



### IC TEST CLIPS

#### FOR DUAL-IN-LINE PACKAGES

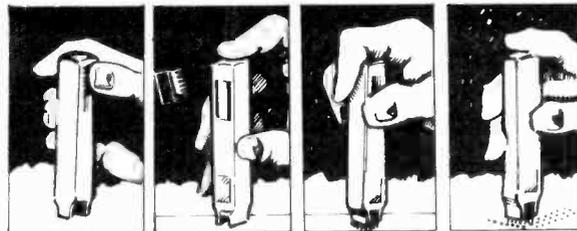


- Solve probe attachment problems.
- Simplify prototype and production testing, field service work, and quality control.

- Provide full access to integrated circuit DIP leads.
- Remove DIP's damage free.
- Available in sizes to accommodate all DIP's; TC-14 fits 14-pin DIP's etc.

£2-75

### DIP/IC INSERTION TOOL WITH PIN STRAIGHTENER



STRAIGHTEN PINS    RELEASE    PICK UP    INSERT

14-16 Pin Dip IC Inserter	INS-1416	£2-58
---------------------------	----------	-------



### DIP SOCKET

Dual-in-line package, 3 level wire-wrapping, phosphor bronze contact, gold plated pins. .025 (0.63mm) sq., .100 (2.54mm) centre spacing.

14 Pin Dip Socket	14 Dip
16 Pin Dip Socket	16 Dip

FROM 14p

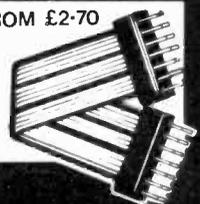
### DIP/IC EXTRACTOR TOOL

The EX-1 Extractor is ideally suited for hobby enthusiast or lab engineer. Featuring one piece spring steel construction. It will extract all LSI, MSI and SSI devices of from 8 to 24 pins. Extractor Tool EX-1. £1-10



### RIBBON CABLE ASSEMBLY FROM £2-70

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We have been fortunate to obtain a large quantity of untested, mostly unmarked glass silicon diodes. Testing a sample batch revealed about 70% usable devices—signal diodes, high voltage rect and zeners may all be included. These are being offered at the incredibly low price of £1.25/1000—or a bag of 2500 for £2.25. Bag of 10,000 £8. Box of 25,000 £17.50. Box of 100,000 £80.

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52 logic IC's including 32 x 74161 (4 bit binary counter) + 16 tan bead caps. R's, C's, etc. Over £30 worth of TTL alone!! ONLY £3.00.

## MISCELLANEOUS IC's

All supplied with data, if requested.  
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 MC1469R Voltage reg. £1.50.  
 ZN1034E Precision timer £2.25.  
 LM1303 Dual stereo preamp £1.40.  
 LM1301 Op amp 40p. ITT326 2 x 2 & 2 x 2 3 1/2 TTL NAND gate, 10 for £1.  
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Type C500 by G1. 4 function + constant. 8 digit. Multiplexed output for simple keyboard interfacing. 24 pin DIL. With comprehensive data + socket £1.50

## TMS4030 RAM

4096 bit dynamic RAM with 300ns access time. 470ns cycle time. single low capacitance high level clock up. Fully TTL compatible. Low power dissipation. Supplied with data £2.75

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DG-10Q1 Green seven segment display tubes. 0.3" character height. Require 0.6V filament voltage and 18V HT. Supplied with connection data. 80p each, 4 for £2.50, 10 for £5.50.

## SPECIAL TRANSISTOR OFFERS

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PN71(BCY71)	14 for £1
PN72(BCY72)	15 for £1
MSPS1218 (2N3702)	20 for £1

## HEAT SINK OFFER

Copper T05 sink 17mm dia x 20mm. 10 for 40p; 100 for £3; 1000 for £25.

## DARLINGTON COMP PAIR

BD695A and BD695A—45V 8A 70W plastic power!! gain 750 @ 4A. PNP-NPN pair £1.50

## SPECIAL SUMMER OFFERS

Audio IC's			
76003N	£1.40	76013N	£1.00
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LM380	80p	TBA810S	70p
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741 (8DIL)	18p	BD131	24p
555	25p	BD132	28p
1N4148	2p	2N3819	18p

## LOW COST PLASTIC BOXES

Made in high impact ABS. The lids are retained by 4 screws into brass inserts. Interior of box has PCB guide slots (except V219).

V210	80x62x40mm black	58p
V213	100x75x40 mm black	72p
V216	120x100x45mm black	86p
V219	120x100x45mm white	85p

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Plastic top and bottom, ally panels front and back.

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1238	154x85x60	£2.79
1239	154x85x80	£3.32
3007	180x120x40	£3.30
3008	180x120x65	£3.50
3009	180x120x90	£3.74
1410	205x140x40	£3.51
1411	205x140x75	£4.05
1412	205x140x110	£5.12

We keep a very large range of VERO products — inc. their recently introduced G range of cases, and Series II boxes. SAE for their catalogue.

## 1977/8 CATALOGUE

48 BIG pages packed with over 4,000 items, many of them illustrated. Discount vouchers worth 50p. PRICE 30p + 15p post. (Overseas send 60p surface or £1 airmail.) Also included is our current Bargain List. Send SAE for bargain list alone.

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★ **SAVE ON TIME**—No delays in waiting for parts to come or shops to open!

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**K008** Extended range, as above, also including 220, 470 and 1000µF. Total 100 for £5.90

**K021** Miniature carbon film 5% resistors. CR25 or similar. 10 of each value from 10R to 1M, E12 series. Total 610 resistors, £8.00

**K022** Extended range, total 850 resistors from 1R to 10M £8.30

**K041** Zener diodes. 400mW 5% 8ZY88, etc. 10 of each value from 2.7V to 36V, E24 series. Total 280 for £15.30

**K042** As above but 5 of each value £8.70

## PC ETCHING KIT MK III

Now contains 200 sq. ins. copper clad board, 1lb. Ferric Chloride, DALO etch-resist pen, abrasive cleaner, two miniature drill bits, etching dish and instructions. £4.15

## VERO OFFCUTS

Pack A, All 0-1" Pack B, All 0-15" Pack C, Mixed Pack D, all 0-1" Plain Each pack contains 7 or 8 pieces with a total area of 100 sq. in. Each pack is £1.30. Also available by weight. 1lb £4.20, 10lb £32.50, 17 x 3 1/2" Strips: 0-1" £2.20; 10 for £15 0-15" £1.96 0-1" Plain £1.83

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Special purchase of these 0-1" pitch double-sided gold-plated connectors enables us to offer them at less than one-third of their original list price! 18 way 41p; 21 way 47p; 32 way 72p; 40 way 90p.

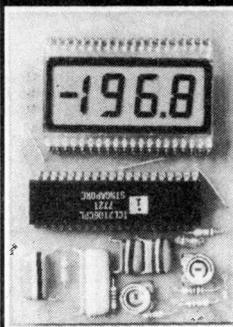
## DISC CERAMIC PACK

Amazing variety of values and voltages from a few pF to 2-2µF 3V to 3kV! 200 £1.00, 500 £2.25, 1000 £4.00.

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Look out for details of the GREENWELD 100W amplifier kit... and an IC amplifier kit... and some incredible component bargains!!!

## DIGITAL VOLTMETER/THERMOMETER KIT



Based on the 7106 single IC 3 1/2 digit D.V.M. the Kit contains a PCB, resistors, capacitors, pre-sets, I.C. and 0.5" liquid crystal display. Components are also included to enable the basic D.V.M. kit to be modified to a Digital Thermometer using a single transistor as the sensor.

ONLY £23.75

## TRIAC BARGAINS

400V Plastic Case	
3A	68p
6.5A with trigger	86p
8A	85p
12A	90p
16A	113p
20A	178p
25A	205p
SCR (C106D) 5A/400V	54p
Diac	23p

## \* SPECIALS \*

4 x 555	£1.08
4 x 2N3055	£1.19
5 x 741	£1.08
LM3911	97p

## OPTO ELECTRONICS

0.2" L.E.D.s	
Red 11p (86p/10)	
Green 23p	
Yellow 27p	
DL727 0.5" display	£1.62

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ZN1034E	£1.94
AY-5-1230	£5.24
AY-5-1224	£3.51

## MINI MAINS TRANSFORMERS

Standard 240V mains primary	
100mA secondary	
6-0-6V	92p
9-0-9V	97p
12-0-12V	102p

## 24HR CLOCK/APPLIANCE TIMER KIT



Switches any appliance of up to 1KW on and off at preset times once a day. KIT contains: AY-5-1230 Clock/Appliance Timer IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, complete with PCBs and full instructions. £14.85 White box (56 x 131 x 71mm) — drilled £2.70 — undrilled £2.38

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240V 12V (or 6-0-6)	200mA	0.98	ICs	
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			HEFA00 1P Quad NOR 14 DIL	0.19
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3pin TD-202 200mA	0.79
LM 342 P-12 +12V	
3pin TD-202 200mA	0.79
LM 342 P-24 +24V	
3pin TD-202 200mA	0.79
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3pin TD-202 500mA	1.48

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This kit is suitable for record players, tape play back, guitars, electronic instruments or small P.A. systems. Two versions are available. The mono kit uses 13 semiconductors. The stereo kit uses 22 semiconductors. Both kits have printed front panel and volume, bass and treble controls. Spec. 10W output into 8 ohms, 7W into 15 ohms. Response 20c/s to 30kc/s. Input 100mV, high imp. Size 9 1/2 x 3 x 2 1/2 in. A/C mains operated.

Mono kit **£12.50** Stereo kit **£20** Post 45p  
Easy to build Full instructions supplied



**ELAC SPEAKER 10 inch £4.50**

Twin cone. Large ceramic magnet 50-16,000 c/s. Bass resonance 55 c/s. 10W. 8 ohm impedance.

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

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ALL POST 50p each  
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2A, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £8-50  
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20-0-20V 1A £2-95, 30V 1A £2-75, 20V 1A £2-20,  
5V 3 amp £2-75, 50V 40V 20V 20-0-20V 1A £3-90,  
30-0-30 2A £7, 3V 250mA £1-30.  
AUTO TRANSFORMERS 115V to 230V or 230V to 115V  
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CHARGER TRANSFORMERS Input 200/250V for 6 or 12V  
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Standard 12in diameter fixing with cut sides 10 1/2in square, 14,000 gauss magnet 30 watt r.m.s., 4 ohm impedance. Bass resonance 30 c.p.s., Frequency response 30-8,000 c.p.s. £10.95 each. Post £1.00. 20 Watt model £9.95.



**10 WATT PER CHANNEL STEREO AMPLIFIER**  
In chassis form. A.C. mains operated. Volume, balance, treble and bass slider controls. Pick up and tape inputs. Recording output. Socket. Front panel size: 16 1/2 x 1 1/2 in. Chassis size: 13 x 15 in. Bargain **£18.50** Post 50p

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Size 10 1/2 x 8 1/2 in. Operating voltage 200-250V a.c. 250W approx. Suitable for Heating Pads, Food Warmers, Convector Heaters, etc. Must be clamped between two sheets of metal or asbestos.

ONLY **40p** EACH (FOUR FOR £1-50)  
ALL POST PAID—Discounts for quantity

**E.M.I. 13 1/2 x 8in SPEAKER SALE!**

With tweeter. And crossover. State 4 or 8 ohm.  
**10W Model £7-95** Post 45p  
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ACOUSTIC WADDING 18in. wide, 20p ft.



**MONO PRE-AMPLIFIER**

A mains operated solid state pre-amplifier unit designed to compliment amplifiers without low level phono and tape input stages. This free standing cabinet incorporates circuitry for automatic R.I.A.A. equalisation on magnetic phono input and N.A.B. equalisation for tape heads. Power ON/OFF, PHONO/TAPE switches and pilot lamp are on the front panel; phono socket input and output are rear located. AC mains 240V. Size 6 x 3 1/2 x 2in.



**£4.50** ea. — 2 for **£8.** Post 50p.

**BAKER MAJOR 12 INCH £16.88**



30-14,500 c/s. 12in double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwell. Bass resonance 40 c/s. Rated 25W. NOTE 4 or 8 or 16 ohms available

Module kit, 30-17,000 c/s with tweeter, crossover, baffle, 19 x 12 1/2 in. instructions. As illustrated **£20.52** Please state 4 or 8 or 16 ohms. Post £1 60

**"BIG SOUND" BAKER SPEAKERS**

Robustly constructed to stand up to long periods of electronic power. As used by leading groups and discos. Useful response 30-13,000 c/s. Bass Resonance 55 c/s

**GROUP "25"**

12in 30W £12.96 Post £1  
4, 8 or 16 ohms.

**GROUP "35"**

12in 40W £15.12 Post £1  
4, 8 or 16 ohms

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12in 60W £22.68 Post £1 60  
4 or 8 or 16 ohms with aluminium presence dome

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15in 75W £28.08 Post £1 60  
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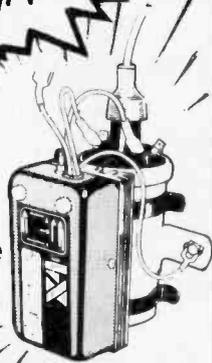
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#### PRINTED CIRCUIT MATERIALS

PC etching kits—economy £1-70. standard £3-82. 50 sq ins pcb 40p. 1 lb FeCl<sub>3</sub> £1-05. Etch resist pens—economy 45p. Dialo 79p. small drill bit 20p. Etching dish 68p. Laminate cutter 75p.

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IC radio chip £1-05. Extra parts and pcb for radio £3-85. Case £1. Send sae for free data.

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Send sae for free leaflet on range. 100ma radio types with press stud connectors. 4½V £1-80. 6V £1-80. 9V £1-80. 4½ + 4½V £2-50. 6 + 6V £2-50. 9 + 9V £2-50. Cassette type 7½V 100ma with diil plug £1-80. Heavy duty 13 way types 4½/6/7½/11/13/14/17/21/25/28/34/42V. 1Amp £4-65. 2Amp £7-25. Transistor stabilized 8-way types for low hum 3/4½/6/7½/9/12/15/18V 100ma £3-20. 1Amp £8-40. Car converter kit input 12V dc. Output 6/7½/9V 1A stabilized £1-95.

#### BULK BUY OFFERS

Minimum purchase £10 any mix 1½W resistors 5% £12 1 ohm to 10M 0.8p. 741 8 diil 20p. NE555 8 diil 32p. Dialo pens 59p. Plastic covers of BC108/BC109 3.8/4.4p. 1N4148 1.9p. BC107 7p. BC109 7p. BC212 8p. 1N4002 4.2p. 250V polypropyl capacitors 0.15mf 1.1p. 0.68mf 1.4p. 0.1mf 1.5p. 0.33mf 2.5p. Zener diodes 400mW E24 2V to 33V 5.5p.

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Resistors 5% carbon £12 10 to 10M. 1½W 1p. 1W 2p. Polyester capacitors 250V £6. 0.1 to 0.68mf 3½p. 0.1mf 2p. 1.5mf 5p. 22mf 4p. 33. 47mf 6p. Polystyrene capacitors £12 63V 15pf to 6800pf 2½p. Ceramic capacitors 50V £12 22pf to 1000pf 2½p. E6 1500pf to 47000pf 2½p. Milar capacitors 100V 0.01, 0.02, 0.05mf 4p. 0.1, 0.2mf 4½p. 0.4, 0.5mf 5½p. Electrolytics 50V 47.2mf 5p. 25V 5mf 5p. 10mf 4p. 16V 22mf 5p. 33.47.100mf 6p. 220.330mf 9p. 470mf 11p. 1000mf 8½p. Zeners £3-82. 50 sq ins pcb 40p. 1 lb FeCl<sub>3</sub> £1-05. Etch resist pens—economy 45p. Dialo 79p. small drill bit 20p. Etching dish 68p. Laminate cutter 75p.

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Ref	12V	24V	£	P & P
111	0.5	0.25	2.20	0.45
213	1.0	0.5	2.64	0.78
71	2	1	3.51	0.78
18	4	2	4.03	0.96
70	6	3	5.35	0.96
108	8	4	6.98	1.14
72	10	5	7.67	1.14
116	12	6	8.99	1.32
17	16	8	10.39	1.32
115	20	10	13.18	2.08
127	30	15	17.05	2.08
286	60	30	26.82	0.84

50 VOLT RANGE Prim 220/240V Sec 0-20-25-33-40-50V. Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V, 25V-0-25V.				
Ref	Amps	£	P & P	
102	0.5	3.41	0.78	
103	1.0	4.57	0.96	
104	2.0	6.98	1.14	
105	3.0	8.45	1.32	
106	4.0	10.70	1.50	
107	6.0	14.62	1.64	
118	8.0	17.05	2.08	
119	10.0	21.70	2.08	

MAINS ISOLATING (SCREENED) PRIM 120/240 SEC 120/240 CT TAPPED				
Ref	VA (Watts)	£	P & P	
07*	20	4.40	0.79	
149	60	6.20	0.96	
150	100	7.13	1.14	
151	200	11.16	1.50	
152	250	12.79	1.84	
153	350	16.28	1.84	
154	500	19.15	2.15	
155	750	29.06	2.15	
156	1000	37.20	2.15	
157	1500	45.60	2.15	
158	2000	54.80	2.15	
159	3000	79.65	2.15	

HIGH VOLTAGE MAINS ISOLATING Prim 200/220V or 400/440V Sec 100/120V or 200/240V				
VA	Ref	£	P & P	
60	243	5.89	1.32	
350	247	14.11	1.84	
1000	250	35.65	2.15	
2000	252	54.25	2.15	

30 VOLT RANGE Prim 220/240V Sec 0-12-15-20-24-30V. Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V, 15V-0-15V.				
Ref	Amps	£	P & P	
112	0.5	2.84	0.78	
79	1.0	3.57	0.96	
3	2.0	5.27	0.96	
20	3.0	7.44	1.14	
21	4.0	8.20	1.14	
51	5.0	8.37	1.32	
117	6.0	9.92	1.45	
88	8.0	11.73	1.64	
89	10.0	13.33	1.84	

60 VOLT RANGE Prim 220/240V Sec 0-24-30-40-48-60V. Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V or 24V-0-24V, 30V-0-30V.				
Ref	Amps	£	P & P	
124	0.5	3.88	0.96	
126	1.0	5.58	0.96	
127	2.0	7.60	1.14	
125	3.0	10.54	1.32	
123	4.0	12.23	1.84	
40	5.0	13.95	1.64	
120	6.0	15.66	1.84	
121	8.0	20.15	1.84	
122	10.0	24.03	2.08	
189	12.0	27.13	2.08	

AUTO TRANSFORMERS				
Ref	VA (Watts)	Volts	£	P & P
113	15	0-115-210-240	2.48	0.71
64	15	0-115-210-240	3.95	0.96
4	150	0-115-200-220-240	5.35	0.96
67	500	0-115-200-220-240	10.99	1.64
84	1000	0-115-200-220-240	18.76	2.08
93	1500	0-115-200-220-240	23.36	2.08
95	2000	0-115-200-220-240	34.82	2.08
73	3000	0-115-200-220-240	48.00	2.08

CASED AUTO TRANSFORMERS 240V cable in & 115V USA 2 pin outlet				
VA	£	P & P	Ref	
15	4.96	0.96	113W	
150	8.48	1.14	4W	
200	9.92	1.45	65W	
250	10.49	1.45	69W	
500	15.73	1.64	67W	
750	18.55	1.76	83W	
1000	22.68	1.84	84W	
1500	28.02	2.08	93W	
2000	37.65	2.08	95W	

SCREENED MINIATURES				
Ref	mA	Volts	£	P & P
238	3-0.3		1.99	0.55
212	1A, 1A	2-5, 0-6	2.14	0.38
13	100	9-0-9	2.14	0.38
235	300, 330	0-9, 0-9	1.99	0.38
207	500, 500	0-8-9, 0-8-9	2.59	0.71
208	1A, 1A	0-8-9, 0-8-9	3.53	0.78
236	200, 200	0-15, 0-15	1.99	0.38
214	300, 300	0-20, 0-20	2.56	0.78
221	700 (DC)	20-12-0-12-20	3.41	0.78
206	1A, 1A	0-15-20-0-15-20	4.63	0.96
203	500, 500	0-15-27-0-15-27	3.99	0.96
204	1A, 1A	0-15-27-0-15-27	5.39	0.96
S112	500	12-15-20-24-30	2.64	0.78
239	50	12-0-12	1.99	0.38

MINI-MULTIMETER DC-1000V AC-1000V DC-100mA Res-150kΩ 1000V/DC Bargain £5.86 P & P 62p VAT 8%				
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1000V AC/DC 2.5A AC/DC 500k res. in robust steel case and leads £15.85				
BX505	Sanwa	£3-68	MM5	£26-10
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ELECTRONIC CONSTRUCTION KIT 10 projects (including electronic organ). No soldering needed £7.29. VAT 8% P & 70p.				
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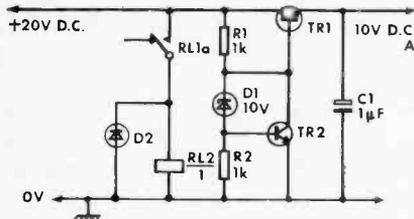
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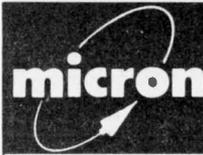
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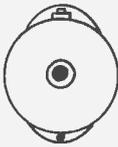
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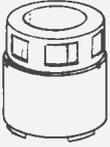
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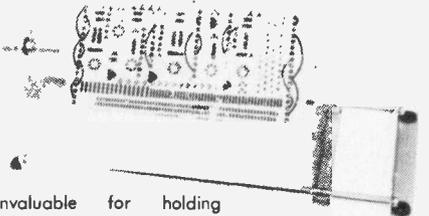
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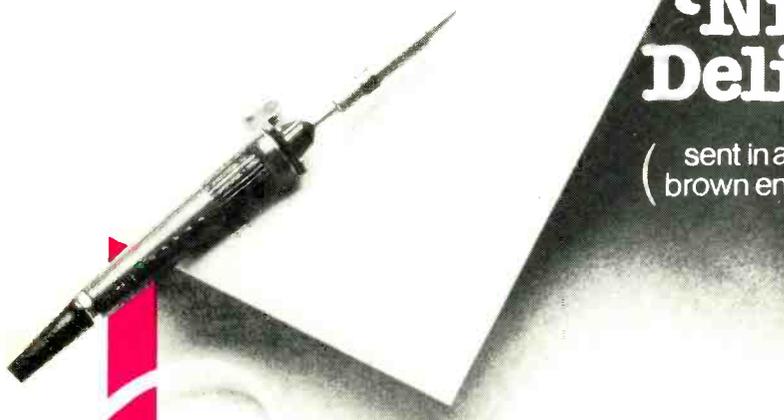
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7447A	70p	74175	85p	74LS157	60p	74C73	75p	4060	115p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7448	80p	74176	90p	74LS158	120p	74C74	70p	4063	120p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7450	17p	74177	90p	74LS160	130p	74C85	200p	4068	55p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7451	17p	74178	80p	74LS161	100p	74C86	85p	4068	22p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7453	17p	74180	93p	74LS162	140p	74C90	80p	4069	20p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7454	17p	74181	200p	74LS163	140p	74C95	130p	4070	30p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7450	17p	74182	90p	74LS184	120p	74C107	125p	4071	22p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7470	36p	74184A	150p	74LS165	80p	74C150	250p	4072	22p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7472	34p	74185	200p	74LS166	80p	74C20	27p	4052	80p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7473	34p	74186	700p	74LS174	110p	74C157	250p	4075	22p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7474	30p	74190	100p	74LS175	110p	74C160	155p	4076	107p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7475	36p	74191	100p	74LS181	320p	74C181	155p	4081	22p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7476	35p	74192	100p	74LS180	100p	74C182	155p	4082	22p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7480	50p	74193	100p	74LS191	100p	74C183	155p	4093	80p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7481	100p	74194	100p	74LS192	140p	74C184	120p	4098	107p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7482	84p	74195	95p	74LS193	140p	74C173	120p	4502	120p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7483	90p	74196	100p	74LS194	140p	74C174	160p	4503	70p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7484	100p	74197	80p	74LS198	120p	74C175	210p	4507	59p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7485	110p	74198	150p	74LS221	100p	74C192	150p	4510	99p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59C	40p	*2N5261	30p	*1N4005	6p		
7486	34p	74199	150p	74LS240	245p	74C193	150p	4511	150p	*LM380	99p	*TBA800	90p	*BC549C	18p	*MPS59							



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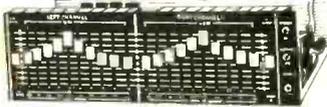
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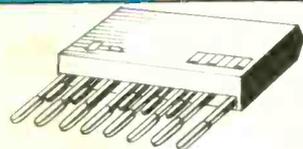
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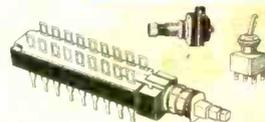
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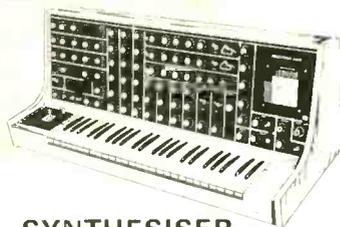
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