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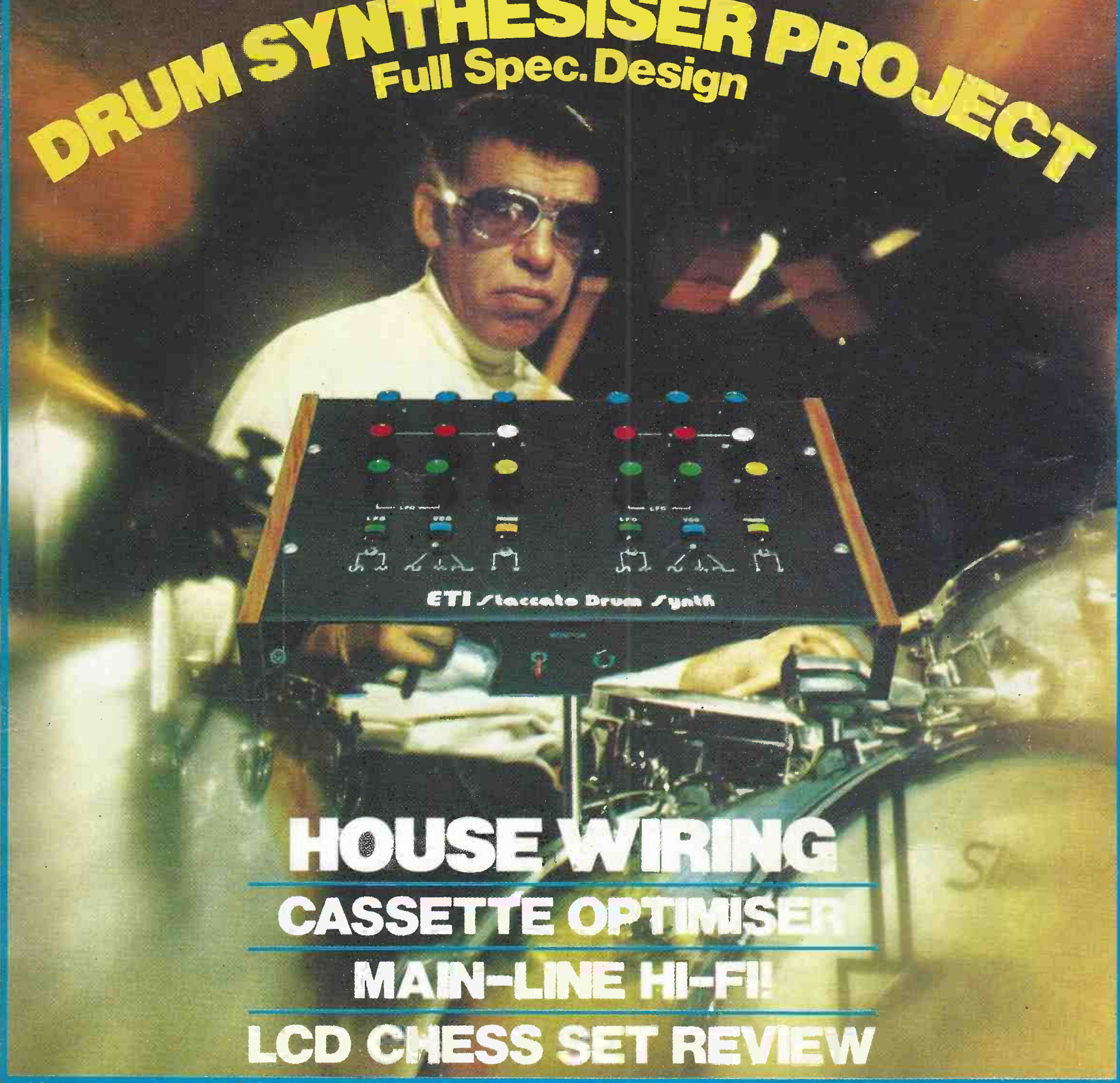
electronics today INTERNATIONAL

JUNE 1980 60p

DRUM SYNTHESISER PROJECT
Full Spec. Design



HOUSE WIRING
CASSETTE OPTIMISER
MAIN-LINE HI-FI!
LCD CHESS SET REVIEW

FREE INSIDE!
AUDIO DESIGNER'S HANDBOOK
CIRCUIT SECRETS UNFOLDED

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

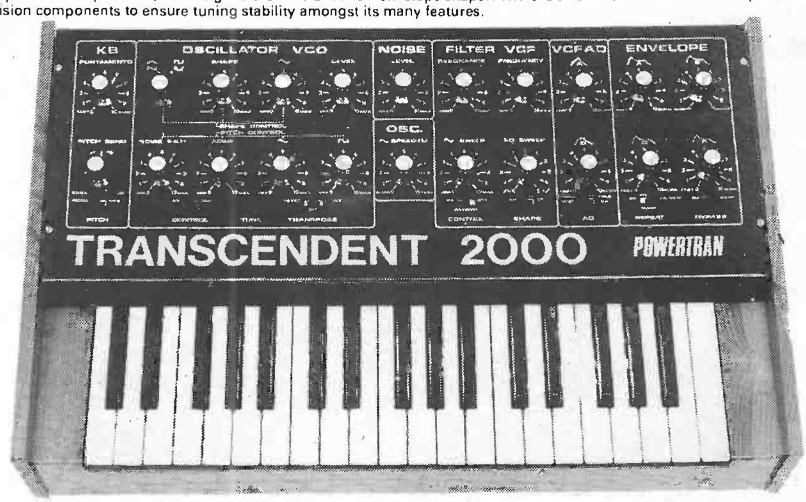
TRANSCENDENT 2000
SINGLE BOARD SYNTHESIZER

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

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

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

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



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

COMPLETE KIT ONLY £168.50 + VAT!

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

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

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

TRANSCENDENT DPX

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

ANOTHER SUPERB DESIGN BY SYNTHESIZER EXPERT TIM ORR — PUBLISHED IN ETI

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

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

COMPLETE KIT ONLY £299.00 + VAT!

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

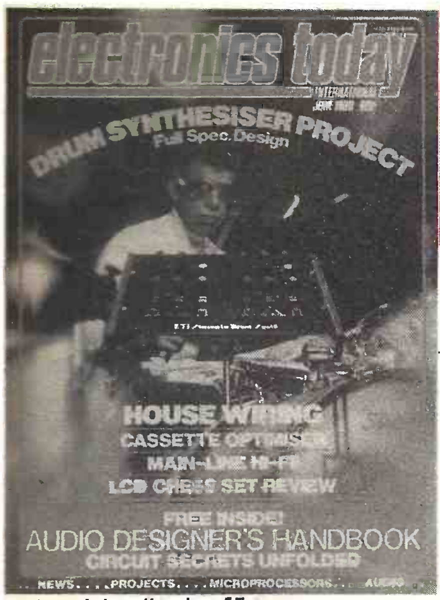
As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing etc., etc.)

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

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

POWERTRAN

ORDERING INFORMATION AND MORE KITS INCLUDING THE BLACK HOLE ON PAGE 8



Designer's handbook p.57


Check and mate p.49

Box o'Bangs p.84

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JUNE 1980 VOL 9 NO 6

FEATURES

PROJECTS

INFORMATION

OVERSEAS EDITIONS

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MITRAD (MIDLAND TRADING COMPANY)

ZETRON BRITAIN'S FINEST SELLING RANGE ZETRON

NEW ZETRON L.C.D. CALCULATOR NEW

Superb value in the economy range of LCD calculators. What more could you ask for? This marvel of the silicon chip era boasts the following:

Four basic functions, chain and mixed operations, constants for four functions, % calculations including discounts and mark-ups. Automatic accumulation in four functions.

★PLUS★ Square Root facility
★PLUS★ Memory facility
★PLUS★ Auto Power Off (7 minutes)

ALL THIS FOR A MODEST £4.95

GENTS MELODY ALARM CHRONO DUAL TIME

Brand new Melody Alarm, Chrono. Constant display of hours, mins, secs, weekday, am/pm and mode square flag indication.

The chrono runs to a 1/10th sec (running horse style) split and lap mode facilities are standard. Dual timing facilities. The alarm system is unique in the fact that it plays the tune "Yellow Rose Of Texas" for 20 seconds.

The tune can be actuated at any instance by the press of a button. Backlight, infinitely adjustable stainless steel strap.

VERY LOWLY PRICED £17.75

NEW QUARTZ L.C.D. TIMER NEW

A new style timer incorporating split second accuracy. The timer is finished in a strong black plastic case with large L.C.D. readout of hours, mins and secs. A further optional display mode of month, date and weekday is available. The timer incorporates a 1/100th sec chronograph with numerous facilities.
(i) The timer can be frozen.
(ii) Two people can be timed simultaneously.
(iii) Split and lap mode facilities are available. A strong black cord is attached to the timer which aids movement at sporting events.

Battery replacement is made easy with a screw back.

OFFERED AT ONLY £19.95

GENTS FRONT BUTTON CHRONO ALARM

Latest style! Constant display of hours, mins, secs, am/pm, weekday and alarm indication. A further two optional display modes are available. The watch comprises of 7 digits, 12 function and is programmed to the year 2009. The alarm can be set to any time within 24 hours and operates for 30 sec. Back-light and a closely woven adjustable stainless steel strap finish the watch off with a really superb sleek look, only 8mm thick.

£13.25

GENTS ALARM CHRONO (12/24 CYCLE)

A really superb watch and module. It can be set as a 12- or 24-hour watch with hours, mins, secs, am/pm and weekday indication always on display. A unique calendar is built into the watch. You can have month followed by date or date followed by month, it's entirely up to you. A 24-hour alarm can be set to any time within a 24-hour period.

The chronograph has a 12-hour capacity and runs at 1/10's. Split and lap mode facilities are available.

Battery hatch, mineral glass, long-life battery and a closely woven adjustable stainless steel strap finish the watch off with impeccable looks.

ONLY £16.50

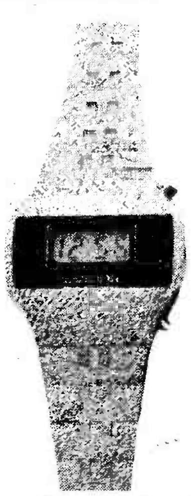
LADIES COCKTAIL

Elegance and style for the lady with the discerning taste. In gold or silver finish with matching bracelet. Constant display of hours and mins with month, date, secs, auto calendar and back-light.

VERY SPECIAL £10.50

LADIES SUGAR COATED

Another superb ladies watch with that extremely popular sugar frosted finish. Links can easily be removed from the strap and the clasp has a spring mechanism built in to give a comfortable fitting. Constant display of hours and mins, with month, date, secs, auto calendar and back-light.



£10.50

GENTS CHRONOGRAPH

Probably the best looking chrono on the market. Constant display of hours, mins, secs with am/pm indication. Also month, date and weekday indication. 1/100th and 1/10th sec with split and lap mode facilities. Back-light, closely woven adjustable stainless steel strap.

SPECIAL £8.95

GENTS MELODY MULTI-CHIME ALARM CHRONO

Latest technology! Constant display of hours, mins and secs, weekday, date and month with mode and chime indication display. The musical alarm once actuated plays the tune "Oh Suzanna". Two further alarm systems are incorporated in this outstanding watch: (i) 24-hour alarm; (ii) count-down alarm. The watch can be set to chime on every full hour. A 1/100th sec chrono is standard to the watch. Can be switched off. Mineral glass face. The watch also has a battery hatch backlight and infinitely adjustable stainless steel strap.

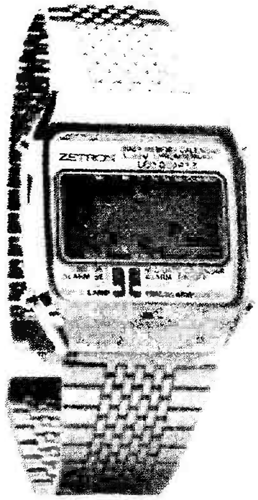
VALUE AT £19.95

ZETRON WHERE RELIABILITY, STYLE AND ELEGANCE REALLY COUNT ZETRON

MITRAD (MIDLAND TRADING COMPANY)

THREE OF THE FINEST SELLING WATCHES ON THE BRITISH MARKET

GENTS MEMORY CALENDAR ALARM CHRONO



A really successful watch incorporating all the latest technology.

Hours, mins, secs, weekday and snooze alarm indication on constant display.

A further two optional display modes are available, one being the calendar and month, which can be increased or decreased to give the appropriate month of the year.

A 1/106th second chronograph with split and lap mode facilities are built into the watch with a 12-hour capacity.

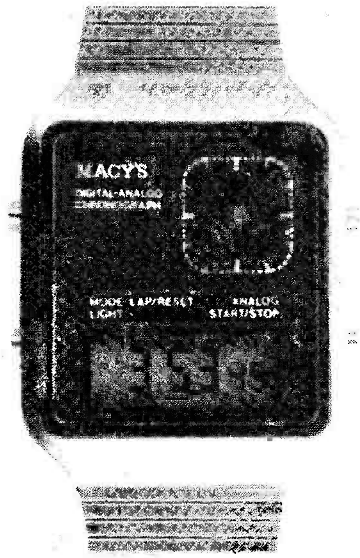
A 21-hour alarm with a 10-minute snooze function is also standard to this watch. A further feature is the backlight and fully adjustable stainless steel bracelet.

★ STAR VALUE £19.95

GENTS DIGITAL ANALOGUE CHRONOGRAPH

Just look at this outstanding watch:
i) 6 functions (hours, mins, secs, month, date, weekday); ii) chronograph resolution; iii) automatic 4-year guarantee; iv) five buttons control all functions; v) back-light available.

ONLY £29.95 + P/P



The above watch is a new style digital analogue featuring complete up-to-date modern technology. The watch basically constitutes a traditional hand watch plus a modern digital watch, both battery powered.

Hours, mins and seconds are on constant display and with the press of a button, month, date and weekday is displayed.

This unique timepiece also has a chronograph built in which runs to a 1/100th sec, and has a 12-hour capacity. Features include: i) the chronograph can be frozen; ii) two people can be timed simultaneously, and iii) split and lap mode facilities are available.

The watch is finished off with an elegant infinite adjustable stainless steel strap.

ORDER NOW TO AVOID DISAPPOINTMENT ! ! !

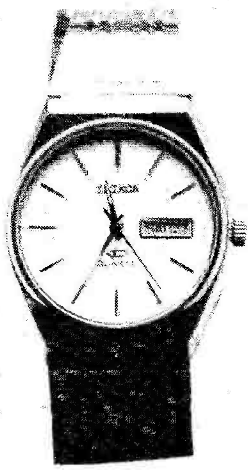
GENTS QUARTZ ANALOGUE

A truly superb timepiece with extreme accuracy. A choice of two colours on this outstanding watch are available, blue or white.

The calendar in the watch can be set to give a readout in either French or English with date indication being automatic.

An infinitely adjustable stainless steel strap is built in as part of the watch.

The watch is fitted with a long-life battery and comes with luminous markings to aid night-time vision.



YES ONLY £19.95

! MITRAD ! THE UNRIVALLED RANGE ! MITRAD !

We are able yet again to offer you the above watches plus a complete quartz watch range. All at unrivalled prices. Just look at the following points:

- (i) 48-hour despatch guaranteed on both retail and trade orders.
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- (iii) Our own free back-up service.
- (iv) 10-day full money refund if not completely satisfied.
- (v) Free felt presentation case with each watch.

M I T R A D

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POLYESTER CAPACITORS: Axial lead type.
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n **9p**; 18n **10p**; 22n, 33n **11p**; 47n, 68n **14p**; 100n **17p**; 150n, 220n **24p**; 330n, 470n **41p**; 680n **48p**; 1µF **64p**; 2µ2 **82p**.
160V: 10nF, 12n, 39n, 100n, 150n, 220n **11p**; 330n, 470n **19p**; 680n, 1µF **22p**; 2.2µF **32p**; 4.7µF **36p**.
1000V: 10n, 15n **20p**; 22n **22p**; 47n **26p**; 100n **38p**; 470n **53p**; 1µF **175p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10n, 15n, 22n, 27n **5p**; 33n, 47n, 68n, 100n **7p**; 150n **10p**; 220n, 330n **13p**; 470n **17p**; 680n **19p**; 1µ **22p**; 1µ5 **30p**; 2µ2 **34p**.

FEEDTHROUGH CAPACITORS 1000pF/350V **8p**

ELECTRONIC CAPACITORS: (Values are in µF) **500V:** 10 **40p**; 47 **68p**; **250V:** 100 **65p**; **63V:** 0.47, 1.0, 1.5, 2.2, 3.3, 4.7, 6.8 **8p**; 47, 32, **11p**; 63, 100, **27p**; **50V:** 50, 100, 220, **25p**; 470, **32p**; 1000, **60p**; **40V.** 2, 33, **8p**; 100, **12p**; 2200, 3300, **85p**; 4700, **98p**; **35V:** 10, 33, **7p**; 330, 470, **32p**; 1000, **50p**; **25V:** 10, 22, 47, 80, 100 **8p**; 160, 220, 250, **15p**; 470 **28p**; 640, **35p**; 1000, **33p**; 1500, **40p**; 2200, **45p**; 3300, **77p**; 4700 **85p**; **16V:** 10, 47, **7p**; 100, 125, **8p**; 220, 330, **14p**; 470, **20p**; 1000, 1500, **30p**; 2200 **36p**; **10V:** 100, **7p**; 640, **12p**; 1000, **16p**.
TAG-END TYPE: 450V: 100µF **180p**; **70V:** 4700, **165p**; **64V:** 3300 **150p**; 2500 **110p**; **50V:** 4700, **150p**; 3300 **135p**; 2200 **99p**; **40V:** 15,000 **399p**; 4700 **130p**; 4000 **92p**; 3300 **98p**; 2500 **90p**; **30V:** 4700 **110p**; **25V:** 15000 **195p**; 6400 **120p**; 4700 **100p**; 3300 **80p**; 2200 **60p**.

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0.22, 0.33, 0.47, 0.68, 1.0, 2.2µF, 3.3, 4.7, 6.8. **25V:** 1.5, 10. **20V:** 1.5. **16V:** 10µF **13p** each.
16V: 15, 22 **25p**. 47, 100 **50p**. 220 **70p**.
10V: 15, 22, 33, **20p**.
6V: 47, 68, 100 **30p**; **3V:** 100 **20p**.

MYLAR FILM CAPACITORS
100V: 0.001, 0.002, 0.005, 0.01µF **6p**
0.015, 0.02, 0.04, 0.05, 0.056µF **7p**
0.1µF, **9p**. 0.2 **11p**. **50V:** 0.47µF **12p**

CERAMIC CAPACITORS 50V
Range: 0.5pF to 10,000pF **4p**
0.015µF, 0.022µF, 0.033µF **5p**
0.047µF **5p**; 0.1µF, 0.2µF **7p**

SILVER MICA (Values in pF) 3.3, 4.7, 6.8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220 **11p** each
250, 270, 300, 330, 360, 390, 470, 600, 800, 820 **16p** each
1000, 1200, 1800, 2000 **26p** each

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1.5nF to 47nF **10p**

MINIATURE TYPE TRIMMERS
2.5-6pF; 3-10pF; 10-40pF **22p**
5-25pF; 5-45pF; 60pF; 88pF **30p**

COMPRESSION TRIMMERS
3-40pF; 10-80pF, 25-190pF **30p**
100-500pF **45p** 400-1250pF **58p**

GAS & SMOKE DETECTORS
TGS 812 & 813 **415p**; Socket **25p**

POTENTIOMETERS: Rotary, Carbon, Track, 0.25W Log & 0.5W Lin. 470Ω, 680Ω, 1KΩ & 2KΩ (Linear only) Single Gang **29p**
5KΩ-2MΩ Single Gang Log & Lin. **29p**
5KΩ-2MΩ Single Gang D/P Switch **69p**
5KΩ-2MΩ Double Gang Log & Lin **88p**
Wire Wound Single Turn 1 Watt 20Ω-20KΩ **105p**

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm
5KΩ-500KΩ single gang **60p**
10KΩ-500KΩ dual gang **80p**
Self Stick Graduated Bezels **30p**

PRESET POTENTIOMETERS
0.1W 50Ω—5MΩ Miniature Vertical & Horizontal **7p**
0-25W 100Ω—3-3MΩ horiz. larger **10p**
0-25W 200Ω—4-7MΩ Vert. **10p**
Cermet, Precision, multiturn, 0.75W ¾in 100Ω-100K **90p**

RESISTORS — Erie make 5% Carbon Miniature High Stability, Low noise

	RANGE	VAL	1-99	100+
¼W	2.2Ω-4.7M	E24	2p	1p
½W	2.2Ω-4.7M	E12	2p	1p
1W	2.2Ω-10M	E12	5p	4p
2%Metal Film	10Ω-1MΩ		6p	4p
1%0.5W	51Ω-1M	E24	8p	6p

100+ price applies to Resistors of each type not mixed values.

COMPUTER ICs

2102	125
2102-2	225
2112-2	250
2114	350
2708	595
27L08	995
4116	850
4047	750
6502	995
6503	850
6504	785
6505	850
6520	525
6532	1050
6551	1150
6800	800
6810	360
6821	500
6850	485
6852	485
8080A	595
8085A	1220
81LS95	125
81LS96	125
81LS97	135
8251	700
8253	1275
8728A	235
8T28A	280
BT95N	160
BT97N	150
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AY-5-1013	399
AY-5-2376	920
CP1610	920
DM8123	200
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MC1489	90
MC14411	1020
MC14412	1520
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MK4027-3	445
MK4027-4	350
MK4116	850
MK4118-4	2099
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RO-3-2513U	850
SFF96364E	1050
SFC71301	820
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TMS2716	1750
TMS4035	250
TMS4039	250
TMS4045	1083
TMS6011	365
Z80 CPU 2.5M	990
Z80 CPU 4M	1099
Z80 CTC	595
Z80A CTC	720
Z80 P10	600
Z80A P10	720

TRANSISTORS

	p												
AC125	35	BC213	9	BF200	40	OC26	170	ZTX531	25	2N3703	10	BD158	60
AC126	25	BC213L	9	BF224A	24	OC28	120	ZTX550	25	2N3704	10	BD206	110
AC127	22	BC214	9	BF244B	60	OC35	125	40311	60	2N3705	10	BD222	65
AC128	20	BC214L	10	BF245	24	OC36	130	40313	125	2N3706	10	BDY56	170
AC141	27	BC237	10	BF256A	50	OC41	125	40315	55	2N3707	10	BDY60	140
AC142	28	BC238	10	BF256B	45	OC42	48	40316	85	2N3708	11	BF184	25
AC176	25	BC307B	12	BF257	30	OC43	55	40324	91	2N3709	11	BF185	25
AC187	26	BC308	12	BF258	28	OC44	55	40326	52	2N3710	10	BF245	24
AC188	26	BC327	12	BF259	28	OC45	30	40327	62	2N3711	10	BF337	32
ACY17	60	BC328	15	BF451	20	OC70	35	40347	80	2N3713	140	BFX29	26
ACY18	60	BC337	12	BF336	35	OC71	28	40348	105	2N3771	179	BFY55	38
ACY19	60	BC338	12	BF337	32	OC72	35	40360	43	2N3772	195	BFY56	32
ACY20	53	BC441	27	BF594	30	OC74	50	40361	45	2N3773	288	BFY81	99
ACY21	40	BC461	27	BF595	20	OC75	45	40362	42	2N3819	20	BSX29	45
ACY22	60	BC477	35	BFR39	25	OC76	36	40467A	95	2N3820	45	BSX78	75
ACY28	60	BC516	38	BFR40	25	OC77	76	40468	60	2N3822	130	BSY26	40
ACY39	80	BC517	35	BFR41	24	OC81	35	40468A	70	2N3823	70	MJ490	90
ACY41	39	BC547	10	BFR79	24	OC82	50	40408	95	2N3824	70	MJE170	130
AD149	75	BC548	10	BFR80	24	OC83	48	40411	280	2N3866	90	MJE180	130
AD161	42	BC549C	15	BFR81	24	OC84	45	40594	98	2N3879	150	MPU131	45
AD162	42	BC556	15	BFR98	105	OC140	110	40595	90	2N3903	20	TIS59	50
AF114	60	BC557	10	BFX29	26	OC170	85	40603	67	2N3904	18	TIS74	47
AF115	60	BC558	10	BFX81	45	OC171	45	40636	130	2N3905	18	UC734	50
AF116	60	BC559	10	BFX84	26	OC200	48	40673	68	2N3906	17	40324	91
AF117	50	BCY30	80	BFX85	28	TIP29	31	2N697	40	2N4037	52	40467A	95
AF118	75	BCY34	75	BFX86	28	TIP29B	56	2N698	40	2N4041	40	40468A	70
AF139	40	BCY35	50	BFX87	28	TIP29C	60	2N699	30	2N4058	17	40636	130
AF178	75	BCY39	78	BFX88	28	TIP30	32	2N706A	19	2N4061	17	2N1302	35
AF186	50	BCY40	48	BFY50	21	TIP30B	40	2N708	33	2N4062	17	2N1306	40
AF239	42	BCY42	14	BFY51	21	TIP30C	43	2N918	33	2N4064	115	2N1307	45
ASZ21	60	BCY70	14	BFY52	21	TIP31A	38	2N1131	22	2N4220	60	2N1308	50
BC107	10	BCY71	16	BFY53	28	TIP31B	43	2N1132	24	2N4234	36	2N2297	45
BC107B	10	BCY72	15	BFY55	38	TIP32A	40	2N1302	35	2N4236	45	2N2476	120
BC108	10	BCY78	19	BFY56	32	TIP32C	55	2N1303	50	2N4264	24	2N2497	50
BC108B	10	BD112	95	BFY64	40	TIP33A	54	2N1304	50	2N4286	15	2N3020	33
BC108C	12	BD124	115	BFY71	20	TIP33C	70	2N1305	35	2N4289	15	2N3252	36
BC109	10	BD131	42	BFY81	99	TIP34A	63	2N1306	40	2N4314	61	2N3302	26
BC109B	12	BD132	42	BRY39	39	TIP34C	75	2N1307	45	2N4400	20	2N3441	140
BC109C	12	BD133	50	BSX20	20	TIP35A	135	2N1308	50	2N4427	75	2N3703	10
BC114	20	BD135	30	BSX26	75	TIP35C	165	2N1613	23	2N4859	65	2N3713	140
BC115	20	BD136	30	BSX29	45	TIP36A	145	2N1670	150	2N4871	50	2N3822	130
BC117	20	BD137	30	BSX78	75	TIP36C	185	2N1671B	120	2N4898	135	2N3824	70
BC118	18	BD138	35	BSY26	40	TIP41A	50	2N2160	350	2N4901	160	2N3879	150
BC119	28	BD139	30	BSY95A	18	TIP41B	55	2N2217	43	2N4921	40	2N4041	40
BC140	26	BD140	30	BU105	115	TIP42A	64	2N2218A	34	2N4922	55	2N4064	115
BC142	26	BD144	198	BU205	125	TIP42B	82	2N2219A	22	2N5102	125	2N4220	60
BC143	26	BD145	175	BU208	215	TIP120	72	2N2220A	23	2N5135	21	2N4234	36
BC147	9	BD158	60	E421	158	TIP121	90	2N2221A	23	2N5136	21	2N4236	45
BC147B	10	BD205	110	MD8001	179	TIP142	125	2N2222A	20	2N5138	20	2N4264	24
bc148	8	BD206	110	MJ491	175	TIP147	145	N2297	45	2N5172	25	2N4286	15
BC148B	10	BD222	65	MJ2955	105	TIP2955	60	n2303	45	2N5179	60	2N4289	15
BC149	9	BD245	50	MJE170	130	TIP3055	48	2N2368	21	2N5180	38	2N4314	61
BC149C	10	BD378	70	MJE180	130	TIS43	30	2N2369A	15	2N5191	70	2N4400	20
BC153	20	BD434	32	MJE340	54	TIS44	45	2N2476	120	2N5305	20	2N4427	75
BC154	13	BD517	70	MJE370	58	TIS45	45	2N2483	28	2N5308	20	2N4898	135
BC157	10	BD695A	85	MJE371	54	TIS46	45	2N2484	30	2N5457	32	2N4901	160
BC158	10	BD696A	85	MJ490	90	TIS59	50	2N2492	50	2N5458	32	2N4921	40
BC159	11	BDY56	170	MJE520	65	TIS74	47	2N2646	48	2N5459	32	2N4922	55
BC160	28	BDY60	140	MJE521	74	TIS88	35	2N2784	55	2N5485	35	2N5102	125
BC167A	11	BF115	26	MJE2955	90	TIS90	20	2N2904	24	2N5777	45	2N5135	21
BC168C	10	BF154	29	MJE3055	70	TIS91	24	2N2905A	22	2N6388	126	2N5136	21
BC169C	10	BF158	30	MPF102	66	UC734	50	2N2906	22	2N6027	40	2N5138	20
BC170	15	BF167	25	MPF103	36	ZTX107	11	2N2907	22	2N6109	50	2N5180	38
BC172	11	BF173	24	MPF104	36	ZTX108	11	2N2907A	22	2N5879	140	2N55305	20
BC177	15	BF177	25	MPF105	36	ZTX109	11	2N2926G	10	2SD234	50	2N5308	20
BC178	14	BF178	30	MPF106	40	ZTX300	13	2N3011	24	3N128	112	2N5879	140
BC179	15	BF179	38	MPSA05	15	ZTX301	16	2N3020	33	3N140	112	2N6388	126
BC182	10	BF180	38	MPSA06	16	ZTX302	20	2N3053	19	AC187	26		
BC183	10	BF184	25	MPSA12	22	ZTX303	25	2N3054	55	AC188	26		
BC184	10	BF185	25	MPSA55	22	ZTX304	17	2N3055	48	AF139	40		
BC182L	10	BF194	11	MPSA56	22	ZTX314	24	2N3250	40	BC118	18		
BC183L	10	BF195	12	MPSU02	58	ZTX326	45	2N3252	36	BC237	10		
BC184L	10	BF196	12	MPSU05	50	ZTX341	28	2N3302	26	BC238	10		
BC187	22	BF197	12	MPSU06	50	ZTX500	15	2N3441	140	BC337	12		
BC212	9	BF198	16	MPSU52	65	ZTX501	15	2N3442	140	BCY34	75		
BC212L	9	BF199	29	MPSU55	55	ZTX502	17	2N3663	14	BCY45	50		
				MPSU56	60	ZTX503	15	2N3702	10	BCY78	19		
				MPU131	45	ZTX504	25			BD112	95		

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JACKSONS VARIABLE CAPACITORS
DILICON 100/300pF **205p**; 500pF **250p**
6:1 Ball Drive 4511/OAF **145p**
Dial Drive 4103 6:1/36:1 **775p**
Drum 54mm **55p**
0-1-365pF **325p**
00 2 365pF **395p**
0 2 365pF with slow motion Drive **450p**
00 208/176 **350p**
... with slow motion drive **410p**
C804-5pF: 10; 15: 25: 50pF **250p**
100, 150pF **335p**
'L' 3x310pF **725p**
00-3x25pF **550p**

RF CHOKES
1µH, 4.7, 10, 22, 33, 47, 100, 200, 470, 750, 1mH, 2.5, 5, 10 **30p each**
43mH, 100 **60p each**

VEROBOARD
	0.1	0.15	0.15
	(copper clad)		(plain)
2½ x 3¼"	46p	39p	24p
2½ x 5"	55p	50p	31p
3¾ x 3¾"	55p	50p	—
3¾ x 5"	62p	67p	43p
2½ x 17"	169p	135p	92p
3¾ x 17"	218p	180p	120p
4¾ x 17"	280p	—	183p

Pkt. of 36pins **20p**. Spot face cutter **105p**.
Pin insertion tool **140p**. VQ Boards **129p**.
DIP Boards **290p**. Veroblock **324p**.

VERO WIRING PEN
Plus Spool **325p**
Spare spool (wire) **80p** Combs **7p** each

FERRIC CHLORIDE
1lb bag Anhydrous **125p** + 35p P&P

DALO ETCH RESIST PEN + spare tip **75p**

COPPER CLAD BOARDS
	Fibre Glass Single-sided	Double sided	SRBP 9.5"x8.5"
6" x 6"	85p	105p	90p
6" x 12"	130p	195p	

DIL PLUGS (Headers)
14 pin **35p**; 16 pin **40p**; 24 pin **85p**; 40 pin **375p**.

Soldercon pins: 100 **55p**; 500 **250p**.

DIL SOCKETS (TEXAS) Low Wire prof. Wrap

	Low prof.	Wire Wrap
8pin	10p	25p
14pin	12p	35p
16pin	13p	48p
18pin	16p	52p
20pin	22p	65p
22pin	25p	70p
24pin	36p	78p
28pin	39p	85p
36pin	—	105p
40pin	50p	109p

EDGE CONNECTORS: (Double type)

	.1	.156
2x10 way	—	85p
2x15 way	—	99p
2x18 way	115p	120p
2x22 way	130p	135p
2x25 way	149p	160p
2x30 way	170p	—
2x36 way	194p	—
2x40 way	210	—
2x43 way	232p	—

DIODES
BA102	15
AA119	18
AAZ15	15
BY100	24
BY126	12
BY127	12
CR033	157
OA9	75
OA47	12
OA70	12
OA79	15
OA81	15
OA85	14
OA90	7
OA91	7
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IN5404	17
IS44	20
3A/100V	15
3A/400V	20
3A/600V	27
3A/1000V	30

NOISE
Z5J **180**

VARICAPS
MVAM115	140
BA102	25
BB105B	40
BB106	40
MVAM2	150

TRIACS
3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
12A800V	115
16A100V	240
16A400V	105
16A500V	120
25A500V	235
25A800V	295
T2800D	120

BRIDGE RECTIFIERS
(plastic case) p

1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/100V	72
4A/400V	79
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

ZENERS
Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V 1.3W **15p each**

SCRs Thyristors
0.6A200V	30
0.8A100V	30
0.8A200V	35
5A100V	32
5A400V	39
5A600V	43
8A300V	48
8A500V	58
8A600V	85
12A100V	42
12A300V	59
12A500V	92
12A800V	120
BT106	150
BT116	150
C106D	38
TIC44	22
TIC45	25
2N4444	140
2N5064	35

DIAC
ST2 **20**

LINEAR ICs
702	75
709 14 pin	38
709C 8 pin	35
710	67
723 14 pin	38
733	99
741 8 pin	17
741 TO5	35
747C 14 pin	78
748C 8 pin	36
753 8 pin	150
810	159
AY-1-0212	580
AY-1-1313A	660
AY-1-1320	315
AY-1-5050	190
AY-1-5051	145
AY-1-6721/6	195
AY-3-1270	840
AY-3-8500	390
AY-3-8910	850
AY-5-1224A	260
AY-5-1230	450
AY-5-1315	560
AY-5-1317A	630
AS-5-3500	510
AY-5-3507	415
AY-5-3600	1090
AY-5-4007D	650
AY-5-8100	735
CA3011	110
CA3012	150
CA3014	157
CA3018	68
CA3019	70
CA3020	186

CA3023	191	MC1312PQ	195	TBA820	70
CA3028A	80	MC1458	45	TBA920Q	260
CA3035	235	MC1495	350	TBA990Q	270
CA3036	115	MC1496L	92	TCA270Q	220
CA3043	275	MC1596	225	TCA965	120
CA3045	335	MC3302	150	TDA1004	290
CA3046	71	MC3340P	120	TDA1008	310
CA3048	214	MC3360P	120	TDA1022	575
CA3059	175	MC3401	52	TDA1024	120
CA3075	213	MC3403	135	TDA2020	320
CA3080E	65	MC3405	150	TDA1490	290
CA3081	190	MEM780	205	TDA2030	300
CA3085	95	MFC6040	97	TL061CP	54
CA3089E	215	MK50398	635	TL062CP	120
CA3090AQ	375	MM5303	635	TL064CN	150
CA3123E	150	MM5307	1275	TL071	45
CA3130	90	MM57160	620	TL072CP	90
CA3140	48	NE515	80	TL074CN	140
CA3160	95	NE518	210	TL081CP	42
ICL7106	795	NE543K	210	TL082CP	96
ICL7107	975	NE544	185	TL083CP	95
ICL8038CC	340	NE555	20	TL084CN	120
ICL8211A	150	NE556	55	UAA170	150
ICM7205	1150	NE560	325	UAA180	150
ICM7215	1050	NE561	395	XR2206	350
ICM7216AJ	1950	NE562B	410	ZN414	80
ICM7216B	1950	NE564	425	ZN424E	130
ICM7216C	1950	NE565A	120	ZN425E	415
ICM7217A	790	NE566	160	ZN1034E	200
ICM7224	785	NE567V	170	ZN1040E	685
ICM7227A	885	NE570	375		
ICM7555	89	NE571	420		
LD130	452	RC4136D	110		
LF356	90	SG3402	295		
LM10	395	S556B	275		
LM301AP	23	SL414A	150		
LM308T	70	SN76003N	240		
LM311	80	SN76013	170		
LM318S	195	SN76013ND	130		
LM324A	45	SN76018	148		
LM339	70	SN76023	170		
LM348	90	SN76023ND	130		
LM349	125	SN76033N	195		
LM379	375	SN76115N	215		
LM380	80	SN76131	110		
LM381N	145	SN76227N	95		
LM382	125	SN76477	200		
LM386	99	SN76660	120		
LM387	150	SP8629	299		
LM1458	40	TAA550	50		
LM3900	60	TAA621AX1	250		
LM3909N	70	TAA661A	155		
LM3911	130	TAA700	353		
LM3914	240	TAA960	320		
LM13600	135	TAD100	159		
M252AA	625	TBA120S	70		
M253AA	1150	TBA540Q	220		
MC663	275	TBA550Q	330		
MC1204	250	TBA641-A12			
MC1301	79	BX or BX11	250		
MC1303	88	TBA651	190		
MC1304P	260	TBA800	90		
MC1310P	175	TBA810	95		

TTL 74 (TEXAS)

7400	11	7441	74	74153	75	74190	135
7401	12	7442	71	74154	140	74191	135
7402	12	7443	120	74155	75	74192	135
7403	14	7444	116	74156	80	74193	135
7404	14	7445	118	74157	75	74194	105
7405	18	7446	132	74159	185	74195	198
7406	48	7447	99	74160	99	74196	130
7407	48	7448	99	74161	99	74197	90
7408	22	7450	20	74162	99	74198	195
7409	22	7451	20	74163	99	74221	140
7410	19	7453	20	74164	120	74246	195
7411	25	7454	20	74165	120	74247	195
7412	20	7460	20	74166	155	74248	195
7413	33	7470	41	74167	240	74249	195
7414	52	7472	31	74170	230	74251	120
7416	31	7473	40	74172	420	74265	63
7417	31	7474	34	74173	120	74273	270
7420	19	7475	56	74174	105	74278	220
7421	38	7476	41	74175	82	74279	99
7422	26	7480	55	74176	90	74283	150
7423	30	7481	120	74177	90	74284	385
7425	44	7482	75	74178	149	74285	385
7426	41	7483	94	74180	90	74290	120
7427	32	7484	113	74181	290	74293	125
7428	35	7485	121	74182	88	74297	236
7430	20	7486	33	74184	145	74298	185
7432	28	7489	215	74185	145	74365	95
7433	38	7490	57	74188	299	74366	95
7437	35	7491	85			74367	95
7438	30	7492	59			74368	95
7440	20	7493	59			74390	185
		7494	95			74393	185
		7495	75			74179	155
		7496	95			74199	198
		7497	180			74490	150
		74100	130				
		74104	62				
		74105	62				
		74107	35				
		74109	60				
		74110	54				
		74111	68				
		74112	150				
		74116	198				
		74118	99				
		74119	125				
		74120	105				
		74121	41				
		74122	55				
		74123	55				
		74125	45				
		74126	50				
		74128	74				
		74132	70				
		74136	65				
		74141	85				
		74142	195				
		74143	350				
		74144	350				
		74145	90				
		74147	180				
		74148	145				
		74150	150				
		74151	75				

74L
74L00	78
L30	80
L47	395
L75	220
L85	360
L121	195
L123	340

74S
74S00	60
S04	73
S132	350
S138	250
S158	524
S188	210
S189	158
S194	195
S195	795
S241	195
S262	895
S287	325
S288	210
S470	325
S472	1150
S475	825

74LS
LS00	13	LS73	40
LS01	13	LS74	40
LS02	15	LS75	48
LS03	15	LS76	45
LS04	20	LS78	45
LS05	23	LS83	105
LS08	23	LS85	105
LS09	23	LS86	45
LS10	20	LS90	50
LS11	32	LS91	125
LS12	32	LS92	75
LS13	40	LS93	75
LS14	75	LS95	115
LS15	40	LS96	180
LS20	21	LS107	45
LS21	32	LS109	75
LS22	40	LS112	80
LS26	48	LS113	65
LS27	45	LS114	49
LS28	48	LS122	70
LS30	24	LS123	95
LS32	30	LS124	180
LS33	39	LS125	60
LS37	39	LS126	60
LS38	39	LS132	95
LS40	28	LS136	55
LS42	80	LS138	70
LS47	85	LS139	90
LS48	120	LS145	120
LS49	120	LS147	210
LS51	25	LS148	175
LS54	30	LS151	96
LS55	70	LS153	85
LS63	150	LS155	86
		LS156	96
		LS157	76
		LS158	85
		LS160	120
		LS161	98
		LS162	110
		LS163	100
		LS164	164
		LS165	165
		LS166	166
		LS168	210
		LS169	210
		LS170	288
		LS173	105
		LS174	147
		LS175	110
		LS181	295
		LS183	298
		LS189	120
		LS190	120
		LS191	120
		LS192	125
		LS193	125
		LS194	125
		LS195	125
		LS196	120
		LS197	120
		LS199	
		LS200	345

WATFORD ELECTRONICS

THE DIGITAL FREQUENCY METER with a Difference

- 0-150MHz in 5 ranges.
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8-way SPST	**145**

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SWITCHES

TOGGLE: 2A, 250V.

SPST	**28p**
DPST	**34p**
DPDT	**38p**
4 pole on/off	**54p**

SUB-MIN TOGGLE

SP changeover	**59p**
SPST on/off	**54p**
SPST biased	**85p**
DPDT 6 tags	**70p**
DPDT centre off	**79p**
DPDT biased	**115p**

SLIDE 250V:

1A DPDT	**14p**
1A DPDT c/over	**15p**
½A DPDT	**13p**
4 pole 2-way	**24p**

PUSH BUTTON

DPDT Black Body Red, Blue, Grn., Yell.

SRL Latching	**125p**
SRM Momentary	**125p**

MINI. Non Locking

Push to Make	**15p**
Push Break	**25p**
Push to c/over	**85p**

ROTARY: Make your own multiway Switch. Adjustable Stop Shafting Assembly. Accommodate up to 6 Wafers **90p**
Mains Switch DPST to fit **40p**
Break Before Make Wafers. 1 pole/12 way, 2p/6 way, 3p/4 way, 4p/3 way, 6p/2 way **56p**
Spacer and Screen **6p**
ROTARY: (Adjustable Stop) 1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way **43p**
ROTARY: Mains 250V AC. 4 Amp **52p**

CRYSTALS

100KHz	**323**
455KHz	**383**
1MHz	**323**
1.008M	**395**
1.28MHz	**392**
1.6MHz	**323**
1.8MHz	**323**
1.8432MHz	**362**
2.4576MHz	**362**
3.2768M	**323**
3.57954M	**195**
4.000MHz	**290**
4.032MHz	**323**
4.433619M	**135**
5.0MHz	**355**
5.185M	**323**
5.24288M	**425**
6.0MHz	**323**
6.5536M	**200**
7.680M	**323**
8.0MHz	**392**
8.86723M	**323**
9.375M	**323**
10.0MHz	**323**
10.7MHz	**323**
12MHz	**392**
14.3181MHz	**300**
18MHz	**323**
18.432M	**323**
20.0MHz	**323**
27.648M	**323**
38.6667M	**350**
48.0MHz	**323**
100.00MHz	**323**

ETI Projects: Parts available for: Click Eliminator, DM900, 60W Amplifier System. Send SAE plus 5p for list.

TRANSFORMERS (Mains Prim. 220-240V)
6-0-6V; 9-0-9V; 12-0-12V 100mA **95p**
3VA: 0-6V 0-6V (PCB mouning) **150p**
8VA: 6V-.5A 6V-.5A; 9V-.4A 9V-.4A; 12V-.3A 12V-.3A; 15V-.25A 15V-.25A **215p**
12V: 4.5V-1.3A 4.5V-1.3A; 6V-1.2A 6V-1.2A; 12V-.5A 12V-.5A; 15V-.4A 15V-.4A; 20V-.3A 20V-.3A **235p** (20p p&p)
24VA: 6V-1.5A 6C-1.5A; 9V-1.3A 9V-1.3A; 12V-1A 12V-1A; 15V-.8A 15V-.8A; 20V-.6A 20V-.6A **320p** (45p p&p).
50VA: 6V-4A 6V-4A; 9V-2.5A 9V-2.5A; 12V-2A 12V-2A; 15V-1.5A 15V-1.5A; 20V-1.2A 20V-1.2A; 25V-1A 25V-1A; 30V-.8A 30V-.8A **365p** (50p p&p).
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2.5A 20V-2.5A; 30V-1.5A 30V-1.5A; 40V-1.25A 40V-1.25A; 50V-1A 50V-1A **695p** (60p p&p). (N.B. p&p charge to be added above our normal postal charge.)

ALUM. BOXES WITH LID

	p
3x2x1"	**55**
2¼x5¼x1½"	**75**
4x4x1½"	**75**
4x2¾x1½"	**75**
4x5¼x1⅛"	**90**
4x2½x2"	**80**
5x4x2"	**107**
6x4x2"	**110**
7x5x2½"	**145**
8x6x3"	**185**
10x7x3"	**240**
10x4¼x3"	**228**
12x5x3"	**230**
12x8x3"	**275**

PANEL METERS

FSD 60x46x35mm
0-50µA
0-100µA
0-500µA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
445p each

4¼x3¼x1½"
0-50µA
0-100µA
0-500µA
595p each

VOLTAGE REGULATORS

1A	TO3	+ ve		—ve	
5V	7805	**175p**		7905	**220p**
12V	7812	**175p**		7912	**220p**
15V	7815	**175p**			—
18V	7818	**175p**			—
1A	TO220	Plastic Casing			
5V	7805	**60p**		7905	**65p**
12V	7812	**60p**		7912	**65p**
15V	7815	**60p**		7915	**65p**
18V	7818	**60p**		7918	**65p**
24V	7824	**60p**			
100mA	TO92 Plastic Casing				
5V	78L05	**30p**		79L05	**65p**
6V	78L62	**30p**			—
8V	78L82	**30p**			—
12V	78L12	**30p**		79L12	**65p**
15V	78L15	**30p**		79L15	**65p**

LM300H	**170p**	LM327	**270p**
LM305H	**140p**	LM723	**38p**
LM309K	**135p**	TAA550	**50p**
LM317K	**350p**	TBA625B	**95p**
LM323K	**550p**	TDA1412	**150p**
LM325N	**240p**	78HO5 +5/5A	**595p**
LM326N	**240p**	78HG 5 TO +25V	**650p**

OPTO

LEDs with Clips

TIL209 Red	**13**
TIL211 Grn.	**17**
TIL212 Yel.	**18**
TIL220 .2" Red	**14**
.266 Green, Yellow or Amber	**18**
Square LEDs, Red, Green, Yellow	**36**
LD271 Infra Red	**40**
SFH205 Detector	**90**
TIL32 Infra Red	**58**
TIL78 Detector	**70**
BARGRAPH, Red 10 segments	**225**
LS400	**255**
OCP71	**120**
ORP12	**63**
ORP61	**85**
2N5777	**45**

ISOLATORS

IL74	**48**
TIL111/2	**85**
TIL114	**95**
TIL117	**110**
Bargraph	**225**

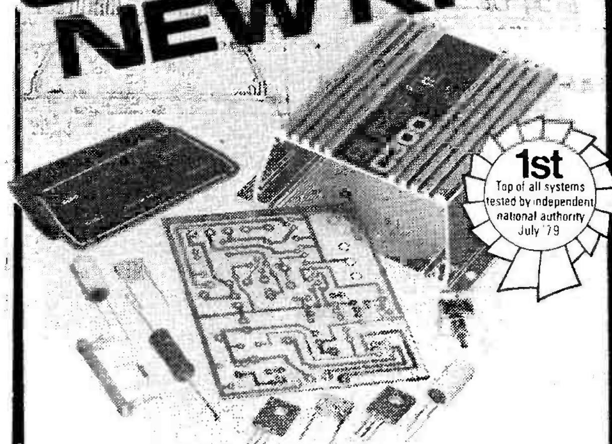
7 Segment Displays

TIL307	**675**
TIL312 .3" CA	**105**
TIL313 .3" CC	**105**
TIL321 .5" CA	**115**
TIL322 .5" CC	**115**
DL704 .3" CC	**99**
DL707 .3" CA	**99**
DL747 .6" CA	**180**
.8" Orange CA	**250**
FND357 Red	**120**
.3" Green CA	**150**
.6" Green CA	**215**
.3" ± Red CA	**150**
.3" ± Green CA	**150**
LCD 3½ Digit	**875**
LCD 4 Digit	**975**

LS202	**345**	LS352	**185**	4011	**24**	4050	**48**	4162	**125**	4520	**115**
LS221	**120**	LS353	**185**	4012	**24**	4051	**80**	4163	**125**	4521	**250**
LS240	**225**	LS355	**65**	4013	**45**	4052	**80**	4174	**130**	4522	**150**
LS241	**225**	LS366	**65**	4014	**85**	4053	**80**	4175	**120**	4526	**150**
LS242	**232**	LS367	**65**	4015	**85**	4054	**130**	4194	**125**	4527	**160**
LS243	**232**	LS368	**65**	4016	**42**	4055	**135**	4408	**790**	4528	**120**
LS244	**225**	LS373	**180**	4017	**82**	4056	**135**	4409	**790**	4529	**175**
LS245	**270**	LS374	**180**	4018	**88**	4057	**1900**	4410	**790**	4530	**89**
LS247	**135**	LS375	**150**	4019	**48**	4059	**575**	4411	**1020**	4531	**165**
LS248	**135**	LS377	**199**	4020	**99**	4060	**130**	4412F	**1520**	4532	**140**
LS249	**135**	LS378	**185**	4021	**105**	4061	**1225**	4412V	**1520**	4534	**575**
LS251	**130**	LS379	**215**	4022	**95**	4062	**995**	4415F	**850**	4536	**395**
LS253	**130**	LS384	**50**	4023	**25**	4063	**120**	4415V	**850**	4538	**160**
LS257	**115**	LS385	**420**	4024	**75**	4066	**58**	4419	**320**	4539	**135**
LS258	**120**	LS386	**85**	4025	**25**	4067	**430**	4422	**570**	4541	**150**
LS259	**160**	LS390	**140**	4026	**180**	4068	**26**	4432	**1050**	4543	**175**
LS261	**450**	LS393	**140**	4027	**48**	4069	**26**	4435	**1050**	4549	**296**
LS266	**75**	LS395	**210**	4028	**82**	4070	**30**	4440	**999**	4553	**440**
LS273	**180**	LS396	**199**	4029	**105**	4071	**25**	4450	**350**	4554	**175**
LS275	**320**	LS398	**275**	4030	**60**	4072	**25**	4451	**350**	4555	**85**
LS279	**88**	LS399	**230**	4031	**225**	4073	**25**	4452		4556	**75**
LS280	**250**	LS445	**140**	4032	**125**	4075	**25**	4490F	**750**	4557	**425**
LS283	**190**	LS447	**195**	4033	**175**	4076	**99**	4490V	**750**	4558	**130**
LS290	**130**	LS490	**150**	4034	**210**	4077	**48**	4501	**28**	4559	**290**
LS293	**130**	LS668	**105**	4035	**125**	4078	**30**	4502	**125**	4560	**235**
LS295	**215**	LS669	**105**	4036	**365**	4081	**88**	4503	**75**	4561	**95**
LS298	**215**	LS670	**270**	4037	**115**	4082	**28**	4506	**75**	4562	**595**
LS299	**420**	LS673	**750**	4038	**118**	4085	**90**	4507	**60**	4566	**190**
LS300	**175**	LS674	**850**	4039	**360**	4086	**90**	4508	**325**	4568	**299**
LS302	**175**	**CMOS**		4040	**105**	4089	**150**	4510	**99**	4569	**250**
LS320	**270**	4000	**18**	4041	**80**	4093	**89**	4511	**150**	4572	**48**
LS323	**450**	4001	**18**	4042	**80**	4094	**240**	4512	**98**	4580	**595**
LS324	**200**	4002	**24**	4043	**95**	4095	**105**	4513	**225**	4581	**350**
LS325	**320**	4006	**92**	4044	**95**	4096	**105**	4514	**265**	4582	**150**
LS326	**330**	4007	**22**	4045	**175**	4097	**350**	4515	**299**	4583	**125**
LS327	**315**	4008	**82**	4046	**130**	4098	**115**	4516	**120**	4584	**64**
LS346	**185**	4009	**40**	4047	**98**	4099	**190**	4517	**450**	4585	**140**
LS347	**150**	4010	**48**	4048	**65**	4160	**125**	4518	**105**	40106	**95**
LS348	**190**			4049	**45**	4161	**125**	4519	**70**		

2 SUPERB NEW KITS!

Special Offer. £2 OFF!



C300/ES200

high performance electronic ignition, to add power, economy, reliability, sustained smooth peak performance, instant all weather starting, to your car.

Surefire has sold in its thousands in ready made form from big name accessory firms, but it is now available in quality kit form to fit all vehicles with coil ignition up to 8 cylinders.

ES200. A high performance inductive discharge ignition incorporating a power integrated circuit (special selection): electronic variable dwell circuit (maximises spark energy at all speeds): pulse processor (overcomes contact breaker problems). Coil governor (protects coil). Long burn output. Negative earth only. Compatible with all rev. counters.

C300. In it's ready built form (C3000) it came top of all systems tested by an independent national authority July '79. A high energy capacitive discharge ignition incorporating a high output short circuit proof inverter, top grade Swedish output capacitor, pulse processor circuit, transcient overload protection. Fast rise bidirectional output ideal for fuel injection, sports carburation, oily engines. Compatible with most rev. counters. (Low cost adaptors available for rare cases. Application list enclosed with each kit. Note: Vehicles with Smiths Jaeger rev. counters code RVI on dial will require adaptor type TCI).

What's in the kits. Surefire's own precision anodised aluminium extruded case. P.C. mounted security changeover switch, static timing light. Special selection Motorola semi-conductors. Capacitors, resistors etc. selected after 5 years experience. Glass fibre pcb, solder, complete down to last washer.
Fully illustrated comprehensive instructions and full technical back up service.

SUREFIRE ELECTRONIC IGNITION

Dept. ETI6

Suretron Systems (UK) Ltd.
Piccadilly Place, London Rd., Bath BA1 6PW. Tel: Bath (0225) 23194

Name

Address

Phone order with Access Barclaycard VAT and P & P inc

Quantity required

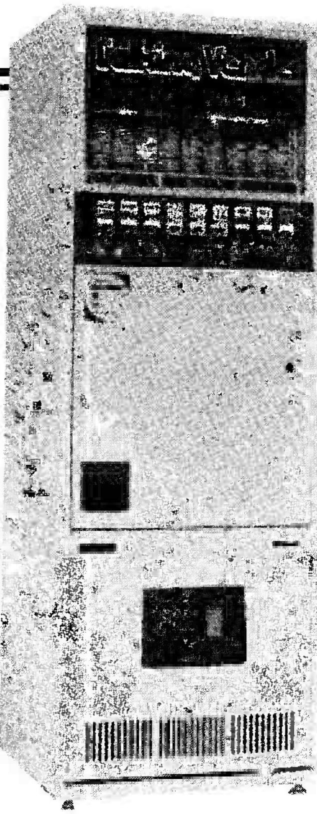
ES200: Neg ⏚	~~£13.95~~	£11.95	
C300: Pos ⏚	~~£17.95~~	£15.95	
C300: Neg ⏚	~~£17.95~~	£15.95	
Tacho Adapt. TC1		£3.90	

I enclose chq PO's
£
Chq No

DIGEST

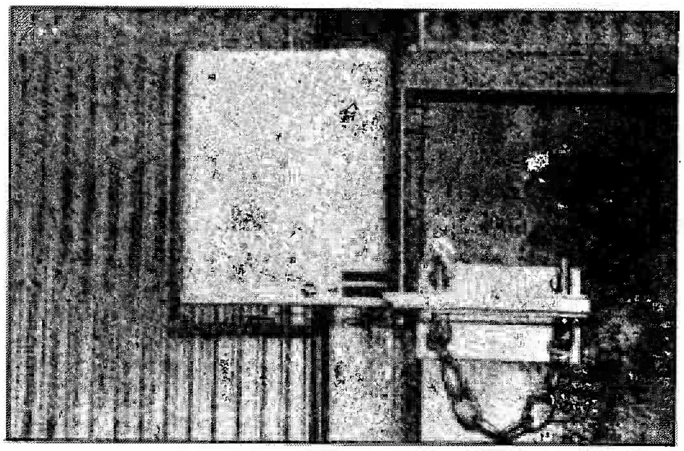
Vending Over Backwards

A source of constant frustration to many people is vending machines. Invariably they have run out of what you want, or give you chicken soup flavoured coffee, or refuse to refund your money. The average vending machine certainly bears signs of the dislike its customers have for it, mostly in the form of dents, framed by boot marks. The wonderfully inscrutable Japanese have, of course, developed a cure in the form of the machine pictured here — not particularly beautiful to look at, but with a heart of gold. When the customer approaches it, a sensor picks up the infra-red rays emitted by him, and a 'soft female voice' says "Welcome" and lists the merchandise in the machine. It also tells the customer when there is no change available, when items are out of stock and reminds him if he has not fed enough money into it for the item he requires. Finally the machine says a cheerful "Thank you" and reminds the buyer to pick up his change. This machine, although a novelty at the moment, has quite interesting possibilities, but there are no marketing plans for it as yet. Wouldn't it be nice to walk away from a vending machine, clutching exactly what you asked for and with the echoes of that warm welcome ringing in your ears? The system was developed by Mitshushita Reiki, a Mitshushita Electric subsidiary, which specialises in refrigeration equipment.



Solid Security

This is Clarke's Instruments Ltd motor driven door lock type 838. It is a remotely operated door lock, which is last to be released on strong doors that give public access to high security areas. After the dead locks have been unlocked by key, the door is held by the motor lock, whose double shear action gives 4 to 6 tonnes of shear strength. When relocking the door, the motor lock is first to be operated. The new microswitching system ensures greater reliability of operation and permits positive indication of full lock closure. Automatic locking of the door each time it closes can also be arranged. It is mains operated and needs no other power supply, great if you don't live in a high risk area for power cuts, although there is an integral manual emergency release on the inside of the door — unless of course, you're trying to get in! Further information is from Clarke Instruments Ltd, 91a High Street, Camberley, Surrey GU15 3RN.



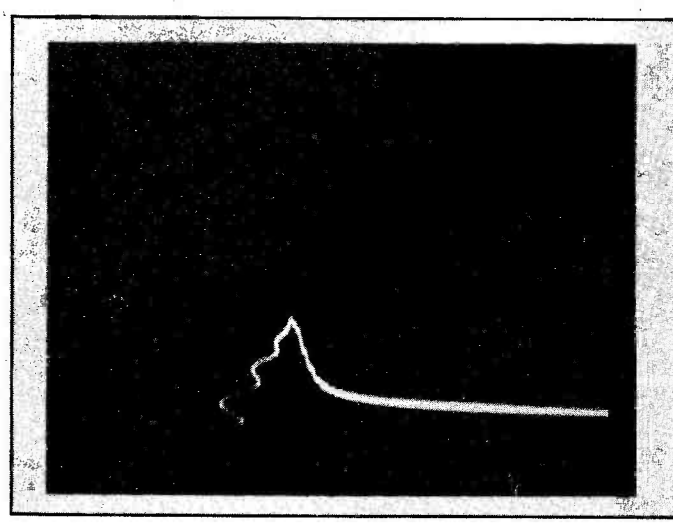
Ex-Static

'Discguard' from Metrosound is an everlasting anti-static treatment for records. In the kit you find a spray pump, a bottle of 'special' fluid and a record cleaner for buffing.

The makers claim that there is no detectable change in sound quality except as we found that the treble sounds cleaner, as it should. We extensively tested it of course, sneakily spraying some of the Editor's prized record collection, and then waiting for a response! In fact there were no adverse reactions, so we think this kit could prove quite useful to audiophile freaks. For £4.50 there is sufficient fluid in the kit to treat both sides of 40 LP records. For further information contact Metrosound, 4/10 North Road, London N7 9HN.

Doctor Who

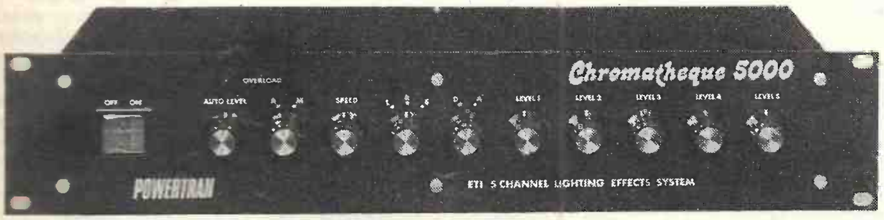
One of our readers, Mr. S. Knowles of Hampshire, sent us a scope picture he took whilst designing with a Textronix 7403 on 500 nS/div with x10 expand. It seems he was looking for a pulse, but he may well have discovered the secret of time travel!



CHROMATHEQUE 5000

POWERTRAN

5 CHANNEL LIGHTING EFFECTS SYSTEM



Panel size 19.0" × 3.5". Depth 7.3"

COMPLETE KIT

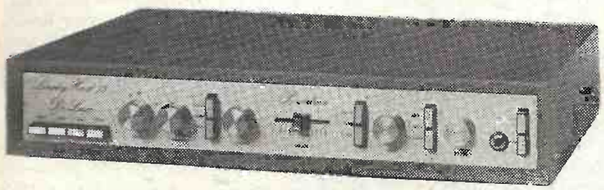
ONLY

£49.50 + VAT!

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward.

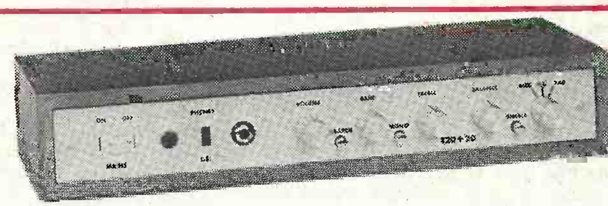
Kit includes fully finished metalwork, fibreglass PCB controls, wire, etc. — Complete right down to the last nut and bolt!

All kits also available as separate packs (eg PCB, component sets, hardware sets etc). Prices in our FREE CATALOGUE.



DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £99.30 + VAT

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring whilst distortion is less than 0.01%.



T20+20 20W STEREO AMPLIFIER £33.10+VAT

This kit, based upon a design published in Practical Wireless, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers. A 30-watt version of this kit (T30+30) is also available for **£38.40** + VAT.

Above 2 kits are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cable, nuts, bolts, etc and full instructions — in fact everything! Matching TUNERS and CASSETTE DECK — see our free catalogue!

BLACK HOLE

LAST MONTH'S FRONT COVER FEATURE!

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments, offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a 'spacey' feel to the sound achieved by delaying the input signal and mixing it back with the original. Notches (HOLES), introduced in the frequency response, move up and down as the time delay is modulated by the chorus sweep generator. An optional double chorus mode allows exciting antiphrase effects to be added. The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity input, has high signal/noise ratio obtained by an audio compander and is mains powered — no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure.

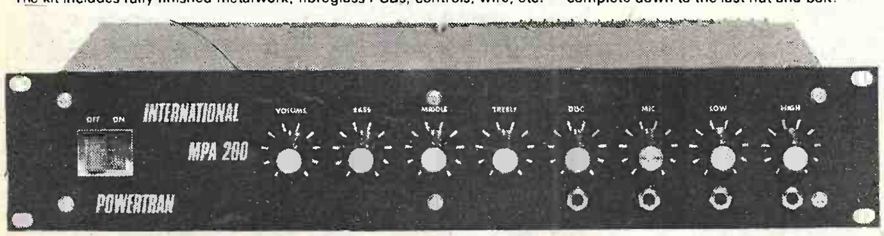
COMPLETE KIT ONLY £49.80 + VAT (single delay line system)

De Luxe version (dual delay line system) also available for **£59.80 + VAT**

MPA 200

100 WATT (rms into 8Ω) MIXER/AMPLIFIER

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features adaptable input mixer which accepts a wider range of sources such as microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward.
The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.



Panel size 19.0" × 3.5". Depth 7.3"

COMPLETE KIT

ONLY

£49.90 + VAT!

MATCHES THE CHROMATHEQUE 5000 PERFECTLY!

PRICE STABILITY: Order with confidence. Irrespective of any price changes we will honour all prices in this advertisement until July 31st, 1980, if this month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.
EXPORT ORDERS: No VAT. Postage charged at actual cost plus £1 handling and documentation.
U.K. ORDERS. Subject to 15%* surcharge for VAT. No charge is made for carriage. *or at current rate if changed.
SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.
SALES COUNTER: If you prefer to collect kit from the factory, call at Sales Counter. Open 9 a.m.-12 noon, 1-4.30 p.m. Monday-Thursday.

NEW FACTORY ON SAME INDUSTRIAL ESTATE ADDRESS AND PHONE NUMBER UNCHANGED

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

POWERTRAN ELECTRONICS

PORTWAY INDUSTRIAL ESTATE ANDOVER, HANTS SP10 3NM

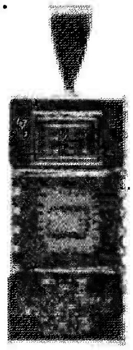
ANDOVER (STD 0264) 64455

SPECIAL PENDANT OFFER

All ETI readers are kind, generous people with an impeccable sense of taste. Witness their choice of electronics magazine. With this in mind, we thought we would give them a chance to exercise all three attributes simultaneously by purchasing an excellent gift for the woman (or women) in their life.

Our pendant contains a (working — but what a shame to ruin it by wiring!) chip with quartz window, beautifully clasped in either silver or gold, depending just HOW generous you're feeling.

The price is pretty tasteful too and as the holder is emblazoned with the ETI logo, there is no better way of advertising the extent of your appreciation of the finer things in life.



In silver : **£30** all inc.

gold : **£69** all inc.

To. ETI Pendant Offer, Modmags Sales Office, 145 Charing Cross Road, London WC2H 0EE.

Please send me . . . . silver/gold pendants. I enclose cheque/PO payable to Modmags for . . . .

Name . . . .

Address . . . .

. . . .

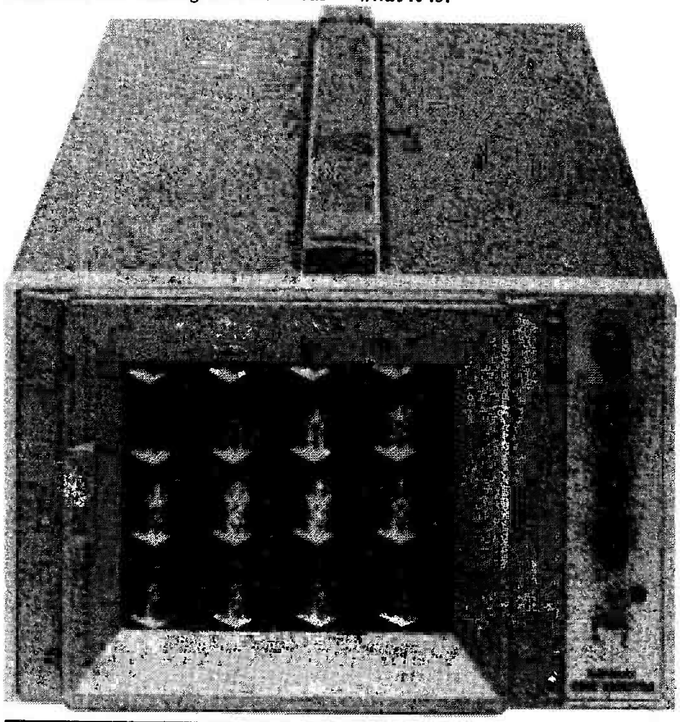
. . . .

Allow 21 days for delivery.

Invasion Monitor?

Here is the model 606B display monitor from Tektrónix. It is a high resolution display for anyone needing critical sharpness for displays or display photographs. This monitor gives a spot size of only 0.079cm, and the manufacturers are aiming this at areas such as medical multi-imaging and electron microscopy. For further information contact Tektronix UK Ltd, Beaverton House, PO Box 69, Harpenden, Hertfordshire.

But what we'd like to know is what is being displayed on the screen! A free subscription to whoever out there can tell us what it is!



Instant Surgery

This may look like the surgical equipment of a mad doctor, but we are assured that this isn't its only function. Alternatively it can be used for DIP IC insertion and extraction. The kit has extractors for 14-16 pin devices, 24-40 pin chips plus inserters for 14-16, 24-28 and 36-40 pin ICs. All the surfaces that could engage conductive surfaces are CMOS safe. It is available from OK Machine & Tool (UK) Ltd, Dutton Lane, Eastleigh, Hants SO5 4AA, and costs £22.35, a small price to pay for budding Dr. Frankensteins.

SOUTHEAST ENGLAND'S ELECTRONICS CENTRE

OLIVETTI TE318

ONLY
£130
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+ VAT

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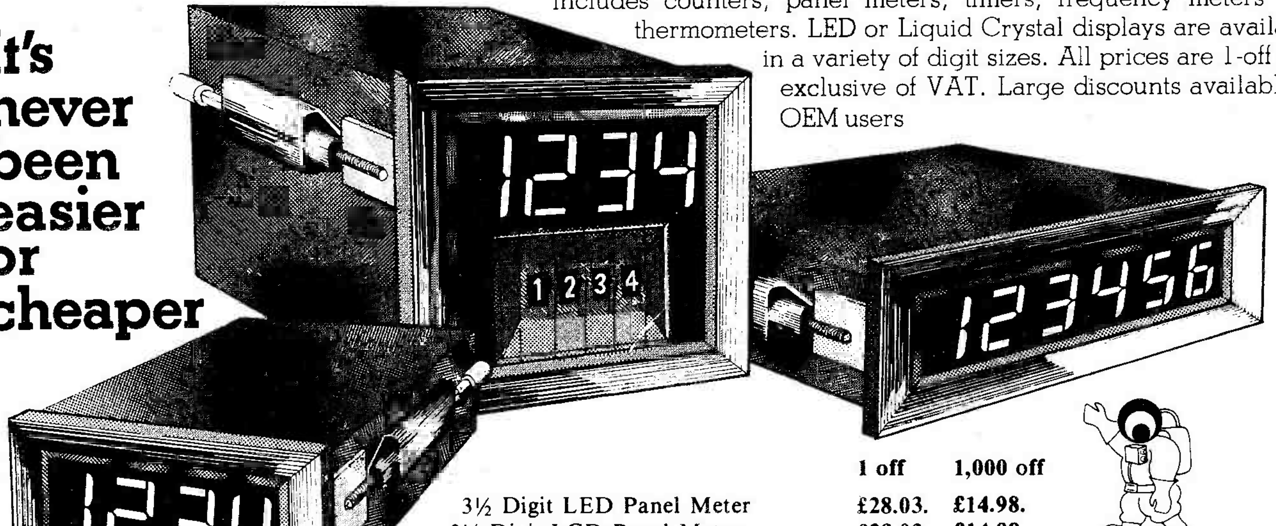

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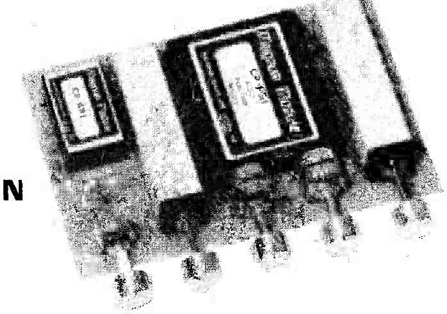
STEREO FUNCTION MODULE CP-FG1



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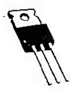

400V Plastic Case (Texas)

3A	49p	16A	90p
8A	58p	20A	165p
12A	85p	25A	190p
6A with trigger			80p
8A isolated tab			65p
Diac			18p

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Based on the ICL7106. This kit contains a PCB, resistors, presets, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer, using a single diode as the sensor. Requires a 3mA 9V supply (PP3 battery) **£20.75**

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LEDs

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0.1" Red	9p
0.1" Green	12p
0.1" Yellow	12p
0.2" Red	9p
0.2" Green	12p
0.2" Yellow	12p
0.2" clips	3p
Rectangular Red	18p
Rectangular Green	20p
Rectangular Yellow	21p

MINI KITS

These KITS form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB short instructions and all components.

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Uses LM3911 IC to sense temperature (80 C max.) and triac to switch heater. PCB (4 cm sq.) potentiometer, plus all other components included with instructions.
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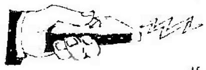
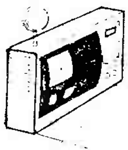
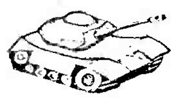
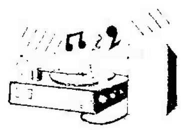
DL307 Red 0 3" c a pin comp DL707	70p
DL847 Red 0 8" (pin comp DL747) c a	£1.80
DL850 Red 0 8" c c (pin comp DL750)	£1.80
DL727 Dual 0 5" c a Red	£1.50

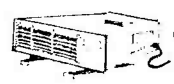
INFRA RED REMOTE CONTROL











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Data sheets (per device) 05

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LD300K - LIGHTDIMMER KIT **£2.90**

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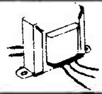

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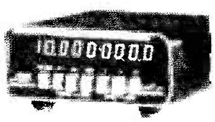

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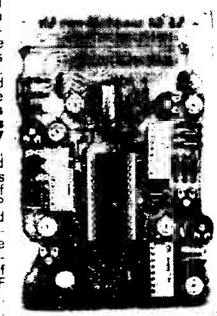

The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477** Sound Chip, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" x 3" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosion, Phaser Guns, Steam Trains,** or almost an infinte number of **other sounds.** The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included.)

COMPLETE KIT ONLY £12.50
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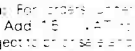

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MV57164 **£2.25**

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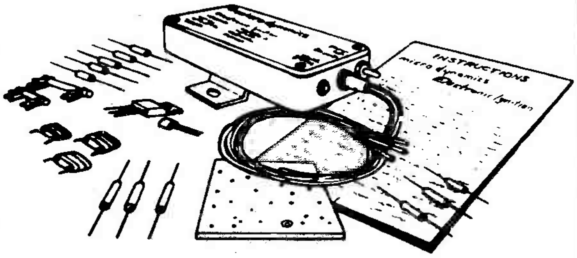
A Professional Electronic Ignition — in kit form



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BUY A COMPLETE RANGE OF COMPONENTS AND THESE PACKS WILL HELP YOU

ALL PACKS CONTAIN FULL SPEC. BRAND NEW MARKED DEVICES — SENT BY RETURN OF POST VAT INCLUSIVE PRICES.

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Exclusive Greenweld design — better spec. than anything on the market being offered at the price. Panel 110×82×33mm high contains all components including bridge rectifier and smoothing capacitor. Ready built and tested — just add a 30V 2A transformer and two pots for a fully variable voltage and current supply.

SPEC
Output voltage 0-28V
Output current 20mA-2A
Source Impedance OR1
Open circuit ripple 10mV

Send SAE for full details of the many ways this useful module can be used, together with price list of parts for various options. Only **£6.75**

TRANSISTOR PACK K516

Take advantage of this unbelievable offer!!
Small signal NPN/PNP transistors in plastic package at an incredibly low, low price!! Almost all are marked with type number — almost all are full spec. devices. Some have bent leads. Over 30 different types have been found by us including BC184/212/238/307/328, BF196/7, ZTX107/8/9/342/450/550, etc. Only available as a mixed pack at **£3** per 100; **£7** per 250, **£25** per 1000

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See last month's ad for other items

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4096 bit dynamic RAM with 300ns access time; 470ns cycle time; single low capacitance high level clock i/p; fully TTL compatible; low power dissipation. Supplied with data **£2.75.**

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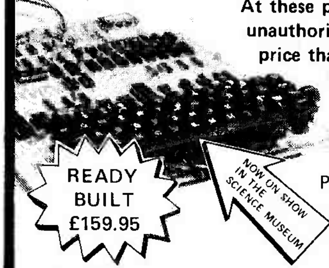
AC187K	.20	BF757	.27
AD161/2	.45	BFR40	.17
BC107	.07	BFW43	.32
BC108	.08	BFY17	.19
BC109	.07	BYF50	.13
BC114	.06	BFY51	.13
BC117	.07	BFY52	.13
BC118	.05	BFY56A	.16
BC119	.14	BFY56A	.16
BC125	.06	BFY64	.15
BC139	.14	BR101	.28
BC147	.05	BRX48	.095
BC148	.05	BRY46	.17
BC148B	.05	BSX20	.075
BC149	.05	BSY38	.12
BC159	.05	BSY56	.10
BC168C	.055	BSY82	.19
BC169C	.055	BSY85	.23
BC172C	.05	BSY95A	.065
BC177	.07	BT121	.90
BC182B	.045	BU205	.60
BC183B	.045	BU206	.60
BC184L(TO5)	.045	BU407	.60
BC212	.045	CV7001	.23
BC212B	.045	CV7493	.19
BC213L	.045	CV7588	.18
BC214L(TO5)	.045	ME0475	.055
BC237	.05	MJE340	.22
BC237B	.05	MPS2369	.08
BC237C	.055	MPS3638A	.06
BC238B	.05	MPS6515	.06
BC239B	.055	MPSA66	.24
BC252	.07	OC44	.19
BC256A	.05	OC45	.17
BC308	.05	OC139	.26
BC308B	.055	OCP71	.63
BC320	.07	PBC108	.065
BC328	.07	TIP32	.22
BC337	.07	TIP41A	.28
BC348	.07	TIP42A	.29
BC351	.14	TIP2955	.46
BC413	.05	TIP3055	.45
BC485B	.06	TIS91	.12
BC486A	.06	ZTX107	.06
BC546B	.06	ZTX212	.06
BC547C	.055	ZTX214	.06
BC548B	.05	ZTX303	.07
BC556A	.06	ZTX311	.07
BC556B	.06	ZTX313	.06
BC557A	.06	ZTX341	.07
BC737	.07	ZTX450	.06
BCX32	.05	ZTX501	.96
BCX33	.05	ZTX503	.07
BCY32	.12	ZTX550	.06
BCY71	.11	2N1021	.94
BCY72	.10	2N1132	.16
BD112	.64	2N1377	.62
BD131	.18	2N1711	.18
BD132	.18	2N1893	.16
BD133	.18	2N2369	.12
BD137	.20	2N2646	.34
BD138	.20	2N2894	.12
BD181	.40	2N2926Y	.045
BD184	.45	2N2926R	.045
BD246	.30	2N3053	.13
BD278A	.32	2N3064	.36
BD433	.32	2N3055	.30
BD525	.24	2N3442	.78
BD526	.24	2N3583	.42
BD543A	.30	[illegible]	.80
BD695A	.45	[illegible]	.045
BD696A	.45	[illegible]	.08
BF173	.13	[illegible]	.08
BF181	.15	[illegible]	.06
BF195	.055	[illegible]	.06
BF196	.055	[illegible]	.06
BF197	.055	[illegible]	.20
BF198	.055	[illegible]	.22
BF241	.055	[illegible]	.17
BF255	.075	[illegible]	.06
BF257	.19	[illegible]	.08
BF258	.20	[illegible]	.16
BF324	.13	[illegible]	.05
BF337	.19	[illegible]	.62
BF355	.18	[illegible]	.43
BF394	.055	[illegible]	.45
BF414	.065		
BF450	.095		
BF451	.09		

Send SAE for latest bulk buyers list.

Superboard II

8k MICROSOFT BASIC 4k RAM



At these prices why waste time and money on unauthorised kit copies? Just a little more in price than Sinclair for a whole lot more and fully expandable !

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NOW ON SHOW IN THE SCIENCE MUSEUM

610 Expansion Board 8k RAM ONLY £159.95 + VAT

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Challenger IP-Metal Cased, Superboard, PSU modulator ONLY £208 +VAT

NEW 50Hz version - NO FLICKER

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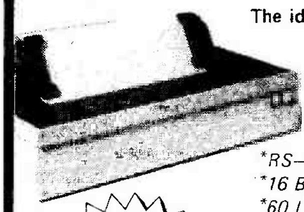
80 COLUMN HIGH PERFORMANCE IMPACT PRINTER



The ideal companion for PET, APPLE, TSR80, Exidy, Superboard, Compukit, Ohio Challengers and most micro's

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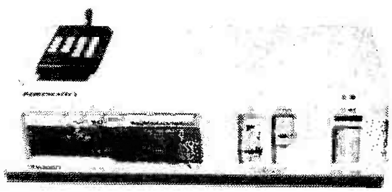

Works on any TV (RF in RF out), remote control unit, Teletext colours, CEEFAX and ORACLE via 6 preset tuner, enlarge facility, Time on, Time off facility, reveal button - for quiz games hold button.

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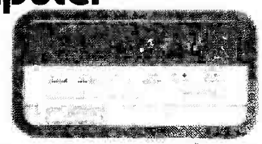

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Accuracy: Time: ± 30 secs/month
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Takes only about 2 hours to fit

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1nF to 68nF	6p
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1uF: **14p** 2.2uF: **20p**	
3.3uF: **22p** 4.7uF: **24p**	
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1/25 to 47/25	6p
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2N5777	55p
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DL707	110p
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24 pin	21p
28 pin	25p
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1A/200V	32p
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7812/15	70p
7818/24	70p
7905	80p
7912/15	80p
7918/24	80p
DIODES	
BY127	10p
OA47	8p
OA91	8p
OA200	6p
OA202	9p
1N916	5p
1N4148	4p
1N4001/2	4p
1N4003	5p
1N4004/5	6p
1N4006/7	8p
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CA3046	70p
CA3054	40p
CA3080	75p
CA3130	88p
CA3140	40p
LF351N	40p
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LM318N	200p
LM324N	57p
LM339N	60p
LM348N	90p
LM377N	175p
LM380N	90p
LM381N	140p
LM382N	130p
LM1310N	150p
LM3900N	55p
LM3909N	78p
MC1496P	85p
NE531	110p
NE555	25p
NE556	60p
NE566	140p
TBA641B	200p
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TBA810S	110p
ZN414	100p
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CMOS A	
4000	15p
4001/2	20p
4006	77p
4007	15p
4008	80p
4009	40p
4010	44p
4011/2	22p
4013	46p
4014	80p
4015	75p
4016	44p
4017	60p
4018	80p
4019	45p
4020	95p
4021/2	85p
4023	22p
4024	58p
4025	22p
4027	45p
4028	70p
4029	82p
4030	60p
4035	107p
4041	75p
4042	70p
4043/4	88p
4047	92p
4048	55p
4049	35p
4050	44p
4066	50p
4069	20p
4070/1	22p
4072/3	20p
4081/2	22p
4086	80p
4510	100p
4511	100p
4516	100p
4518	100p
4520	100p
4528	100p

TTL	
7400/1	13p
7402/3	13p
7404/5	13p
7406/7	20p
7408/9	13p
7410	13p
7411	18p
7412	15p
7413	27p
7414	31p
7416/7	25p
7420	14p
7421/2	17p
7427	20p
7428	25p
7430	14p
7432	18p
7433	24p
7437/8	15p
7440	10p
7441	56p
7442	51p
7443	70p
7444	80p
7445	75p
7446	65p
7447	55p
7448	62p
7450	10p
7451/3	13p
7454	10p
7460	13p
7470	20p
7472	21p
7473	28p
7474	24p
7475	34p
7476	30p
7480	25p
7485	80p
7486	25p
7490	36p
7491	45p
7492	30p
7493	35p
7494	50p
7495	40p
7496	50p
7497	200p
74100	70p
74105	43p
74107	20p
74109	40p
74110	40p
74118	90p
74121	26p
74122	30p
74123	45p
74125/6	37p
74132	48p
74141	50p
74145	55p
74150	78p
74151	48p
74153	43p
74154	90p
74155	46p
74156	40p
74157	43p
74160	64p
74161	55p
74162/3	64p
74164	78p
74165	70p
74166	85p
74173/4	70p
74175	60p
74176	64p
74177	60p
74180	50p
74181	80p
74182	45p
74190	75p
74191	70p
74192	50p
74193	64p
74194	70p
74195	57p
74196	100p
74197	80p
74198	135p
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TRANSISTORS	
AC126/7	23p
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AC153	30p
AC176	23p
AC187/8	23p
AD149	70p
AD161/2	40p
AF114	30p
AF124	40p
AF125	35p
AF126/7	37p
AF139	40p
AF239	42p
BC107/8	10p
BC109	10p
BC117	20p
BC142/3	30p
BC147/8	9p
BC149	9p
BC157/8	9p
BC159	9p
BC167	9p
BC169C	13p
BC171	10p
BC173	8p
BC177/8	18p
BC179	18p
BC182/3	11p
BC184	11p
BC186	30p
BC207/9	13p
BC212/3	11p
BC214	11p
BC214L	11p
BC238	18p
BC261B	20p
SUPER BC478	
BC301/3	32p
BC328	17p
BC338	17p
BC461	37p
BC477	23p
BC478/9	23p
BC547/B	12p
BC549	12p
BC557/8	14p
BC559	14p
BCY70	17p
BCY71/2	17p
BD115	55p
BD121/3	75p
BD124	81p
BD131 TO	
BD140	42p
BF178	27p
BF180	34p
BF181	8p
BF183	34p

BF184	25p
BF185	25p
BF194/5	10p
BF196/7	10p
BF224B	14p
BF244B	35p
BF258	32p
BF259	32p
BFR39	30p
BFR40	20p
BFR79	30p
BFR80	20p
BFX29	25p
BFX84	25p
BFX87/8	28p
BFY50	22p
BFY51/2	22p
BFY53	10p
BRY39	50p
BSX19	12p
BSX20	22p
BU205	150p
BU208	210p
MJ2955	110p
MJE340	60p
MJE2955	110p
MJE3055	85p
MPF102/3	40p
MPF104/5	40p
MPF106	45p
MPSA06	20p
MPSA56	26p
MPSU06	61p
OC28	92p
OC35	92p
OC72	20p
TIP29	40p
TIP29B	48p
TIP30	40p
TIP30B	48p
TIP31	40p
TIP32	40p
TIP33	65p
TIP33C	70p
TIP34A	90p
TIP35B	240p
TIP36B	280p
TIP41A	60p
TIP42A	60p
TIP2955	70p
TIP3055	55p
ZTX107/8	13p
ZTX109	13p
ZTX300	14p
ZTX301	16p
ZTX302	18p

ZTX303	19p
ZTX304	22p
ZTX311	18p
ZTX341	22p
ZTX500/1	15p
ZTX502	21p
ZTX503	17p
ZTX504	23p
2N696	35p
2N697	28p
2N698	40p
2N706	19p
2N914	22p
2N918	35p
2N1131	20p
2N1132	13p
2N1302	35p
2N1303	40p
2N1304	50p
2N1306	30p
2N1308	22p
2N1613	25p
2N1711	13p
2N1893	32p
2N2222A	23p
2N2217	22p
2N2219	23p
2N2369	20p
2N2484	30p
2N2646	55p
2N2904	23p
2N2905	23p
2N2906	23p
2N2907	23p
2N2926G	11p
2N3053	22p
2N3054	40p
2N3055	45p
2N3442	140p
2N3702 TO	
2N3711	11p
2N3772	150p
2N3773	250p
2N3819	22p
2N3820	40p
2N3823	75p
2N3866	75p
2N3903/4	15p
2N3905/6/	15p
2N4037	52p
2N4058/9	10p
2N4060/1	10p
2N5457/8	36p
2N5459	36p
2N6027	40p

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Greenbank

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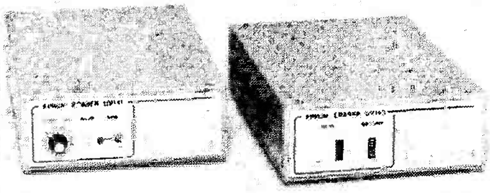
Wirral, Merseyside L62 5AG
(Tel: 051-645 3391)

TERMS. VAT. CWO. Cheques etc payable to Greenbank Electronics. Add VAT to all prices at 15% except where stated otherwise. Post etc: UK 35p (+5p VAT = 40p) per order. Export: NO VAT but add 35p (Eire), 75p (Europe) and £2.50 elsewhere. Access. Barclaycard. Visa. telephoned orders accepted. (Polys, universities, govt depts, etc can telephone their orders for immediate despatch on account.)

BARCLAYCARD

UV EPROM ERASERS



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

Features:

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

Supplied complete with mains plug and flex.

Model UV141. Price £77.70

Also available without timer as

Model UV140: Price £61.20

PROM WASHING SERVICE: 50p each prom

COMPUTER BOARDS

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

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

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

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

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

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

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

We do not propose to defend the (relatively) small ... er of bus connexions (42), against such standards as the 'S100' ... bus. The S-100 bus, as it originated in America, is bigger ... re expensive. In the same way, a Ford 'Granada' ... rd 'Cortina', but it doesn't mean a Cortina ... ws — it may even be better value!

The Inter... it 3U' 19" rack ... nd a variety of ... stomising their ... the firm 'R.S. ... ity.) ... to compete ... e purchaser ...) assembly ... computer ... virtually iden... The ... nt. You choos... will be used ... s, or indeed ... s not permit y... re to offer gui... your needs, in ... As mentio... he design of ... arrangemen... obsolete ove... have been pro... pattern which ... Often these ca... decoding. An ex... regulator, or gat... Input/Output Re... already have this facility.

Of course we know ... ould faint clean away at the thought of cutti... ing extra integrated circuits and bits of wire in the ... ve, but it is not for these people that this sort of system has ... ed. We would like to think of this system as basis on which you c... uild your own personal design, perhaps as an alternative to the use of Veroboard or etching your own pcb's.

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

NEW! 'ISBUS-1.1'

Low-cost commercial quality computer back board, 13" x 4 3/8" approx, for the International Standard (114×203mm) cards. Although intended for the 86-way double sided connector, it can be used with the 43-way connector specified for the computer boards we advertise. (Pin 37 is used for polarisation.) Takes up to 13 cards on 1" centres, and provides for 4 power rails, 58 parallel address/data etc. bus lines and 3 'daisy chains'. Epoxy glass, tinned, price £11.50. More details in our free leaflet 'ISB-1/1'. Existing enquirers: Note Leaflets have been delayed, but will follow soon (MP4, ISBUS leaflets)

CMOS

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

4000	18p	4042	80p	4096	95p	4451	£3.81	4549	£4.38
4001	25p	4043	90p	4097	£3.40	4461	£3.93	4552	£14.85
4002	25p	4044	90p	4098	£1.20	4462	£4.41	4553	£4.50
4006	95p	4045	£1.45	4099	£2.00	4490FP	£4.20	4554	£1.38
4007	18p	4046	£1.10	40100	£2.20	4490VP	£3.14	4555	78p
4008	80p	4047	£1.00	40101	£1.32	4500	£6.95	4556	72p
4009	40p	4048	55p	40102	£1.80	4501	29p	4557	£3.86
4010	50p	4049	45p	40103	£1.80	4502	£1.20	4558	£1.25
4011	25p	4050	49p	40104	99p	4503	70p	4559	£4.38
4012	18p	4051	80p	40105	99p	4505	£5.71	4560	£2.50
4013	50p	4052	80p	40106	90p	4506	50p	4561	81p
4014	84p	4053	80p	40107	60p	4507	55p	4562	£5.60
4015	84p	4054	£1.50	40108	£4.70	4508	£2.90	4566	£1.59
4016	45p	4055	£1.25	40109	£1.00	4510	99p	4568	£2.38
4017	80p	4056	£1.35	40110	£3.00	4511	£1.50	4569	£2.50
4018	89p	4059	£6.00	40114	£2.50	4512	80p	4572	40p
4019	45p	4060	£1.15	40181	£3.39	4514	£2.65	4580	£4.77
4020	99p	4062T	£10.00	40182	£1.40	4515	£3.00	4581	£2.62
4021	£1.10	4063	£1.20	40192	£1.40	4516	£1.10	4582	£1.14
4022	£1.00	4066	55p	40193	£1.40	4517	£4.46	4583	90p
4023	27p	4067	£4.50	40194	£1.18	4518	£1.00	4584	90p
4024	50p	4068	27p	40257	£1.48	4519	80p	4585	£1.27
4025	27p	4069	27p	4160	98p	4520	£1.00	4597	£2.44
4026	£1.30	4070	30p	4161	98p	4521	£2.50	4598	£2.98
4027	50p	4071	25p	4162	98p	4522	£1.11	4599	£6.95
4028	84p	4072	25p	4163	98p	4526	£1.08	4700	£1.75
4029	99p	4073	25p	4174	90p	4527	£1.50		
4030	55p	4075	25p	4175	£1.15	4528	£1.20		
4031	£2.00	4076	£1.07	4194	£1.16	4529	£1.30		
4032	£1.31	4077	29p	4408	£9.37	4530	70p		
4033	£1.80	4078	29p	4409	£9.37	4531	£1.45		
4034	£2.00	4081	27p	4410	£8.55	4532	£1.30		
4035	£1.10	4082	27p	4411	£10.72	4534	£5.60		
4036	£2.95	4085	74p	4412VP	£14.93	4536	£3.69		
4037	£1.15	4086	72p	4415V	£5.24	4537L	£26.10		
4038	£1.20	4089	£1.38	4422	£5.66	4538	£1.20		
4039	£2.95	4093	80p	4433	£12.30	4539	97p		
4040	£1.00	4094	£2.50	4435V	£5.40	4541	£1.19		
4041	80p	4095	95p	4450	£3.81	4543	£1.80		

74C

		74C76	81p	74C163	£1.72	74C904	85p	74C926	£7.26
		74C83	£1.94	74C164	£1.62	74C905	£10.89	74C927	£7.26
		74C85	£1.94	74C165	£1.62	74C906	85p	74C928	£7.26
74C00	33p	74C86	96p	74C173	£1.35	74C907	85p	74C929	£17.90
74C02	33p	74C89	£6.57	74C174	£2.27	74C908	£1.44	80C95	85p
74C04	33p	74C90	£1.28	74C175	£1.27	74C909	£2.45	80C96	92p
74C08	33p	74C93	£1.28	74C192	£2.59	74C910	£10.17	80C97	85p
74C10	33p	74C95	£1.56	74C193	£1.72	74C911	£10.69	80C98	92p
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UM111: E36 UHF Ch.36 Vision Modulator £2.50
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AC 5421S 5V/20A £99.20
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114 x 203 mm fibreglass, with gold plated edge connector.

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2k RAM board (2102s) 1k-2k	£9.40
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TAPE interface	£8.90
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PSU 5v, +12v, −12v board	£8.90
PSU 5v, −12v board	£5.50

Further details on request

Z80

Z80 CPU (2½MHz)	£9.90
Z80-CTC (2½MHz)	£5.95
Z80-PIO (2½MHz)	£6.60

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

SC/MP II RAM I/O

SC/MP II (4MHz)	£8.82
INS 8154 RAM I/O	£8.18

6800

6800 MPU	£6.55
6802 MPU	£9.95
6810 (128 × 8 RAM)	£2.97
68A10 (128 × 8 RAM)	£3.75
6820, 6821 PIA	£3.96
6850 ACIA	£3.08
MC6880	£2.64

6502

6502	£12.00
6520 PIA	£6.22

CMOS

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

STATICS (Mostly 450nS)

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2112—256 x 4	£2.25
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2114L—1K x 4	£7.00
4118—1K x 8	£20.99

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MK 4816 2K x 8	£30.52

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2716/2516 2K x 8 single 5v	£19.95
2532 4K x 8 (5v)	£47.00

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AY-5-1013 UART TR 1602	£4.00
AY-5-1013A	£4.70
AY-3-1014A	£5.60
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MCM 66760	£9.75
MK 5302	£15.29
RO-3-2513 (5v Uppercase)	£6.00
DM 8678 CAB/BWF	£14.27
AY-5-2376	£9.75

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2K Tiny Basic for Z80 (2 x 2708)	£25
4K NIBL in 4 x 2708	£55
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KITBUG MM (1 x 2708)	£19.95
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LM 323K	£5.61

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8.388608 MHz	£3.23
8.867237 MHz	£3.23
9.375 MHz	£3.92
9.800 MHz	£3.92
10.000 MHz	£3.23
10.245 MHz	£3.23
10.700 MHz	£3.23
10.92 MHz	£3.92
11.000 MHz	£3.92
12.000 MHz	£3.92
14.0 MHz	£3.92
14.31818 MHz	£3.23
16.000 MHz	£3.92
18.000 MHz	£3.23
18.432 MHz	£3.23
20.000 MHz	£3.62
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27.0 MHz	£3.92
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MK 50253	£5.50
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MK 50395/6/7	£9.90
MK 50398/9	£7.50

DATA

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

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

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

c50-page Finite State Fantasies (Cartoons putting programming on human level) (Matrix Press)	£2.00
c175 page Home Computers: Beginners Glossary and Guide by Miller and Sippl (Dillithium)	£4.95

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		74LS27	28p	74LS76	40p	74LS125	60p	74LS163	£1.18	74LS240	£2.36	74LS283	£1.92	74LS375	£1.68
		74LS28	48p	74LS78	40p	74LS126	60p	74LS164	£1.14	74LS241	£2.32	74LS290	£1.28	74LS377	£2.12
74LS00	14p	74LS30	22p	74LS83	£1.15	74LS132	95p	74LS165	75p	74LS242	£2.32	74LS293	£1.28	74LS378	£1.84
74LS01	14p	74LS32	27p	74LS85	£1.18	74LS136	55p	74LS166	£2.26	74LS243	£2.32	74LS295	£1.85	74LS379	£2.15
74LS02	16p	74LS33	39p	74LS86	43p	74LS138	85p	74LS170	£2.88	74LS244	£1.70	74LS298	£1.68	74LS384	96p
74LS03	16p	74LS37	39p	74LS90	60p	74LS139	85p	74LS173	£1.05	74LS245		74LS324	£2.40	74LS386	96p
74LS04	16p	74LS38	39p	74LS91	£1.04	74LS145	£1.03	74LS174	£1.06	74LS247	£1.90	74LS325	£2.90	74LS390	£2.38
74LS05	20p	74LS40	28p	74LS92	89p	74LS147	£1.70	74LS175	£1.10	74LS248	£1.90	74LS326	£2.94	74LS393	£2.38
74LS08	22p	74LS42	98p	74LS93	89p	74LS148	£1.73	74LS181	£3.98	74LS249	£1.90	74LS327	£2.86	74LS395	£2.18
74LS09	22p	74LS47	90p	74LS95	£1.16	74LS151	96p	74LS183	£2.98	74LS251	£1.34	74LS347	£1.48	74LS396	£2.15
74LS10	20p	74LS48	£1.20	74LS96	£1.16	74LS153	75p	74LS190	£1.40	74LS253	£1.42	74LS348	£1.86	74LS398	£2.76
74LS11	22p	74LS49	£1.20	74LS107	44p	74LS154	£1.70	74LS191	£1.40	74LS257	£1.10	74LS352	£2.28	74LS399	£2.30
74LS12	23p	74LS51	24p	74LS109	55p	74LS155	96p	74LS192	£1.30	74LS258	£1.46	74LS353	£2.28	74LS445	£1.50
74LS13	38p	74LS54	28p	74LS112	55p	74LS156	96p	74LS193	£1.30	74LS259	£1.60	74LS365	65p	74LS447	£1.44
74LS14	75p	74LS55	28p	74LS113	50p	74LS157	76p	74LS194	£1.66	74LS261	£4.50	74LS366	65p	74LS490	£1.80
74LS15	30p	74LS63	£1.50	74LS114	50p	74LS158	96p	74LS195	£1.36	74LS266	52p	74LS367	65p	74LS668	£1.82
74LS20	20p	74LS73	46p	74LS122	70p	74LS160	£1.28	74LS196	£1.00	74LS273	£2.44	74LS368	66p	74LS669	£1.82
74LS21	22p	74LS74	41p	74LS123	70p	74LS161	98p	74LS197	£1.40	74LS275	£2.50	74LS373	£1.80	74LS670	£2.48
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VISA

Access

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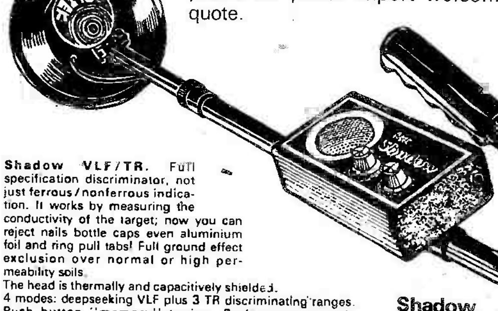

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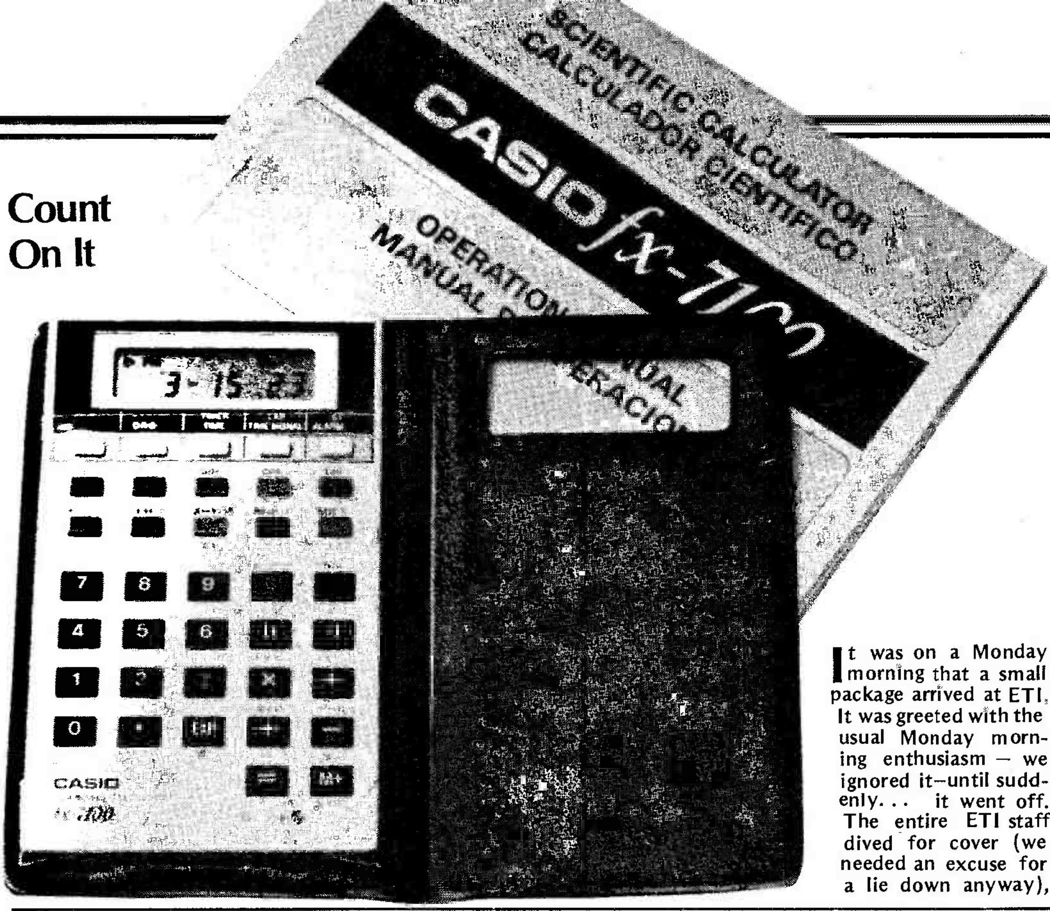

It was on a Monday morning that a small package arrived at ETI. It was greeted with the usual Monday morning enthusiasm — we ignored it—until suddenly. . . it went off. The entire ETI staff dived for cover (we needed an excuse for a lie down anyway), but as ever, our intrepid telephonist saved the day by ripping open the package, and there, to our surprise. . .Yes, it was yet another member of the ever growing family of Casio, which has produced a new infant in the form of the fx-7100. A veritable baby, it measures 5mmH x 55mmW x 91.5mmD and weighs only 44gms. It incorporates a scientific calculator with 39 built-in functions, a continual display alarm clock accurate to 3 seconds a day under normal temperatures, a countdown alarm (repeater timer), a 1/100 sec stopwatch and an hourly on the hour time signal — a useful extra for clock-watchers (this had been the cause of the trouble that morning, and still causes the more somnambulant staff members to say 'wot dat?' every hour of the day).

The power consumption is 8mW, which gives a life of approximately 1 year for the two sliver oxide batteries it uses. The package includes the usual data cards and a 70-page operation manual (cough). This little gem normally costs £27.95, or £24.95 from Tempus.

Metal Locator (March)

Well, the world famous ETI mistake maker has struck again, this time his mistakes were located (!) in the Metal Locator project from our March edition. These were many and varied so here goes: In figure 1 the circuit diagram, starting from the left, the unmarked resistor is R4 18k, at top centre V/2 is not +18V and underneath that R19 100k does not go to +18V but to Vs. IC4d should be labelled IC4a and at bottom centre the common line to C2 470n, L1 and R2 15k should be connected to 0V. C18 10n and C20 470u should be transposed, and transistor Q9 is BC158. In figure 3, the component overlay, the tag which says White/WH should be White/BLK and the unmarked IC should be IC4, Q8 and Q9 should be transposed and the missing resistor value is R45. Track C17 should go to pin 13 and not to 12. Figure 4 connection for front panel, lead marked Blue/BLK should be Blue/WH.

Radio Control Protector (April)

We made an incorrect statement last issue with regard to the PPIM—4CH from Chromatronics. We said that their device would not operate if one of the decoder outputs locked high. Well it does and we were wrong. Sorry Chromatronics.

B&B 1537 VCA Article

Here they are again. Errors. Rearing their ugly heads amongst the otherwise unsullied pages of ETI. But wouldn't you miss them if they weren't there?

The first error was on the schematic on figure 5. R6 and R9 should be shown as joined at pin 3 of the 1537A and R8 and R10 should be similarly joined at pin 6.

In figure 6, the trace connecting pins 1 and 2 of IC1 is slightly obscured by the IC outline, so take note all of you out there who are making there own PC board!

Also the titles for figures 14 and 15 are exchanged and a non-inverting VCA configured as per figure 15 would have a minimum gain of unity, whereas the inverting VCA of figure 14 could attenuate to the common mode limits of the op amp used. OK?

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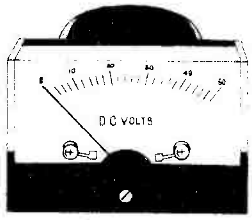

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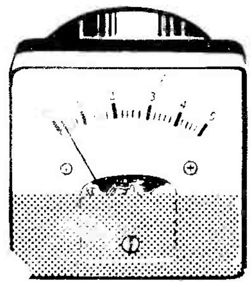

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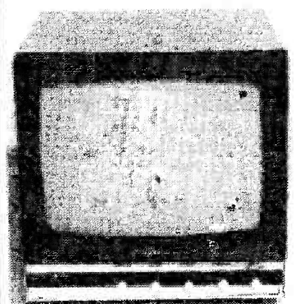

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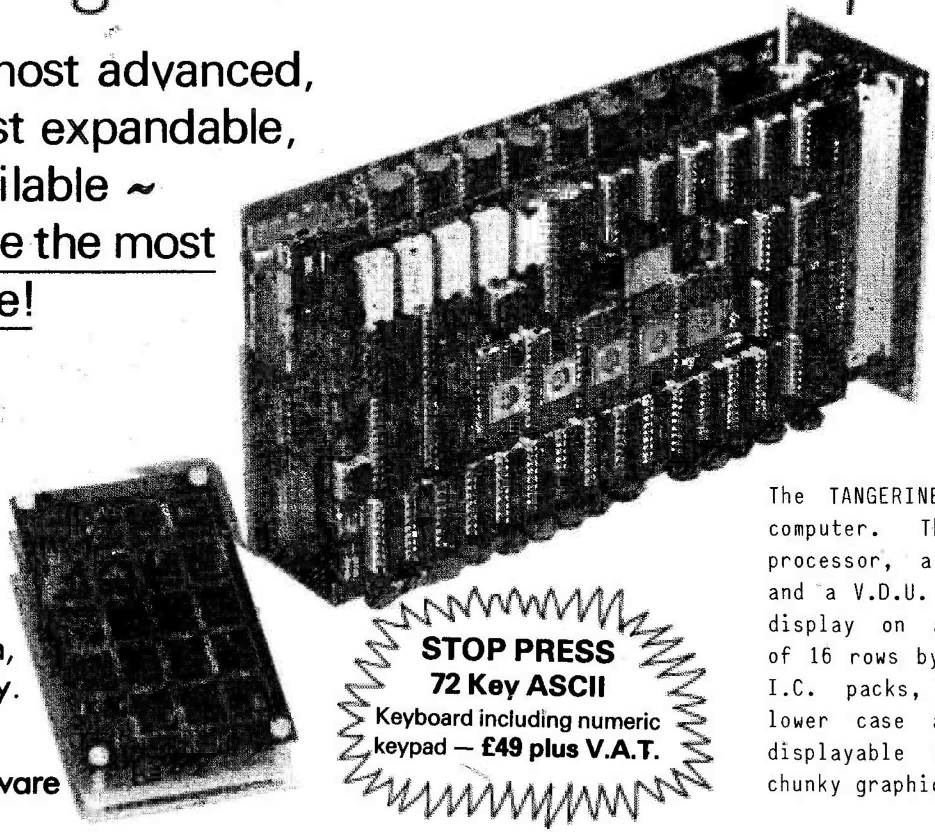

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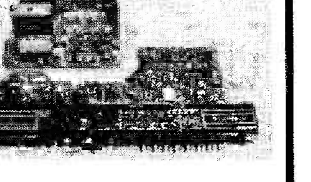

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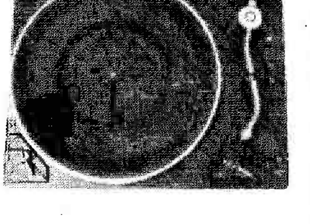

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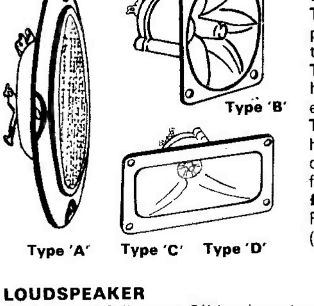

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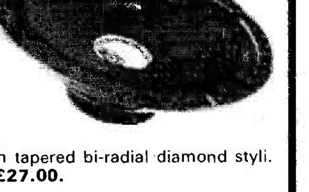

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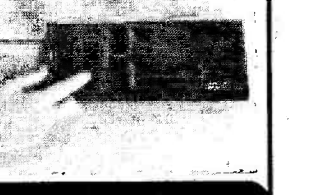

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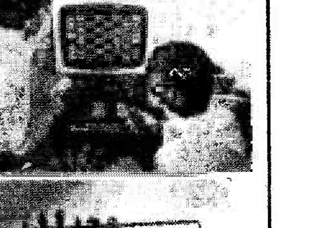
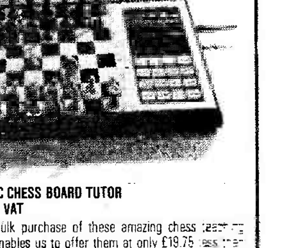
The TV game can be compared to an audio cassette deck and is programmed to play a multitude of different games in COLOUR, using various plug in cartridges. At long last a TV game is available which will keep pace with improving technology by allowing you to extend your library of games with the purchase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

EXTRA CARTRIDGES:
ROAD RACE – £8.87 + VAT.
Grand Prix motor racing with gear changes, crash noises
SUPER WIPEOUT – £9.17 + VAT.
10 different games of blasting obstacles off the screen.
STUNT RIDER – £12.16 + VAT.
Motorcycle speed trials, jumping obstacles, leaping various rows of up to 24 buses etc.
NON-PROGRAMMABLE TV GAMES
6 Game – COLOURSCORE II – £13.50 + VAT.
10 Game COLOUR SPORTSWORLD £22.50 + VAT.

CHESS COMPUTERS
STAR CHESS – £55.09 + VAT.
PLAY CHESS AGAINST YOUR PARTNER.
using your own TV to display the board and pieces. Star Chess is a new absorbing game for two players, which will interest and excite all ages. The unit plugs into the aerial socket of your TV set and displays the board and pieces in full colour (or black and white) on your TV screen. Based on the moves of chess. It adds even more excitement and interest to the game. For those who have never played, Star Chess is a novel introduction to the classic game of chess. For the experienced chess player, there are whole new dimensions of unpredictability and chance added to the strategy of the game. Not only can pieces be taken in conventional chess type moves, but each piece can also exchange rocket fire with its opponents. The unit comes complete with a free 18V mains adaptor, full instructions and twelve months guarantee.



CHESS CHALLENGER 7 – £85.65 + VAT.
PLAY CHESS AGAINST THE COMPUTER.
The stylish, compact, portable console can be set to play at seven different levels of ability from beginner to expert including "Mate in two" and "Chess by mail". The computer will only make responses which obey international chess rules. Castling, en passant, and promoting a pawn are all included as part of the computer's programme. It is possible to enter any given problem from magazines or newspapers or alternatively establish your own board position and watch the computer react. The positions of all pieces can be verified by using the computer memory recall button.
Price includes unit with wood grained housing, and Staunton design chess pieces. Computer plays black or white and against itself and comes complete with a mains adaptor and 12 months guarantee.



OTHER CHESS COMPUTERS IN OUR RANGE INCLUDE:
CHESS CHAMPION – 6 LEVELS £47.39 + VAT.
CHESS CHALLENGER – 10 LEVELS – £138.70 + VAT.
BORIS – MULTI-LEVEL TALKING DISPLAY £163.04 + VAT.

ELECTRONIC CHESS BOARD TUTOR
£17.17 + VAT
A special bulk purchase of these amazing chess teaching machines enables us to offer them at only £19.75 less than half recommended retail price. The electronic chess tutor is a simple battery operated machine that can actually teach anyone to play chess and improve their game right up to championship level. This machine is not only for total beginners but also for established players wanting to play better chess. Unit contains the electronic chessboard with 32 chess pieces, a 64 page explanatory booklet and a set of 32 progressive programme cards including 6 beginners cards, 16 check mate positions, 9 miniature games, 6 openings, 3 end games, 28 chess problems and 3 master games.

DRAUGHTS COMPUTERS
CHECKER CHALLENGER 2 LEVELS £43.00 + VAT
4 LEVELS £78.00 + VAT
The draughts computer enables you to sharpen your skills, improve your game, and play whenever you want. The computer incorporates a sophisticated, reliable, decision making microprocessor as its brain. Its high level of thinking ability enables it to respond with its best counter moves like a skilled human opponent. You can select offence or defence and change playing difficulty levels at any time. Positions can be verified by computer memory recall. Machine does not permit illegal moves and can solve set problems. Computer comes complete with instructions, mains adapator and twelve months guarantee.

PLAY DRAUGHTS/CHECKERS AGAINST THE COMPUTER

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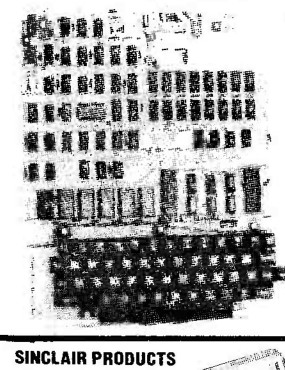
THE NEW 50HZ COLOUR VERSION OF OHIO SCIENTIFIC'S SUPERBOARD II IS HERE AND LIKE A TON OF BRICKS DOWN CRASHES THE PRICE OF STANDARD SUPERBOARD II.



50HZ UK BLACK AND WHITE SUPERBOARD II
£159.95 + VAT POST FREE
COLOURBOARD II £205 + 15% VAT

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THE UNIQUE SPECIAL OFFER YOU CAN'T RESIST

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If bought with superboard or colour board these items are at the reduced prices shown first. Also sold separately at the bracketed prices. Add 15% VAT. Modulator and power supply kit **£5.95 (£9.95)**. 4K extra ram **£19 (£24)**. Case **£19 (£24)**. Cassette recorder **£13 (£15)**.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

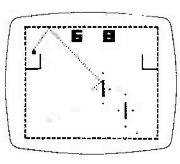
SINCLAIR PRODUCTS

PFM200 **£51.95**, case **£2.07**, adaptor **£4.20**, connector kit **£13.95**. Microvision TV **£89**, mains adaptor **£6.88**. PDM35 **£34.23**. mains adaptor **£4.20**, case **£2.07**. DM350 **£76.70**, DM450 **£102.17**, DM235 **£55.55**. Accessories for all 3 models:— rechargeable batteries **£7.99**, mains adaptor/charger **£4.20**, case **£8.90**. Enterprise prog calculator **£19.95**. New SC110 10MHz oscilloscope **£144.95**.

COMPUTER GAMES

Chess challenger 7 (illustrated) **£84**. Chess champion 6 **£49.95**. Checker challenger 2 **£46**. Star Chess **£62**. Grandstand video entertainment computer **£79.95**. Videocarts **£12.60**. Phillips G7000 Videopak home computer **£139**. Video paks **£12.95**. Atari Videocomputer **£129**. Cartridges **£14.85** (except chess **£43.95** and backgammon **£33.95**).

TV GAMES



AY-3-8500 chip **£5.85**. Kit **£4.25**. Stunt cycle AY-3-8760 chip **£13.71**, kit **£4.95**. 10 game paddle 2 AY-3-8600 chip **£10.25**, kit **£10.25**, kit **£7.03**. Racing car chip AY-3-8603 **£13.63**. Modified shoot kit **£5.28**. Colour generator kit **£9.05**.

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6-0-6V 100ma **80p**, 1½a **£2.60**. 9-0-9V 75ma **80p**, 1a **£2.40**, 2a **£3.94**. 12-0-12v 100ma **99p**, 1a **£2.90**. 15-0-15V 1a **£13.15**.

JC12 and JC20 AMPLIFIERS

Integrated circuit audio amplifier chips with data and printed circuits. JC12 6 watts **£2.08**. JC20 10 watts **£3.14**.

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PRINTED CIRCUIT MATERIALS

PC etching kits:— economy **£2.42**, standard **£4.76**. 40 sq ins pcb **45p**. 1 lb FeCl **£1.50**. Etch resist pens:— economy **50p**, dalo **84p**. Drill bits 1/32" or 1mm **34p**. Etching dish **92p**. Laminate cutter **£1.20**.

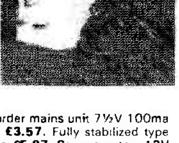
BI-PAK AUDIO MODULES

AL30A **£4.08**.
PA12 **£8.38**.
PS12 **£1.58**.
T538 **£2.70**.
S450 **£25.06**.
AL60 **£5.06**.
PA100 **£17.33**.
SPM80 **£4.74**.
BMT80 **£6.06**.
Stereo 30 **£21.57**.
AL80 **£7.71**.

COMPONENTS

1N4148 **0.09p**. 1N4002 **2.9p** 723 14 kil **33p**. NE555 8 dil **24p**. 741 8 dil **18p**. bc547, bc549 **4.9p**. bc182, bc184, bc212, bc214, bc548 **5.5p**. tip31c, tip32c **36p**. tip41c **40p**. bd132 **27p**. plastic equiv bcy72 **4.5p**. fuses 20mm × 5mm cartridge .15, .25, .5, 1, 2, 3, 5Amp quickblow **1p**. resistors 5% ¼W E12 10R to 10M **1p**, **0.8p** for 50+ of one value. polyester capacitors 160V .015, .068mf 2.6p, .1mf **4.0p**, .01mf **3.0p**, .022, .033mf **3.3p**, .047mf **3.5p**, .15, .22, .33, .47mf **4.9p**. polystyrene capacitors E12 63V 10 to 1000pf **3p**, 1n2 to 10n **4p**. ceramic capacitors 50V E6 22pf to 47n **2p**. electrolytic capacitors 50V .5, 1, 2mf **5p**, 25V 5, 10mf **5p**, 16V 22, 33mf **5p**, 47, 68mf **3.5p**, 100mf **6p**, 330, 470mf **9p**, 1000mf **11p**. zeners 400mw E24 2V7 to 33V **7p**. preset pots subminiature 0.1W horiz or vert 100 to 4M7 **7p**. potentiometers ¼W 4K7 to 2M2 log or lin single **27p**, dual **71p**. ⅛" red LEDS **9.7p**. ic sockets 8 dil **8.7p**, 14 dil **10.1p**, 16 kil **12p**.

BATTERY ELIMINATORS



3-way types with switched output and 4 way multi jack:— 3/4½/6V 100ma **£2.67**, 6/7½/9V 300ma **£2.34**. 100ma radio types with press-stud connectors 9V **£3.57**, 6V **£3.57**, 4½V **£3.57**, 9+9V **£4.79**, 6+6V **£4.79**, 4½+4½V **£4.79**. cassette recorder mains unit 7½V 100ma with 5 pin din plug **£3.57**. Fully stabilized type 3/6/7½/9V 400ma **£5.97**. Car convertors 12V dc input, output 9V 300ma **£1.19**, output 7½V 300ma **£1.19**, output 3/4½/6/7½/9/12V 800ma **£2.66**.

BATTERY ELIMINATOR KITS

100ma radio types with press-stud connectors 4½V **£1.49**, 6V **£1.49**, 9V **£1.49**, 4½+4½V **£1.92**, 6+6V **£1.92**, 9+9V **£1.92**. cassette type 7½V 100ma with din plug **£1.49**. heavy duty 13-way types 4½/6/7/8½/11/13/14/17/21/25/28/34/42V 1A **£5.52**. 2A **£8.80**. car convertor input 12V dc, output 6/7½/9V 1A stabilized **£1.35**.

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S-Dec **£3.79**. T-Dec **£4.59**. u-DecA **£4.69**. U-DecB **£7.16**. 16 dil adaptor **£2.31**.

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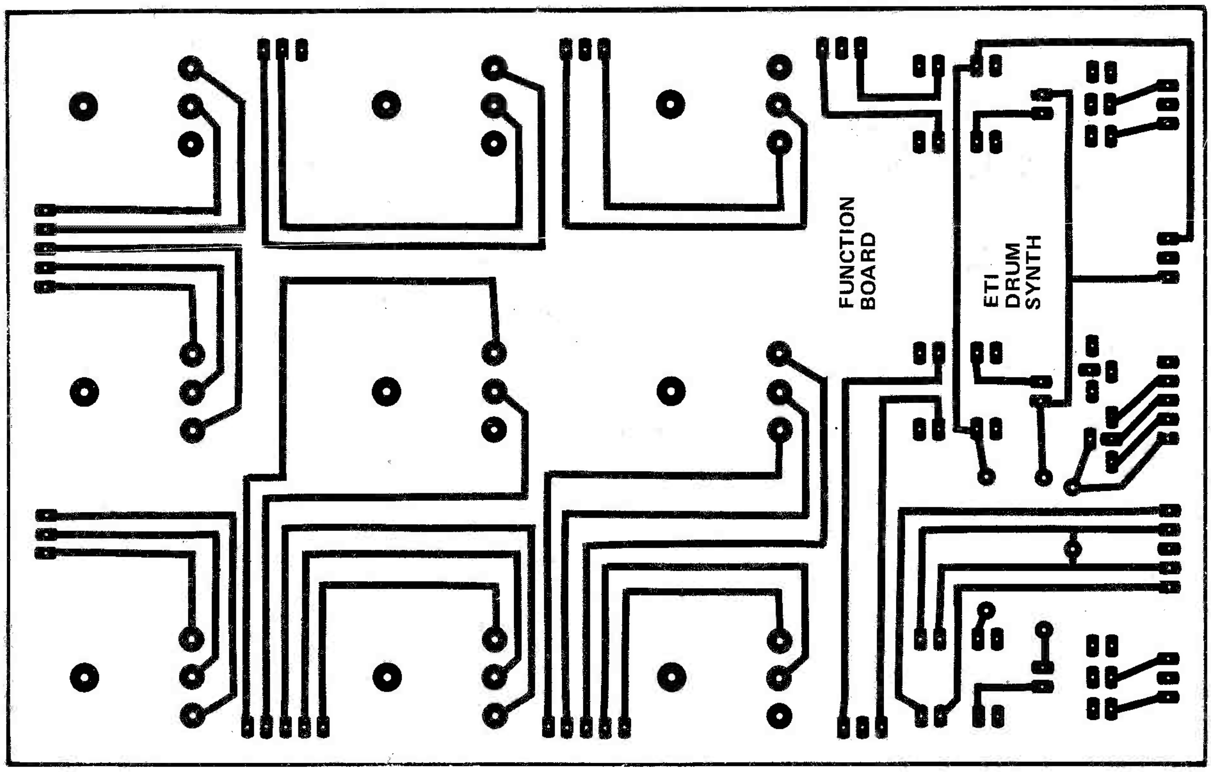

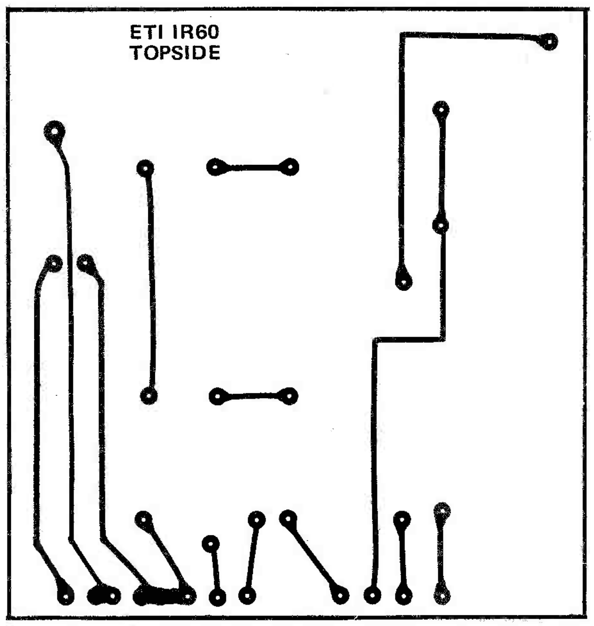

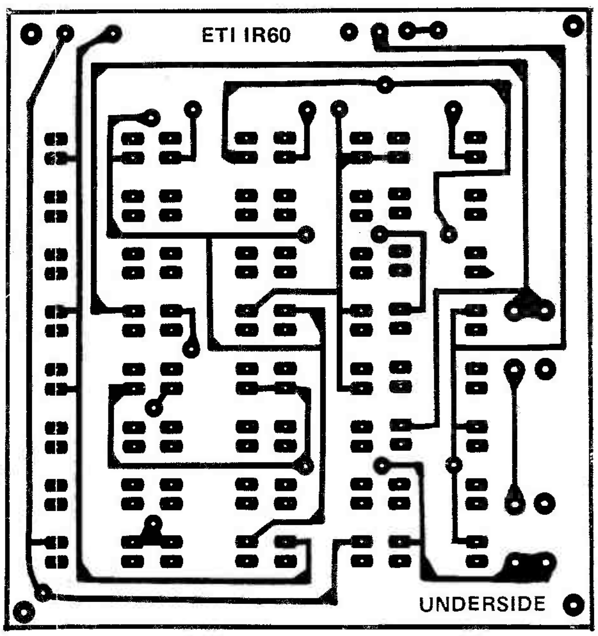

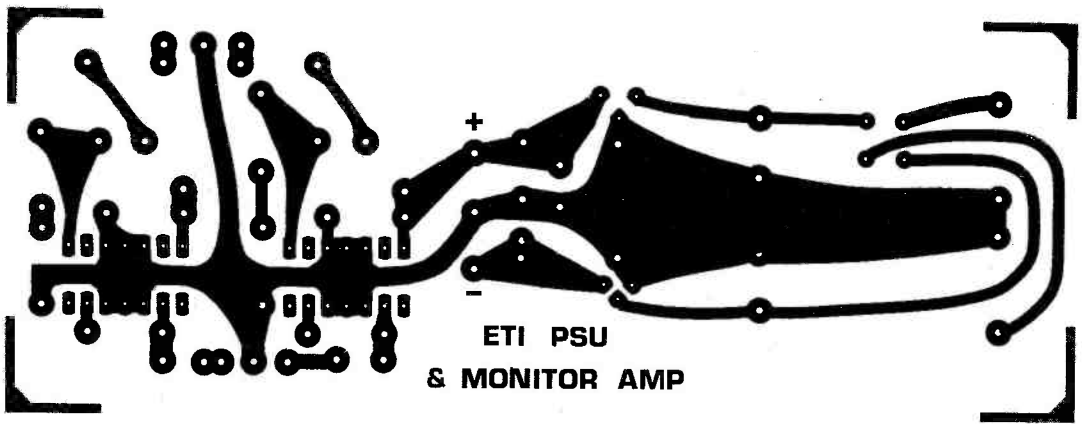
+
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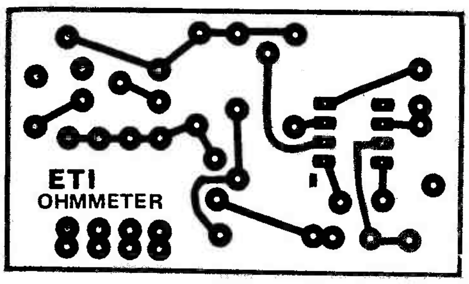
ETI PSU
& MONITOR AMP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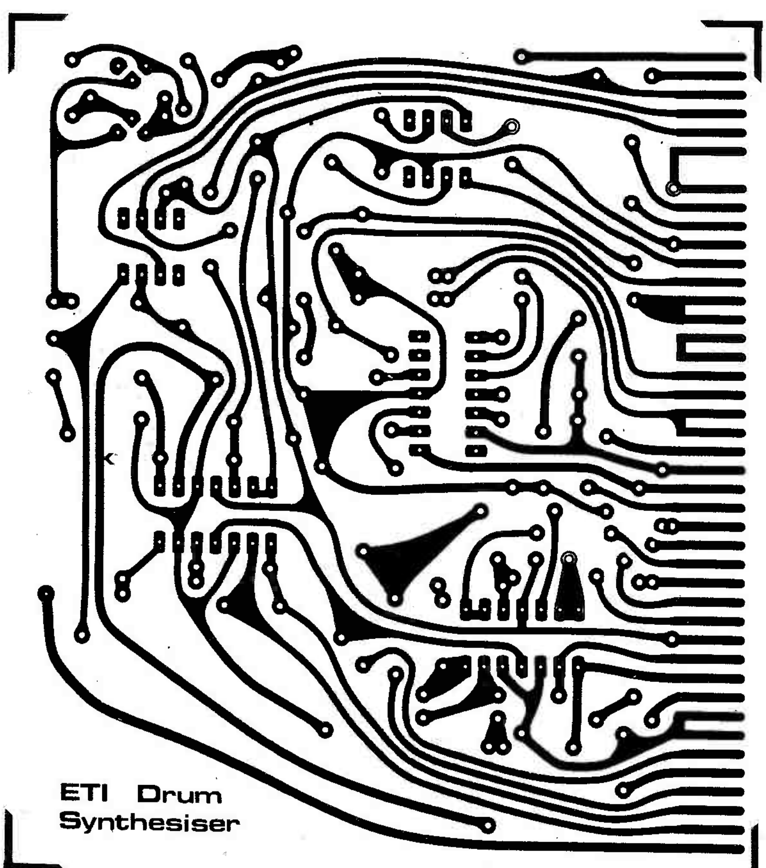
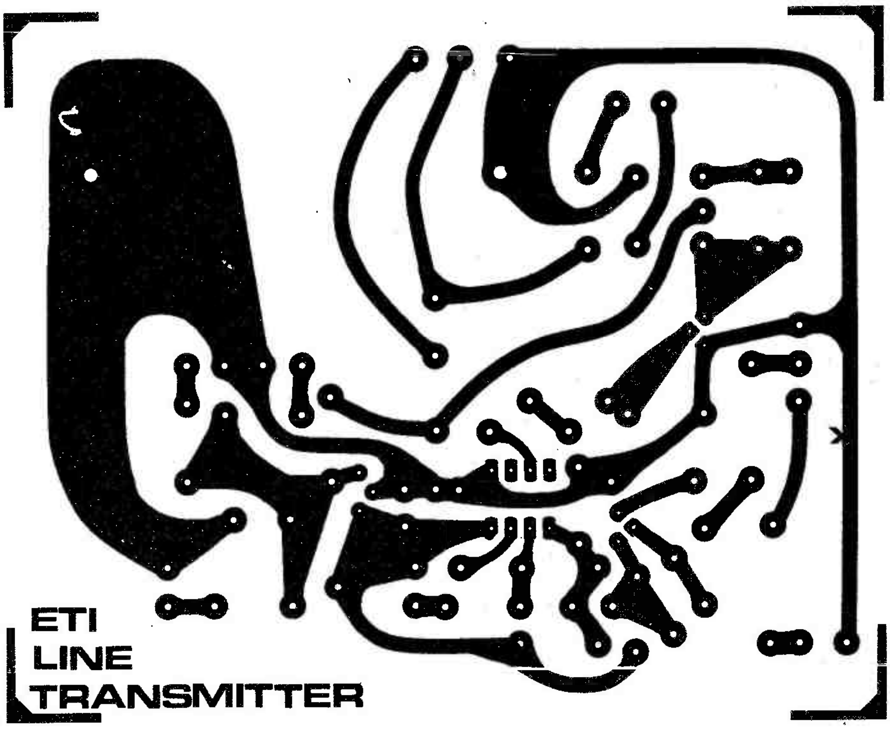
OHMMETER


ETI Drum
Synthesiser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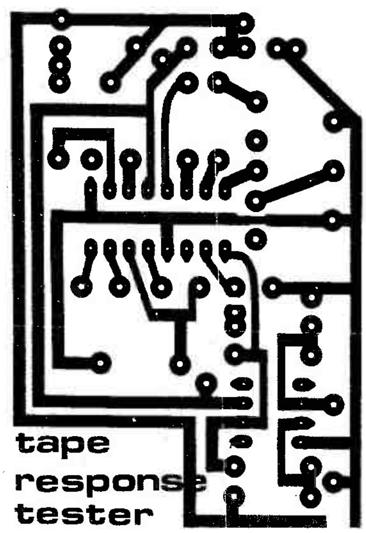
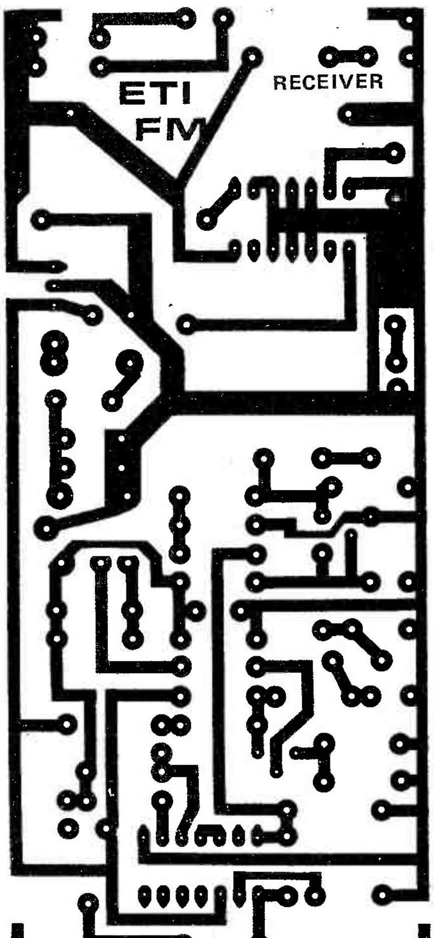
TRANSMITTER


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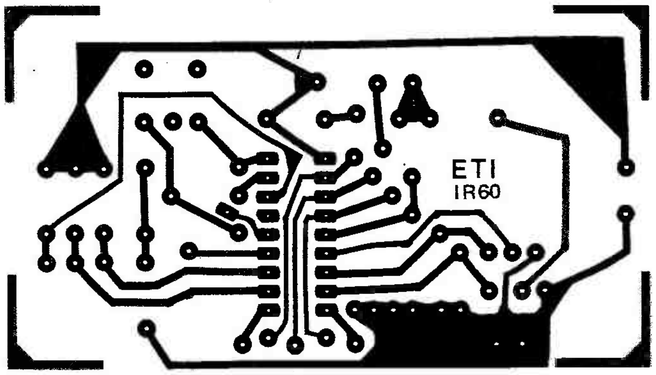
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ETIPRINTS are a fast new aid for producing high quality printed circuit boards. Each ETIPRINTS sheet contains a set of etch resistant rub down transfers of the printed circuit board designs for several of our projects.

ETIPRINTS are made from our original artwork ensuring a neat and accurate board. We thought ETIPRINTS were such a good idea that we have patented the system (patent numbers 1445171 and 1445172).

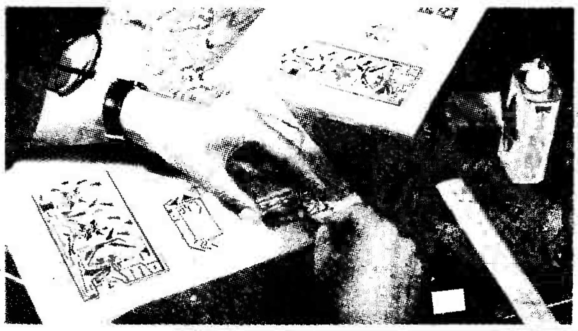
PARTS LIST

Shown below is the listing for the last year's ETIPRINTS.

Earlier sheets are available, ring Tim Salmon for details.

035	Oven Leakage Detector, Pinball Wizard	Nov 79
036A	3 x Display Board, Relay Activator, Points Controller	Nov 79
036B	Data Distributor (double sided)	Nov 79
036C	Train Speed Controller, Track Cleaner & Electronic Pot (double sided)	Nov 79
036D	Power Switch Selector (double sided)	Nov 79
037A	Encoder (double sided)	Dec 79
037B	Decoder (top side)	Dec 79
037C	Decoder (bottom side)	Dec 79
038A	Long Period Timer, Rain Alarm, Touch Switch, Flash Trigger, Pseudo Random Noise Gen	Dec 79
038B	Hum Filter, Dice, Logic Probe	Dec 79
038C	Function Generator	Dec 79
039	Buffer, Moving Coil Preamp, Process Controller	Jan 80
039A	Hum Filter, Logic Probe	Dec 79
039B	Long Period Timer, Rain Alarm, Touch Switch, Flash Trigger, Pseudo Random Noise Gen	Dec 79
039C	Function Generator	Dec 79
049A	ETI 80 — VCO and VCLFO	Feb 80
040B	ETI 80 — PSU, Tuning Fork, Filter, Coin Toss	Feb 80
041A	ETI Audiophile, ETI VCA, Signal Trace, ETI HC, Electromyogram	Mar 80
041B	VCM, Heater Controller	Mar 80
042A	300W Amp Module	Apr 80
033	Fuel Level Monitor, Alarm, Screen Controller, Dynamic Noise Reducer	Sep 79
042B	Touch Dimmer, Battery Charger, RC Guardian (Top, Bottom) 1 & 2	Apr 80
043	IR60 Preamps, Receiver, PSU, Servo Tester, VU—PPM	May 80

HOW IT WORKS



Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

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POWERTRAN

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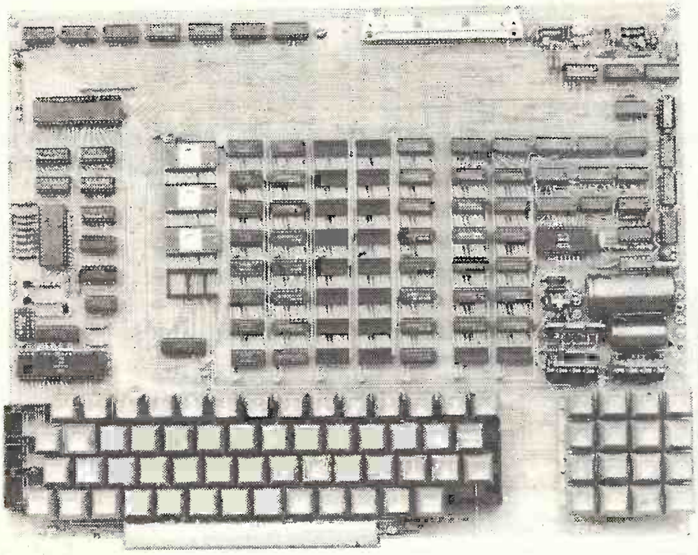
Included in the PSI COMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double sided, plated-through-hole printed circuit board. 2 keyboards PCB mounted for ease of construction, IC sockets, high reliability metal oxide resistors, power supply using custom designed toroidal transformer. 2K Basic and 1K monitor in EPROMS and, of course, wire, nuts, bolts, etc.



KIT ALSO AVAILABLE AS SEPARATE PACKS
For those customers who wish to spread their purchase or build a personalised system the kit is available as separate packs eg. PCB (16″ × 12.5″) £43.20. Pair of keyboards £34.80. Firmware in EPROMS £30.00. Toroidal transformer and power supply components £17.60. Cabinet (very rugged, made from steel, really beautifully finished) £26.50. P.S. Will greatly enhance any other single board computer including OHIO SUPERBOARD for which it can be readily modified. Other packs listed in our FREE CATALOGUE.

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	Set of components including IC sockets, plug and socket but excluding RAMs	£11.20
	2114L RAM (16 required)	£5.00
	Complete set of board, components, 16 RAMS	£89.50
8K ROM board	Fibre glass double sided plated through hole P.C.B. 5.6″ x 4.8″	£12.40
	Set of components including IC sockets, plug and socket but excluding ROMs	£10.70
	2708 ROM (8 required)	£8.00
	Complete set of board, components, 8 ROMs	£78.50

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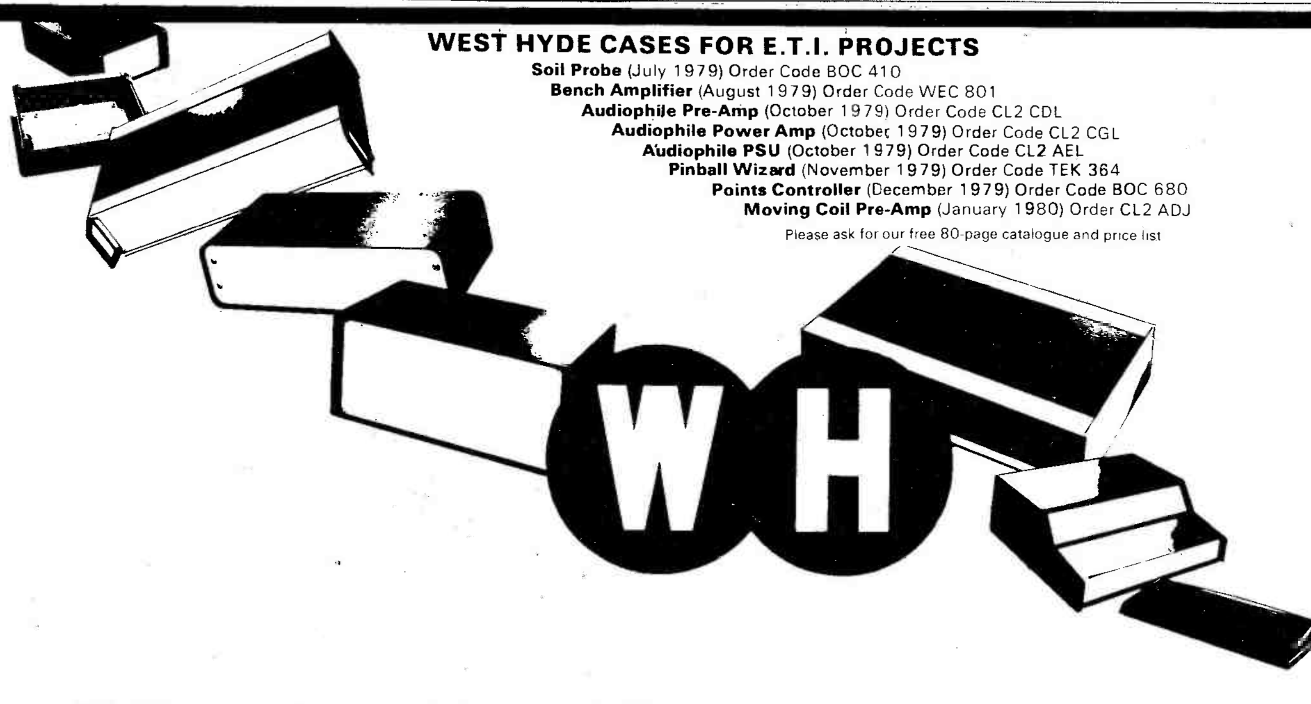

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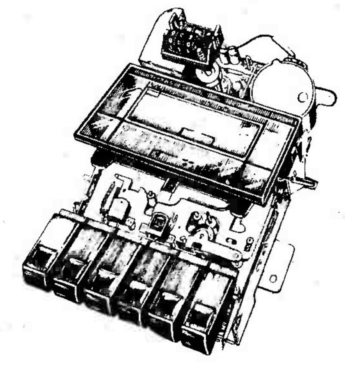

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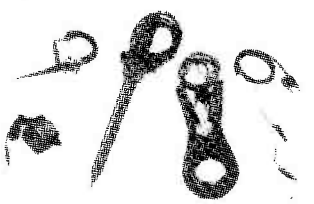

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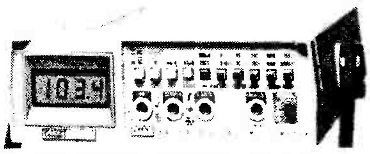

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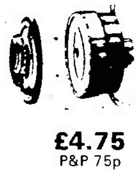

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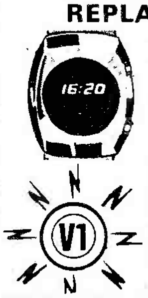

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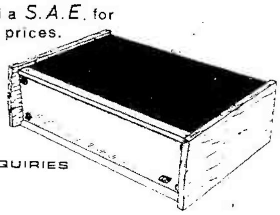

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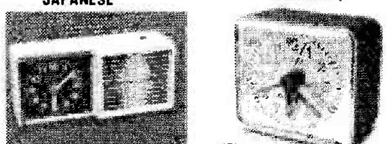

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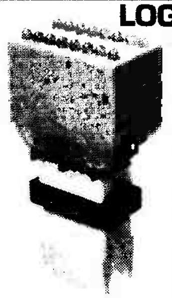

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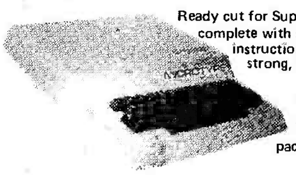

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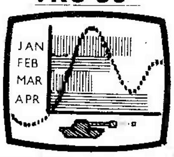

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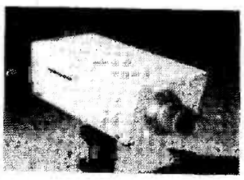

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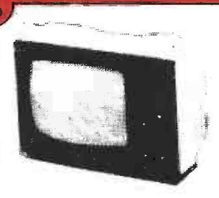

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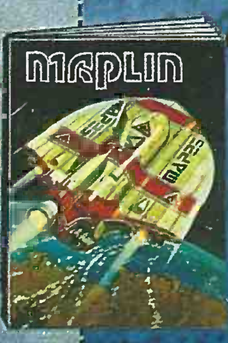

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- 4514 265p
- 4515 300p
- 4516 110p
- 4518 100p
- 4520 100p
- 4521 250p
- 4526 108p
- 4527 150p
- 4528 120p
- 4538 120p
- 4543 180p
- 4553 450p
- 4556 72p
- 4560 250p
- 4569 250p
- 4572 40p
- 4583 90p
- 4584 90p
- 4585 150p
- 4724 250p
- 40097 90p
- 14411 1100p
- 14412 1100p
- 14433 1100p
- 14500 700p
- 14599 290p
- CD22100 350p
- CD22101 700p
- CD22102 700p

INTERFACE ICs

- DM8123 175p
- DP8304 450p
- DM8835 250p
- DM8836 250p
- MC1488 100p
- MC1489 100p
- 25S10 350p
- 75107 160p
- 75150 175p
- 75154 175p
- 75182 230p
- 75322 300p
- 75324 375p
- 75325 375p
- 75361 300p
- 75363 400p
- 75365 350p
- 75451 72p
- 75491/2 96p
- 8T26 250p
- 8T28 300p
- 8T95 200p
- 8T97 200p
- 81LS95 140p
- 81LS96 140p
- 81LS97 140p
- 81LS98 140p
- 9601 110p
- 9602 220p

93 SERIES

- 9301 160p
- 9302 175p
- 9308 316p
- 9310 275p
- 9311 275p
- 9312 160p
- 9314 165p
- 9316 225p
- 9321 225p
- 9322 150p
- 9334 360p
- 9368 200p
- 9370 200p
- 9374 200p

VEROBOARDS

	0.1	0.15
(copper clad)		
2.5×3.75"	48p	43p
2.5×5"	57p	51p
3.75×3.75"	57p	—
3.75×5"	64p	64p
3.75×17"	222p	194p
4.75×17.9"	290p	—

- Pkt of 100 pins 50p
- Spot face cutter 86p
- Pin insertion tool 118p
- Vero Wiring Pen + 2 wire spools + combs 370p
- Combs 7p

LINEAR ICs

- AY1-0212 600p
- AY1-1313 668p
- AY1-1320 320p
- AY1-5050 140p
- AY3-1270 840p
- AY5-1224A 240p
- AY5-1315 600p
- AY5-1317A 775p
- CA3019 80p
- CA3046 70p
- CA3048 225p
- CA3080E 72p
- CA3086 48p
- CA3089E 225p
- CA3090AQ 375p
- CA3130E 90p
- CA3140E 50p
- CA3160E 100p
- CA3161E 140p
- CA3162E 450p
- CA3189E 400p
- DAC1408-8 225p
- FX209 750p
- ICL7106 850p
- ICL8038 340p
- ICM7555 80p
- LF356P 95p
- LM10C 425p
- LM301A 30p
- LM311 120p
- LM318 200p
- LM319 225p
- LM324 50p
- LM339 75p
- LM348 95p
- LM377 175p
- LM380 75p
- LM381AN 200p
- LM709 36p
- LM710 50p
- LM725 250p
- LM733 100p
- LM741 18p
- LM747 70p
- LM748 35p
- LM2917 250p
- LM3900 70p
- LM3909 70p
- LM3911 130p
- LM3914 250p
- LM3915 250p
- LM4136 120p
- MC1310P 150p
- MC1458 48p
- MC1495L 350p
- MC1496 100p
- MC3340P 120p
- MC3360P 120p
- MK50398 750p
- MM57160 620p
- NE531 150p
- NE555 22p
- NE556 70p
- NE5534AN 300p
- NE561B 425p
- NE562B 425p
- NE565 130p
- NE566 155p
- NE567 175p
- NE571 425p
- RC4151 400p
- SAB3209 POA
- SAD1024A 1250p
- SFF96364 1100p
- SN76003N 250p
- SN76013N 140p
- SN76013ND 120p
- SN76023N 140p
- SN76023ND 120p
- SN76477 200p
- SP8515 750p
- TAA621 275p
- TBA641B11 225p
- TBA651 200p
- TBA800 90p
- TBA810 100p
- TBA820 90p
- TCA940 175p
- TDA1004 300p
- TDA1008 320p
- TDA1010 225p
- TDA1022 600p
- TDA1024 120p
- TDA1034B 250p
- TDA1170 250p
- TDA2002V 325p
- TDA2020 320p
- TL071 50p
- TL072 95p
- TL074 150p
- TL081 45p
- TL082 95p
- TL084 130p
- TL170 50p
- UAA170 200p
- UDN6118 320p
- UDN6184 320p
- ULN2003 100p
- XR2206 350p
- XR2207 400p
- XR2211 600p
- XR2216 675p
- XR2240 400p
- ZN414 90p
- ZN419C 225p
- ZN424E 135p
- ZN425E 400p
- ZN1034E 200p
- 95H90 800p

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		−ve	
5V	7805	80p	7905	70p
12V	7812	60p	7912	70p
15V	7815	60p	7915	70p
18V	7818	60p	7918	70p
24V	7824	60p	7924	70p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

- LM309K 135p
- LM317T 200p
- LM323K 550p
- LM723 37p
- 78HGKC 600p
- 78H05KC 600p
- 78MGT2C 135p
- 78P05 900p
- 79BIGKC 700p

OPTO-ELECTRONICS

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

OPTO-ISOLATORS

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

LEDS

0.125"		0.2"	
TIL32	75p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular	
TIL216 Red	18p	LEDs (R, G, Y)	30p

DISPLAYS

- 3015F 200p
- DL704 140p
- DL707 Red 140p
- 707 Gr 140p
- DL747 Red 225p
- 747 Gr 225p
- FND357 120p
- FND500 120p
- FND507 120p
- MAN3640 175p
- MAN4640 200p
- NSB5881 570p
- TIL311 600p
- TIL312/3 110p
- TIL321/2 130p
- TIL330 140p
- 7750.60 200p

DRIVERS

- 9638 200p
- 9370 200p
- UDN6118 320p
- UDN6184 320p

TRANSISTORS

- AC126 25p
- AC127/8 20p
- AC176 25p
- AC187/8 25p
- AF116 50p
- AD149 70p
- AD161/2 45p
- AU107 200p
- BC107/8 11p
- BC109 11p
- BC117 20p
- BC147/8 9p
- BC149 10p
- BC157/8 10p
- BC159 11p
- BC169C 12p
- BC172 12p
- BC177/8 17p
- BC179 18p
- BC182/3 10p
- BC184 11p
- BC187 30p
- BC212/3 11p
- BC214 12p
- BC237 15p
- BC327 16p
- BC337 16p
- BC338 16p
- BC461 36p
- BC477/8 30p
- BC516/7 50p
- BC547B 16p
- BC548C 16p
- BC549C 18p
- BC557B 16p
- BC559C 18p
- BCY70 18p
- BCY71/2 22p
- BD131/2 50p
- BD135/6 54p
- BD139 58p
- BD140 60p
- BD189 60p
- BD232 95p
- BD233 75p
- BD235 85p
- BD241 70p
- BD242 70p
- BDY56 200p
- BF200 32p
- BF244B 35p
- BF256B 70p
- BF257/8 32p
- BF259 36p
- BFR39 25p
- BFR40 25p
- BFR41 25p
- BFR79 25p
- BFR80 25p
- BFR81 25p
- BFX29 30p
- BFX30 34p
- BFX84/5 40p
- BFX86/7 30p
- BFX88 30p
- BFW10 90p
- BFY50 30p
- BFY51/2 30p
- BFY90 90p
- BRY39 45p
- BSX19/20 20p
- BU104 225p
- BU105 190p
- BU108 250p
- BU109 225p
- BU205 200p
- BU208 200p
- BU406 145p
- E300 50p
- E308 50p
- E310 50p
- MJ2501 225p
- MJ2955 90p
- MJ3001 225p
- MJE340 70p
- MJE2955 100p
- MJE3055 70p
- MPF102 45p
- MPF103/4 40p
- MPF105/6 40p
- MPS6531 50p
- MPS6534 50p
- MPSA06 30p
- MPSA12 50p
- MPSA13 50p
- MPSA20 50p
- MPSA42 50p
- MPSA43 50p
- MPSA56 32p
- MPSA70 50p
- MPSU06 63p
- MPSU07 90p
- MPSU45 90p
- MPSU65 78p
- OC28 130p
- OC35 130p
- TIP29A 40p
- TIP29C 55p
- TIP30A 48p
- TIP30C 60p
- TIP31A 58p
- TIP31C 62p
- TIP32A 68p
- TIP32C 82p
- TIP33A 90p
- TIP33C 114p
- TIP34A 115p
- TIP34C 160p
- TIP35A 225p
- TIP35C 290p
- TIP36A 270p
- TIP36C 340p
- TIP41A 65p
- TIP41C 78p
- TIP42A 70p
- TIP42C 82p
- TIP54 160p
- TIP120 120p
- TIP122 130p
- TIP142 160p
- TIP147 160p
- TIP2955 78p
- TIP4055 70p
- TIS43 34p
- TIS93 30p
- ZTX108 12p
- ZTX300 13p
- ZTX500 15p
- ZTX502 18p
- ZTX504 30p
- 2N696 35p
- 2N697 25p
- 2N698 45p
- 2N706A 20p
- 2N918 45p
- 2N930 18p
- 2N1131/2 20p
- 2N1613 25p
- 2N1711 25p
- 2N2102 70p
- 2N2160 350p
- 2N2219A 30p
- 2N2222A 20p
- 2N2369A 20p
- 2N2484 30p
- 2N2646 45p
- 2N2904/5 30p
- 2N2906A 30p
- 2N2907A 30p
- 2N2926 9p
- 2N3053 30p
- 2N3054 65p
- 2N3055 48p
- 2N3442 140p
- 2N3553 240p
- 2N3565 30p
- 2N3584 250p
- 2N3643/4 48p
- 2N3702/3 12p
- 2N3704/5 12p
- 2N3706/7 14p
- 2N3708/9 12p
- 2N3773 300p
- 2N3819 25p
- 2N3820 50p
- 2N3823 70p
- 2N3866 90p
- 2N3902 700p
- 2N3903/4 18p
- 2N3905/6 20p
- 2N4036 70p
- 2N4037 65p
- 2N4058/9 12p
- 2N4060 12p
- 2N4061/2 18p
- 2N4123/4 27p
- 2N4125/6 27p
- 2N4401/3 27p
- 2N4427 90p
- 2N4871 60p
- 2N5087 27p
- 2N5089 27p
- 2N5172 27p
- 2N5179 90p
- 2N5191 90p
- 2N5194 90p
- 2N5245 40p
- 2N5296 55p
- 2N5401 50p
- 2N5457/8 40p
- 2N5459 40p
- 2N5460 60p
- 2N5485 44p
- 2N5875 250p
- 2N6027 48p
- 2N6107 65p
- 2N6247 190p
- 2N6254 130p
- 2N6290 65p
- 2N6292 65p
- 2SC1172 150p
- 3N128 120p
- 3N140 100p
- 3N141 110p
- 3N201 110p
- 3N204 100p
- 40290 250p
- 40361/2 75p
- 40364 120p
- 40408 70p
- 40409 86p
- 40410 85p
- 40411 300p
- 40594 97p
- 40595 105p
- 40673 75p
- 40841 90p
- 40771/2 90p

DIODES

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

HEAT SINKS

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

BRIDGE RECTIFIERS

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

ZENERS

2.7V-33V
- 400mW 9p
- 1W 15p

TRIACS PLASTIC

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

THYRISTORS

- 1A 50V 40p
- 1A 400V 65p
- 3A 400V 90p
- 8A 600V 140p
- 12A 400V 160p
- 16A 100V 160p
- 16A 400V 180p
- 16A 600V 220p
- BT106 110p
- C106D 45p
- MCR101 36p
- TIC44 35p
- 2N3525 120p
- 2N4444 140p
- 2N5060 34p
- 2N5064 40p

LOUDSPEAKERS

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

MEMORIES

- 2102-2L 120p
- 2107B 500p
- 2111-2 225p
- 2112-2 300p
- 2114 400p
- 2114-2L 500p
- 4027 375p
- 4044 900p
- 4116 500p
- 5101 510p
- 6810 350p
- 74S201 350p
- 82S16 325p

ROM/PROMs

- 71301 700p
- 74S188 225p
- 74S287 350p
- 74S387 350p
- 74S470 650p
- 74S471 650p
- 74S571 650p
- 82S137 750p
- 93427 400p
- 93436 650p
- 93446 650p
- 93448 900p

CPUs

- 1600 1200p
- 1802CE 650p
- 2650A 2000p
- 6502 1000p
- 6800 700p
- 6802 1250p
- 6809 2500p
- 8080A 550p
- 8085A 1400p
- INS8060 1000p
- Z80 1100p
- Z80A 1250p

EPROMS

- 1702A 500p
- 2708 800p
- 2716 (+5V) £16

SUPPORT DEVICES

- 3242 800p
- 3245 400p
- 6532 1000p
- 6820 500p
- 6821 500p
- 6845 2500p
- 6850 500p
- 8205 320p
- 8212 225p
- 8216 225p
- 8224 400p
- 8228 525p
- 8251 700p
- 8253 1200p
- 8255 550p
- 8257 1100p
- 8259 1400p
- Z80P10 650p
- Z80AP10 800p
- Z80CTC 650p
- MC14411 1100p
- MC14412 1100p

UART

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

CHARACTER GENERATORS

- 3257ADC 990p
- MCM6576 1000p
- RO-3-2513 U.C. 600p
- RO-3-2513 L.C. 700p
- SN74S262AN 900p

KEYBOARD ENCODER

- AY-5-2376 900p

TRANSFORMERS

(prim 220/240V)
- 6-0-6 100mA 88p
- 9-0-9 75mA 92p
- 0-120 12500mA 280p
- 0-25V (5VA) 250p
- 9-0-9 1A 270p*
- 12V 2A 350p*
- 0-12-15
- 20-24-30 1A 340p*
- 15-0-15 1A 265p*

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

RESISTORS High Stab 5% E12 Carbon Film

- ¼W 10R-1M 7p/5pcs one value
- ½W 10R-10M 5p/3pcs one value
- Miniature Presets Hor/Vert 100R-1M 12p
- Carbon Track Pots 5K-1M Log or Lin
- Single 30p
- Single with Switch 60p
- Dual 72p
- SLIDER POTS 60mm Track LIN 5K, 10K, 50K, 100K 60p
- LOG 10K 60p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	10p	18 pin	20p	24 pin	28p
14 pin	11p	20 pin	22p	28 pin	32p
16 pin	12p	22 pin	25p	40 pin	40p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	70p	24 pin	90p
14 pin	40p	20 pin	75p	28 pin	110p
16 pin	55p	22 pin	80p	40 pin	140p

SUBMINIATURE SWITCHES

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

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

ANTEX SOLDERING IRONS

- C-15W 400p
- CX-17W 420p
- CCN-15W 420p
- X25 420p

SPARE BITS

- C/CX/CCN 46p
- X25 50p

SPARE ELEMENTS

- C/CX/X25 180p
- CCN 200p

ADCOLA IRONS

- K1000 550p
- K2000 550p

CRYSTALS

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

VEROBOARDS

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

CONNECTOR PLUGS

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

EDGEBOARD CONNECTORS 0.156" PITCH

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

COUNTERS

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

TTL & ECL

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

SPECIAL OFFERS (subject to stocks)

555	£18/100	7805	£5/10
741	£16/100	7812	£5/10
2114L-3	£4.50	7905	£6/10
2708	£6.75	7912	£6/10
2708 (650 ns)	£4.00	2114L 450 ns	£28/8
2716 (plus 5V only)	£16.00	P&P + VAT Extra	
4116 (200 ns)	£36/8		

BREADBOARDS

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

IC TEST CLIPS

- 14 pin £2.60
- 16 pin £2.75
- 24 pin £4.90
- 40 pin £7.90

PROTOBOARD (R) SOLDERLESS BREADBOARDS

Socket Strips/Bus Strips/Binding Posts mounted on sturdy base plate.
- P86 6 × 14 DIL ICs £9.20
- PB100 10 × 14 DIL ICs £11.80
- PB102 12 × 14 DIL ICs £22.95
- PB103 24 × 14 DIL ICs £34.45
- PB104 32 × 14 DIL ICs £45.95

(The above boards are suitable for all DIL ICs.)

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

COMPUTER KITS

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

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HM 307-3 10MHz single beam with Component Tester **170.00**
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Super 10 10MHz dual trace **239.00**
SINCLAIR 10MHz Miniscope. P/S **4.00**, Nicads **7.95**, Case **8.80** **152.50**
PROBES x1/x10 **12.95**, x10 **10.50**, x1 **8.50**, x100 **16.95**.

FREQUENCY COUNTERS

OPTO 7010 9 digit, 600MHz Portable. 0.1HZ Resolution with NiCADS **139.95**
MAX 50 50MHz 6 digit pocket counter **61.00**
MAX 100 100MHz 8 digit portable counter **88.75**
MAX 550 550MHz 6 digit pocket counter **106.00**
500 MHZ Prescaler for max 50 or max 100 .... **40.00**
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c7216R. 10MHz. 8 Digit Panel Mounting **55.80**
c7216RP. 150MHz version **68.25**

DIGITAL MULTIMETERS

DM235 Sinclair portable 3½ digit LED **56.50**
PDM35 Sinclair Pocket 3½ digit LED **36.50**
DM350 Sinclair 3½ digit } with 10 amp range **78.50**
DM450 Sinclair 4½ digit } with 10 amp range **107.95**
(30Kv Probes **15.95.** P/S **4.00.** DM Nicads **7.95.** Cases **8.80**)
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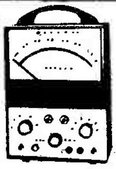

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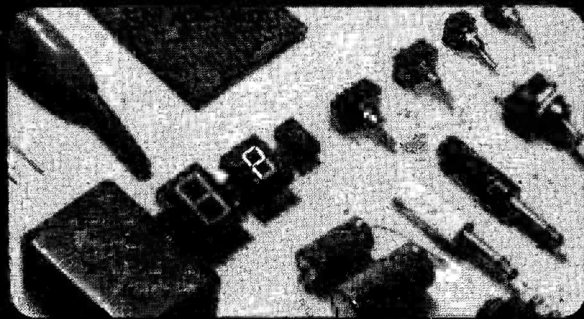

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FM MAINS DISTRIBUTOR

A system for distributing a Hi-Fi or other audio signal to any number of remotely-located speakers, using the mains wiring as the communication link.

This unusual project is designed to distribute an audio signal to any number of speakers that are remotely-located throughout a house or office building, using the mains wiring as the communication link. The system has an overall audio frequency response that extends to 20 kHz, with typically less than 0.5% total harmonic distortion and is designed to deliver a maximum of about 2 watts to each speaker. The system rejects all unwanted mains noise and has an overall audio sensitivity of about 10 mV for 2 watts output on each speaker.

The system comprises a single transmitter unit and any required number of remotely-located receiver/amplifier units. The transmitter unit generates a 200 kHz carrier signal, which is frequency modulated by the audio input signal and which the transmitter superimposes on the neutral line of the 230 volt AC mains wiring. At each receiver unit, this FM signal is picked up from the mains, is amplified, demodulated and the resulting audio signal is then fed to an external eight ohm speaker via a 2 watt power amplifier IC.

The transmitter and each receiver unit is provided with its own volume control. Each receiver unit is also provided with an automatic mute facility, which disables its audio output when the transmitter is turned off. All units are mains powered and simply plug into existing mains sockets via fused (1 amp) plugs, no other interconnections being required. All units incorporate a variety of safety features, but it is essential for correct operation that the mains sockets be wired in the correct polarity: each socket should thus be tested with a neon indicator or similar device before plugging a unit into place.

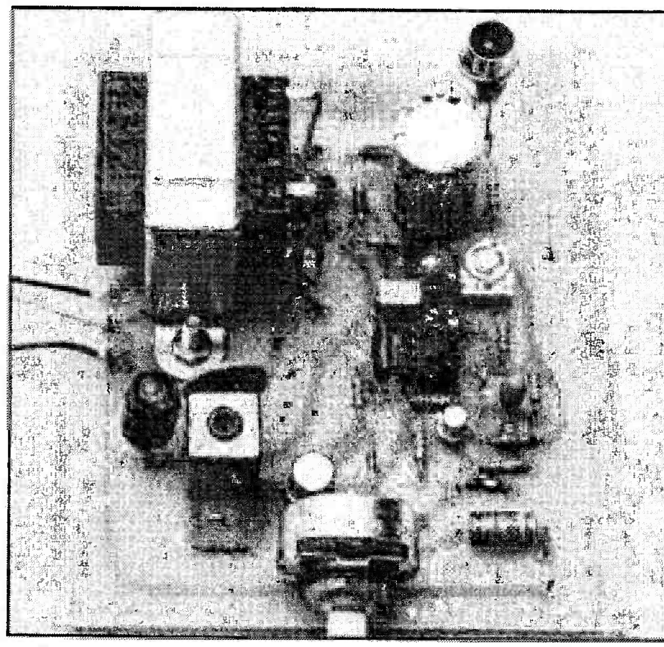
The Mains-Line system can readily distribute an audio signal throughout an entire house or office building and has a variety of practical applications. In the home, it can be used to transmit the output of a music centre or other audio source to all rooms in the building. Alternatively, the transmitter can be fitted with a microphone and pre-amp and used as a baby alarm, enabling the baby to be heard from any part of the house.

In an office, the transmitter can be coupled to a mixer unit and used to distribute music signals and announcements throughout the entire building without the expense of having to fit additional wiring.

Construction: The Transmitter

The entire transmitter unit, including the power transformer, is assembled on a single PCB. Construction should present few problems if the usual precautions are taken to ensure that all semiconductor devices and electrolytics are fitted in the correct polarity.

When construction is complete, set the core of L2 and the slider of RV1 to mid position. If you have a 'scope, give the



unit a functional check by checking that a signal of a few hundred mV at about 200 kHz is present across the output terminals of T2: set the frequency to precisely 200 kHz via RV1 and trim the core of T2 for maximum output.

You can, if you wish, case the complete unit; our own prototype is uncased, as it is intended to be built into an existing audio amplifier system.

Construction: The Receiver

Most of the receiver unit (except T1, RV2, SW1 and LED 1) is wired up on a single PCB. Construction should present few problems if the overlay is followed with care. When construction is complete, fit the PCB and remaining components into a suitable case and complete the interconnections to T1, RV2, SW1 and LED 1, as indicated on the overlay and the circuit diagram.

When construction is complete, set the core of T2 and the slider of RV1 to their mid position, connect the output of the unit to an eight ohm speaker and switch the unit on. With mute switch SW1 on, little noise should come from the speaker: with SW1 off, lots of 'white' noise should come from the speaker, indicating that the system is functional. If you have a 'scope, monitor pins 4–5 of IC1 and adjust RV1 to obtain a frequency of about 400 kHz.

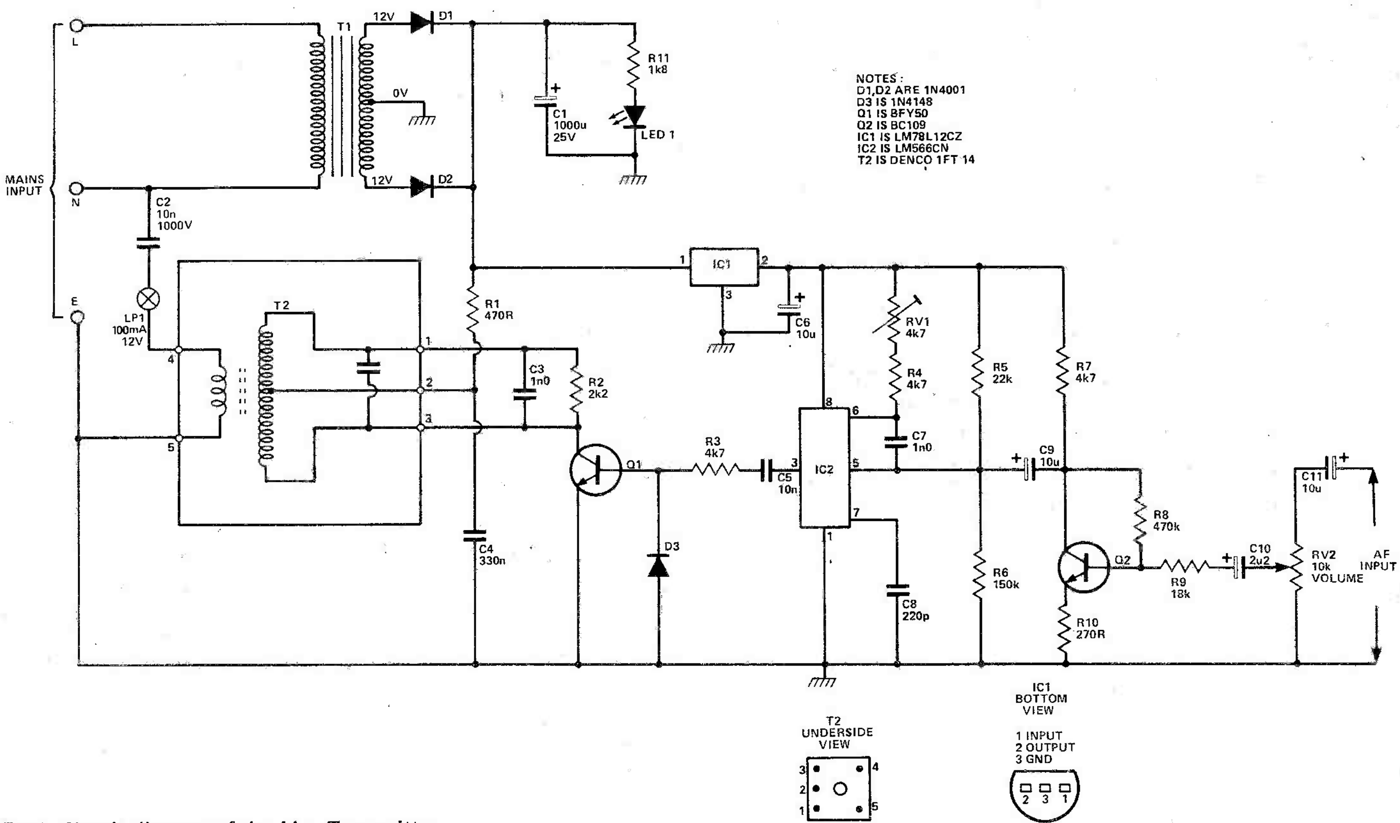


Fig.1. Circuit diagram of the Line Transmitter.

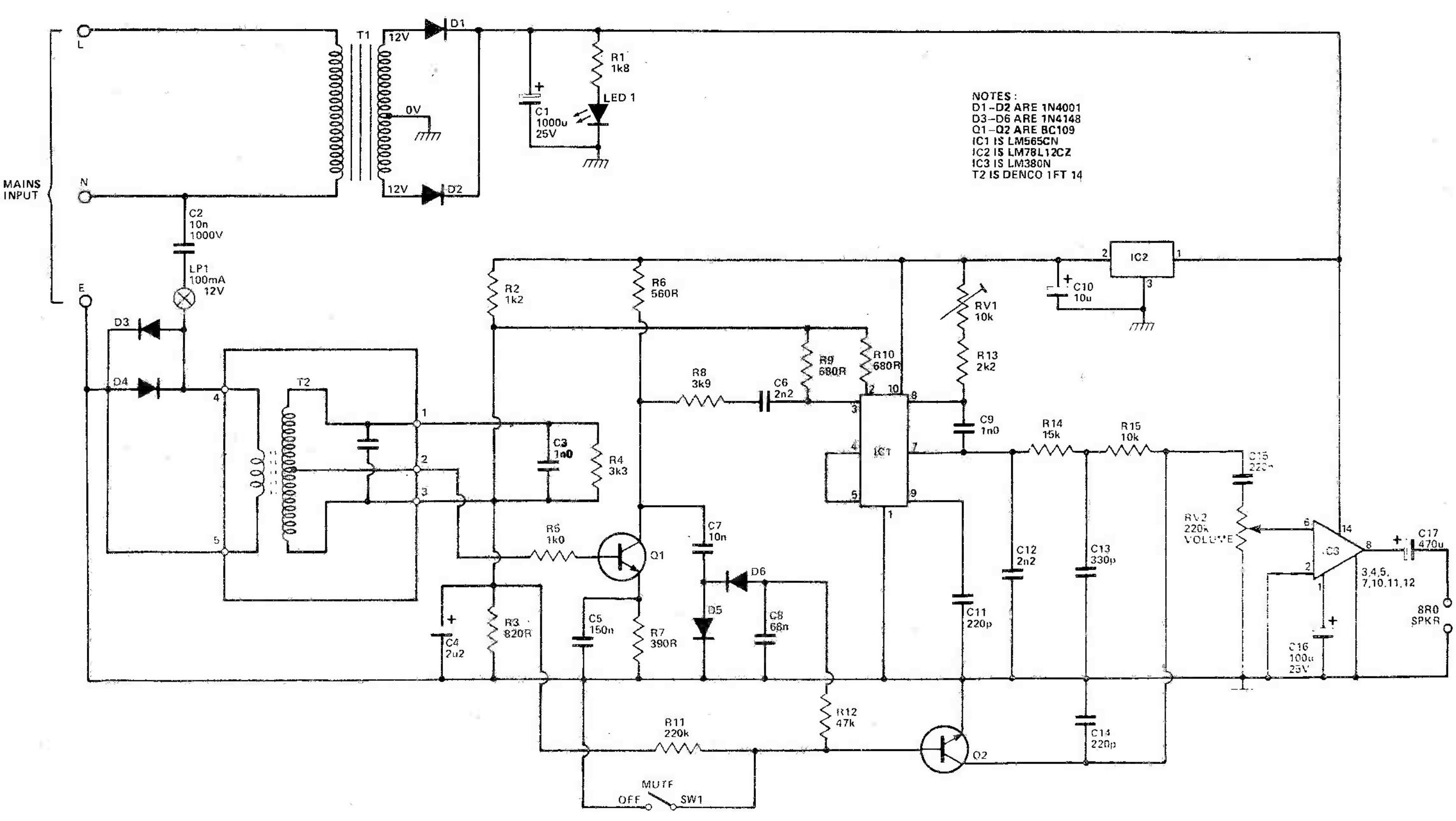


Fig.2. Circuit diagram of the Line Receiver.

HOW IT WORKS

The system is designed to transmit an audio signal to any number of remotely-located receiver/speaker units, using the mains wiring as the communication link. The transmitter produces a low-level 200 kHz carrier signal, frequency modulated by the audio signal, which it superimposes on the neutral line of the mains wiring. At each receiver unit, the carrier signal is picked up from the mains, amplified, demodulated and the resulting audio signal is passed on to a speaker via a 2 watt audio amplifier IC. The use of an FM link ensures a good audio response and excellent noise rejection.

System operation relies on the fact that the mains wiring is highly inductive and acts as a fairly high impedance to a 200 kHz signal. At this frequency, the wiring can be regarded as an inductive potential divider, with the power sub-station at its 'low' end. This 'divider' normally produces relatively little signal attenuation between power points that are separated by scores or hundreds of metres of wiring and can be used as an excellent built-in 'data link' in any home.

The Transmitter

IC2 is a voltage-controlled oscillator, or VCO. Its operating frequency is determined by the values of RV1–R4 and C8 and by the voltage on pin 5. With the component values shown, the VCO operates at a centre frequency of 200 kHz and produces a square wave output at pin 3. This output is used to drive common emitter amplifier Q1, which uses a standard IF transformer (T2) as its collector load; the centre frequency of T2 is shifted to 200 kHz by C3 and its 'Q' is reduced to a fairly low value (to give a broad-band response) by R2. The output signal on T2 secondary (pins 4 and 5) has an amplitude of a few hundred mV rms.

Audio input signals to the unit are fed to volume control RV2 via C11 and then subjected to about 20 dB of amplification via Q2. The output of Q2 is used to frequency modulate the VCO via C9 and pin 5. Consequently, the output of T2 is a 200 kHz 'carrier' signal frequency modulated by the audio signal. This output is coupled into the neutral line of the mains wiring via low-value capacitor C2 and current-limiting 'fuse' LP1. Note that one side of T2 output is wired to the Earth line of the mains, thereby ensuring that standing DC potentials of only a few volts exist between the primary and secondary windings of the transformer. C2 and LP1 ensure that the system will not be damaged if the output signal is accidentally fed to the live, rather than the neutral, side of the mains.

Q2 and IC2 are powered from a stabilised supply via IC1, a 12 volt regulator.

The Receiver

The 200 kHz frequency-modulated mains signal is picked up on the input of T2 via C2 and current-limiting 'fuse' LP1; D3 and D4 are used to limit the T2 signal amplitudes to a few hundred millivolts. T2 is tuned to 200 kHz via C3 and has its 'Q' reduced to a fairly low value via R4, to give a broad-band response. The isolated output signal of T2 is fed to the base of common emitter amplifier Q1 via current-limiting resistor R5.

The base of Q1 is biased to 4V5 via the R2–R3 divider network. Q1 is overdriven by the input signal and has its output clipped at about 6 volts peak-to-peak. The output of Q1 is fed to the pin 3 input terminal of IC1 via R8–C6–R9. IC1 is a phase locked loop and is used to demodulate the 200 kHz FM carrier signal. This IC contains a reference oscillator, which is set to the same centre frequency as the carrier via RV1–R13 and C11. The demodulated audio signal appears at pin 7 of IC1. C12–R14–C13–R15–C14 are used to filter out any vestiges of the carrier and the resulting 'clean' audio signal is passed on to volume control RV2 via C15. The output of the volume control is fed to 2-watt audio amplifier IC3 and is then passed on to an external eight ohm speaker via C17. Most of the circuit (other than IC3) is powered from a stabilised supply via IC2, a 12 volt regulator.

The receiver unit is provided with an automatic 'mute' facility, which kills the audio output in the absence of a carrier signal, via Q2 and its associated network. Q2 is wired across the input to the volume control and kills the audio signal when biased on. Q2 is biased from two independent sources. It is positively biased (biased on) via R11 and the R2–R3 potential divider and can also be negatively biased (biased off) from the output of Q1 via the C7–D5–D6–C8–R12 rectifier network. The values of R11 and R12 are chosen so that the negative bias is predominant and Q2 is turned off in the presence of a carrier signal that has sufficient strngth to produce a peak-to-peak signal in excess of about 1V5 at Q1 collector. In the absence of a suitable carrier signal the negative bias falls to a negligible value and Q2 is turned on via R11.

The automatic mute circuit can be disabled by closing SW1, in which case the phase-locked loop tries to lock on to noise signals in the absence of a carrier and consequently produces very high noise levels at the output of IC3.

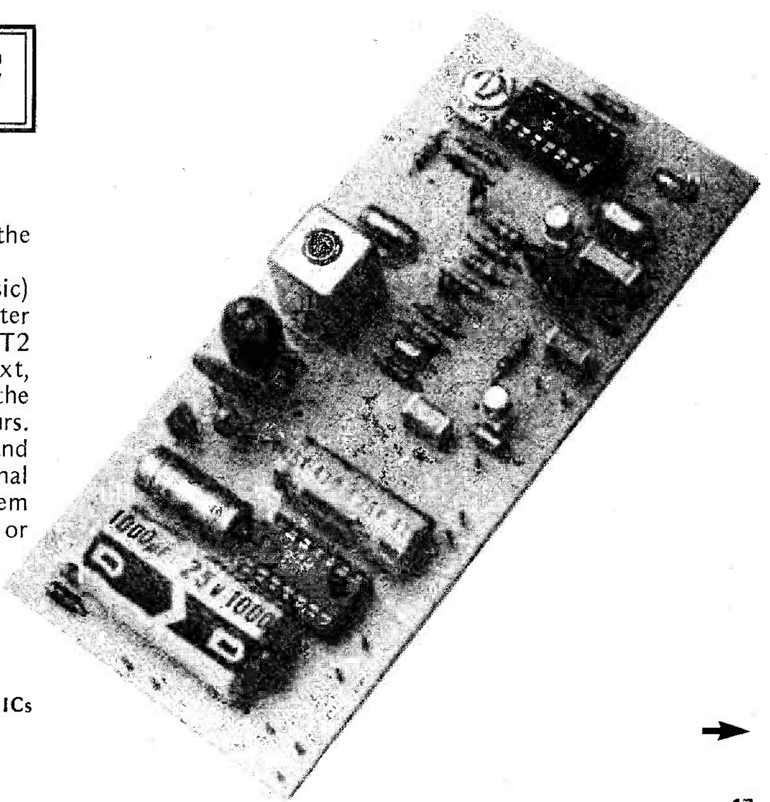
BUYLINES

The Denco IF transformer used in this project is available from Watford Electronics. The other components should be readily obtainable.

Setting Up The System

Access to a 'scope is needed when initially setting up the system, as follows.

Switch on both units and apply a suitable audio (music) signal to the input of the transmitter. Turn the transmitter volume control to zero, use the 'scope to monitor pin 2 of T2 in the receiver and adjust T2 core for maximum signal. Next, monitor pins 4–5 of IC1 in the receiver and set RV1 to the mid position at which locking to the 200 kHz carrier occurs. Finally, set the receiver volume control to mid value and adjust the transmitter volume control so that the music signal is heard at the receiver without apparent clipping. The system is then complete and ready for use throughout the house or office.



Right:a fully assembled line receiver PCB. Note the polarity of the ICs and polarised components.

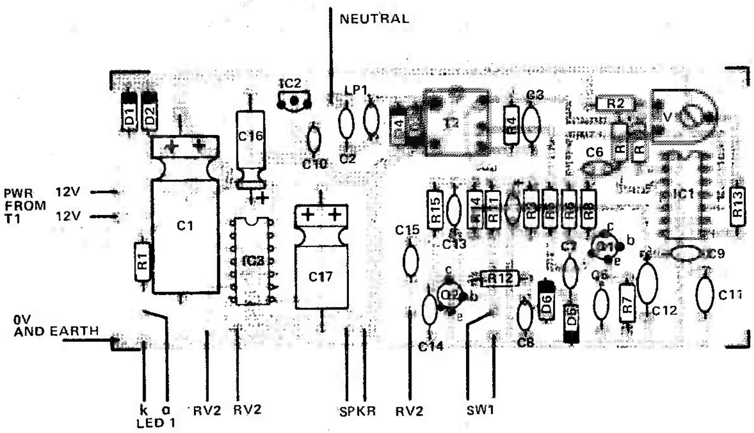


Fig.3. Component overlay for the transmitter board.

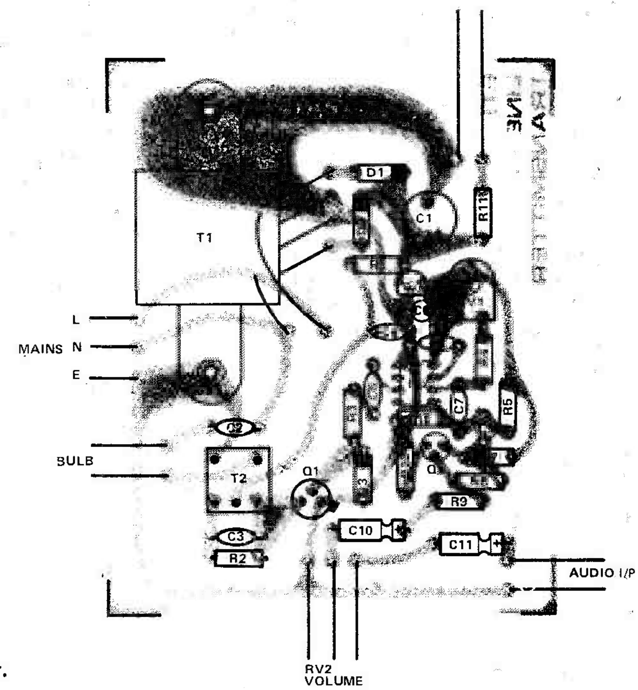


Fig.4. Component overlay of the receiver.

PARTS LIST

TRANSMITTER

Resistors All ¼W, 5%

R1	470R
R2	2k2
R3,4,7	4k7
R5	22k
R6	150k
R8	470k
R9	18k
R10	270R
R11	1k8

Potentiometers

RV1	4k7 min horiz preset
RV2	10k log

Capacitors

C1	1000u 25V PCB electrolytic
C2	10n 1000V disc ceramic
C3	1n0 polyester
C4	330n polycarbonate
C5	10n polyester
C6,9	10u 16V tantalum
C7	1n0 ceramic
C8	220p polystyrene
C10	2u2 16V electrolytic
C11	10u 16V electrolytic

Semiconductors

IC1	78L12
IC2	LM566CN
D1,2	1N4001
D3	1N4148
Q1	BFY50
Q2	BC109
LED 1	0.2" red LED

Miscellaneous

T1 12-0-12 6VA transformer, T2 Denco IFT 14, 12V 100 mA bulb.

RECEIVER

Resistors All ¼W, 5%

R1	1k8
R2	1k2
R3	820R
R4	3k3
R5	1k0
R6	560R
R7	390R
R8	3k9
R9,10	680R
R11	220k
R12	47k
R13	2k2
R14	15k
R15	10k

Potentiometers

RV1	10k min horiz preset
RV2	220k

Capacitors

C1	1000u 25V electrolytic
C2	10n 250V AC ceramic
C3	1n0 polystyrene
C4	2u2 tantalum
C5	150n polycarbonate
C6	2n2 ceramic
C7	10n polyester
C8	68n polycarbonate
C9	1n0 ceramic
C10	10u tantalum
C11,14	220p polystyrene
C12	2n2 polystyrene
C13	330p polystyrene
C15	220n polycarbonate
C16	100u 25V electrolytic
C17	470u electrolytic

Semiconductors

IC1	LM565CN
IC2	LM78L12CZ
IC3	LM380N
Q1,2	BC109
D1,2	1N4001
D3,4,5,6	1N4148
LED 1	any LED

Miscellaneous

12-0-12 transformer 6VA, 12V 100 mA bulb, T2 is Denco IFT 14, 8 ohm loudspeaker.

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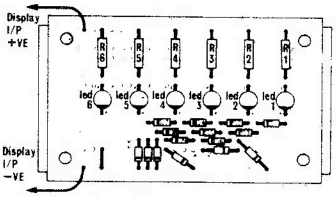

YOU WILL NEED

e.g. LED Bar Graph (a previous project)
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D1 to D15 — Silicon Diodes
R1 to R6 Resistors
LED 1 to LED 6 Light emitting diodes

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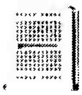
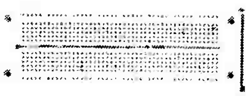
All EXP Breadboards have two bus-bars as an integral part of the board, if you need more than 2 buses simply snap on 4 more bus bars with the aid of an EXP 4B

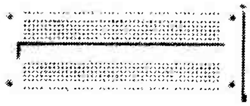


EXP 325 £1.60 The ideal breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22 pin ICs. Has 130 contact points including two 10 point bus-bars

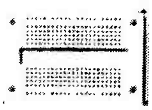
EXP 350 £3.15 Specially designed for working with up to 40 pin ICs perfect for 3 & 14 pin ICs. Has 270 contact points including two 20 point bus bars



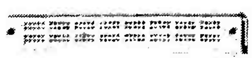
EXP 300 £5.75 The most widely bought bread-board in the UK With 550 contact points, two 40 point bus bars, the EXP 300 will accept any size IC and up to 6 × 14 pin DIPS. Use this breadboard with adventures in microelectronics.



EXP 600 £6.30 Most MICROPROCESSOR projects in magazines and educational books are built on the EXP 600.



EXP 650 £3.60 Has ·6" centre spacing so is perfect for MICROPROCESSOR applications



EXP 4B £2.30 Four more bus bars in "snap on" unit

The above prices are exclusive of P&P and 15% VAT

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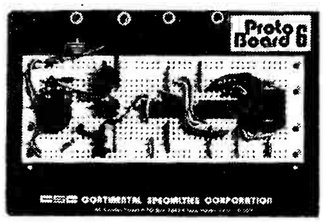
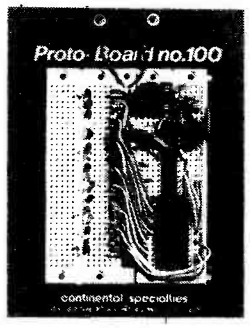


PB6 Kit, 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips.

PROTO-BOARD 6 KIT £9.20



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7423	£0.24	7460	£0.13	74104	£0.45	74163	£0.71		
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CD4006	£1.06	CD4016	£0.49	CD4025	£0.22	CD4040	£1.01	CD4050	£0.55
CD4007	£0.20	CD4017	£0.94	CD4026	£1.38	CD4041	£0.87	CD4054	£1.27
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CD4009	£0.52	CD4019	£0.48	CD4028	£0.78	CD4043	£1.01	CD4055	£1.15
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CA3014	£1.55	CA3140	£0.81	NE550	£1.09	72723	£0.52	TAA550B	£0.40
CA3018	£0.75	LM301	£0.33	NE555	£0.28	UA741C	£0.28	TAA621A	£2.30
CA3020	£1.96	LM304	£1.84	NE556	£0.69	72741	£0.28	TAA621B	£2.88
CA3028	£0.92	LM308	£1.15	NE565	£1.38	741P	£0.23	TAA661	£1.73
CA3035	£1.61	LM309	£1.73	NE566	£1.73	UA747C	£0.69	TAD100	£1.50
CA3036	£1.15	LM380	£0.98	NE567	£1.96	72747	£0.69	TBA540	£2.42
CA3042	£1.73	LM381	£1.67	UA702C	£0.53	UA748	£0.40	TBA810S	£0.86
CA3043	£2.13	LM3900	£0.67	72702	£0.53	72748	£0.40	TBA810	£1.13
CA3046	£0.81	MC1303L	£0.98	UA703	£0.29	748P	£0.40	TBA820	£0.81
CA3052	£1.84	MC1304	£2.19	UA709	£0.29	SN76013N		TBA9200	£2.88
CA3054	£1.27	MC1310	£1.09	72709	£0.53		£2.01	TCA270S	£2.30
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CA3081	£1.73	MC1350	£1.38	UA710C	£0.46		£2.01	TBA120	£0.60
CA3089	£2.30	MC1352	£1.61	72710	£0.35	SN76110	£1.73	TBA641A	£1.84
CA3090	£4.14	MC1469	£3.39	UA711C	£0.37	SN76115	£2.19	TBA641B	£2.53
CA3123	£2.19	MC1496	£1.04	72711	£0.37	SN76660	£0.86	ZN414	£1.15

THYRISTORS

Volts	No	Price
10	THY600ma/10v	£0.17
20	THY600ma/20v	£0.18
30	THY600ma/30v	£0.23
60	THY600ma/50v	£0.25
100	THY600ma/100v	£0.29
200	THY600ma/200v	£0.44
400	THY600ma/400v	£0.51

Volts	No	Price
50	THY1A/50	£0.30
100	THY1A/100	£0.32
200	THY1A/200	£0.37
400	THY1A/400	£0.44
600	THY1A/600	£0.52
800	THY1A/800	£0.67

Volts		Price
50	THY3A/50	£0.32
100	THY3A/100	£0.35
200	THY3A/400	£0.37
400	THY3A/400	£0.48
600	THY3A/600	£0.58
800	THY3A/800	£0.75

Volts	No	Price
50	THY5A/50	£0.41
100	THY5A/100	£0.51
200	THY5A/200	£0.57
400	THY5A/400	£0.65
600	THY5A/600	£0.79
800	THY5A/800	£0.93

Volts		Price
50	THY7A/50	£0.55
100	THY7A/100	£0.58
200	THY7A/200	£0.65
400	THY7A/400	£0.71
600	THY7A/600	£0.89
800	THY7A/800	£0.05

Volts	No	Price
50	THY10A/50	£0.58
100	THY10A/100	£0.65
200	THY10A/200	£0.71
400	THY10A/400	£0.80
600	THY10A/600	£1.13
800	THY10A/800	£1.40

Volts	No	Price
50	THY16A/50	£0.62
100	THY16A/100	£0.66
200	THY16A/200	£0.71
400	THY16A/400	£0.88
600	THY16A/600	£1.03
800	THY16A/800	£1.59

Volts	No.	Price
50	THY30A/50v	£1.36
100	THY30A/100v	£1.64
200	THY30A/200v	£1.87
400	THY30A/400v	£2.06
500	THY30A/600v	£4.03

SILICON RECTIFIERS

200MA		
IS920	50v	£0.07
IS921	100v	£0.08
IS922	150v	£0.09
IS923	200v	£0.10
IS924	300v	£0.11
1 Amp		
IN4001	50v	£0.05
IN4002	100v	£0.05
IN4003	200v	£0.07
IN4004	400v	£0.08
IN4005	600v	£0.09
IN4006	800v	£0.10
IN4007	1000v	£1 11
1.5 Amp		
IS015	50v	£0 0
IS020	100v	£0.11
IS021	200v	£0.12
IS023	400v	£0.14
IS025	600v	£0.16
IS027	800v	£0.18
IS029	1000v	£0.23
IS031	1200v	£0.28
3 Amp		
IN5400	50v	£0.16
IN5401	100v	£0.17
IN5402	200v	£0.18
IN5404	400v	£0.19
IN5406	600v	£0.24
IN5407	800v	£0.28
IN5408	1000v	£0.34

10 Amp		
IS10/50	50v	£0.21
IS10/100	100v	£0.24
IS10/200	200v	£0.26
IS10/400	400v	£0.40
IS10/600	600v	£0.48
IS10/800	800v	£0.58
IS10/1000	1000v	£0.69
IS10/1200	1200v	£0.79
30 Amp		
IS30/50	50v	£0.64
IS30/100	100v	£0.79
IS30/200	200v	£1.06
IS30/400	400v	£1.43
IS30/600	600v	£2.02
IS30/800	800v	£2.23
IS30/1000	1000v	£2.65
IS30/1200	1200v	£3.31
60 Amp		
IS70/50	50v	£0.86
IS70/100	100v	£0.96
IS70/200	200v	£1.38
IS70/400	400v	£2.01
IS70/600	600v	£2.58
IS70/800	800v	£2.87
IS70/1000	1000v	£3.45

TRIACS & DIACS

2 amp TO5 case

volts	No.	Price
100	TR12A/100	£0.36
200	TR12A/200	£0.59
400	TR12A/400	£0.82

6 amp

volts		
100	TR16A/100	£0.59
200	TR16A/200	£0.70
400	TR16A/400	£0.88

10 amp

volts		
100	TR110A/100	£0.88
200	TR110A/200	£1.06
400	TR110A/400	£1.29

10 amp Plastic

volts		
400	TR110A/400P	£1.29

DIACS
BR100 £0.23 D32 £0.23

BRIDGE RECTIFIERS

SILICON 1 amp

Type	No.	Price
50v RMS	BR1/50	£0.23
100v RMS	BR1/100	£0.25
200v RMS	BR1/200	£0.29
400v RMS	BR1/400	£0.41

SILICON 2 amp

Type	No.	Price
50v RMS	BR2/50	£0.52
100v RMS	BR2/100	£0.55
200v RMS	BR2/200	£0.60
400v RMS	BR2/400	£0.67

SILICON 10 amp

Type	No.	Price
50v RMS	BR10/50	£1.73
200v RMS	BR10/200	£1.96

SILICON 25 amp

Type	No.	Price
50v RMS	BR25/50	£2.19
200v RMS	BR25/200	£2.53

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA110	£0.09	BY100	£0.25	BYZ11	£0.52	OA90	£0.12
AA120	£0.09	BY101	£0.25	BYZ12	£0.46	OA91	£0.12
AA129	£0.09	BY105	£0.25	BYZ13	£0.46	OA95	£0.12
AAY30	£0.10	BY114	£0.25	BYZ16	£0.47	OA182	£0.15
AAZ13	£0.17	BY124	£0.25	BYZ17	£0.41	OA200	£0.09
BA100	£0.12	BY126	£0.17	BYZ18	£0.41	OA202	£0.09
BA102	£0.37	BY127	£0.18	BYZ19	£0.41	SD10	£0.07
BA148	£0.17	BY128	£0.18	OA5	£0.69	SD19	£0.07
BA154	£0.14	BY130	£0.20	OA10	£0.40	IN34	£0.08
BA155	£0.16	BY133	£0.24	OA47	£0.09	IN34A	£0.08
BA173	£0.17	BY164	£0.58	OA70	£0.09	IN914	£0.07
BB104	£0.46	BY176	£0.86	OA79	£0.12	IN916	£0.07
BAX13	£0.08	BY206	£0.34	OA81	£0.12	IN4148	£0.07
BAX16	£0.09	BYZ10	£0.52	OA85	£0.12	IS44	£0.06
						IS920	£0.07

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1503	125	YELLOW	£0.16
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1506	2	YELLOW	£0.16
1509	2	CLEAR (Ill Red)	£0.12
SUPER 'Hi'Brite' Type			
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1721	20 pin DIL	£0.20	16117	TO5 transistor	£0.13
1722	22 pin DIL	£0.22	1724	14 pin DIL Wire wrap gold plated Cambion	£0.25
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HOUSE WIRING

Ray Marston discusses house wiring systems of the past, present and future, presents some useful 're-wiring' aids and talks about some facinating line-based gadgets for the '80s.

Modern house wiring circuits are designed to conform to regulations laid down in 1947, that far-distant time when valves were in vogue and the word 'electronics' was used only in Sci-Fi movies. Consequently, modern house wiring works fine when used to power simple devices like flourescent lamps and electric toasters, but presents distinct problems if you want to use modern electronic lamp dimmers, FM power-line audio distribution systems, power-line remote control systems, or similar '1980s' devices.

If you happen to live in a house built before 1947, when 'modern' wiring was first introduced, it's a fair bet that your wiring is not only highly inefficient but is *downright dangerous*, with its rubber insulation perished to the point where total breakdown is imminent and the whole shambles is in danger of bursting into flames! So you'd better think about a rewire. And if you are going to rewire, you may as well rewire for the '80s.

In the next few pages we'll tell you how 'modern' wiring systems work, explain the wiring needs of the '80s, give a few hints on how to conduct a rewiring job and tell you about some of the wiring-based electronic control and data distribution systems that you are likely to see in the next year or so.

Conventional Power Wiring Systems

Electric power is fed into the house from the outside mains and passes to the building's electricity meter. It is then fed to the individual household circuits via individual fuse units or, in the latest systems, via a multi-fused 'consumer' unit.

The household circuits are, for convenience, classified as three distinct types, (a) power circuits (feeding sockets, etc), (b) lighting circuits and (c) accessory circuits (individual heavy-duty circuits feeding immersion heaters, cooker panels, etc). Let's look first at 'power' circuits.

Old-style (pre 1947) electrical systems use a 'radial' system of power wiring, as shown in Fig.1. Here, each individual power socket or small group of sockets is treated as an individual circuit and is connected to the mains via its own specific fuse; often, the live and neutral lines of each circuit are individually fused.

Sometimes, different circuits have different fuse ratings (sometimes the cable gauges may also be different), so that an electric fire (for example) may work on one socket but blow the fuses (or the wiring) when connected to another socket.

The radial wiring system is clearly inefficient and requires the use of excessive amounts of cable and an excessive number of fuses.

'Modern' (post 1947) electrical systems use a 'ring' system of power wiring, as shown in Fig.2. Here, a power cable is run from the fuse box to the first (hall) socket, then sequentially to all of the sockets on (say) the ground floor and finally back to the fuse box again, so that a 'ring' of cable is formed. The ring is treated as a single circuit and provided with a single

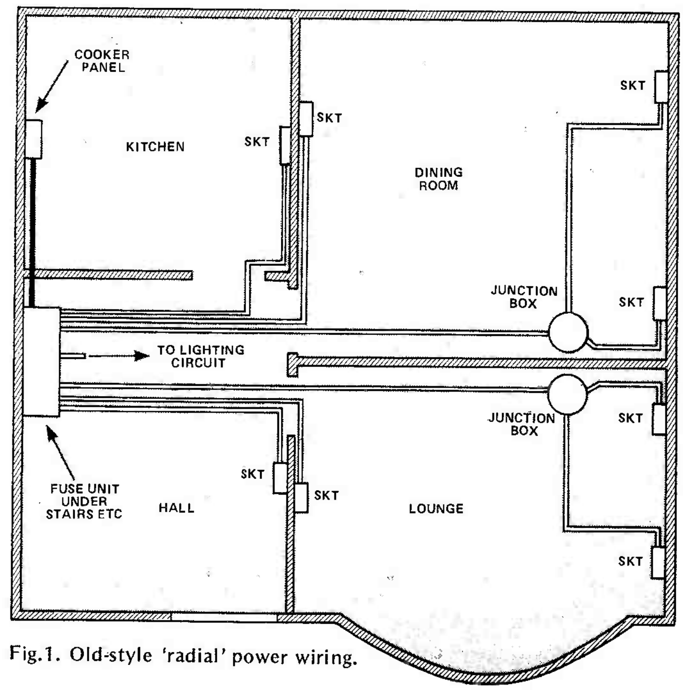


Fig.1. Old-style 'radial' power wiring.

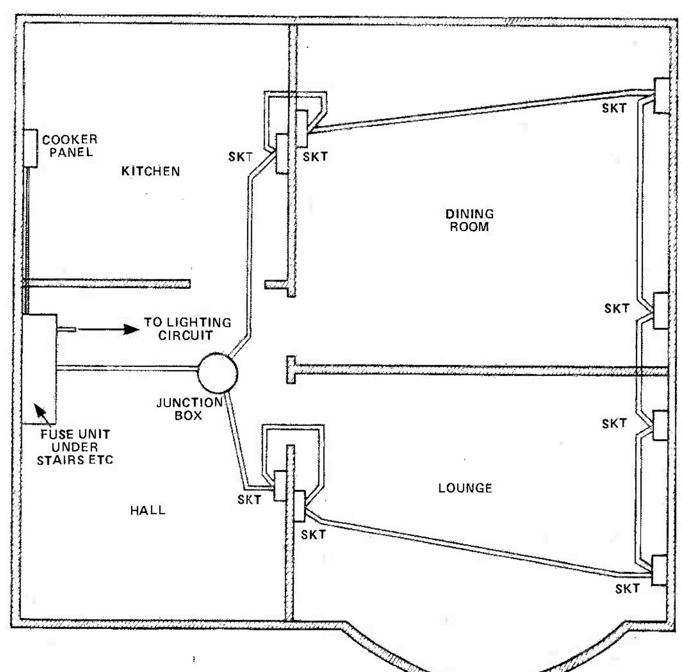


Fig.2. Modern-style 'ring' power wiring circuit. The 'ring' is shown here connected to the fuse unit via a junction box, but in practice the 'ring' may be connected directly to the fuse unit.

master fuse, but all socket plugs are individually fused. Most modern houses are provided with two ring circuits, one for each floor. On the upper floor, the ring may be connected to the fuse unit via a junction box and feeder cable.

The ring system is very efficient in the use of cable. Power is fed to each individual socket via both sides of the ring, which are thus effectively wired in parallel and share the socket current. This factor enables a relatively light gauge of ring cable to be used. In practice, 2.5 mm^2 PVC sheathed cable is used for ring circuits. Any number of sockets can be fitted on a ring serving a surface area of less than 100 m^2 (1000 ft^2): the ring must be fitted with a 30 A (max) fuse and can handle up to 7.2 kW. The feeder cable to such a ring (if used) must be 4 mm^2 type.

Power Wiring For The 80s

The most important 'house wiring' innovation of the '80s will be the widespread use of the mains wiring as a high frequency (a few tens or hundreds of kHz) data link between different parts of the house. The live and neutral lines of the house wiring each contain very considerable lengths of cable and consequently have substantial inductance. The reactance of the wiring is negligible at 50 Hz but can be quite significant at frequencies of a few tens or hundreds of kHz.

High frequency signals can thus readily be superimposed on the power wiring at any power socket in the house and can then be picked off again at any (or all) of the remaining sockets throughout the household.

Cable Music

You have two 'sets' of cables in the power wiring (earth-neutral and earth-live), giving you two indpendent data links throughout the house. One link can be used for distributing hi-fi signals via an FM system of the type described elsewhere in this issue. The other link can be used for distributing control data instructions to remote units: a 6-bit data word can be used to address any one of 16 different devices and convey up to four different instructions to those devices.

Figure 3 shows an example of the degree of control that can be obtained via a data-link system: only seven of the 16 available remote control channels are shown in use. On a cold and frosty morning you can, from the comfort of your bed, switch on the sump heater in the garage, activate the hi-fi distribution system and turn on the kettle and toaster in the kitchen. In the evening you can turn on the immersion heater and the electric blanket while sitting in your armchair in the lounge.

Absolute Luxury.

In the diagram we've shown a single 16-station transmitter unit that can be plugged into any convenient socket. In practice, you may prefer to have individual transmitter units permanently fitted into the lounge, kitchen and master bedroom. If you are really lazy, you can have a single 16-station infra-red transmitter unit that can pump signals into the mains via infra-red receiver/re-transmitter unit built into each room.

These high frequency distribution systems have considerable range and will work perfectly with all existing house wiring. This range is so great that signals can easily be picked up in neighbouring houses as well. If your neighbour happens to have a similar distribution system (it's a fair bet that he will within the next few years) the systems will interact. To overcome this problem you'll have to fit an efficient RF filter to the feeder lines, as shown in Fig.4, so that the unwanted external signals see the low impedances of the filter capacitors, while the signals on the internal rings see the high impedances of the filter inductors and do not escape.

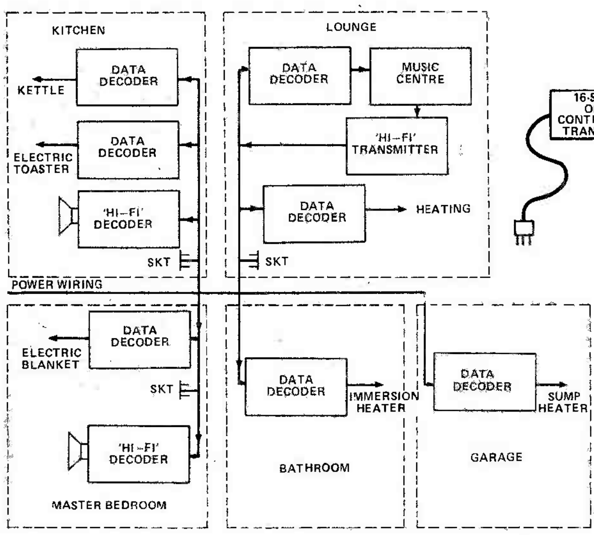
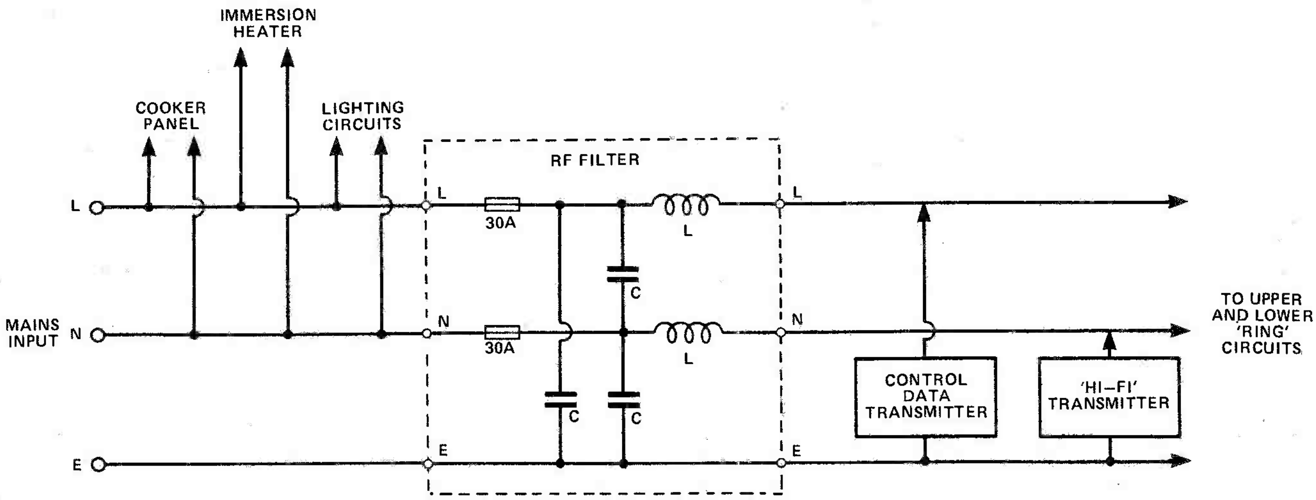


Fig.3. (left) Hi-Fi signals are fed to all power sockets in the house via an FM distribution system. Kettles, toasters, heaters, etc can be activated from any room in the house fitted with a power socket via a 16-channel remote control system: only seven channels are shown in this diagram.

Fig.4. (below) When power-circuit data distribution systems become widespread, it will be necessary to fit efficient RF filters to the feeder lines of the ring circuits.



Ring For Roses

A major problem with the Fig.4 circuit is that suitable (30 A) filter inductors are not readily available at the present time. When planning a rewire for the '80s, space should, however, be left in the fuse box area for the eventual fitting of such a filter when suitable components become available. Note that high-current 'accessory' circuits such as the cooker panel and immersion heater are not fed by the filter: nor are the lighting circuits, which generate a good deal of electrical noise when used with lamp dimmers, etc.

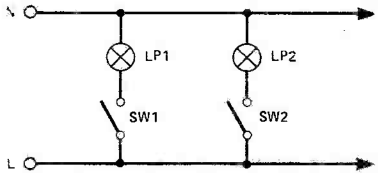


Fig.5. The basic lighting circuit (earth wiring not shown).

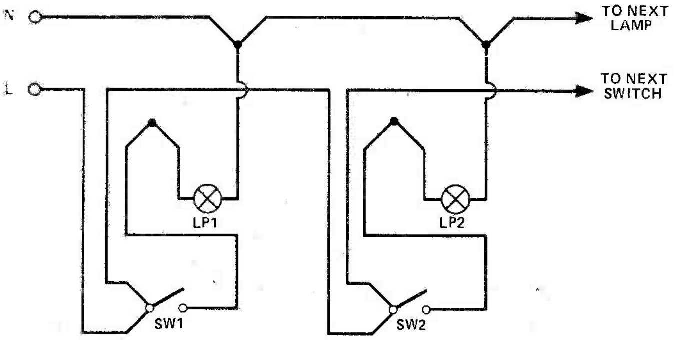


Fig.6. Old-style implementation of the lighting circuit (earth wiring not shown), with three wires (plus earth) running down to each switch.

In summary, then, power wiring for the '80s will take the form of 'modern' (post 1947!) ring circuits except that the feed line to the rings should be fitted with RF filters.

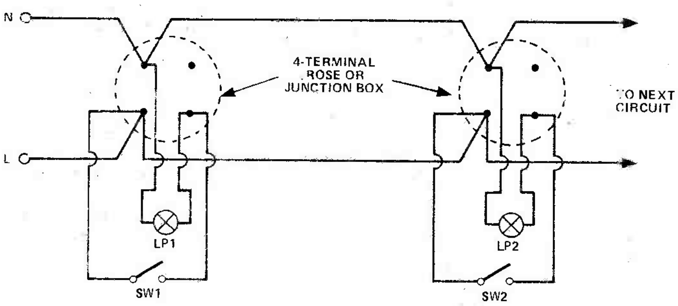


Fig.7. Modern-style implementation of the lighting circuit (earth wiring not shown), with two wires (plus earth) running down to each switch.

Conventional Lighting Circuits

The basic lighting circuit of a domestic system is deceptively simple, as shown in Fig.5. Note that the light switch is used to connect the lamp to the live side of the circuit, thereby ensuring that a shock cannot be received from the lamp holder (when changing a bulb) when the switch is open or off.

The physical implementation of the Fig.5 circuit is not a simple task. Fig.6 depicts the old-style (pre 1947) method of implementation, in which Neutral goes to one side of each lamp and the Live line is looped from one switch to the next. Note that this method requires three wires (plus Earth) to be run down to each switch. In practice, the old-style wiremen tended to disregard the 'polarity' rules and often switched the Neutral line, so that the lamp holder remained permanently (and dangerously) 'live'.

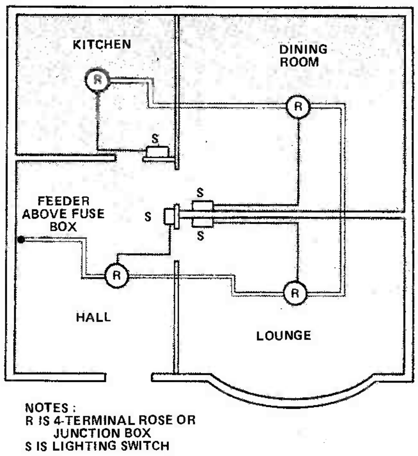


Fig.8. Typical ground-floor lighting circuit of a medium sized house.

Once again, the system in Fig.8 looks deceptively simple. In practice, the system may, if you are unlucky, take a full weekend to implement, particularly if you are changing the positions of light switches and have to cut new down-channels in the plaster to accommodate new cable runs.

Lighting The Way

Figure 9 shows the circuit and implementation of 2-way light switching. In practice 2-core, plus earth, cable is used to connect SW1 to the ceiling rose and 3-core plus earth is used to interconnect SW1 and SW2. A lot of channelling work may be required to implement the system. Note that changeover switches are required for 2-way switching.

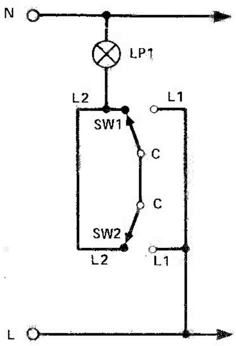
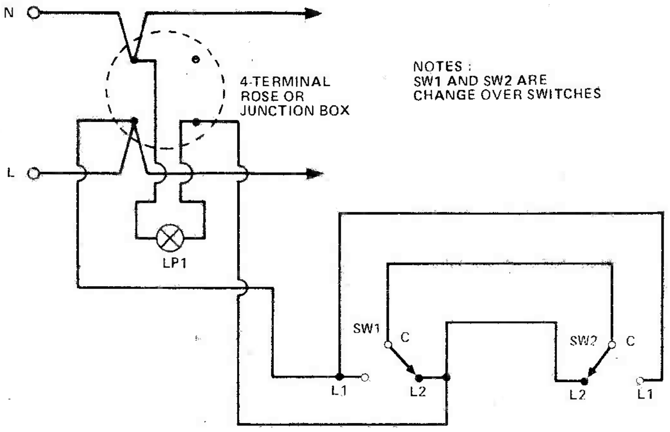


Fig.9. Circuit (left) and implementation (below) of modern 2-way light switching (earth wiring not shown). Note the large number of wires running down to the switches; in practice, a total of seven wires run down to SW1. The switching is shown in the OFF position.



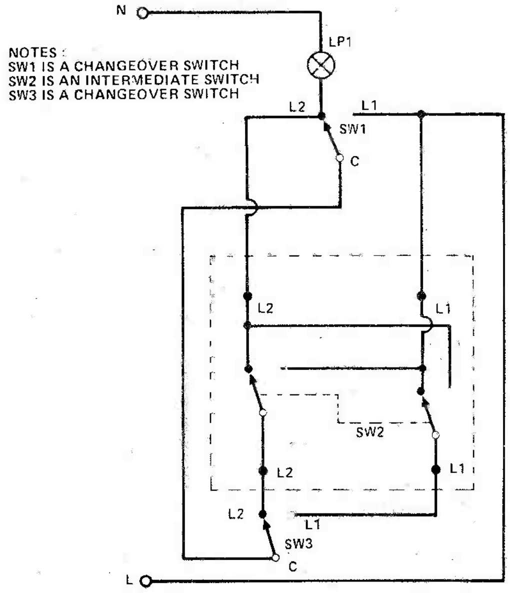
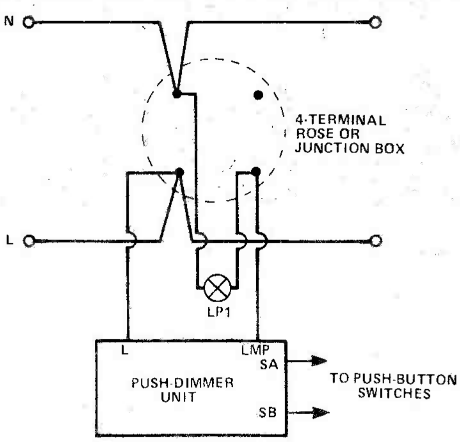


Fig.10. The electrical circuit that is used in 3-way light switching.

Lighting Circuits

A major deficiency of 'modern' lighting systems is the physical difficulty that is involved in initially installing the light switch wiring or in converting the system to multi-way switching. An ideal '1980s' solution to this problem is offered by the push-button-activated lamp dimmer/on-off circuit of Fig.11.



Note that the control (push-button) switches of the above circuit carry maximum currents of only a few mA and that any number of switches can be wired in parallel, enabling multi-way control to be readily implemented.

Ideally, this unit should be connected into the house wiring in a position that is close to the 4-terminal ceiling rose (but readily accessible for maintenance purposes): the push-button control switches should then be installed in the desired 'wall switch' positions and connected to the unit via low-power twin flex, shallowly buried in the plaster.

Note that the circuit uses components L1 and C1 for RFI suppression. All lamp dimmer circuits generate substantial RFI and should therefore incorporate suitable suppression networks: in practice, the very limited size of the conventional 'plaster-depth switch box' precludes the fitting of suitable filters, so most of todays 'manual' dimmer circuits generate unsuppressed RFI. A major advantage of the remote-controlled dimmer/on-off circuit of Fig.11 is that its physical size is not significantly constrained, so excellent filtering can readily be incorporated.

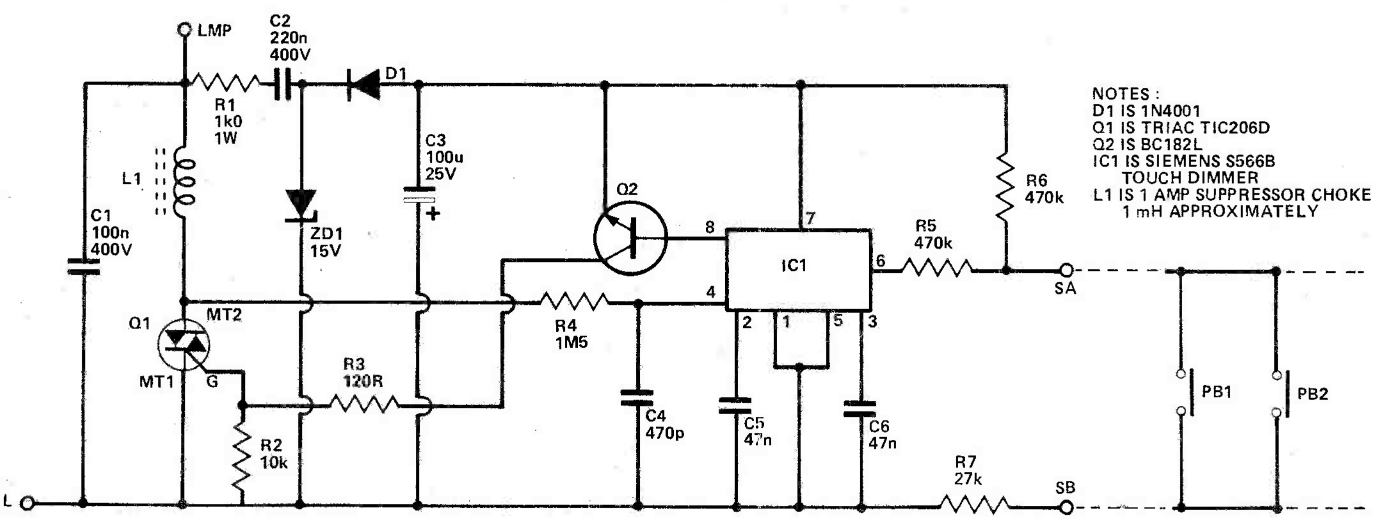
Practical Rewiring Hints

Electrical re-wiring is a technically simple but physically arduous and time consuming task. Floor boards have to be raised to gain access to the wiring and holes have to be drilled through joists and beams to facilitate wiring runs: plaster has to be channelled to accept new cable runs and must be remade afterwards.

Essential tools for the job include 2½" bolster chisels, a lump hammer and a decent power drill. Before starting the job, plan your new wiring layout with care, giving thought to the sensible positioning of new power sockets, light switches and ceiling roses. Your task may be simplified by using the conduit of the old wiring system.

Figs.12 to 14 show some useful rewiring aids. The Fig.12 and 13 circuits are used for tracing old wiring and conduit. The Fig.12 wire tracer works on the magnetic-field detection principle and is used to trace 'live' wiring. The Fig.13 circuit acts as a simple 'metal' detector and is used in conjunction with a hand-held pocket radio to trace cables, conduit and

Fig.11. This push-button-activated dimmer/on-off unit (below) can accept any number of parallel-connected inputs and offers a state-of-the-art solution to the multi-way light-switching problem. The unit can be wired into the domestic lighting circuit (left).



plumbing. These two circuits are described in greater detail in the June '79 issue of ETI.

Finally, the Fig.14 'marker beacon' circuit is useful for indicating the loft or under-floor break-through positions of pilot holes drilled through ceilings when installing new feeder cable runs or when re-positioning ceiling roses.

The cable used for rewiring will be 1.0 mm T & E for the lighting circuits, 2.5 mm T & E for power rings and 4 mm T & E for the ring feeders. All metal switch boxes and metal conduit, etc, must be earthed; the earth cable must be connected to the earth line of the mains feeder into the house.

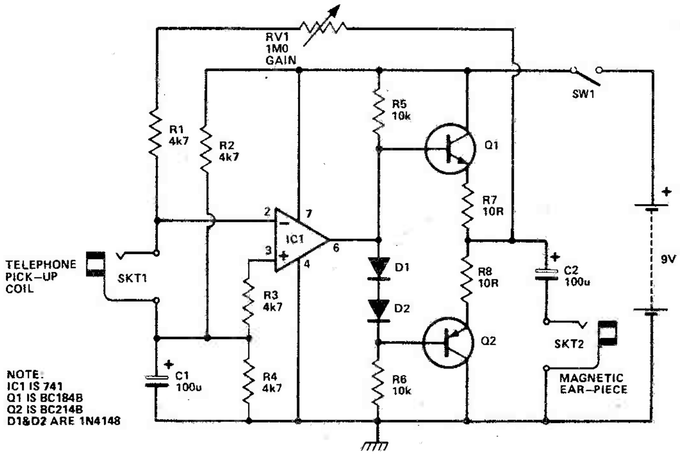


Fig.12. This wiring tracer works on the magnetic-field detection principle.

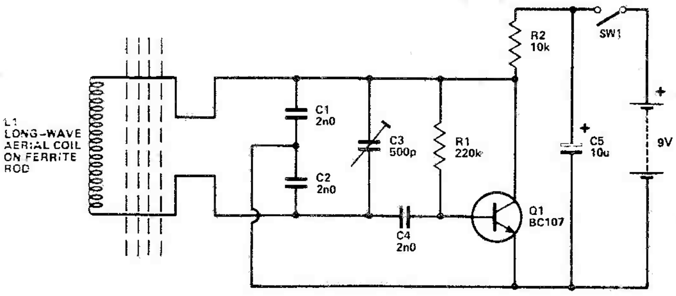


Fig.13. Circuit of a simple BFO-type mains and plumbing seeker; the unit is used in conjunction with a hand-held pocket radio.

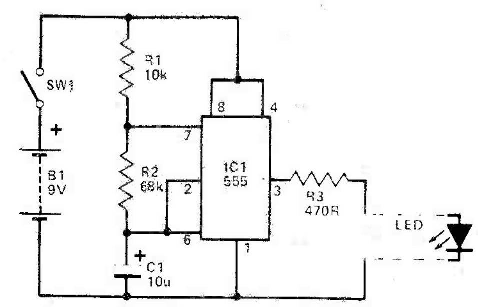


Fig.14. This 'marker beacon' circuit can be used to indicate the position at which pilot holes break through into dark places.

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9-0-9	100	13	**2.25**	.65
0.9, 0.9	330 330	235	**2.10**	.65
0-8-9, 0-8-9	500 500	207	**2.70**	.70
0-8-9, 0-8-9	1A 1A	208	**3.80**	.70
0-15, 0-15	200 200	236	**2.10**	.65
0-20, 0-20	300 300	214	**2.70**	.85
20-12-0-12-20	700(DC)	221	**3.45**	.85
0-15-20, 0-15-20	1A 1A	206	**4.55**	1.00
0-15-27, 0-15-27	500 500	203	**4.00**	.85
0-15-27, 0-15-27	1A 1A	204	**6.05**	1.00

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Pri: 220-240 Volts

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1.0	0.5	213	**2.70**	.85
2	1	71	**3.20**	.85
4	2	18	**4.00**	.85
6	3	70	**5.55**	.90
8	4	108	**7.40**	1.15
10	5	72	**8.20**	1.15
12	6	116	**8.80**	1.15
16	8	17	**10.80**	1.25
20	10	115	**13.80**	1.45
30	15	187	**16.80**	1.45
60	30	226	**33.30**	1.75

30 VOLT (Pri: 220-240V)
Sec: 0-12-15-20-24-30V

Amps	Ref. No.	Price £	P&P
0.5	112	**2.80**	.85
1.0	79	**3.55**	.85
2.0	3	**5.55**	1.00
3.0	20	**6.25**	1.15
4.0	21	**6.55**	1.15
5.0	51	**9.55**	1.15
6.0	117	**11.05**	1.15
8.0	88	**14.30**	1.45
10.0	89	**16.55**	1.45

50 VOLT (Pri: 220-240V)
Sec: 0-19-25-33-40-50V

Amps	Ref. No.	Price £	P&P
0.5	102	**3.55**	.85
1.0	103	**4.55**	1.00
2.0	104	**7.25**	1.15
3.0	105	**8.55**	1.15
4.0	106	**10.80**	1.25
6.0	107	**15.05**	1.45
8.0	118	**20.15**	1.65
10.0	119	**24.05**	2.15

60 VOLT (Pri: 220-240)
Sec: 0-24-30-40-48-60

Amps	Ref. No.	Price £	P&P
0.5	124	**3.80**	.85
1.0	126	**5.55**	1.00
2.0	127	**7.50**	1.15
3.0	125	**11.05**	1.25
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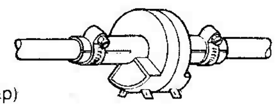

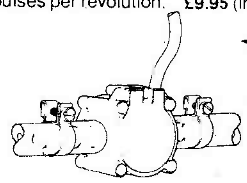

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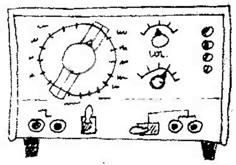

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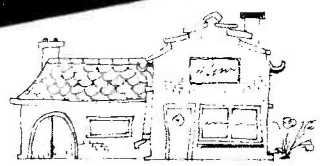

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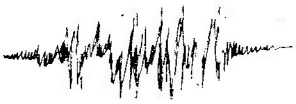

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cars 80

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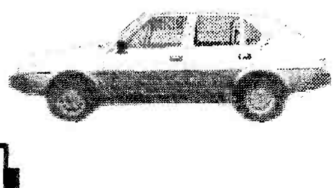

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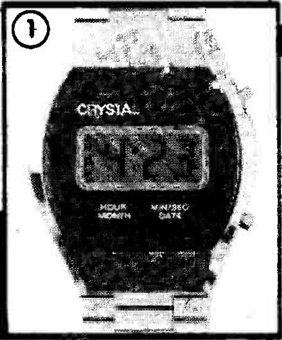

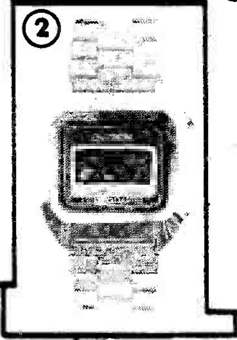

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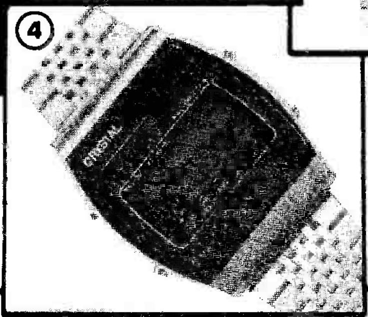

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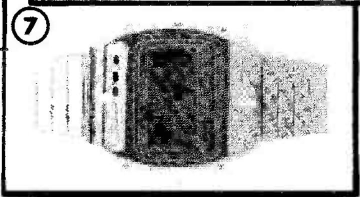

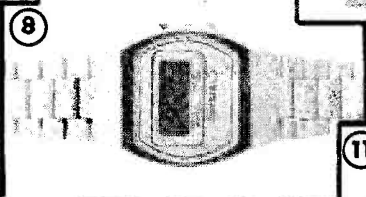

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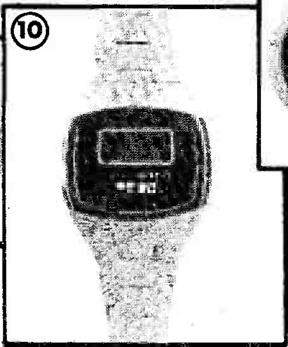

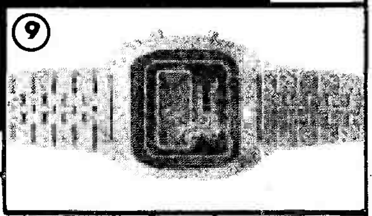

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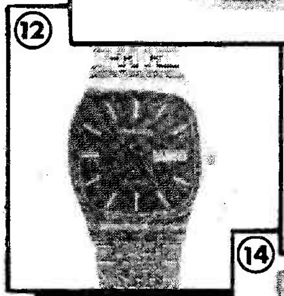

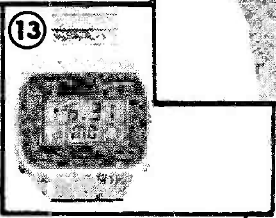

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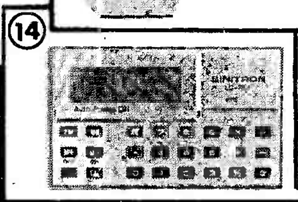

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AUDIOPHILE

Lost in a haystack full of needles (stylii?) Ron Harris presents a review of Shures new M97 cartridge range and compares two other two moving-magnets from Stanton and Ortofon.

I have to start this month with two apologies. The first goes to Videotone who had two pieces of equipment in my £300 system a while back. Seems that while the issue was going to press, they had their bright idea of going direct mail-order, with the result that their prices took a tumble. Being nice helpful people they rang me up to tell me this of course, but being the worlds worst file keeper I promptly lost the piece of paper with the facts scrawled across its tatty, crumpled face.

So, a little belatedly I admit, I have the somewhat unusual task of reporting a price FALL. GB2 loudspeakers can be purchased now for £60 and not the £100 or so they used to cost. The Coral 555E cartridge also comes down, from £25 to around £14. Good news indeed for those shopping in that area and reason enough for me to begin filing things properly.

My second apology goes to everyone, including me, who has the sense of beauty to appreciate the lovely Felicity Kendal. Last month's Audiophile was *supposed* to contain an excellent photograph of the lady, provided by Mr. Rickwood. Sometime between leaving my desk, bound for our printers, and reappearing in the issue, someone or something GOT to it. thing GOT to it.

When I find out *who*, there will be set abroad in the night such things that the miserable wretch will lie shivering and cowering in his repentance . . . .

Tale Of Four Cartridges

To hear some of the disciples speak, you could be excused for thinking that moving-coil cartridges were the only things fit to waggle a cantilever across a record. There are, however, not a few companies still producing some excellent units in the higher price brackets, whose coils remain remarkably static.

Immediate claims to such fame could be made by Shure, Goldring, Stanton, Ortofon, Empire and Grado. Units which earn such accolades might be V15 IV, 900 IGC, 881S, LM30, EDR9 and G2. Might be. That is what I determined to find out. The first two units, the Shure and Goldring, will be no strangers to Audiophile readers as both have been reviewed herein already. This month I have a report on the Stanton 881S and the Ortofon LM30H – SME style. Empire were invited to participate but still had not supplied an EDR9 by the time this magazine went to press. Should they ever awaken down there and one appears over my horizon you'll be hearing about. Until then – a pity.

As more than adequate compensation I can offer a first-ever review on two of the new Shure M97 series of pickups – the top model, the 97HE and the middle of the road M97EJ. Let's start with these Shures then.

V15's For All?

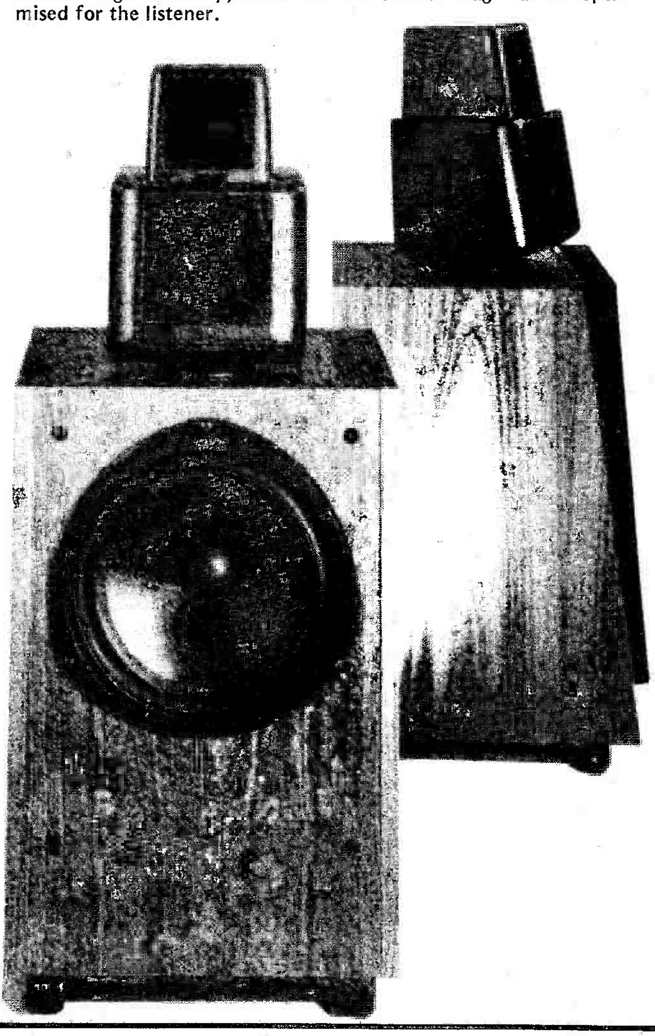
This new range from Shure is based upon the technology of their V15 IV model. All inherit the "dynamic stabiliser" affair from their predecessor – a carbon fibre brush set in damped pivots which rides ahead of the stylus and provides a good deal of isolation from shock – and the 97HE model even has the same stylus contour as the V15 itself.

A feature which I am positively NOT going to test is their 'side-guard'. Shure claim that a 'lateral deflection assembly' allows the cantilever to accept impact in a sideways direction without damage, with the stylus simply withdrawing into the cartridge body. This might occur, say, when the cartridge hits the side of an LP accidentally, or is knocked across a record. Shure – I'll take your word for it, my courage fails me.

These are large cartridges, which look superb set up (in any arm)..As usual for Shure the packaging and presetation is magnificent and the finish on the cartridges faultless.

The HE will take its place beneath the V15 IV in Shure's range, but with the incredible number of cartridges Shure now have on the market, it is difficult to be sure – and they show

Audiophile has acquired a new pair of reference speakers – KEF 105 II's, shown below and (in cutaway) right. These are probably the best speakers on the market today for home use. As you can see the 'head' contains the mid-range and HF units, each in its own little enclosure. This can be tilted and turned through a limited angle laterally, such that the stereo image can be optimised for the listener.



no signs of rationalising. More power to them if they can sell them all.

It should be said, though, that this M97 series is a significant step ahead of their other ranges in terms of sound quality and should outsell them all with ease. Originally I hadn't intended to include either of these two models in with the Stanton and Ortofon — after all the price is noticably lower — but the HE performed well enough for me to think it worthwhile. In fact one of the surprises awaiting me amid this forest of cantilevers, was how close the M97HE came in performance to the exalted V15 IV!

Shure-fire Test?

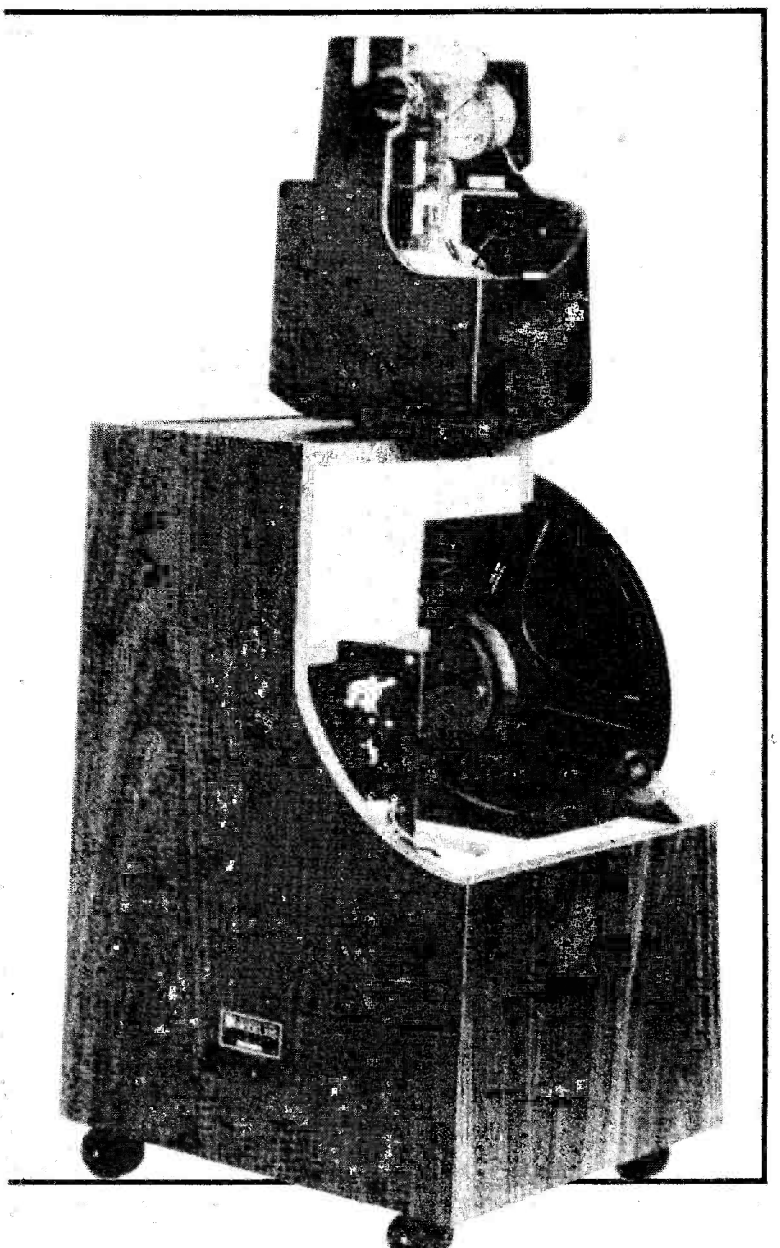
Under test conditions both the M97s proved themselves worthy of their predigrees. Both are top-flight performers in their respective classes and in fact the EJ is capable of tracking higher recorded velocities than the HE — but at a gram more weight. The HE cleared all my traps at 1g actual tracking force (the brush means that you set up for 0.5g more) and the EJ had an optimum force of 2.2g. Have a look at the table for more details of the results.

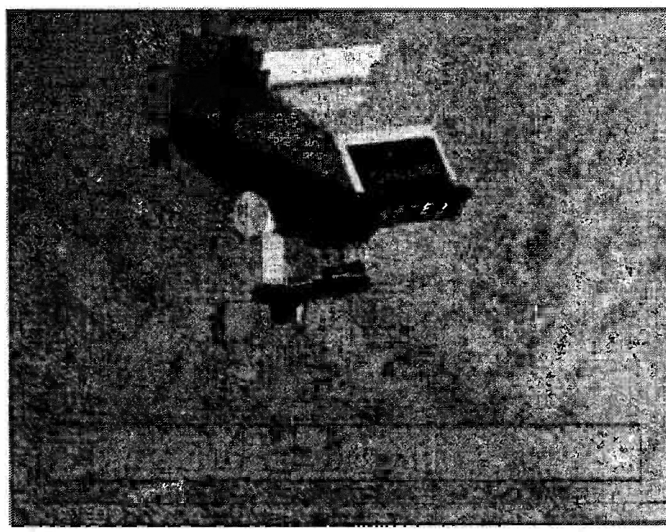
(Throughout these ramblings, "optimum tracking force" is that downforce at the stylus above which no improvement in tracing ability is obtained for increased weight). The 97EJ gave a creditable account of itself all around. Set up in a JVC QLA5R deck it performed very competently and gave a good solidity to the sound, with a warm balance and smooth treble. It would match most good loudspeakers in the £100—£200 class that exhibit a clean top and its powerful bass could be a decided asset, especially to impercunious rock fans.

On the debit side it has a tendency to impose too much of itself upon the music at times and could be tipped over the edge into hardness (surprisingly) by very complex material. Still, these are minor effects — and more minor than you'd expect at the price. Not a serious worry and overall a good design, one which does credit to its designers.

Set up in an SME III the M97HE played very well with all types of music. It is a good cartridge by any standards, having a smooth easy-to-listen-to approach to its task, and is tolerant of material of lesser stature than itself. As I said earlier it is very difficult at times to distinguish this pickup from the V15 IV — it has that same confidence in its own infallible tracking ability, never putting a diamond wrong. Distortion is low and the base possesses a good punch. Detail is well portrayed, but it is here that the V15 shines through with superior mid-range quality. A more refined performance is bought with the extra cash, it seems.

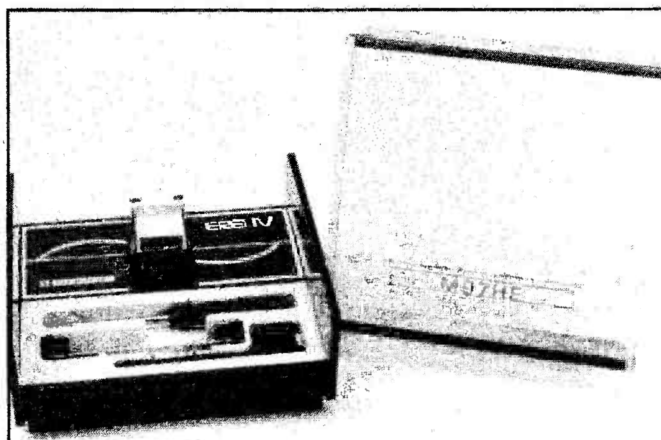
It would take a good system to justify the classier performance though, a careless matching of components could easily obscure the differences. Good enough then, I thought to bear comparison with the Ortofon and Stanton and so included the M97HE in the tests, about which you'll be hearing more later. Remember the price difference though.

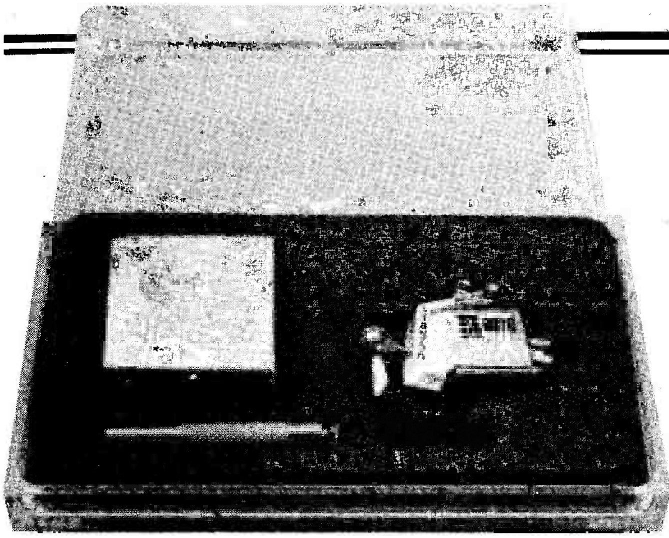




Above: the Shure M97EJ and, below, the M97HE still reclining in its box. Both the cartridges are identical in appearance — so there was little point in showing photos of them both!

Note the dynamic stabiliser clipped down into position as a stylus guard on the EJ.





Left: the Stanton 881S in its plush little box. That relatively huge container holds the fixing hardware for the Stanton cartridge, and everything else you want to hold in the headshell. What looks like a police whistle, in the foreground, is in fact a screwdriver. Very nice presentation.

Stanton On It's Merits?

The Stanton 881S. Doesn't seem so long ago that the 681 and V15 III were considered the two best cartridges around — long were the nights spent arguing over the relative merits of the pair of them.

Stanton seem to have taken something of a low profile lately and this unit has never received the publicity it deserves. Having now auditioned it at greater length, I feel it has a lot to offer, albeit with a few vices amongst its virtues.

The 881S is also very well presented and its appearance is very striking indeed, with the silver finish and white stylus carrier. All preceded, of course, by the inevitable brush — and this I cannot refrain from condemning, both as a cleaner and an aid to the cartirdge as a whole. Thank decibels it is at least removable.

At a time when great effort is being expended to *remove* static, and to ground any charges present on records; listen to Stanton's own description of how the brush does its work :—

"It operates on the principle that the rubbing action of the nylon bristles against the vinyl record surface creates an electrostatic charge which attracts dust particles like a vacuum cleaner"...................Oh.

I'll bet it does. And charges up the record surface nicely too. (Dust sticks to LPs very well under charge conditions.) The stylus is trailing along just behind the brush — straight into that charged patch of vinyl prepared for it. What odds on increased snap, crackle and pop? Why, why, why, why, why, when you have a pickup this good, lumber it with a built-in static generator? I despair of humanity sometimes, I really do.

This is a well engineered unit, as the test results prove. Channel balance is beautifully maintained and resonances tightly controlled. As is Stanton's way, the cantilever is amazingly short and durable. The mass, minus brush, is about average

The sound of the 881S is best described as rich and detailed. There always appeared to be a lot going on in the music, with the cartridge obscuring little of it. The bass is good but not as extended as it might be. Mid-range is sharp and clear but can be a little *too* sharp in the 2kHz — 5kHz range at times. Treble was well extended and crisp and overall the sound was well balanced and exciting to listen to.

A cartridge more than worth its asking price, but capable of being improved still further, I feel.

Ortofon/SME 30H

Now this is something really different. Part of the new ultra-low mass range from Ortofon, the Ortofon/SME 30H is the LM30H cartridge adapted for use with an SME Series III pickup arm. Adaptation here means 'building into'. A normal CA1 arm has been shorn of headshell, and the 30H fitted as part of the new one.

The overall effect is to bring down the effective mass of cartridge and arm to 4.2g and create the most striking pickup around. It looks superb in operation.

Low mass like this has great advantage in the bass registers. Used in the SME, the system resonance — the frequency at which it is easiest to put a peak in the response — lies at 13Hz, which is too high to be effected by record warps, or ripples and too low to let acoustic feedback from the speakers influence it.

So much for the theory of it, in practice we have a very attractive, pencil slim, cartridge with built-in finger lift. Just about every aspect of operation has been well thought out. An alignment tool is provided for setting up the individually shaped cartridge for vertical tracing angle. Without it, it would be virtually impossible. Even the stylus guard will help with lateral balance adjustments! (Try and work *that* one out.)

In play the Ortofon proved to be as much of a contrast to the Stanton in sound as it had been in looks. The bass was nothing short of phenominal. The extension went way down, more importantly though the energy was controlled very well, with no sign of looseness or tendency to 'boom'. The low mass and integrated head were responsible for this, I think. The mid-range was restrained but open. No sign of brightness or sharpness here. Some people would think it too bland I suppose, but then since when does 'neutral' mean 'striking'?

Overall the Ortofon presents a smoothly blended face to the world, with perhaps a slight veiling of the extreme high frequencies.

If ever there was a cartridge that was at home with a certain type of music, it is this one. On classical music of the symphonic variety, the Ortofon really soars. Things simply sound "in place" and natural. It is probably the best pickup I have ever heard on this type of material. The difference between its performance with say, Wagner and with the Floyd is very marked and not a little puzzling. On the former it is staggeringly good, on the latter — simply good.

Listen Here

It was this which started me off on what developed into a full blown comparison session, with the resultant exponential increase in people, equipment and headaches. All though the listening so far I had been using my usual cartridge as a reference against which to measure the others, simply because I am well used to it and know its foibles well enough.

The pickup in question is a Coral MC81 moving coil, which I have been in love with ever since reviewing it in these pages many LPs ago. I consider it one of the best around at any price and as it costs only about £48 these days, affording a head-amp is not the bank-robbing job it might be.

Anyway I digress. What transpired in the end was that I set up a listening -panel type of comparison between the Stanton, Ortofon, Shure M97HE and the Coral as reference.

I have not the space, or inclination, here to go on about the steps taken to ensure impartiality. They were taken, believe me. If you don't you're probably a PE reader anyway!

The rest of the disc playing system comprised. Technics/SMEIII configurations feeding a Lecson amplifier and being relayed to the waiting ears by that same pair of KEF 105 II loudspeakers. Some use was also made of a Sony TCK 55 II cassette.

Right: and below is the amazing Ortofon SME 30H. As you can see there is no real head-shell, just the cartridge itself. The unit looks extremely elegant in use, but the one thing they don't tell you is that it is so light that you need to remove ALL the lead weights from the SME III to balance it — which means that you need more spacers.

After it was all over I took the scores, and 'normalised' the reference at 15 for everything, adjusting the other scores to create the (average) figures obtained below. (Table Two)

Material varied from Wagner to Rickie Lee Jones, via Grieg, Holst, Stravinsky, Thelma Houston, Sky, Alan Parsons and the inevitable Pink Floyd. Each listener was asked to mark the cartridge playing, out of 20, on the parameters shown in Table Two, without knowing which unit was operating.

Not much to choose really is there? The Shure comes out least well, but then its price bracket lies well below the other two and this is in reality a creditable showing indeed. As such I can confidently recommend both examples of the M97 range, secure in the knowledge that few (if any) will be disappointed with the purchase. Yet another nice one Shure.

The Stanton and the Ortofon are a different matter. Both provide ample evidence of the excellence obtainable from moving-magnet methods, but are totally different in their sound balance.

They scored identically in this respect in the test, as you can see, so both are appealing designs.

The Ortofon is to be preferred for classical material and the Stanton for rock. Perhaps that, undoubtedly over-simplified statement is as close as I'll get to defining the differences for you. Comparing the two is entertaining stuff — try it yourself if you plan to spend around £80 on a cartridge. The time will not be wasted and neither will the money!

Back to amps next month, with a look at an offering from Quantum Electronics. Their 102 pre-amp matched to the 110W per channel 204 power amp. You can obtain the units as either kits or ready-built equipment and amplifier modules are available separately. The main question is though — what do they *sound* like?

Table One

	Stanton 881S	Ortofon/ SME 30H	Shure M97HE	Shure M97EJ
Output : 1kHz 5cm/sec	5mV	3.2mV	4.5mV	5mV
Channel Balance	< 1.5dB	< 2dB	< 1.5dB	< 2dB
Optimum tracking force	1.1g	1.3g	1g	2.2g
Frequency Response Limits, 20Hz–20kHz	±1dB	±2dB	±2dB	±2dB
Separation (LonR) 1kHz	32dB	30dB	35dB	28dB
Cartridge Weight	6.7g (inc brush)	10.5g (inc arm)	6.4g	6.4g
Recommended Loading	47k // 275p	47k // 400p	47k // 250p	47k // 250p
Typical selling price	£80	£85	£45	£27

Table One: objective test results. Note the Ortofon specified load is a good deal higher than normal, and a padding capacitor could be used to advantage here. Although its mass looks higher, it includes the pickup arm — effective mass is actually close to 4g, well under the figures for the rest of the pickups.

Table Two

	Bass Extension	Bass Quality	Mid-range Quality	Rendition of Detail	Balance of Sound	Treble Extension	Treble Quality	Neutrality
CORAL MC81	15	15	15	15	15	15	15	15
STANTON 881S	17	14	12	14	14	14	13	13
ORTOFON 30H	18	15	14	14	14	10	12	15
SHURE M97HE	18	13	12	13	13	14	13	13

Table Two : subjective results. These figures are the arranged responses gleaned from the listening panels individual markings.

ETI

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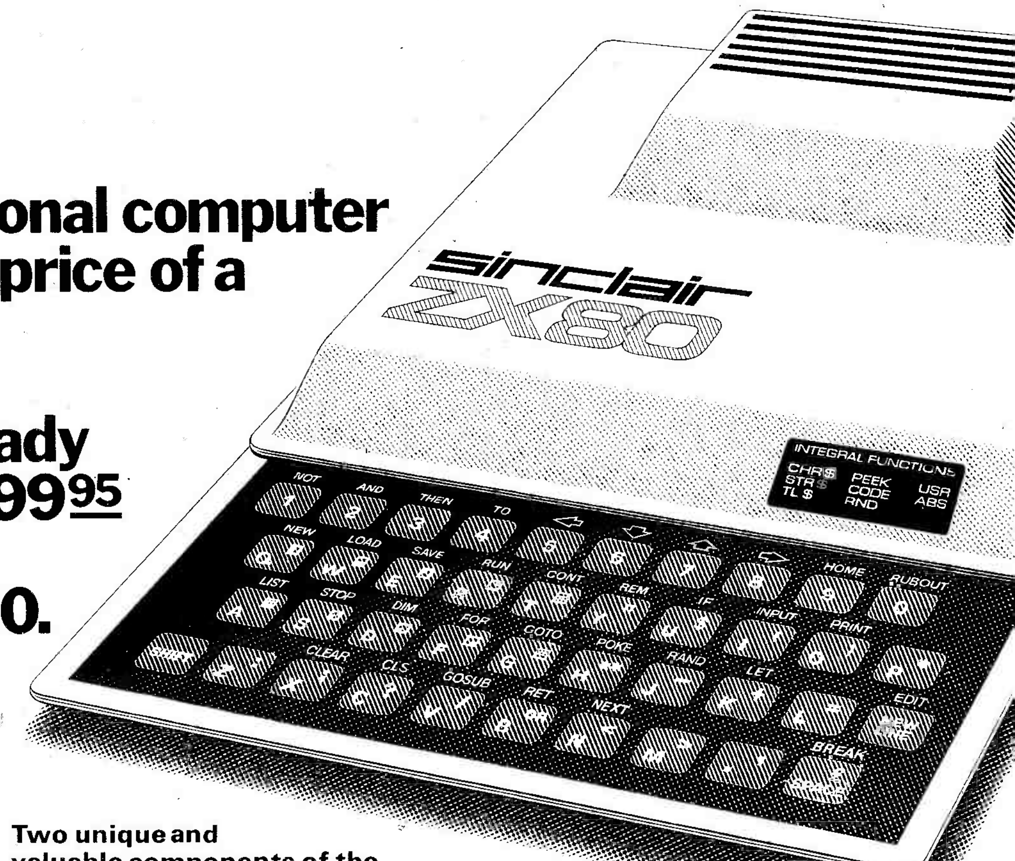

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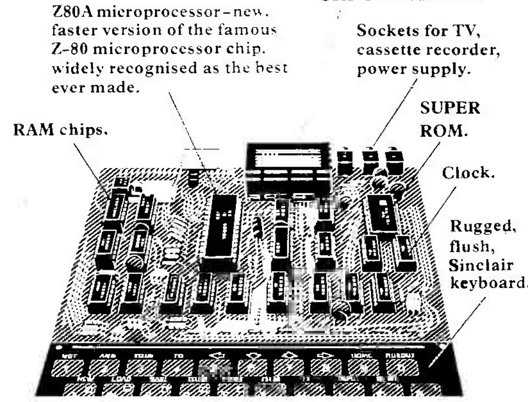

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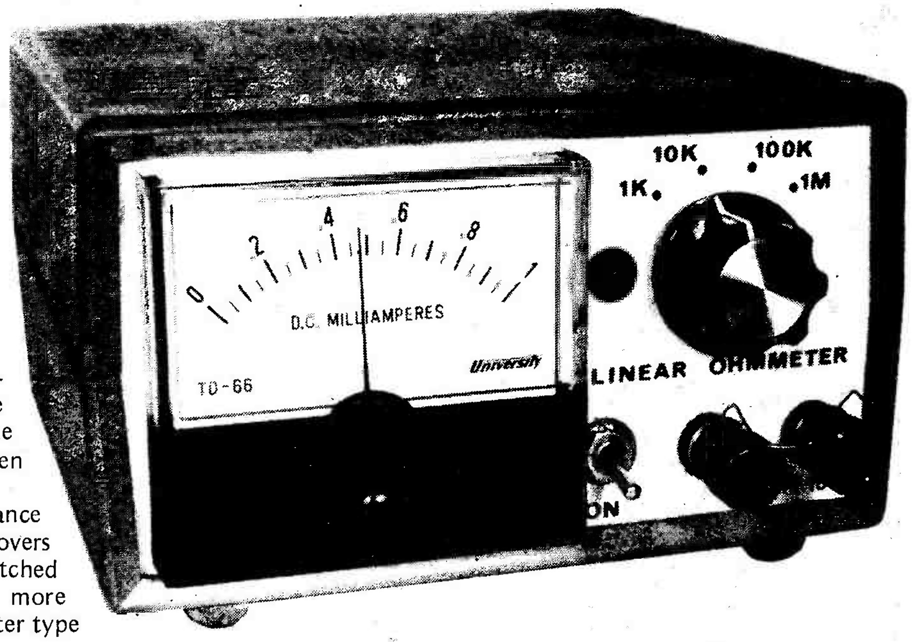
(ETI/6/80)

LINEAR OHMMETER

Well suited to either the lab or hobbist bench this accurate little project will provide an inexpensive answer to many resistive problems.



This instrument is an inexpensive semi-precision ohm meter that can be used to give accurate readings of resistance from a few tens of ohms to one megohm. The unit has four decade ranges covering 1k to 1M full scale and has a full scale accuracy of 2% if low tolerance range resistors are used.

Conventional moving coil ohmmeters have non-linear scales which typically cover two to four decade ranges of resistance value on a single scale. With such a range of resistance it is impossible to obtain an accurate reading, especially at the higher values. To measure resistance values with reasonable accuracy, the usual method is to use a Wheatstone Bridge, often very expensive and time consuming.

By contrast, this ohmmeter gives resistance readings on a linearly calibrated scale and covers only a single decade of resistance on each switched range. The instrument thus gives inherently more accurate readings of resistance than multimeter type ohmmeters.

Construction

The ohmmeter can either be constructed as a completely contained unit, with its own moving-coil meter, as we have done, or it can be built as an add-on to an existing multimeter having a 1 mA DC range.

Take care with the polarity of the zener diode. The 301 op-amp cannot be substituted by a 741 as it has been selected for its low input current. The overall accuracy of the instrument is determined by the tolerance of the range resistors (R3 to R6) and the accuracy of the meter. If 1% or 2% resistors are used the accuracy of the instrument will be about two percent.

When the board assembly is complete, fit into the box and complete the wiring to the major components. If you are making an add-on version of the meter, fit a couple of screw terminals in place of the meter for connection to your multimeter.

Calibration

When construction is complete, switch the unit on and check that the LED lights up. If it doesn't, check the wiring and the polarity of the LED. When all is well connect an accurately known resistor (having a value within the range of the instrument) across the terminals and adjust the trimpot for the correct reading. The unit is then ready for use and should not require further calibration. You could purchase a 1k, 1% resistor specifically for this purpose.

BUYLINES

There are no components here which will prove difficult to obtain. Casing is not critical in the slightest, and all the mail-order advertisers within this issue should be able to provide all the bits and pieces required.

PARTS LIST

Resistors All ½W (*see text)	
R1	2k7 5%
R2	1k0 5%
R3	1k0*
R4	10k*
R5	100k*
R6	1M0*
R7	560k 5%
RV1	5k0 (minimum) vertical
Capacitors	
C1	100p ceramic
Semiconductors	
LED 1	TIL220
ZD1	5V1 400 mW
Q1	BC109, BC549
IC1	301

Miscellaneous
SW1 DPDT toggle switch, SW2 one pole four position wafer switch, M1 1 mA FSD meter, SK1,SK2 screw terminals.

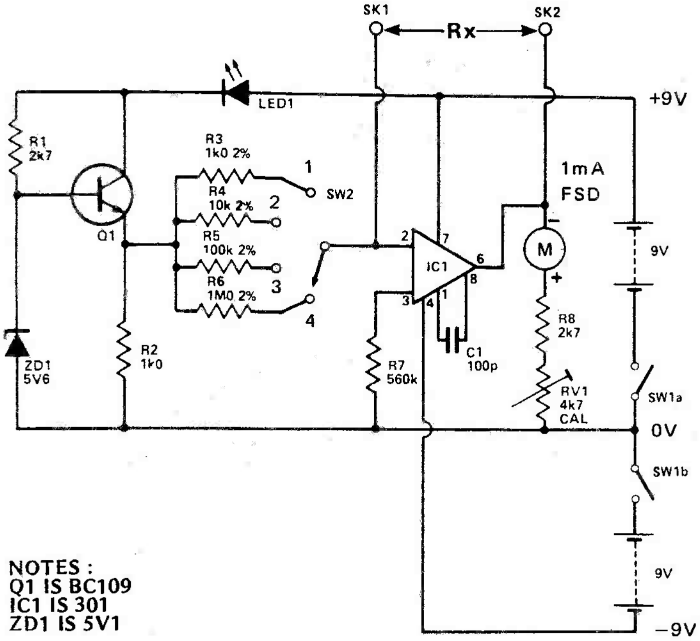
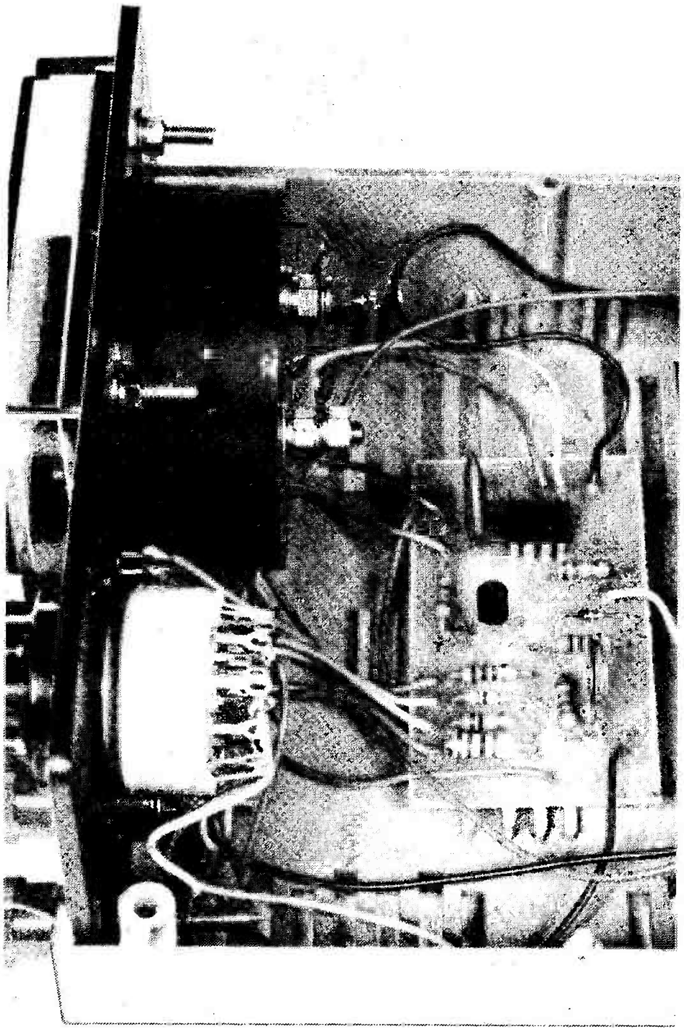


Fig.1. Full circuit diagram of the instrument.

HOW IT WORKS

The linear scale ohmmeter circuit is divided into two parts: a reference voltage generator and a readout unit that indicates the value of the resistor under test. The reference voltage generator section of the circuit comprises zener diode ZD1, transistor Q1, and resistors R1 and R2. The action of these components is such that a stable reference of about 5 V is developed across R2. This reference voltage is fed to the op-amp resistance-indicating circuit via range resistors R3 to R6.

The op-amp is wired as an inverting DC amplifier, with the 1 mA meter and R8—RV1 forming a voltmeter across its output, and with the op-amp gain determined by the relative values of ranging resistors R3 to R6 and by the negative feedback resistor Rx. RV1 is adjusted so that the meter reads full scale when Rx has the same value as the selected range resistor. Under this condition the op-amp circuit has a voltage gain of precisely unity. Since the values of the reference voltage and the ranging resistors are fixed, the reading of the meter is directly proportional to the value of Rx, and the circuit thus functions as a linear-scale ohmmeter and has a full scale value equal to the value of the selected range resistor.



A peek inside at the PCB. Make sure it doesn't foul the range switch or meter.

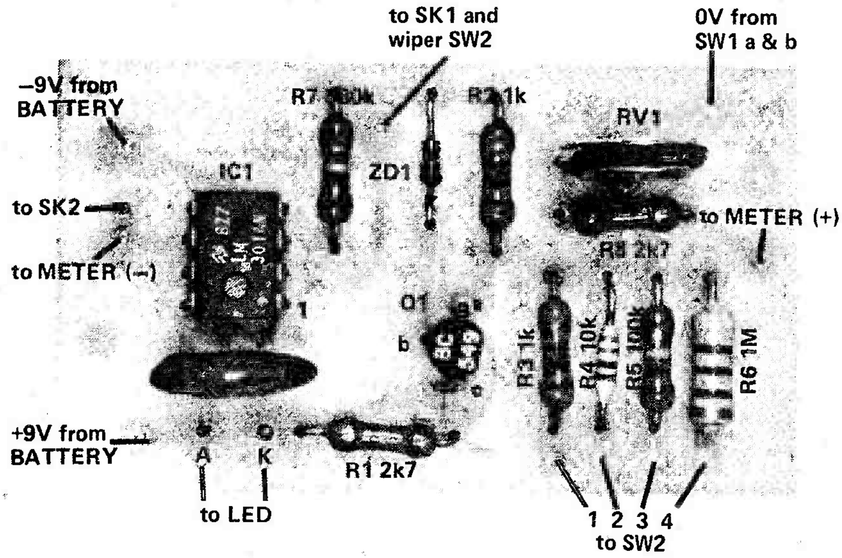


Fig.2. Component overlay.

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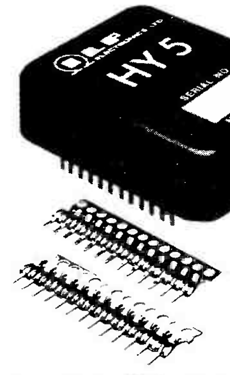

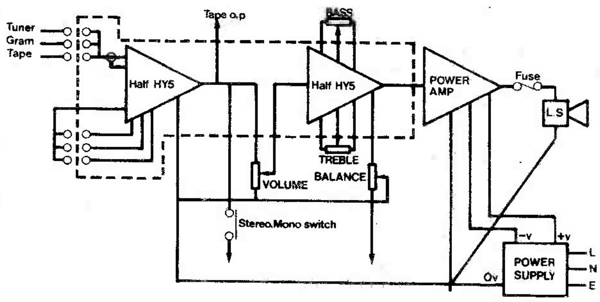

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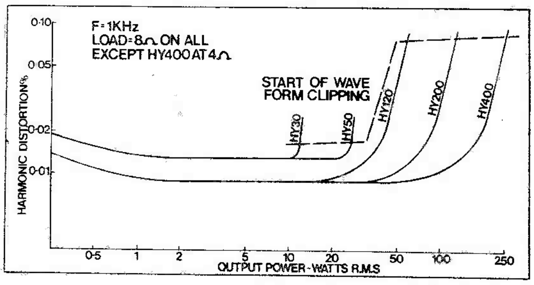

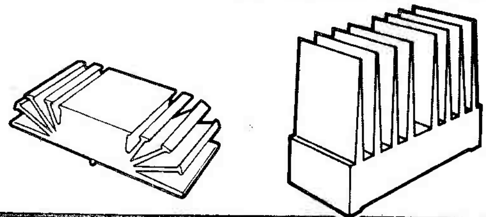

Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/ Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0 +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into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

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

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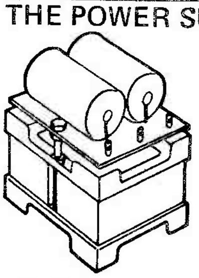

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Next Month

The June issue will be on sale May 16th

HE RADIO CONTROL

Can it be true? Yes, of course it is, all the problems have been sorted out and next month we will be presenting what must be the last word in terms of simple to build, 2 channel proportional R/C systems.

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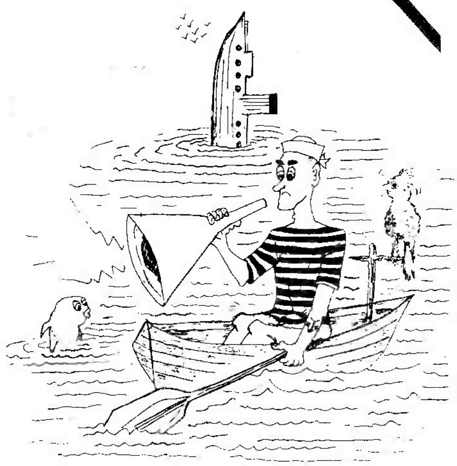
More than that we're not prepared to say, we are keeping the system under close wraps. We're sure it's going to revolutionise constructional radio control. Make sure you place your order early as the June issue is sure to be a sell-out. You have been warned!

CATALOGUE SURVEY

Do you buy components through the services of mail-order companies? If you do then you cannot afford to miss this survey into the various companies, the cost of their components, the service they offer and the quality of their catalogue. Who is the cheapest? Last year we came up with some pretty surprising results, find out if things have changed.

METRONOME

Don't miss a beat with this nifty, state-of-the-art little gadget. This revolutionary design has completely done away with cumbersome ICs. Yes, that's right, absolutely no Integrated Circuits. In fact we have used just four components and if that isn't state-of-the-art, what is?



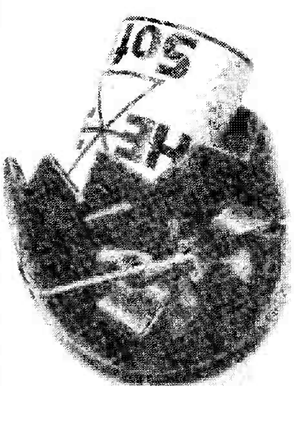
FOG HORN

We're shore you'll build this circuit once you sea it. But be warned your popularity will be at a very low ebb if you use it in the car. It is LOUD, very LOUD, so loud in fact, the only place you'll be able to use it is at sea.

CITIZENS BANNED II

Next month is something of an anniversary for us. It will be exactly one year since we published our feature 'Citizens Banned'. In those twelve months we have carried the campaign for CB (sometimes struggling) into the open. Our petition (which around half our readers signed) gained Government recognition, generated national Newspaper, TV and Radio coverage and was the catalyst for forming CB clubs up and down the country. Something like 250 000 people are actively engaged in the campaign for legalisation MPs, Government Officials, Doctors, in fact everyone and anyone who wants the right for free speech.

In our second major feature we will be looking back over the past year and seeing how the campaign has fared.



EGG TIMER

Something really different for the gadget fans next month. Our Egg Timer is a solid-state version of the 'sand-in-a-glass' egg timer that has been around for hundreds of years. Shake it and set it down and depending upon whether you want a hard or soft boiled egg it will warble at the appointed time. No switches to worry about, is it magic? Find out next month.

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

POWERFETS

Some day all power transistors will be made this way

	CHAN	VDS max V	ID max A	PDISS max W	RDSDN Type Ω	Case	Price
BD512	P	60	1.5	10	†(3.5)	T0202	**85p**
BD522	N	60	1.5	10	2.5	T0202	**80p**
VMP4	N	60	2.0	25	2.0	380-50E	**1250p**
VN10KM	*N	60	0.5	1.0	4.0	T092†	**55p**
VN64GA	N	60	12.5	80	0.3	T03	**750p**
VN67AF	*N	60	2.0	15	2.0	T0202	**75p**
2SJ49	P	140	7.0	100	1.0	T03	**395p**
2SK134	N	140	7.0	100	1.0	T03	**395p**

*I/p protected †our selection. VN/VM, 96-page Design Cat. **20p. Heat clips** TO202 **12p,** T092 **8p.**

MANUFACTURERS/DESIGNERS. We will be stocking Powerfets by IR, TI and Intersil as well as by Hitachi, ITT and Siliconix. We can advise you on applications and type selection, supply samples and quantities.

REMEMBER Powerfets need virtually no drive current, switch in nanoseconds, and are 2nd breakdown free, etc. etc.

CA3026	**70p**
CA3080E	**70p**
CA3140E	**38p**
DAC08	**250p**
DM2502	**555p**
LM308	**50p**
LM3900	**43p**
MC3401	**30p**
NE529	**145p**
NE555	**25p**
SAD1024	**1050p**
SD532	**30p**
TDA1022	**600p**
TL081	**29p**
TL08C	**55p**
2102	**80p**
4011B	**17p**
709	**15p**
710	**25p**
733	**50p**
741	**18p**
78L05/12	**29p**

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(with circuits)
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2SC2545(N) { NFO.2dB **19p**
2SA872(P) 90v **16p**
2SC1775A(N) 120v 50mA, **17p**
2SB716A(P) 140v **19p**
(low Cob 1p8 typ = low distortion)

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DESIGNER'S NOTEBOOK

Project editor Ray Marston discusses the uses and practicalities of voltage regulator circuits.

One of the most common and mundane tasks facing the electronics engineer is that of designing voltage regulator circuits, ie circuits that produce a stable and well defined DC output voltage over a wide range of load current variations. These circuits may vary from simple Zener networks, designed to provide load currents up to only a few mA, to fixed-voltage high current units for powering logic boards, etc, or to variable-voltage high current units designed to act as general-purpose pieces of test gear.

Zener Based Circuits

A Zener diode can be used to produce a fixed reference voltage by using the connections shown in Fig.1. Often, the supply voltage (V_{in}) may be subject to fairly wide variations, causing the Zener current to vary over a similarly large range. As long as V_{in} is always more than a few volts greater than the Zener voltage and provided that the Zener power rating is not exceeded this variation has only a moderate influence on the output voltage of the Zener, which typically has an effective output impedance of a few tens of ohms.

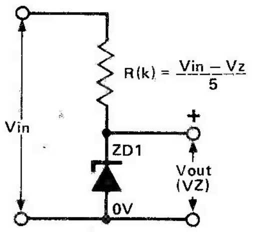

Fig.1. This basic Zener 'reference' circuit is biased at about 5 mA. A current of roughly 5 mA is passed through the Zener diode from the supply line via limiting resistor R.

A Zener can be used as a very simple voltage regulator, providing load currents up to a few mA, by merely selecting the value of 'R' as shown in Fig.2.

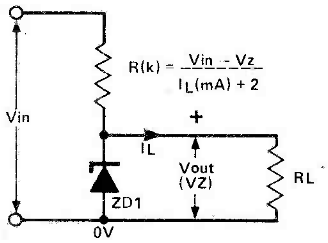

Fig.2. This basic Zener 'regulator' circuit can supply load currents of several milliamps. When the maximum load current is being drawn only 2 mA flows through the Zener. When zero load current is being drawn the Zener passes 2 mA plus the maximum designed load current and thus dissipates maximum power.

In most practical voltage regulator applications the Zener is simply used to apply a 'reference' voltage to a high-gain non-inverting buffer amplifier, which then supplies the required output power. The simplest example of this type of circuit is shown in the series-pass regulator circuit of Fig.3.

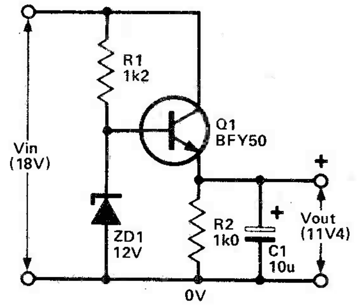

Fig.3. This series pass Zener-based regulator circuit gives an output of 11V4 and can supply load currents up to about 100 mA. Q1 is wired as a voltage follower, its emitter remaining at about 600 mV below its Zener-defined base voltage under all loading conditions. The Zener network provides the base drive current to Q1, this current being equal to the output load current divided by the current gain of Q1. Clearly, the higher the gain of the Q1 'buffer' stage, the better will be the output regulation of the circuit.

Op-Amp Regulators

One way of improving the regulation of the Fig.3 circuit would be to use a Darlington or Super-Alpha pair of transistors in place of Q1. An even better solution is to use the op-amp plus transistor buffer stage shown in Fig.4.

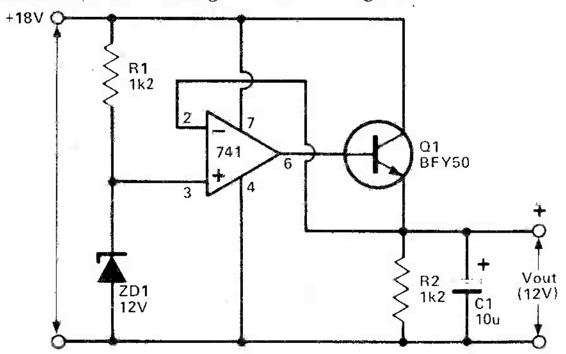

Fig.4. This op-amp based regulator gives an output of 12 V at currents up to 100 mA and gives excellent regulation. The op-amp and Q1 are interconnected as a unity-gain non-inverting DC amplifier with an overall current gain of about one million. The output voltage tracks within a few mV of the Zener reference value and the output impedance is less than one milli-ohm. The safe output current driving capacity of the circuit is limited to about 100 mA by the power rating of Q1; higher currents can be obtained if Q1 is replaced with a power Darlington transistor.

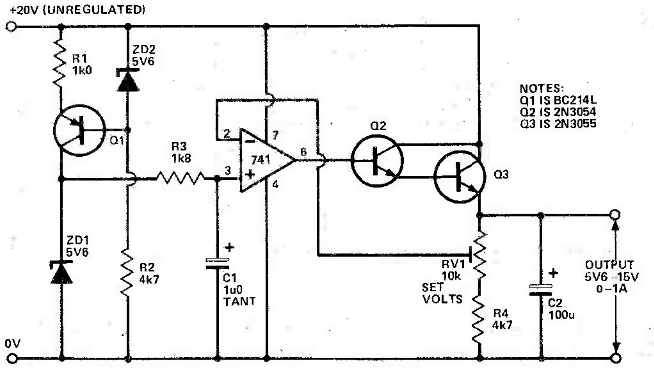

Fig.5. This variable-output 0–1 A circuit gives excellent regulation.

The performance of the basic op-amp circuit of Fig.4 can be improved in a variety of ways, some of which are shown in Fig.5. The first improvement that can be made is to make the Zener reference voltage (ZD1) independent of supply voltage variations by powering ZD1 from the output of constant-current generator Q1–R1–ZD2–R2. Next, the Zener noise can be eliminated by feeding the reference voltage to the op-amp via low-pass filter R3–C1. Thermal drift effects can be eliminated by making ZD1 a 5V6 type, with near-zero (actually about –0.2 mV/°C) temperature coefficient; the op-amp output voltage can then be set to the desired value (greater than 5V6) by using feedback components RV1–R4 to set the op-amp's voltage gain at some appropriate value.

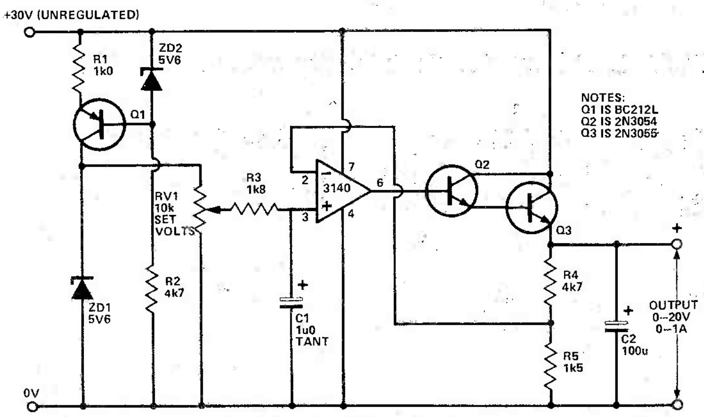

Fig.6. The output of this circuit is fully variable from zero to 20 V. The effective reference voltage is made variable from zero to 5V6 via RV1 and the op-amp is given a fixed voltage gain of about four via R4–R5. Note that a CA3140 op-amp, which can handle input signals down to ground volts, is used in this application.

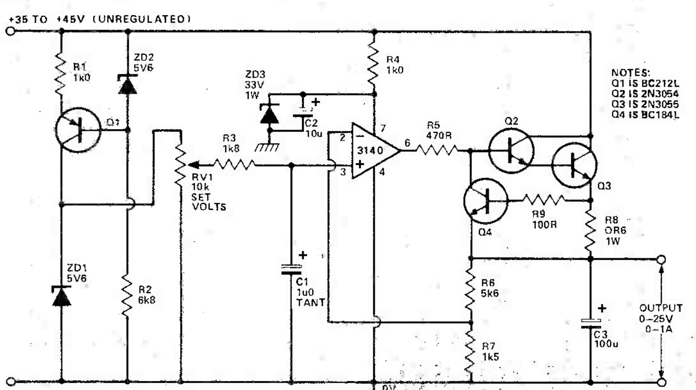

Fig.7. This 0–25 V, 1 A regulator has current limiting in its output stage with short-circuit or overload protection via Q4 and load-sensing resistor R8. The op-amp is protected against excessive supply rail voltages via R4 and ZD3.

Finally, the load current capacity of the circuit can be set to a fairly high value by using a Darlington-connected power transistor in the series-pass output stage.

Three Terminal Circuits

Three-terminal regulators are remarkably easy to use, as shown in the basic circuits of Figs.8 to 10, which show the connections for making positive, negative and dual regulator circuits respectively; the ICs shown in these examples are 12 V units with current ratings of one amp. Note that a 270n or greater disc (ceramic) capacitor should be connected close to the input terminal of the IC and a 10u or greater electrolytic to the output.

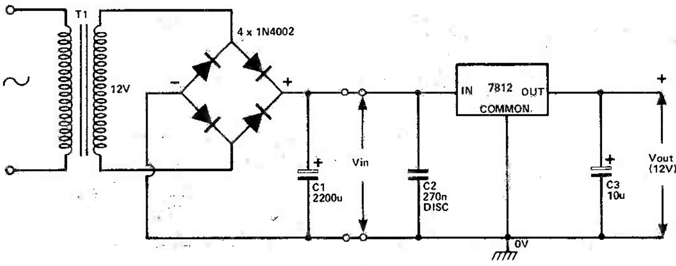

Fig.8. Connections for using a 3-terminal positive regulator IC, in this case a 12 V, 1 A type.

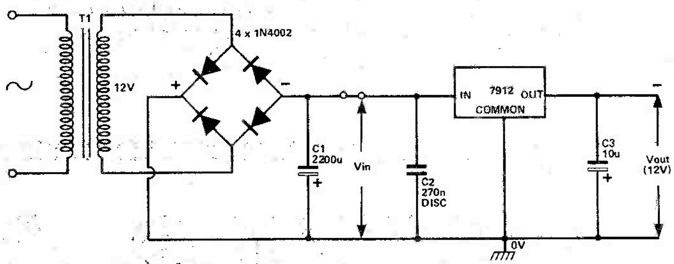

Fig.9. Connections for using a 3-terminal negative regulator IC, in this case a 12 V, 1A type.

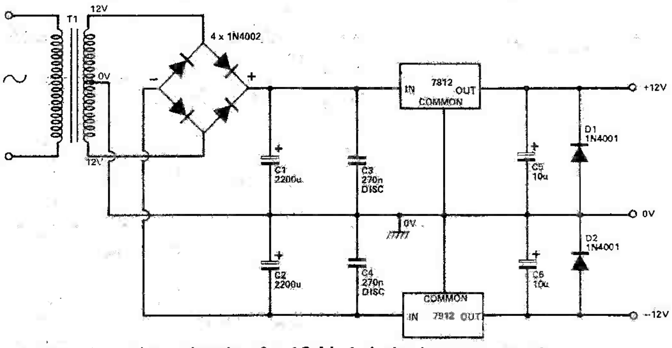

Fig.10. Complete circuit of a 12 V, 1 A dual power supply.

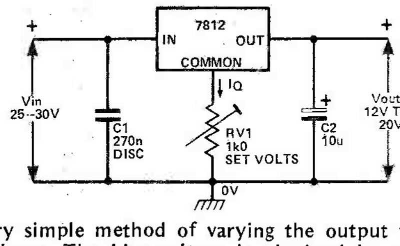

Fig.11. A very simple method of varying the output voltage of a 3-terminal regulator. The bias voltage is obtained by passing the IC's quiescent current (typically about 8 mA) through RV1. This design is adequate in most applications, although the output voltage obviously shifts slightly with changes in quiescent current.

The output voltage of a 3-terminal regulator is referenced to the 'common' terminal of the IC, which is normally grounded. Most regulator ICs draw quiescent currents of a few mA, which flow to ground via the common terminal. The regulator output voltage can thus be raised above the designed value by simply biasing the 'common' terminal with a suitable voltage.

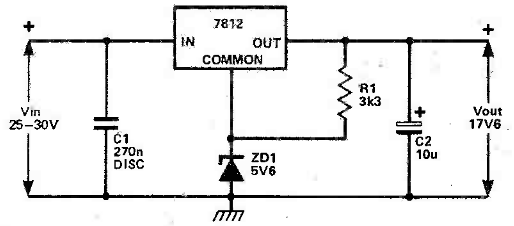

Fig.12. The output voltage of a 3-terminal regulator can be increased by a fixed amount by wiring a suitable Zener in series with the common terminal.

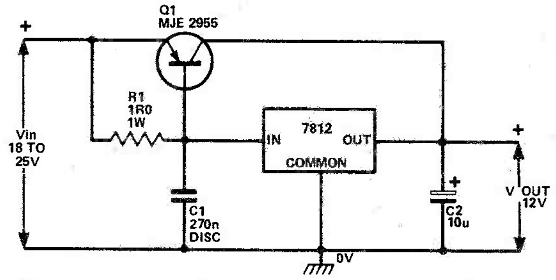

Fig.13. The output current capacity of a 3-terminal regulator can readily be boosted via an external transistor. This circuit can supply 5 A at 12 V. At low currents insufficient voltage is developed across R1 to turn Q1 on and all of the load current is provided by the IC. At currents of 600 mA or greater sufficient voltage (600 mV) is developed across R1 to turn Q1 on, so Q1 provides all currents in excess of 600 mA.

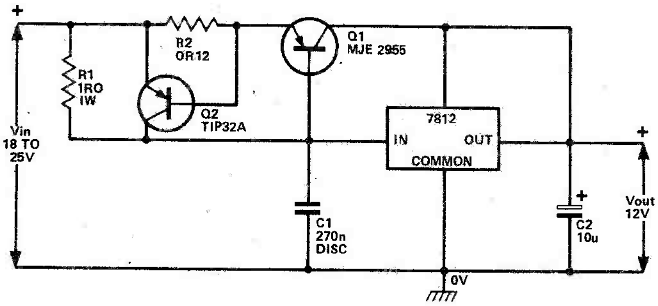

Fig.14. This 5 A, 12 V regulator has overload protection provided via Q2.

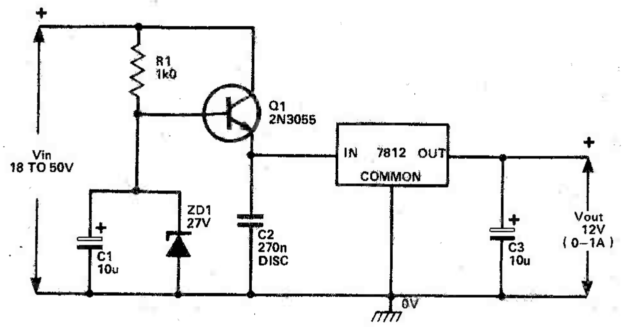

Fig.15. This 12 V lamp regulator circuit is fully protected against excessive input supply line voltages.

ETI

interface components

TRANSISTORS

AC128	15p
AC187K	30p
AC188K	30p
ACY17	90p
AD149	55p
AF127	35p
ASZ17	120p
AU113	150p
BC107	7p
BC108	7p
BC108A	7p
BC108C	7p
BC136	15p
BC140	28p
BC141	30p
BC142	25p
BC143	28p
BC147	6p
BC147B	6p
BC149	7p
BC149C	7p
BC159	9p
BC160	35p
BC167A	10p
BC178	12p
BC179	12p
BC182	8p
BC182L	9p
BC183	9p
BC183L	9p
BC184L	9p
BC186	20p
BC212	9p
BC212L	9p
BC213B	9p
BC327	13p
BC328	13p
BC337	16p
BC338	11p
BC440	32p
BC547	9p
BC548	9p
BC550	14p
BC558	12p
BCY33	99p
BCY34	99p
BCY39	229p
BCY58	16p
BCY70	12p
BCY71	12p
BCY72	12p
BF179	25p
BF183	25p
BF200	29p
BF336	33p
BFX30	32p
BFX86	26p
BFX88	22p
BFY50	13p
BFY51	13p
BFY64	28p
BFY90	56p
BSX19	80p
BSY95A	16p
BU204	149p
BU208	150p
OC29	89p
OC43	50p
2N696	15p
2N930	20p
2N1132	19p
2N1304	40p
2N1613	12p
2N1711	15p
2N2217	20p
2N2219A	20p
2N2221	18p
2N2368	15p
2N2369	14p
2N2894A	20p
2N2904	15p
2N2904A	15p
2N2905	15p
2N2906	15p
2N2926Y	10p
2N2926O	10p
2N2926R	10p
2N3442	102p
2N3702	8p
2N3704	8p
2N3705	8p
2N3708	8p
2N3709K	8p
2N3866	35p
2N3906	10p
2N4058	12p
2N4427	60p

DIODES

AA119	10p
BA154	9p
BA156	9p
IN4001	4p
IN4002	4p
IN4003	5p
IN4005	5p
IN4148	5p
IS44	3p

OPTO

Leds

.125 Red	10p
.125 Orange	10p
.125 Yellow	10p
.2 Red	10p
.2 Green	10p
.2 Clear	10p

DISPLAYS

704	110p
727	160p
741	160p
747	160p
750	160p

REGULATORS

7805	57p
7812	57p
7815	57p
7818	57p
7824	57p
7905	140p
7912	140p
7915	140p
7918	140p
7924	140p
LM320T5	149p
LM320T8	149p
LM320T15	149p
LM320T18	149p
LM340T5	74p
LM340T8	74p
LM340T15	74p
LM340T18	74p

TRIACS

		with internal trigger diac.
4A 400V	54p	66p
4A 600V	60p	75p
6A 400V	60p	75p
6A 600V	66p	90p
8A 400V	66p	90p
8A 600V	72p	95p
10A 400V	72p	95p
10A 600V	84p	100p
15A 400V	108p	120p
15A 600V	126p	138p

TTL

7400	9p
7401	9p
7402	9p
7403	9p
7404	10p
7405	14p
7406	30p
7407	30p
7408	17p
7409	17p
7410	12p
7412	17p
7413	25p
7414	45p
7416	25p
7417	25p
7420	14p
7427	28p
7430	14p
7432	22p
7438	26p
7442	48p
7447	50p
7450	15p
7451	15p
7470	30p
7472	25p
7474	20p
7475	27p
7480	40p
7482	60
4LS00	11p
74LS01	11p
74LS02	12p
74LS03	12p
74LS04	12p
74LS10	19p
74LS11	20p
74LS20	18p
74LS30	18p
74LS32	24p
74LS42	89p
74LS51	24p
74LS55	28p
74LS74	39p
74LS75	46p
74LS76	39p
74LS85	99p
74LS90	36p
74LS93	79p
74LS114	49p
74LS122	65p
74LS123	65p
74LS124	115p
74LS132	89p
74LS139	79p
74LS151	89p
74LS155	91p
74LS156	89p
74LS157	69p
74LS165	69p
74LS168	139p
74LS174	99p
7486	25p
7491	63p
7492	35p
7493	28p
7494	63p
7495	63p
74100	110p
74107	30p
74121	25p
74122	36p
74123	44p
74145	72p
74154	80p
74157	60p
74161	85p
74175	63p
74180	84p
74181	151p
74191	80p
74192	80p
74193	80p
74194	80p
74LS175	99p
74LS190	110p
74LS192	115p
74LS194	115p
74LS196	115p
74LS196	95p
74LS197	125p
74LS257	99p
74LS260	99p
74LS273	199p
74LS367	59p
73LS378	159p

BRIDGES

	50V	100V	200V	400V	600V
2A	45p	52p	60p	75p	100p
4A	52p	60p	68p	82p	105p
6A	60p	68p	75p	90p	112p

DIL SOCKETS

8 pin	10p
14 pin	12p
16 pin	13p
20 pin	25p
24 pin	30p
40 pin	40p

MEMORIES

21L02	109p
211	400p
4027	275p
4116	7500p

EPROMS

2708	750p
2716	2600p

CPUs

Mk 3880	1250p
Mk 3881	750p
Mk 3882	750p

CMOS

4000	14p
4001	14p
4002	14p
4006	69p
4007	16p
4008	79p
4009	36p
4010	36p
4011	19p
4012	16p
4014	59p
4015	73p
4016	42p
4017	79p
4018	79p
4019	45p
4020	89p
4021	83p
4022	79p
4023	16p
4024	49p
4025	17p
4026	129p
4027	39p
4028	59p
4029	89p
4030	49p
4034	189p
4035	99p
4042	69p
4043	86p
4044	83p
4046	109p
4049	45p
4050	43p
4051	69p
4052	69p
4053	69p
4066	49p
4069	17p
4070	17p
4071	17p
4072	17p
4073	17p
4075	19p
4076	75p
4077	35p
4081	19p
4082	17p
4160	105p
4161	105p
4162	105p
4163	105p
4402	36p
4404	110p
4412	86p
4445	174p
4446	148p
4502	99p
4511	89p
4512	89p
4514	229p
4515	229p
4516	99p
4520	79p
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Countdown

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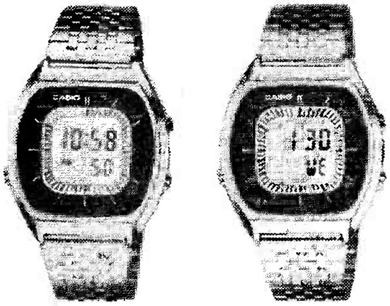

Time display   Time calendar

Time display. Digital: Hours, minutes, seconds, am/pm. Analogue: Seconds
Time/date display. Digital: Hours, minutes, am/pm, date. Analogue: Seconds.
Time/calendar display. Digital: Month, date, day. Analogue: Hours, minutes.
Stopwatch. Measuring net, lap and first & second place times from 1/10 second to 59 minutes, 59.9 seconds.
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Case: **Water resistant. Mineral glass.** 39.6mmx35.8mmx8.3mm.
Battery: One lithium battery type BR-2016 gives approx. 2 years operation.

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For the man who doesn't want hands on his time

Alarm/Chronograph

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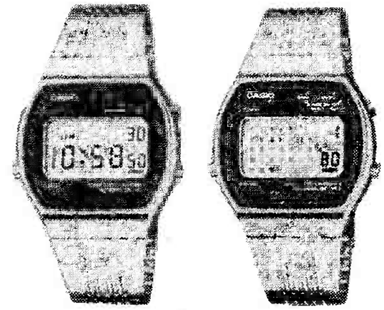
Tone control



Time and date display. Hours, minutes, seconds, am/pm. and date.
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Stopwatch from 1/100 second to 7 hours; net lap and 1st and 2nd place times.

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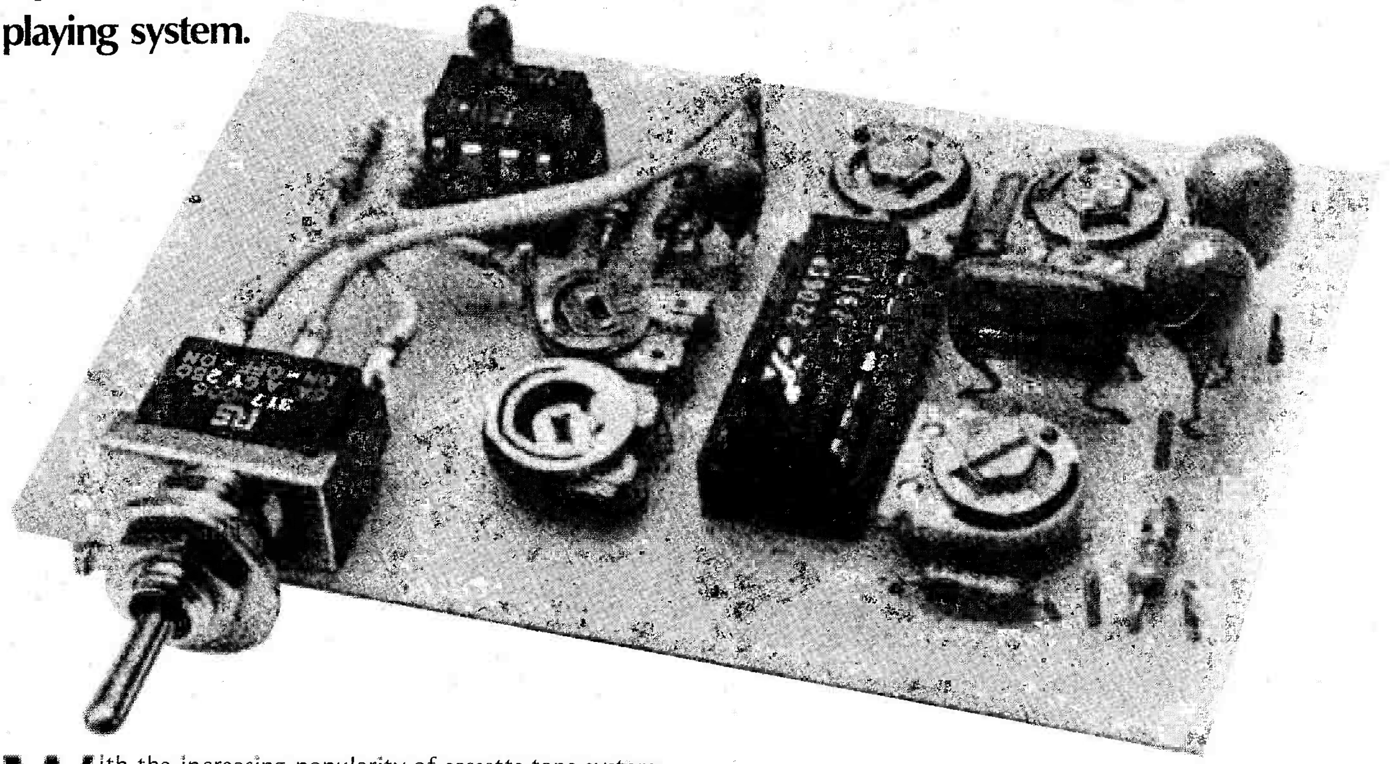
TAPE RECORDER OPTIMISER

Don't be biased! Set up your tape recorder to make the most of those expensive tapes. This unit allows you to optimise the frequency response of any tape playing system.



With the increasing popularity of cassette tape systems, the search for perfect reproduction has led to the introduction of a wide variety of different magnetic media. Even when you use the correct tape for your machine, improvements to the sound may be made by slight adjustments of the bias control. Some decks feature this control on their front panels; even cheaper or older machines will have a bias preset potentiometer inside them somewhere.

Better Bias

This unit produces a 400 Hz and 8 kHz sinewaves of equal amplitude. By recording these using different bias settings, your system can be optimised for a maximally flat response or peaked for treble emphasis. The procedure is to record the two tones using a chosen bias setting then monitor the output levels on the VU meter. If desired, the bias can be adjusted to achieve the required response. If your deck does not feature a VU meter, you can use an oscilloscope instead. The high and low tones may be selected manually or will be produced alternately when the unit is switched to 'auto'. A frequency of about 0.3 Hz was chosen for this function. It can be simply altered by reselecting the value of C1.

Construction And Use

Our PCB design offers a convenient means of building up the unit (after all you need somewhere to put all those presets don't you!). Whatever method of construction you use, there are no special precautions to take except to watch out for the polarity of the semiconductors and tantalum capacitors.

An oscilloscope is an invaluable aid when setting up the unit. However, if one is not available, connect the output to a monitor amplifier and do it by ear. Preset RV5 should be set to mid position and RV3 to maximum resistance. With power applied, RV1 may now be adjusted to produce a 4 V peak to peak triangle waveform at pin 2, IC2. Then RV3 should be adjusted for the best sine wave. Small adjustments of RV5 may now be made to further improve the waveform. You should now have a fairly good sine wave of about 2 V peak to peak at pin 2, IC2.

The frequency of the two tones is set by adjustment of RV2 and RV4. A frequency meter makes this a doddle. If you do not have one, then R7,RV2 and R8,RV4 may be replaced by fixed resistors. The calculated values using C4,10n are 250k (400 Hz) and 12k5 (8 kHz).

This simple project will help you get the very best from your audio system.

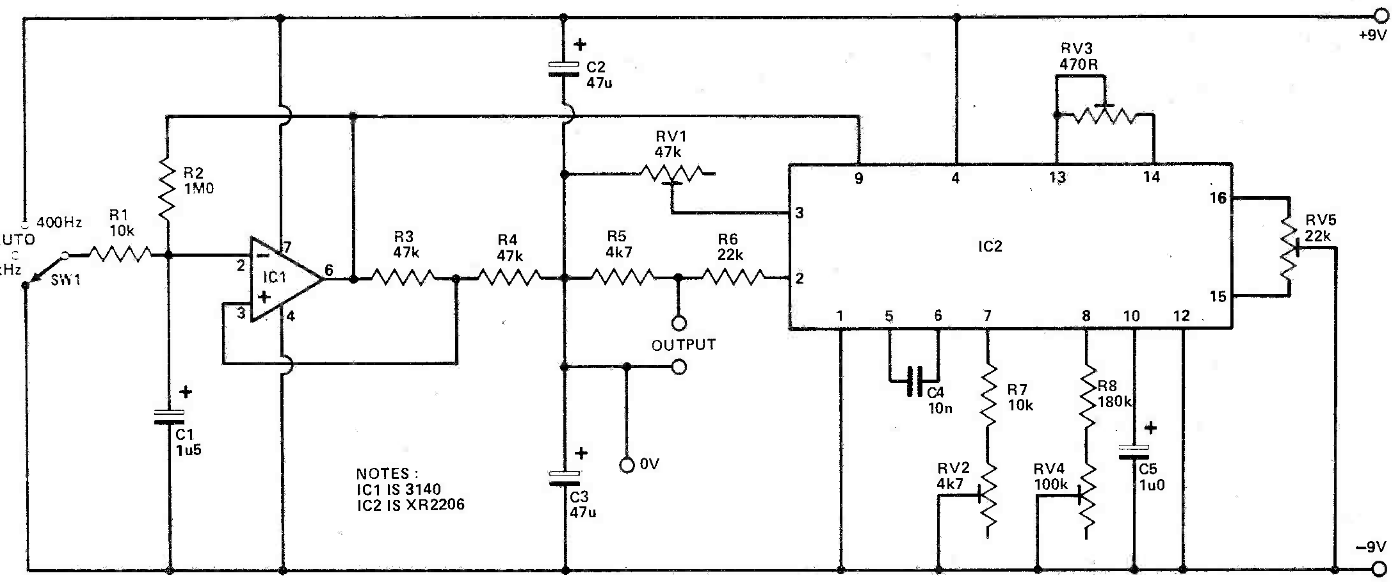


Fig.1. (above) Circuit diagram. RV2 and RV4 are used to set the frequency of the two tones.

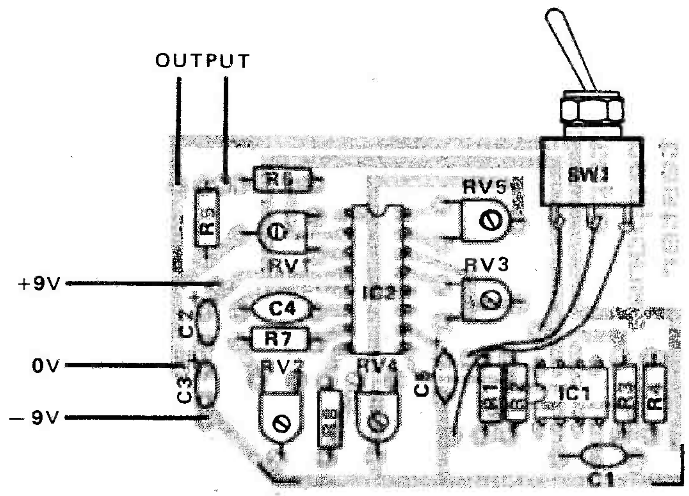


Fig.2. (left) Component overlay. The rate of switching between the two tones is set by C1 (0.3 Hz here, with C1, 1u5).

HOW IT WORKS

Most of the work is taken care of by IC2. This chip generates a triangle waveform which is shaped internally to produce the sine wave output. Frequency is controlled by the value of C4 and choice of resistance from pin 7 or 8 to the negative supply. Only one resistor is actively connected at any moment. Selection is achieved by controlling the voltage applied to pin 9. When the voltage at pin 9 is above two volts, or if the pin is open circuit, then the timing resistor connected to pin 7 is selected. When the signal at pin 9 drops below one volt, control is transferred to the resistor at pin 8.

Changeover is accomplished automatically by connecting the output of IC1, an op-amp configured as an astable oscillator, to pin 9. A high or low output can be 'forced' by switching R1 to either supply rail via SW1. With SW1 in the 'centre-off' position, the op-amp will switch at slightly less than 1 Hz producing alternating tones from the unit. Frequencies are set by adjustment of RV2 and RV4.

The output signal is developed across R5,6. Any convenient ratio may be chosen for these components to provide any desired output level up to a few volts peak to peak. A split supply was chosen as it facilitates circuit design. In any case IC2 needs at least a ten volt supply, precluding the use of a single battery. Current consumption is low and two PP3 type batteries provide a convenient source of power. Frequency stability with falling battery voltage is good and standard dry (Leclanche) batteries are quite adequate. Capacitors C2,3 provide overall decoupling.

PARTS LIST

RESISTORS	
R1,7	10k
R2	1M0
R3,4	47k
R5	4k7
R6	22k
R8	180k
POTENTIOMETERS	
RV1	47k min horiz preset
RV2	4k7 min horiz preset
RV3	470R min horiz preset
RV4	100k min horiz preset
RV5	22k min horiz preset
CAPACITORS	
C1	1u5 tantalum
C2,3	47u tantalum
C4	10n polyester
C5	1u0 tantalum
SEMICONDUCTORS	
IC1	3140
IC2	XR2206
MISCELLANEOUS	
PCB, IC sockets, single pole centre-off change-over switch.	

BUYLINES

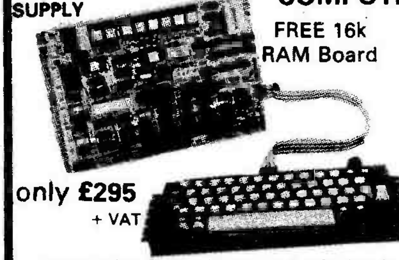
The XR2206 is available from Technomatic Ltd or Stevenson Electronic Components. The other parts should be readily available.

ETI

NASCOM-2 MICRO-COMPUTER

FREE POWER SUPPLY

FREE 16k RAM Board



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Z80A 8 bit. This will run at 4 Mhz but is selected between 1/2/4/Mhz.
On-board, addressable memory. 2K
2K Monitor — Nas-sys 1. 1K Video RAM (MK 4118). 1K work space/User RAM (MK 4118). 8K Microsoft Basic (MK 3600 ROM). 8K Static RAM/2708E Pr.

Microprocessors Z80A. 8 bit CPU. This will run at 4MHz but is selectable between 1/2/4 MHz. This CPU has now been generally accepted as the most powerful, 8 bit processor on the market.

INTERFACE

Keyboard New expanded 57 key Licon solid state keyboard especially built for Nascom. Uses standard Nascom, monitor controlled, decoding.

T.V. The lv peak to peak video signal can drive a monitor directly and is also fed to the on-board modulator to drive the domestic T.V.

I.O. On-board UART (Int. 6402) which provides serial handling for the on-board cassette interface or the RS232/20mA teletype interface.
The cassette interface is Kansas City standard at either 300 or 1200 baud. This is a link option on the NASCOM-2.
The RS232 and 20mA loop connector will interface directly into any standard teletype.
The input and output sides of the UART are independently switchable between any of the options —
i.e. it is possible to house input on the cassette and output on the printer.

PIO There is also a totally uncommitted Parallel I/O (MK 3881) giving 16, programmable, I/O lines. These are addressable as 2 x 8 bit ports with complete handshake controls.

Documentation Full construction article is provided for those who buy a kit and an extensive software manual is provided for the monitor and Basic.

Basic The Nascom 2 contains a full 8K Microsoft Basic in one Rom chip with additional features like DEEK, DOKE, SET RESET for simple programming.

SYSTEM 80 KITS from £225

Microprocessor board* (Nascom 2)
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High strength GRP moulding
Accepts 12x8 Nascom 2 CPU board, four 8x8 expansion boards. £85 incl. frame racking, interconnects and motherboard.

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nascom-1

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NASCOM-1 £125 VAT P&P £1.50

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Nas-sys monitor in 2 EPROM	25.00
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ZEAP 2 tape and documentation for Nas-sys	30.00
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MK3880 (Z80) for N1	7.50
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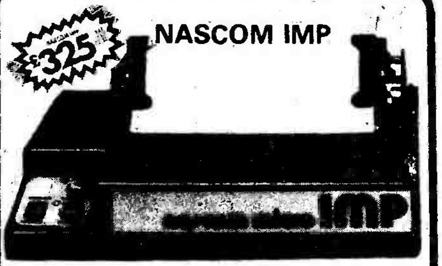
NASCOM IMP



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● 60 lines per minute. ● 80 characters per line. ● Bi-directional printing. ● 10 line print buffer. ● Automatic CR/LF. 96 character ASCII set (including upper/lower case, $, ≠, £). ● Accepts 8½" paper (pressure feed). ● Accepts 9½" paper (tractor feed). ● Tractor/pressure feed. ● Baud rate from 110 to 9600. ● External signal for optional synchronisation of baud rate. Ideal for word processing.

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60 Key ASCII Coded in steel case. Latched output complete with Plug and Cable with circuit to convert to T.T.L. levels.
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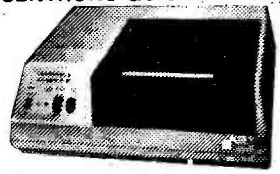

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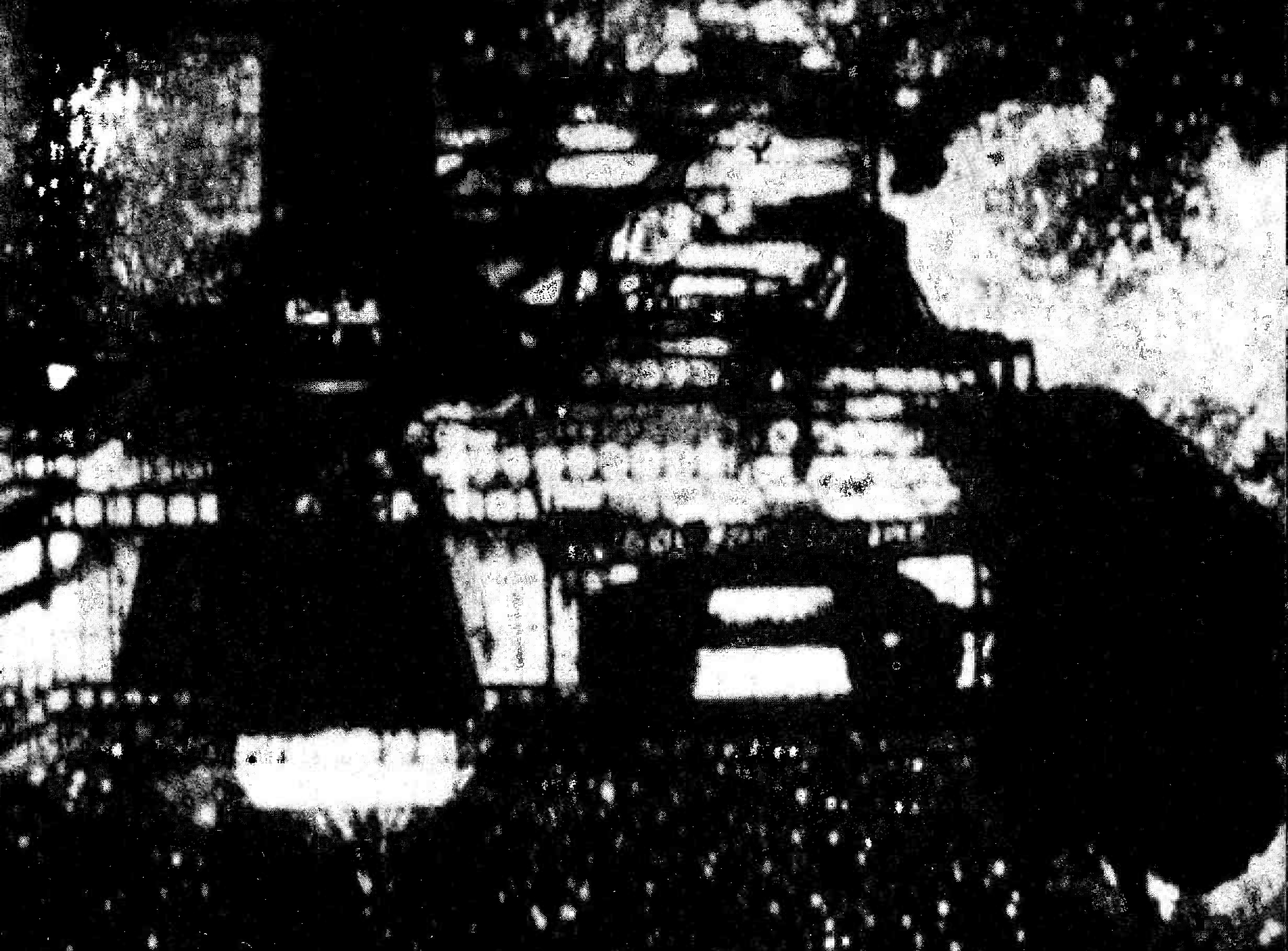
ETI JULY 1980

WHAT TO LOOK FORWARD TO IN OUR JULY ISSUE! ON SALE JUNE 6TH

Next month ETI presents the definitive history of the spacecraft. Ian Graham — our permanently high spaceman — talks us through the hardware of the fastest man-made vehicles to date and takes a look at those which take flight only in our imaginations. For everyone who has looked up at the stars and longed.

Also next issue we have the long awaited Image Co-ordinator which will allow you to do things with your stereo image that your mother wouldn't approve of! Moreover Tim Orr follows up his Handbook of this month, with an article in similar vein, this time on his favourite subject, Active Filters — find out how to design them yourself in the July issue of ETI!

For the audio men there is our first look at one of the rising stars of hi-fi, the Quantum amplifier system. It can be bought as a kit, as modules, or as a fully built and working piece of equipment. As an example of their range we examine the 102 pre-amp and the 204 (110W per channel) power amp — stand by your speakers.



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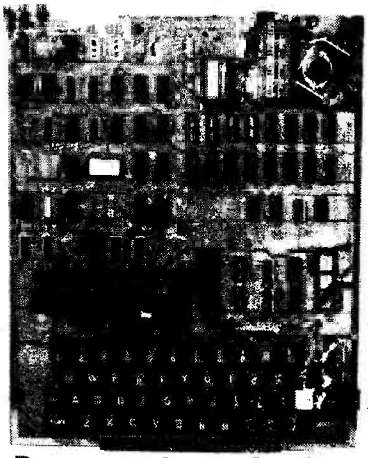

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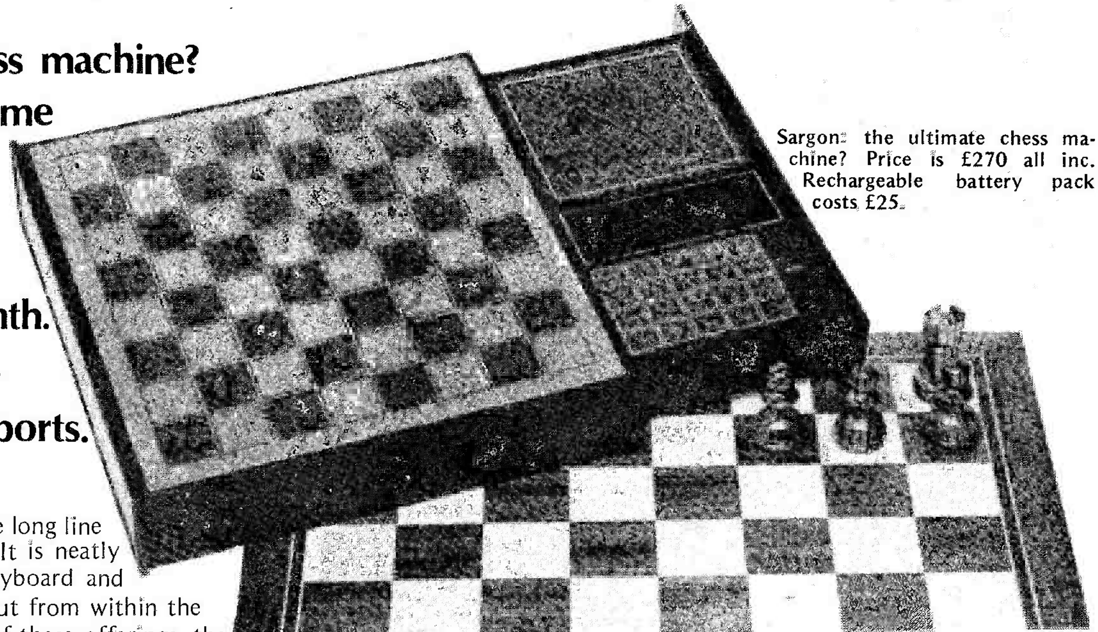
SARGON AND THE LCD CHESS-SET!

The ultimate chess machine? Well this must come pretty close. Ron Harris has been getting beaten regulary this month. Recovering some confidence he reports.



Sargon: the ultimate chess machine? Price is £270 all inc. Rechargeable battery pack costs £25.

Sargon is the latest in the long line of chess playing boxes. It is neatly presented, with the keyboard and piece storage telescoping out from within the board itself. As with most of these offerings, the provided chessmen are abysmal. I really do not know why they bother providing them — surely anyone who can afford a machine like this will have their own decent set anyway?

I digress. Returning to the machine, it is a development of the well known 'Boris', an opponent I crossed pawns with some time ago. Sargon inherits the ability to comment on the games, albeit with a little more reticence. However the chess playing ability of Sargon is far superior to Boris, who would be hard pressed indeed to take a game from his offspring I suspect. (Response times being equal of course.)

Model Modules

The basic concept of Sargon is a modular one. When the program is updated, changing the machine to a 'new' one means nothing more than unplugging the module and replacing it.

The keyboard is provided with different overlays to allow the machine to be used for pursuits other than chess. Backgammon and draughts are to be the first expansions, but here I shall restrict myself to the oldest wargame in history.

Features include a 'Restore' facility which allows you to replace the last move as though it had never happened — handy for training and cheating. A 'Best' button which cancels any random factor in Sargon's play and leads to a totally logical opponent. Frighteningly efficient, predictable (maybe — if you're good enough). Also there is a 'Hint' mode which allows you to obtain an idea of what to do next from the machine itself without having to listen to it if pride rises up and bites you at the last minute.

Fine thing pride. Makes you feel noble while Sargon cleans up your end of the board better than Domestos. Kills all known opponents. Dead. Naturally included are also full board review and alteration facilities.

Level With Me

Sargon is always on the level. Well some level or other, anyway. You set his response time by choosing a level from 0 (instant response) to 6 (postal chess). In between we have :—

Level one : 10 seconds
Level two : 20 seconds
Level three : 45 seconds
Level four : 2 minutes
Level five : 20 minutes

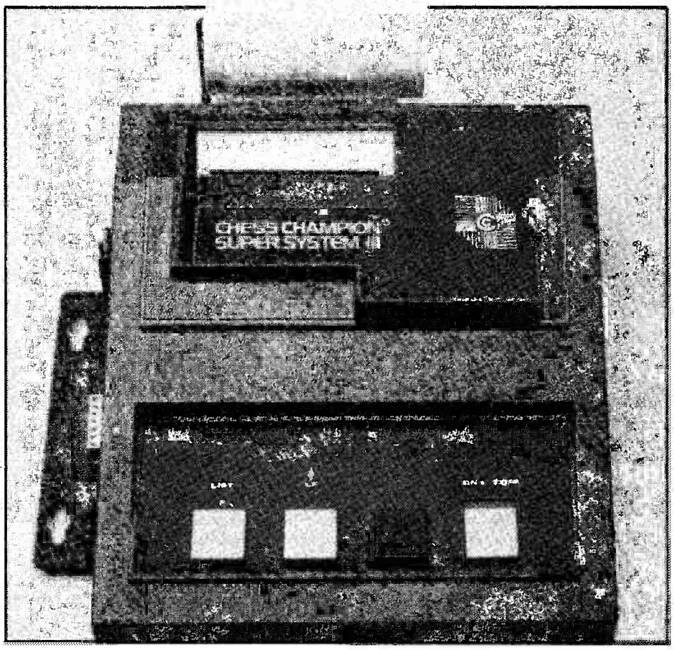
At two minutes thinking time Sargon is formidable indeed and will give a club player an energetic run for his pawns. I only ever beat the infernal thing once at this level — and I lost more than I won at level three.

Sargon is good. Very very good. At instant response it is better than the first generation chess machines and at level three becomes the best chess playing robot available for home use. For those who wish to trace it through I give an example game overleaf. Sargon set at Level 3 and plays Black. If you're interested in buying one, read it through — see if you would have done any better. I got a draw!

1.	E2 – E4	E7 – E5	21.	C1 – E3	B6 x E3
2.	G1 – F3	B8 – C6	22.	E1 x E3	C7 – C6
3.	B1 – C3	G8 – F6	23.	A1 – E1	D6 x E5
4.	F1 – C4	F8 – C5	24.	F4 x E5	E8 – E7
5.	F3 – G5	E8 – G8	25.	G5 – H3	D7 – H3
6.	E1 – G1	D7 – D6	26.	G2 x H3	F8 – D8
7.	D2 – D3	C8 – G4	27.	E5 – E6	E7 x E6
8.	D1 – D2	D8 – E7	28.	E3 x E6	E7 x E6
9.	C3 – D5	F6 x D5	29.	E1 x E6	D8 – C8
10.	C4 x D5	C5 – B4	30.	H3 – H4	G8 – F7
11.	C2 – C3	B4 – A5	31.	E6 – E3	C8 – B8
12.	D5 x C6	B7 x C6	32.	B2 – B3	B8 – E8
13.	F2 – F3	G4 – D7	33.	E3 x E8	E7 x E8
14.	D3 – D4	E7 – F6	34.	H1 – G2	E8 – F7
15.	D4 x E5	A5 – B6	35.	G2 – H3	F7 – F6
16.	G1 – H1	F6 x E5	36.	H3 – G4	F6 – E5
17.	F3 – F4	E5 – B5	37.	G4 – F3	C6 – C5
18.	F1 – E1	A8 – E8	38.	H2 – H3	D5 – D4
19.	E4 – E5	B5 – D5	39.	C3 x D4	E5 x D4
20.	D2 x D5	C6 x D5	40.	F3 – F4	D4 – C3

DRAW?

Figure 1. Playing Sargon at Level 3. Machine plays black. At the end of forty moves it's heading for a draw — providing neither of us does anything stupid!



The Chess Champion printer unit. Price : £104.95.

Summing Totals

There is not much more to say. Sargon is a well presented games machine which is potentially expandable to better chess — or anything else a module appears for. As a player it is the best we've ever seen inside a ROM and will give any player food for thought. Its power is not to be scorned, consider it a toy and you're beat before you start. Tread carefully, oh ye of little faith, lest ye be divested of all manner of men!

Chess Champion

Just when I thought I'd done with chess (for this month at least) and was about to retreat back to wargaming, to regain a little composure, this box of tricks was placed mid-desk with its printer and LCD board — sufficiently interesting I think to hold off the counters a while longer and raise pawns once more.

Chess Champion is a dedicated chess machine. Expansion comes in the form of a printer, LCD board and game memory. A full chess clock will be added later.

Rather than me trying to describe what it looks like, or has to offer, take a look at the photos. It features a fairly standard chess game keyboard with full board checking facilities. You can put back aught that has been removed — and remove what has not.

Display of move and status is via an LCD 'clock-type' display with piece verification symbol. Strength of game played is selected by varying response time. In seconds this time, not levels. In practice you have to double the time to get any appreciable increase in ability from the box.

Board Decision

As I can't see anyone using this unit without the LCD chessboard let me quickly add that to the consideration.

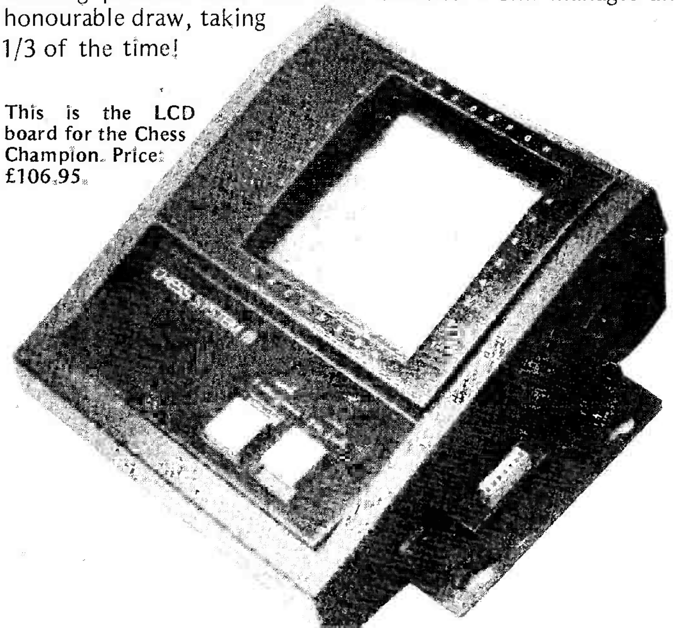
Packaged as a clip-on extra — the data bus edge connects — the board is powered from the main unit and is a complete chess set in itself. The chessmen are based around one symbol, which when displayed in its entirety is a Queen and assumes the guise of everything else as different segments are left unenergised. The photo shows how effective this can be.

Backlighting is available when running from the mains and the board flashes a proposed move until the ENTER key is pushed. As the game progresses the board provides a continuous updated read-out and totally eliminates the need for a separate chess set with all the attendant errors of misinterpretation and mismanagement. Sheer magic! At last a self-contained intelligent chess set! I could forgive a lot of failings in the machine just for this beautiful facility.

As it happens there is little wrong with Chess Champion anyway. I disliked the sloppy keyboard and having to go through the involved key sequence to change level is frustrating, but so what? Sargon's board is touch-switched and an absolute pest. And you have to move men around to play it. Fair exchange?

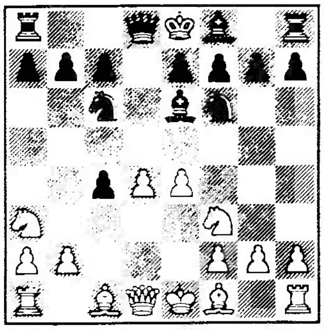
Mating Ritual

As a chess player, Chess Champion is no match for Sargon (at equal response). Witness the game below. Sargon is set to Level one (10 secs) and Chess Champion to 30 seconds response time. Although Sargon wastes what should have been a winning position later on in the conflict it still manages an honourable draw, taking 1/3 of the time!

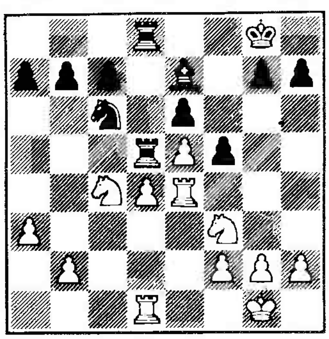


This is the LCD board for the Chess Champion. Price: £106.95.

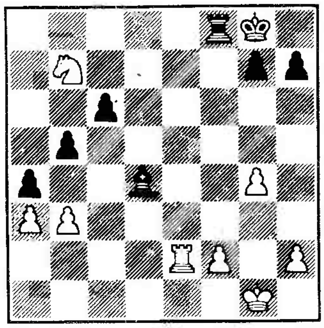
1.	D2–D4	D7–D5
2.	C2–C4	D5xC4
3.	G1–F3	B8–C6
4.	B1–A3	C8–E6
5.	E2–E4	G8–F6



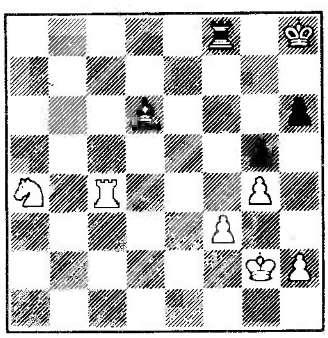
6.	E4–E5	F6–E4
7.	F1xC4	E6xC4
8.	A3xC4	E7–E6
9.	D1–D3	F8–B4
10.	C1–D2	E4xD2
11.	C4xD2	E8–G8
12.	E1–G1	B4–E7
13.	A2–A3	B4–E7
14.	D3–C4	D5xC4
15.	D2xC4	A8–D8
16.	A1–D1	D8–D5
17.	F1–E1	F8–D8
18.	E1–E4	F7–F5



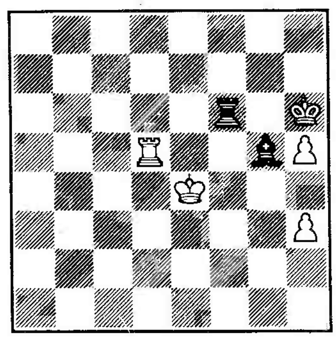
19.	E5–F6	E7xF6
20.	E4xE6	C6xD4
21.	F3xD4	D5xD4
22.	D1xD4	F6xD4
23.	B2–B3	C7–C6
24.	C4–D6	B7–B5
25.	G2–G4	A7–A5
26.	D6–B7	D8–F8
27.	E6–E2	A5–A4



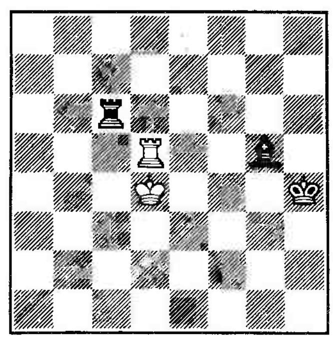
28.	B3xA4	B5xA4
29.	B7–A5	C6–C5
30.	G1–G2	G7–G5
31.	F2–F3	H7–H6
32.	E2–E6	G8–H7
33.	A5–C4	F8–A8
34.	G2–F1	A8–B8
35.	C4–B6	B8–F8
36.	F1–G2	D4–B2
37.	E6–E7	H7–H8
38.	B6xA4	B2xA3
39.	E7–C7	C5–C4
40.	C7xC4	A3–D6



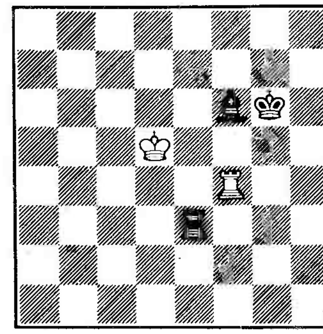
41.	A4–B6	F8–E8
42.	H2–H3	D6–F4
43.	B6–D5	F4–D6
44.	G2–F2	H8–G7
45.	C4–C6	E8–E6
46.	C6–C4	E6–E8
47.	C4–C6	E8–E6
48.	F3–F4	G5xF4
49.	F2–F3	H6–H5
50.	G4xH5	E6–H6
51.	D5xF4	D6xF4
52.	C6–C5	H6–F6
53.	F3–E4	G7–H6
54.	C5–D5	F4–G5



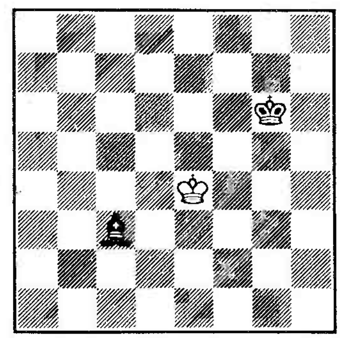
55.	H3–H4	G5xH4
56.	D5–C5	H4–G5
57.	E4–E5	H6xH5
58.	C5–D5	F6–C6



59.	E5–D4	H5–H4
60.	D5–F5	C6–E6
61.	D4–D5	E6–B6
62.	D5–C4	G5–F6
63.	C4–C5	B6–E6
64.	C5–D5	E6–B6
65.	F5–F4	H4–H5
66.	F4–C4	B6–B3
67.	C4–E4	H5–G6
68.	E4–F4	B3–E3



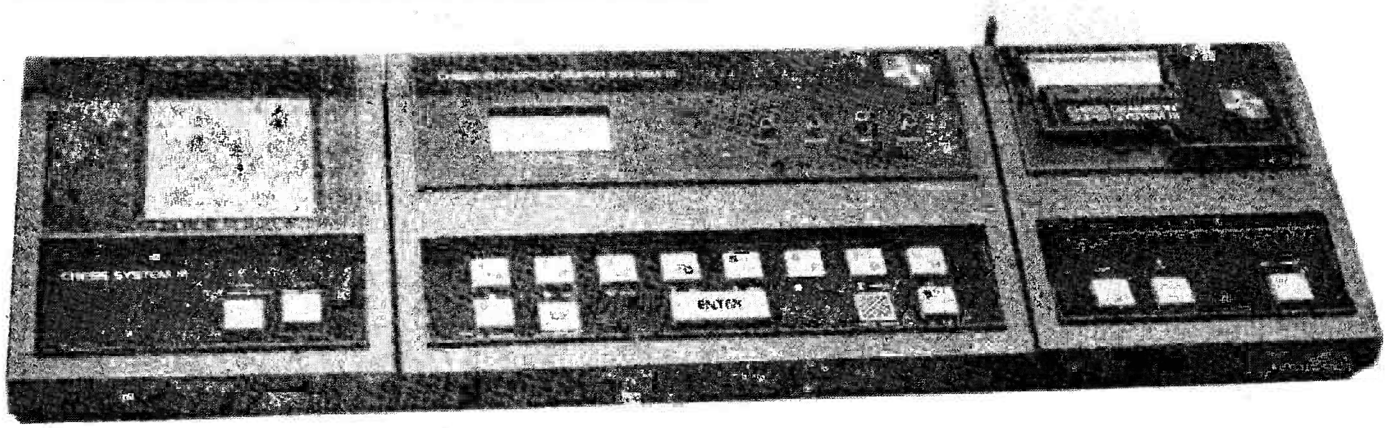
69.	F4–E4	E3xE4
70.	D5xE4	F6–C3



71.	E4–D3	C3–E5
72.	D3–E4	G6–F6
73.	E4–D3	F6–F5
74.	D3–E3	F5–G6

Figure 2 (above) the same between Sargon at 10 second response (white) and Chess Champion at 30 seconds. A draw in the end. Sargon should have won.

Below : the complete Chess Champion, with the LCD board in operation. Fascinating. The main unit will cost you £154.95 all inc. So Sargon costs about the same as the main unit plus LCD board in Chess Champion.

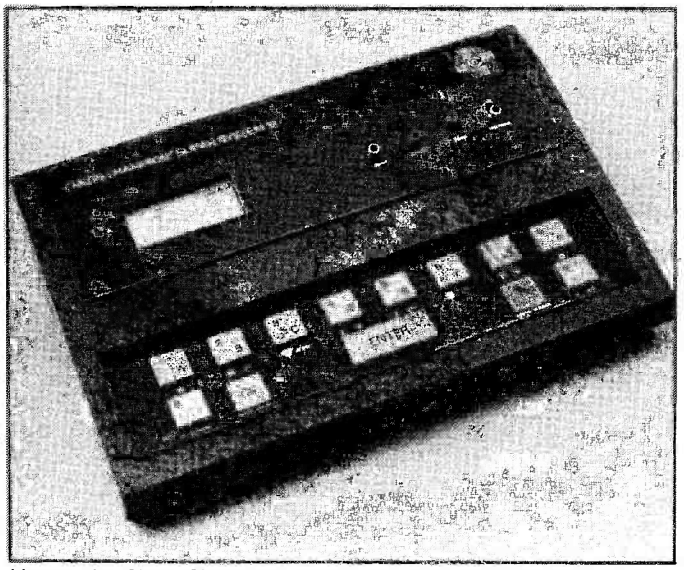


However, please don't think I'm decrying Chess Champion's ability. I wouldn't dare. With the possible exception of the Voice Challenger, I know of no other machine that could best it bar Sargon. Given a little longer Chess Champion will still pin you to the back rank should that be your desire.

It is just that it takes a little while to get over the advanced presentation (i.e. gadgets!) that comes as part of the system. Talking of which I haven't mentioned the printer yet, so let us rectify that immediately.

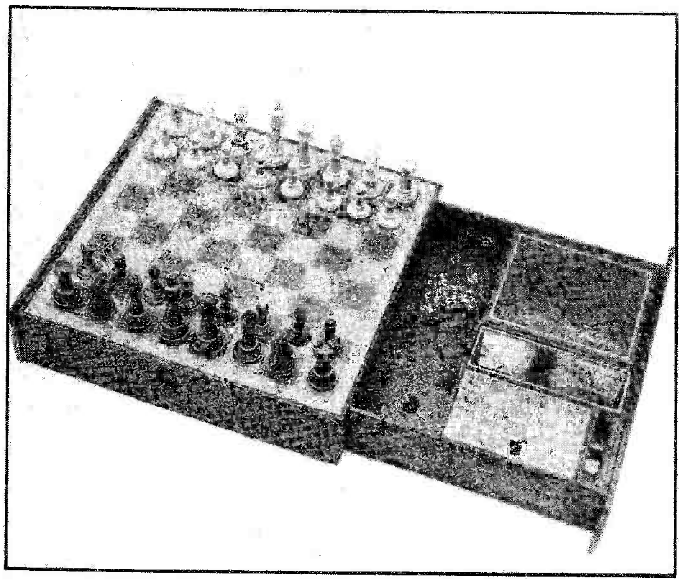
Packaged as another clip-on extra, the printer is a thermal unit with twenty characters per line capability. Shown below is the display of the full board which can be obtained, at any point during a game, by pushing LIST on the printer. Moves are recorded with a "symbol—move from—move to" sequence.

In order to give an example of the printer's output — and because I couldn't resist it — below I have given the ending from a game of Sargon vs Chess Champion at equal response times (20 secs). It's a massacre so don't look if you can't stand the sight of blood! (facing page).

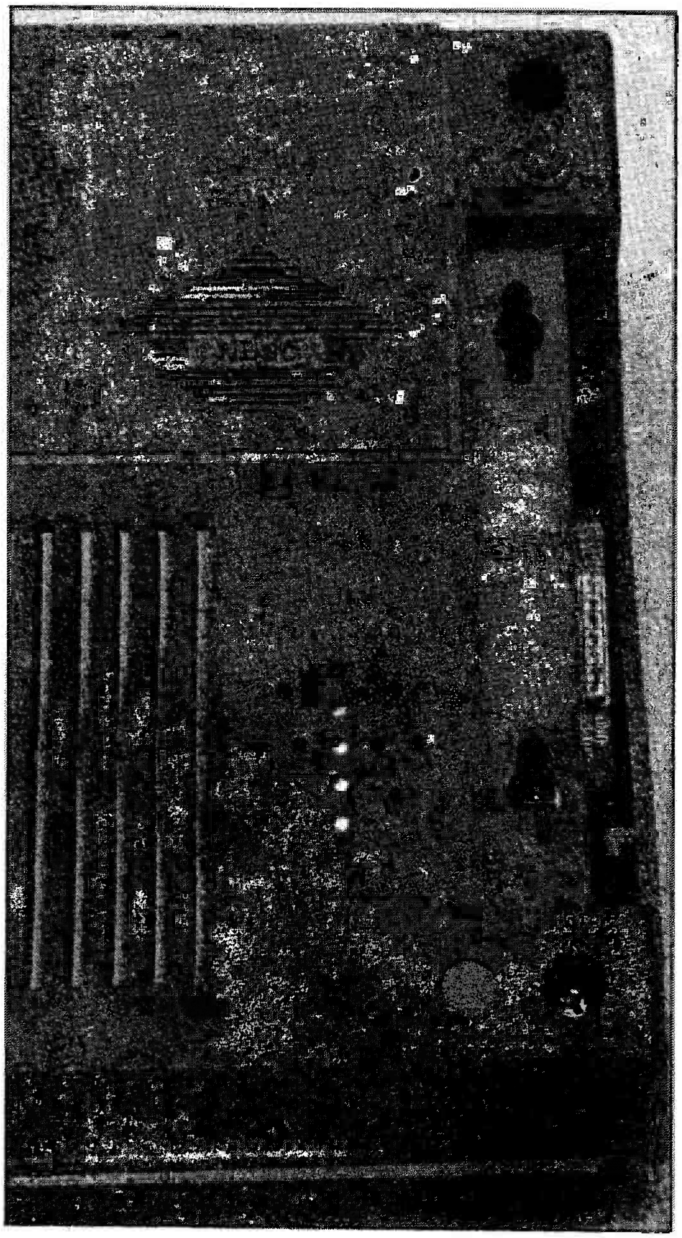


Above: the Chess Champion master unit with its clock-type display. To the right is shown the bus connection for the slave printer-board units.

Below: Sargon ready to play.



Above: Sargon ready to play.



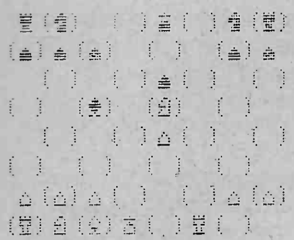
Which Machine?

Choosing between the two is by no means straightforward. If you're a dedicated high-level chess player who will always use his own chess-set anyway, then Sargon will be your best choice for its superior playing ability. On the other hand the LCD board is a huge advantage (and error eliminator) and provided you don't mind waiting that extra time for equal ability Chess Champion is an attractive proposition.

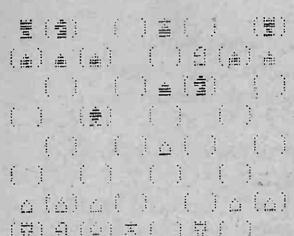
The difference between the machines, in ability, diminishes as the thinking time is increased past 2 minutes, with Sargon always retaining the edge. For my own part I'd tend to go for Chess Champion as that still beats *me* often enough to be challenging and that board fascinates me! I dare say though Sargon will receive heavy support from the better players of this world.

My thanks to Kramer & Co. for lending us the machines for this article. Prices of the units from them are given in the captions.

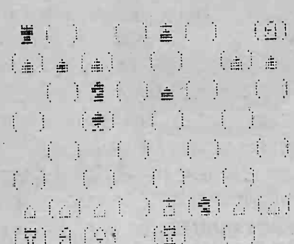
01 ♙E2 E4
*♟E7 E5
02 ♘G1 F3
*♟D7 D5
03 ♘F3xE5
*♟D5xE4
04 ♗F1 C4
*♝C8 E6
05 ♗C4 E6
*♟F7xE6
06 ♙D2 D3
*♝F8 C5
07 ♙D3xE4
*♛D8xD1+
08 ♔E1xD1
*♝C5xF2
09 ♖H1 F1
*♝F2 C5



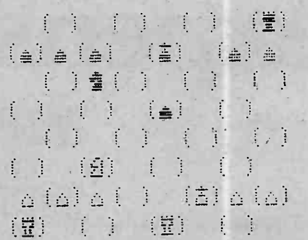
10 ♘E5 F7
*♞G8 F6



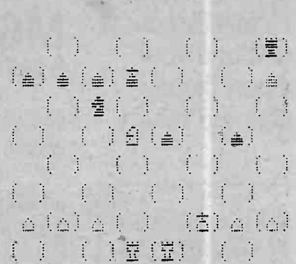
11 ♘F7xH8
*♞F6xE4
12 ♖F1 E1
*♞E4 F2+
13 ♔D1 E2
*♞B8 C6



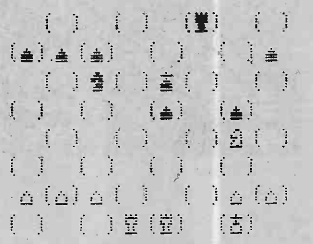
14 ♗C1 E3
*♝C5xE3
15 ♔E2xE3
*♚E8 E7
16 ♔E3xF2
*♜A8xH8
17 ♘B1 C3
*♟E6 E5



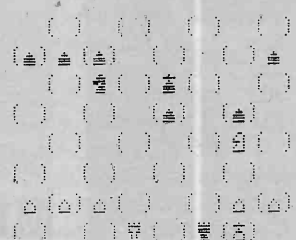
18 ♘C3 D5
*♚E7 D7
19 ♖A1 D1
*♟G7 G5



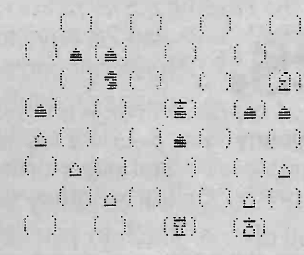
20 ♘D5 F6
*♚D7 E7
21 ♘F6 G4
*♜H8 F8+
22 ♔F2 G1
*♚E7 E6



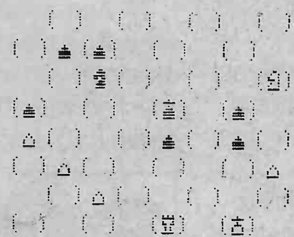
23 ♖E1 F1
*♜F8xF1+



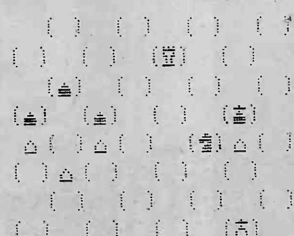
24 ♖D1xF1
*♟E5 E4
25 ♖F1 E1
*♚E6 F5
26 ♙H2 H3
*♟A7 A6
27 ♙A2 A4
*♟A6 A5
28 ♙B2 B3
*♟H7 H5
29 ♘G4 H6
*♚F5 E5



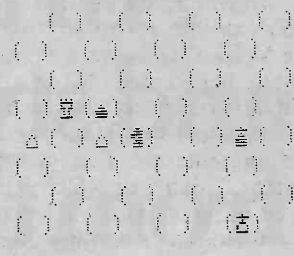
30 ♙G2 G4
*♟H5xG4



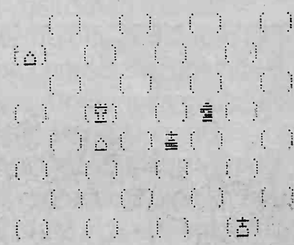
31 ♙H3xG4
*♟B7 B6
32 ♘H6 F7
*♚E5 F6
33 ♘F7xG5
*♚F6xG5
34 ♖E1xE4
*♞C6 B4
35 ♙C2 C3
*♞B4 D5
36 ♙C3 C4
*♞D5 F4
37 ♖E4 E7
*♟C7 C5



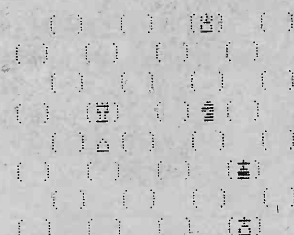
38 ♖E7 B7
*♚G5xG4
39 ♖B7xB6
*♞F4 D3
40 ♖B6 A6
*♞D3 C1
41 ♖A6xA5
*♞C1xB3
42 ♖A5 B5



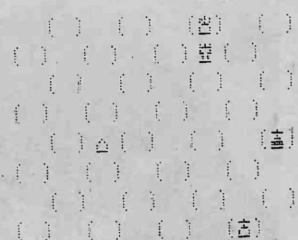
43 ♖B5xC5
*♞D4 F5
44 ♙A4 A5
*♚G4 G5
45 ♙A5 A6
*♚G5 F4
46 ♙A6 A7
*♚F4 E4



47 ♙A7 A8
*♚E4 F4
48 ♕A8 F8
*♚F4 G3



49 ♖C5xF5
*♚G3 G4
50 ♖F5 F7
*♚G4 H4



51 ♖F7 G7
* LOSE

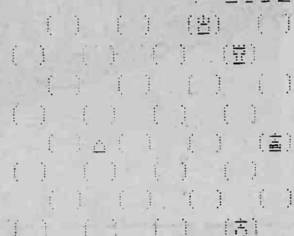


Figure 3. Sargon vs Chess Champion (black) with both machines on 20 seconds think time. The print-out is courtesy of Chess Champ's printer.

ETI

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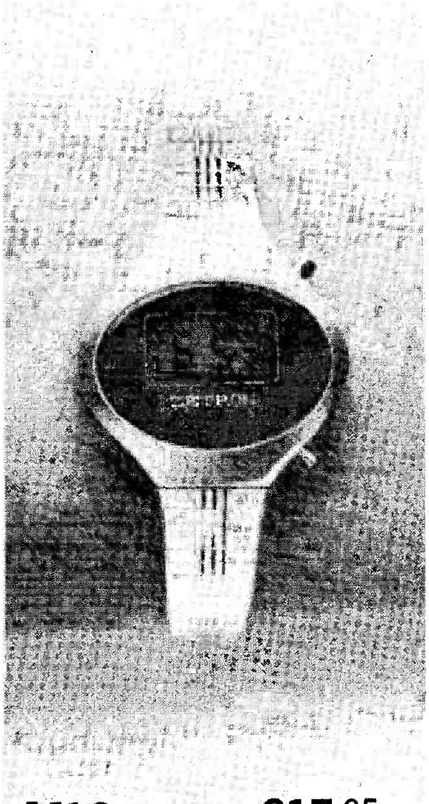
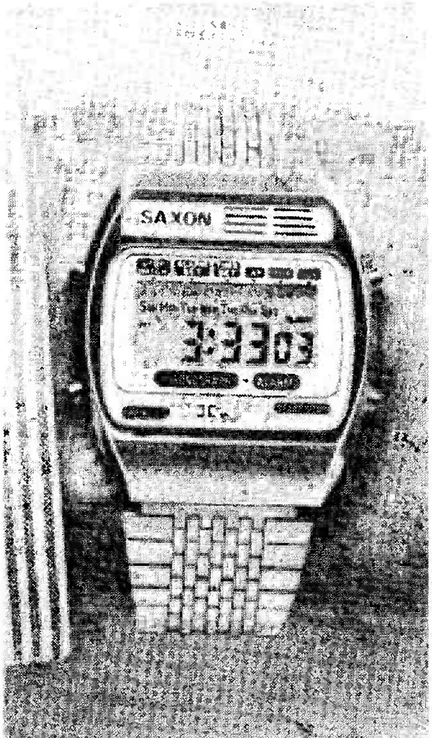


M18 **£15·95** inc p&p
Ladies quartz LCD Fashion Watch



M64 **£14·95** inc p&p
Mans dual time quartz alarm chronograph with 6 digits, 5 indicators and 22 functions.

M18 Ladies quartz LCD Fashion Watch

Highly functional, but beautifully designed watch, suitable for those special occasions.

Displaying hours, mins, secs, day and date, the watch also has an auto calendar and a backlight.

The slim but strong bracelet is fully adjustable and is available in a silver or gold finish.

M64 Mans dual time quartz alarm chronograph with 6 digits, 5 indicators and 22 functions.

For business people with overseas contacts and responsibilities this is the ideal watch.

Local time is always visible, but in addition the watch can be set, and recall, a second time zone, in either 12 or 24 hour formats, and displays a day and date for each zone.

The chronograph/stopwatch displays up to 12 hours, 59 minutes and 59.9 seconds.

On command, the stopwatch display freezes to show intermediate (split/lap) time while the stopwatch continues to run and neither function affects the normal timekeeping.

The alarm can be set to any time within a 24 hour period.

To complete the functions, there is also a 4 year calendar and a fully adjustable stainless steel strap.

£9·95 inc p&p

M15 Ladies quartz LCD Day Watch

This slender watch displays hours, mins, secs, day and date and has an auto calendar and a backlight.

Only 25mm × 20mm × 6mm thick this elegant watch has a bracelet, in silver or gold finish, and is fully adjustable to suit very slim wrists.

M17 Ladies quartz LCD Cocktail Watch

Only 6mm thick, the watch displays hours, mins, secs, day, date and has an auto calendar and backlight.

The fully adjustable bracelet has a bronze/gold or silver finish.

M30 Mans dual time melody alarm chronograph with count-down timer, 34 functions

A very impressive new watch at a superbly low price and with so many useful functions.

There are 5 independent working modes; normal watch, count-down alarm, alarm, dual time zone, 1/100th sec. chronograph.

In addition, the watch can display the day of the week in French, German or English.

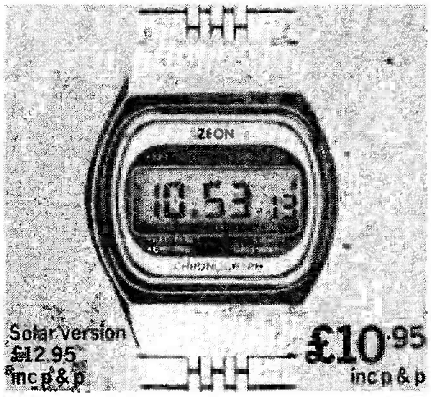
The count-down timer can be used for a variety of applications from boiling an egg to reminding you your parking meter time has expired. Both the count-down alarm and the normal alarm have a clear musical tone.

For the businessman the time zone feature could be a real advantage. Just programme the second time zone and it will be permanently recorded for easy reference.

And as a stop-watch here's a great timepiece for sporting events and for timing recordings.

There's the conventional stop/start counter plus a lap timer which enables first and second places to be timed.

Longer timing intervals, such as journey times can be recorded while the watch is reading its normal time.



M3 Mans quartz LCD with 6 digits and 11 functions

Only 7mm thick and with a fully adjustable stainless steel bracelet, this watch is ideal for all ages.

The normal functions are hours, mins, secs, day, date, and day of week.

But as a stop-watch, which does not affect normal timekeeping you also have 1/100th and 1/10th secs., split, lap and journey timing, a four year calendar and a backlight.

Also available is a solar version.

This is the same watch but incorporated is a solar energy panel which converts normal daylight into electricity.

During periods of darkness the watch instantly operates by battery without losing its accuracy.

M4 Mans quartz LCD alarm with 6 digits and 9 functions

A very useful watch with an effective, loud alarm but still only 8mm thick.

The normal functions are hours, mins, secs, date, day of week, four year calendar and a backlight.

In addition, there is a 24-hour alarm, a 5-minute snooze feature and a 4 second pre-alarm conference bleep.

The conference signal is a bleep, 4 seconds before main alarm to give advance warning and the option to cancel.

After the main alarm stops the snooze repeater alarm sounds 5 minutes later, unless previously cancelled.

To complete the functions, there is also a 4 year calendar and a fully adjustable stainless steel strap.

M16 Mans dual time quartz alarm chronograph with 6 digits, 5 indicators and 22 functions.

This watch has the same functions as M64 except the time is in the 24 hour format only.

A solar version is available.

This is the same watch but incorporated is a solar energy panel which converts normal daylight into electricity.

During periods of darkness the watch instantly operates by battery without losing its accuracy.

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I enclose PO/Cheque for £ ______

Barclaycard/Access No. ______

Name ______

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STEVENSON
Electronic Components

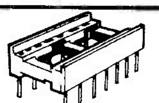
OPTO

LED's	0.125in.	0.2in	each
Red	TIL209	TIL220	10p
Green	TIL211	TIL221	15p
Yellow	TIL213	TIL223	15p
Clips	3p	3p	

DISPLAYS

DL704	0.3 in CC	130p
DL707	0.3 in CA	130p
FND500	0.5 in CC	100p

SKTS



Low profile by Texas

8 pin	9p	18 pin	16p	24 pin	22p
14 pin	11p	20 pin	18p	28 pin	26p
16 pin	12p	22 pin	20p	40 pin	38p

3 lead T018 or T05 skt. 12p each.
Soldercon pins: 100 for 60p.

PCBS

VEROBOARD

Size in.	0.1in.	0.15in.	Vero
25 x 1	16p	—	Cutter 110p.
2.5 x 3.75	60p	53p	
2.5 x 5	70p	65p	Pin insertion
3.75 x 5	75p	75p	tool 150p.
3.75 x 17	275p	240p	
SS pins/100	45p	45p	

Fibreglass board, 203 x 95mm: 80p each.
Alfac – 38p per sheet.

RESISTORS

Carbon film resistors. High Stability, low noise 5%.
E12 series. 4.7 ohms to 10M. Any mix:

	each	100+	1000+
0.25W	1p	0.9p	0.85p
0.5W	2p	1.5p	1.3p

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res) 0.5W £8.50. 0.25W £5.30.

METAL FILM RESISTORS
very high stability, low noise rated at ¼W 1%. Available from 51ohms to 330k in E24 series. Any mix:

	each	100+	1000+
0.25W	4p	3.7p	3.5p

POTENTIOMETERS
Preset vertical or horizontal 100 ohms – 1M 7p
Rotary 5K-2M2 Log or Lin single . 30p
Rotary 5K-2M2 Log or Lin double 90p
Slide 60mm travel 5k-500k Log or Lin, single 60p
Suitable knobs for above with coloured caps in red, blue, green, grey, yellow and black. Rotary controls 16p each. Slide type 12p each.

MISC

Murata Ultrasonic Transducers	350p pair
64mm 8 ohm speakers	100p each
64mm 64 ohmspeakers	100p each
SRB 17W soldering iron	430p each
Reel of 22swg solder (39.6m)	320p each
Desoldering tool	510p each
Precision screwdriver set	170p each
Titan Electric drill	1095p each
Minaiture 606 and 909 at 100mA transformers	105p each

SWITCHES

TOGGLE

Standard	SPST 36p	DPDT 50p
Miniature	SPDT 75p	DPDT 85p
Subminiature	SPST 58p	DPDT 78p

SLIDE
Standard . . . . . . DPDT 17p
Miniature . . . . . . DPDT 16p
ROCKER (10A rating)
SPST 34p each. SPST 46p each.
ROTARY
1P12W, 2P6W, 4P3W or 3P4W 51p each
Key operated DPDT (Yale key) 395p each
PUSH
Non locking - push to make 16p each
- push to break 22p each
Locking - SPST 75p each
- DPDT 100p each

REGULATORS

LM309K	140p
LM317T	220p
LM323K	480p
LM723	40p

100mA + ve		1A + ve		1A – ve	
78L05	30p	7805	70p	7905	85p
78L12	30p	7812	70p	7912	85p
78L15	30p	7815	70p	7915	85p

TRANSISTORS

				TIP32C	60p
				TIP2955	66p
				TIP3055	53p
AC127	22p	BC548	11p	ZTX107	12p
AC128	22p	BCY71	16p	ZTX108	12p
AC176	22p	BCY72	15p	ZTX300	14p
AD161	40p	BD131	40p	ZTX500	15p
AD162	40p	BD132	40p	2N3053	25p
BC107	10p	BD139	33p	2N3054	56p
BC108	10p	BD140	33p	2N3055	50p
BC108C	12p	BFY50	23p	2N3702	9p
BC109	10p	BFY51	23p	2N3704	9p
BC109C	12p	BFY52	23p	2N3706	9p
BC147	9p	MJ2955	100p	2N3819	20p
BC148	9p	MPSA06	16p	2N3904	10p
BC177	16p	MPSA56	16p	2N3905	10p
BC178	16p	TIP29C	60p	2N3906	10p
BC182	10p	TIP30C	48p	2N5459	33p
BC182L	10p	TIP31C	50p	2N5777	50p
BC184	10p	**DIODES**			
BC184L	10p	1N914	4p	1N4006	7p
BC212	10p	1N4148	3p	1N5401	14p
BC212L	10p	1N4002	5p	BZY88ser.	8p
BC214L	10p	1N4148 £1.50 per 100.			

CAPACITORS

POLYSTYRENE
High quality foil type. 63V working, 5% tol.
22pf to 100pf . . . . 7p each
1500pf to 0.01uF . . . . 9p each
TANTALUM BEAD
0.1, 0.15, 0.22, 0.33, 0.47, 0.68
1 & 2.2uF @ 35V . . . . 10p each
4.7, 6.8, 10uF @ 25V . . . . 18p each
22 @ 16V, 47 @ 6V, 100 @ 3V . . . 22p each
MYLAR
0.001, 0.01, 0.022, 0.033, 0.047 . . . 4p each
0.068, 0.1 . . . . 5p each
POLYESTER
Mullard C280 series
0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1. 6p ea.
0.15, 0.22 . . . . 8p each
0.33, 0.47 . . . . 12p each
0.68 . . . . 17p each
1.0uF. . . . . 22p each
CERAMIC
Plate type 50V. Available in E12 series from 22pF to 1000pF and E6 series from 1500pF to 0.047uF . . . . 2p each
MINIATURE TRIMMERS
Miniature film type, in 1.4pF – 5pF, 2pF – 22pF, 2pF – 22pF, 2pF – 10pF, 5.5pF – 65pF. 22p each
RADIAL LEAD ELECTROLYTICS

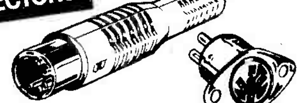
63V	0.47	1.0	2.2	4.7	10	6p each
			22	33	47	8p each
	100					16p each
			220			20p each
25V	10	22	33	47		6p each
	100					8p each
		220				12p each
				470		18p each
	1000					28p each

PACKS

Specially developed packs intended for development work.

¼W CF resistor, 10 each value E12 series 4.7 ohm to 1 Megohm (650 total)	530p each
½W CF resistor, 10 each value E12 series 4.7 ohm to 1 Megohm (650 total)	850p each
¼W MF 1% resistor, 10 each value E24 series 51 ohms to 33oK (930)	2950p each
Preset potentiometers 5 each value from 100 ohms to 1 Megohm (65)	390p each
Polyester capacitors 5 each value 0.01 to 2.2uF (70)	690p each
Ceramic plate capacitors 10 each value 22pF to 0.01uF (310)	575p each

CONNECTORS



DIN PLUGS AND SOCKETS

	plug	chassis socket	line socket
2 pin	8p	8p	12p
3 pin	12p	10p	12p
5 pin 180°	12p	11p	17p
5 pin 240°	14p	11p	22p

JACK PLUGS AND SOCKETS

	unscreened	screened	socket
2.5mm	10p	15p	8p
3.5mm	10p	16p	9p
Standard	16p	30p	19p
Stereo	23p	39p	22p

1mm PLUGS AND SOCKETS
Suitable for low voltage circuits, Red & Black. Plugs: 8p each. Sockets: 9p each.
4mm PLUGS AND SOCKETS
Available in blue, black, green, brown, red, white and yellow. Plugs 18p each Sockets: 15p each.

CMOS

		4023	25p	4054	120p	4502	120p
		4024	55p	4060	120p	4507	60p
		4025	20p	4063	120p	4508	330p
		4026	160p	4066	60p	4510	90p
		4027	45p	4068	25p	4511	90p
4000	20p	4028	90p	4069	25p	4512	90p
4001	25p	4029	100p	4070	25p	4516	90p
4002	20p	4031	220p	4071	25p	4518	90p
4006	90p	4033	150p	4072	25p	4520	110p
4007	25p	4036	350p	4073	25p	4527	165p
4008	100p	4039	350p	4075	25p	4528	100p
4011	25p	4040	110p	4076	90p	4529	160p
4012	20p	4041	85p	4077	25p	4531	150p
4013	40p	4042	80p	4078	25p	4532	125p
4014	85p	4043	95p	4081	25p	4538	160p
4015	90p	4046	110p	4082	25p	4543	170p
4016	40p	4048	60p	4086	75p	4566	410p
4017	70p	4049	50p	4093	60p	4558	120p
4018	90p	4050	50p	4095	110p	4559	410p
4020	110p	4051	80p	4098	120p	4581	320p
4022	100p	4053	80p	4501	20p	4585	115p

LSTTL

		74LS47	75p	74LS126	65p	74LS175	100p
		74LS48	100p	74LS132	95p	74LS190	90p
74LS00	16p	74LS54	25p	74LS136	60p	74LS191	90p
74LS01	22p	74LS73	40p	74LS138	80p	74LS192	90p
74LS02	16p	74LS74	45p	74LS139	80p	74LS193	90p
74LS03	22p	74LS75	50p	74LS151	75p	74LS195	90p
74LS04	16p	74LS76	45p	74LS155	75p	74LS196	90p
74LS08	24p	74LS78	45p	74LS156	80p	74LS197	95p
74LS10	22p	74LS83	85p	74LS157	55p	74LS221	120p
74LS13	45p	74LS85	100p	74LS158	70p	74LS251	70p
74LS14	70p	74LS86	50p	74LS160	75p	74LS266	55p
74LS20	22p	74LS90	50p	74LS161	75p	74LS290	90p
74LS21	22p	74LS93	70p	74LS162	95p	74LS365	60p
74LS27	30p	74LS95	85p	74LS163	90p	74LS366	60p
74LS30	22p	74LS107	50p	74LS164	90p	74LS367	60p
74LS32	30p	74LS114	60p	74LS165	80p	74LS368	60p
74LS37	45p	74LS123	70p	74LS173	120p	74LS386	60p
74LS42	75p	74LS125	45p	74LS174	100p	74LS670	210p

TTL

		7442	50p	7493	35p	74157	50p
		7445	65p	7496	55p	74164	70p
7400	12p	7447	55p	74121	35p	74165	70p
7402	12p	7448	55p	74123	45p	74174	70p
7404	16p	7473	30p	74125	45p	74177	70p
7408	18p	7474	30p	74126	45p	74190	70p
7410	14p	7475	35p	74132	55p	74191	70p
7413	30p	7476	35p	74141	70p	74192	70p
7414	55p	7485	65p	74145	70p	74193	70p
7420	14p	7486	25p	74148	120p	74194	70p
7427	25p	7490	35p	74150	65p	74196	70p
7432	28p	7492	35p	74154	80p	74197	70p

LINEAR

		LM10	400p	LM3909	72p	TBA800	80p
		LM301A	30p	LM3914	280p	TBA810S	110p
		LM308	70p	LM3915	280p	TDA1008	350p
709	40p	LM318	85p	LM3911	120p	TDA1022	630p
741	18p	LM324	52p	LM13600	160p	TDA1024	120p
747	50p	LM339	55p	MC1496	80p	TDA2020	360p
748	35p	LM348	100p	LM1458	40p	TL071	75p
7106	850p	LM377	170p	LM1830	180p	TL072	135p
AY-1-0212	660p	LM378	230p	MC3340P	135p	TL074	200p
CA3046	70p	LM3795	410p	MC3360P	135p	TL081	45p
CA3080	75p	LM380	80p	MM57160	650p	TL082	85p
CA3130	90p	LM381	140p	NE531	110p	TL084	125p
CA3140	50p	LM382	120p	NE555	23p	TL170	60p
FX209	820p	LM383	200p	NE556	60p	XR2206	390p
ICM7555	100p	LM386	90p	NE566	120p	XR2207	450p
ICM7556	POA	LM387	120p	NE567	120p	ZN414	80p
LF347	135p	LM389	100p	NE570	420p	ZN419	POA
LF351	45p	LM391	170p	NE571	460p	ZN424	150p
LF353	85p	LM1310	140p	NE5537	POA	ZN425E	420p
LF355	92p	LM2917	280p	RC4136	100p	ZN460	360p
LF356	95p	LM2924	160p	SAD1024	1310p	ZN1034	230p
LF357	92p	LM3900	60p	SN76477	230p		

MICRO

				CPU's		SUPPORT	
		2112	220p				
		2114LP	420p	6800	650p	6810	350p
		4116	620p	8080A	610p	6821	600p
		2708	680p	Z80	1090p	6850	550p
21L02	120p	2716	1980p			AY5-1013	370p

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ETI

CIRCUIT DESIGN HANBOOK

NO.1 : AUDIO AMPLIFICATION AND OSCILLATORS.

A step by step guide to doing it ALL yourself — by Tim Orr. This is the first of what will become an occasional series of easy to read reference works. Mathematics will be kept to a minimum with the emphasis upon producing practical circuits — quickly. Just the thing you always wanted, but thought no-one was ever going to produce! Future subjects will include radio circuitry, digital logic and signal processing.

SECTION ONE :
small signal and pre-amplifiers
SECTION TWO :
large signal, or power, amplifiers
SECTION THREE :
audio frequency oscillators

1. SMALL SIGNAL AND PRE-AMPLIFIERS

Preamplifiers are used to convert low level signals into higher level signals with low output impedances. The primary design considerations for preamplifiers are input impedance, signal gain, equalisation, noise performance and distortion. It is now possible to buy integrated circuits that will perform virtually all common preamplifier functions. Only rarely, (and with a lot of skill), will one be able to improve upon a monolithic 'best' solution with a discreet component design. However, it is necessary to fully understand the operation of the IC if optimum results are to be obtained.

The Op Amp Building Block

Most IC preamplifiers operate as op amps. They have a single or differential input, a low impedance output and a large frequency dependent voltage gain, (Fig.1). Note that the

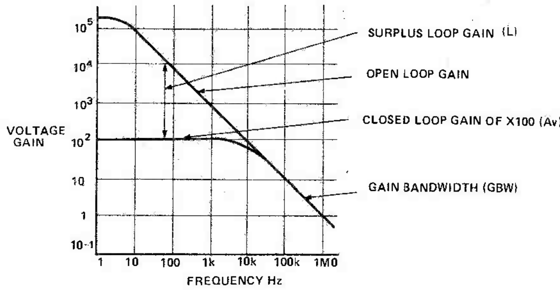


Fig.1. Typical frequency response for the 741 op amp.

open loop voltage gain rolls off at –6 dB per octave. By applying feedback around the op amp (closed loop), the gain is stabilised and is held constant by the resistor ratio until the device runs out of bandwidth. The difference between the open and closed loop gain is known as the surplus loop gain. This surplus loop gain is the negative feedback that is used to iron out non-linearities in the op amp. As the size of the surplus loop gain decreases with increasing frequency, the distortion and output impedance increase. Fig.2 compares the performance of inverting versus non-inverting configurations.

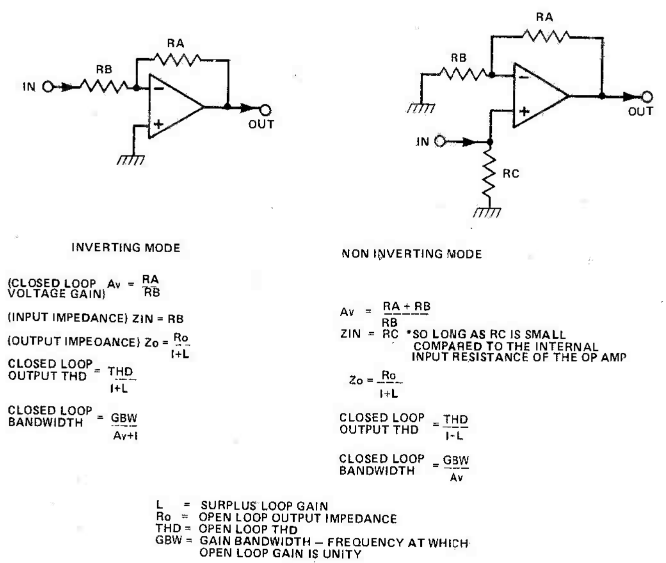


Fig.2. A comparison of the performance of inverting versus non-inverting configurations.

Note that for unity gain the non-inverting mode has twice the closed loop bandwidth of the inverting mode. Also note that the output impedance rises as the surplus loop gain decreases. This can cause a sharp increase in distortion when the op amp is driving a low impedance load at high frequency.

Design Example

Q. Design an amplifier with a gain of 60 dB, a closed loop bandwidth of at least 20 kHz and input impedance of 10 k.

A. First, try the inverting mode as shown in Fig.2.

Zin = 10 k = RB.

$$Av = 60\text{ dB} = X1000 = \frac{RA}{RB}$$

Therefore, RA = 10 k x 1000 = 10 M

If we use a 741 then the input offset voltage will be multiplied by the closed loop gain. The offset is typically ± 1 to 5 mV. Therefore, the output offset will be ± 1 to 5 V! It is possible to null out the input offset (Fig.3a) with a preset. This circuit will not be very satisfactory.

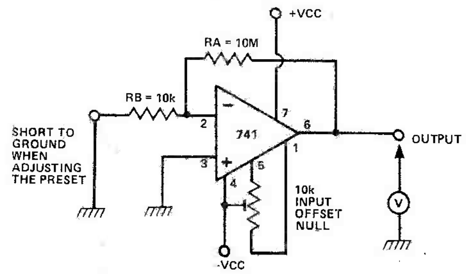


Fig.3a. The input offset can be nulled with a preset.

Its DC output offset will probably drift with temperature and time. If stable high DC gains are required then a 741 should not be used. A high performance instrument op amp should be selected in its place. Another problem in using the 741 is its 1 MHz gain bandwidth product. A closed loop gain of 60 dB will result in a closed loop bandwidth of 1 kHz, and not the 20 kHz needed. An op amp capable of giving 60 dB of gain at 20 kHz would need a gain bandwidth product of 20 MHz.

Although there are some op amps with this performance, they are generally difficult to stabilise and are relatively expensive. A cheap solution is to use two 741s, both with gains of 30 dB (x 33), (Fig.3b). The 741 has a bandwidth of 30 kHz at

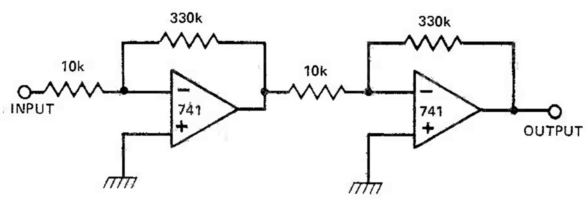


Fig.3b. A cheaper way to achieve higher gain at, say, 20 kHz without incurring a huge bandwidth is to use two 741s.

a closed loop gain of 30 dB. The DC offset still remains a problem, but it could be removed with a nulling preset on the first op amp. However, if the amplifier is to be used for audio then a DC response is not needed and so AC coupling can be used to reduce the final DC offset, Fig.3c. Yet another problem still exists. With the input short circuited the circuit would probably produce about 10 mV of noise at its output. The subject of noise will be dealt with later; suffice it to say that the 741 is not a low noise device. Low noise operation can be obtained by using one of the low noise op amps that are now available.

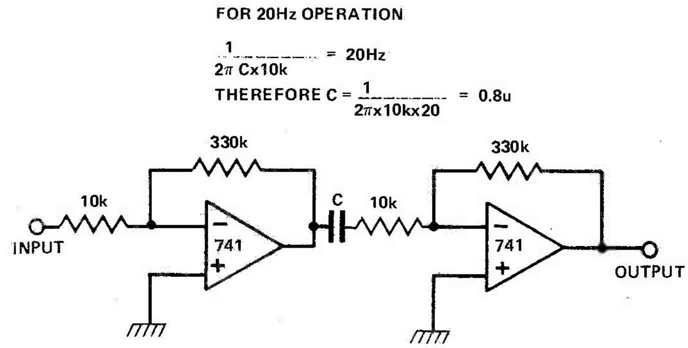


Fig.3c. AC coupling can be used to produce the final offset in audio applications.

Input Offset Voltage And Bias Current

When using op amps as DC amplifiers there are several sources of errors, Fig.4. The input to an op amp is usually an NPN differential pair. To make the device operate, a base current must be supplied (input bias current). Also, to balance the op amp the current through both transistors must be

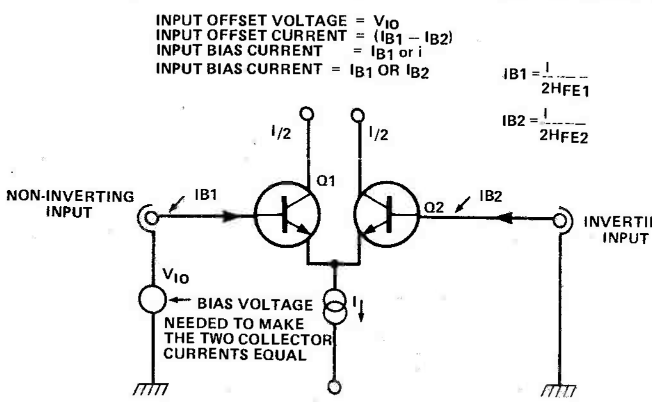


Fig.4. Typical differential op amp input.

equal. The transistor pair is 'matched' for parameters such as Hfe and Vbe versus I_{CE}. However, small differences are caused by the manufacturing process, resulting in the base currents being different (input offset current) and also the base-emitter voltage parameter (input offset voltage). The input offset

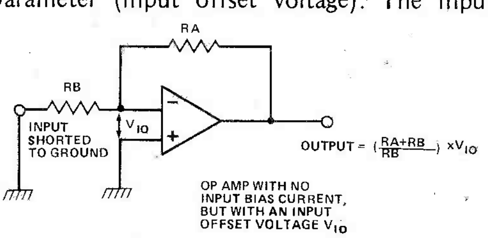


Fig.5. The effect of V_{IO}.

voltage is multiplied by the closed loop DC gain of the op amp (Fig.5) and the input bias current sets up a DC offset across any resistors it flows through (Fig.6). Typical parameters for the 741 op amp are; 2 mV (V_{IO}), 80 nA (IB) and 20 nA (IB1–IB2). These parameters vary from device to device and from manufacturer to manufacturer. The purpose of successful design is to produce circuits that are insensitive to these

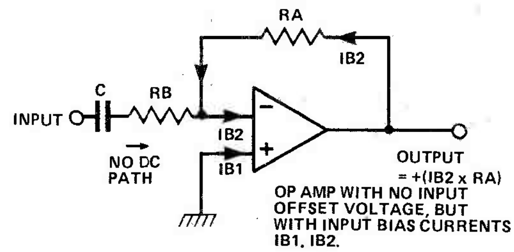


Fig.6. The effect of I_B.

variations. Generally, for audio designs, the DC offsets may be eliminated by AC coupling and other methods (Fig.7). Note that the DC output offset may be reduced by inserting a resistor from the non-inverting input to ground. Without that resistor the DC offset may well have been ± 26 mV (IB2 x RA) as opposed to ± 6.6 mV ((IB1–IB2)xRA). A DC voltage on the output would generate a disturbing crackle when the level pot is adjusted.

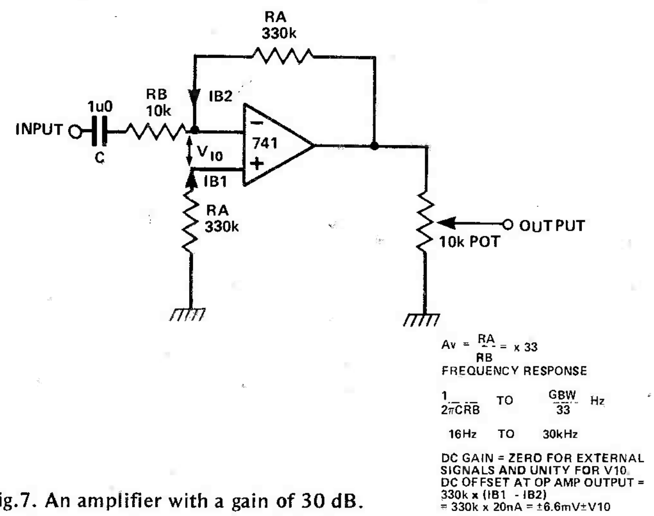


Fig.7. An amplifier with a gain of 30 dB.

Voltage Swing, Power, & Bandwidth

The voltage swing at the output of an op amp is limited in many ways, Fig.8. Most op amps can only swing within a few volts of either supply rail. Also, the speed at which the output voltage can move is limited by the slew rate of the device, which is typically 0V5 per microsecond for a 741. This is the limiting factor in designing amplifiers for high level large signal voltages.

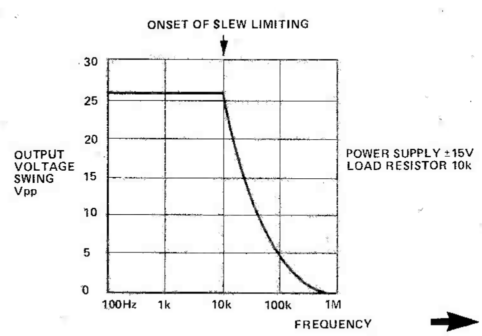


Fig. 8. Typical power bandwidth for a 741 op amp.

Design Example

Q. Design an amplifier with a gain of 4 to amplify a 50 kHz 5 V squarewave.

A. First try a 741, Fig.9. The required output swing is ± 10 V. The 741 can only move at 0V5/uS and so in the half period of the square wave, it can only move 5 V. If the 741 is replaced with a faster device, the TL081 (13 V/uS) then a 'square' wave is produced. The TL081 would take approximately 1.5 uS to travel the 20 V distance, thus generating a

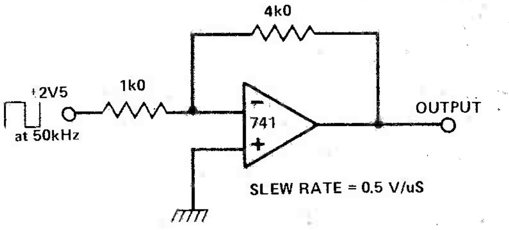


Fig.9. The difference in slew rate between a 741 and a TL081.

rise and fall time of 1.5 uS. Note, that if the resistors were increased in value to say 250 k and 1M0, then the squarewave output would ring. This is because the feedback would have to charge up the stray capacitance at the inverting input, thus generating a lag between the output and the feedback, which in turn would generate an overshoot.

Noise

Noise is always a problem in electronics. The presence of noise degrades the quality of the signal we are interested in. Everytime we amplify, process, transmit, record or replay a signal, noise is introduced thus worsening the signal to noise ratio. Some common signal to noise ratios are shown below.

Telephone 20 to 40 dB
Cheap cassette player 30 dB
Good tape recorder 60 dB
Professional studio equipment 80 dB

The calculations of noise produced by electronics is complex, but with a few short cuts it is possible to get some useable calculations.

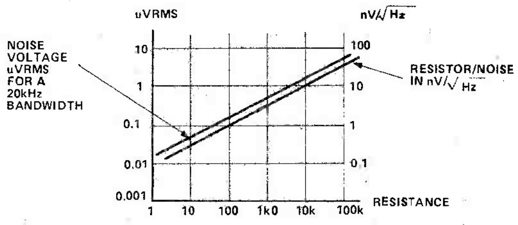


Fig.10. Thermal noise generated by a resistor.

All resistors generate noise due to thermal agitation (Fig.10). Noise is also generated when a voltage is applied to them. Manufacturers generally express this latter noise in uV/V typically 0.1uV/V for metal film devices. For most purposes resistor noise is not a dominating noise source although low level amplifiers perform slightly better with metal film devices. Keeping the resistor values low, helps to obtain low noise operation.

An op amp has several sources of noise generation, Fig.11. there are two noise current generators which both generate noise by flowing through the resistors in the circuit. The resistors themselves generate noise and there is an input voltage noise generator. The total output voltage Eo is given by

$$E_o = (RA+RB) \times \sqrt{(\text{noise voltage source})^2 + (\text{noise from In+Source})^2 + (\text{noise from In-source})^2 + (\text{noise from RC}) + (\text{noise from RA//RB})}$$

$nV/\sqrt{Hz}$

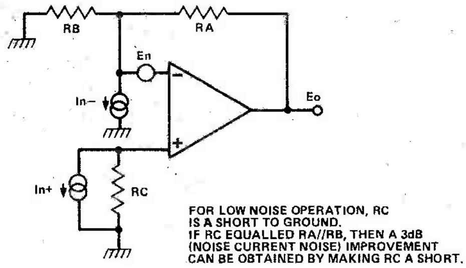


Fig.11. Model of op amp noise generation.

The noise performance curves for a low noise op amp, the SE5534, are shown in Fig.12a,b,c. Graph a shows the input noise voltage density, En (ie total RMS noise in a 1 Hz bandwidth at that particular frequency), as a function of frequency. To convert this input noise voltage, ($4nV/\sqrt{Hz}$) into an equivalent input noise generator, we must define the bandwidth of interest. As the noise spectrum is relatively flat above 100 Hz then we can say,

Fig.12a.The SE5534 low noise op amp input noise voltage density.

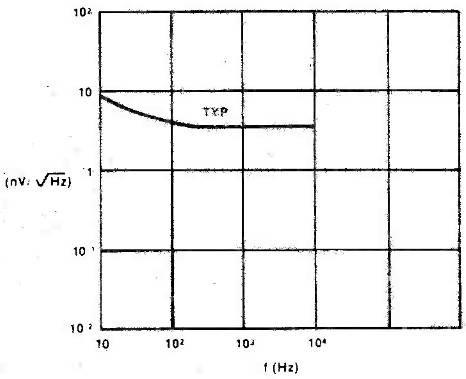


Fig.12b. The variation in total input noise density with source resistance for two frequencies.

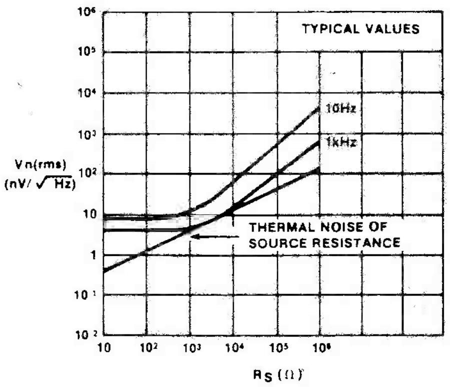
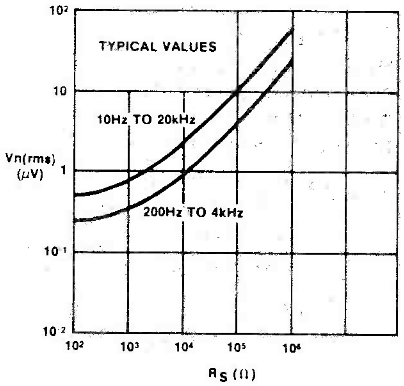


Fig.12c. The equivalent input noise voltage for two bandwidths as a function of frequency.



The equivalent input noise voltage Ein = $\sqrt{(En^2 x bandwidth^2)}$
For 20 kHz bandwidth

$$Ein = \sqrt{(En^2 x 20{,}000^2)}$$

$$Ein = (En \times 141)\ nV_{RMS}$$

But En = $4nV\sqrt{Hz}$

Therefore Ein = 4x141 = 0.564 uV_{RMS} (20 kHz)

Design Example

Q. Calculate the output noise in a 20 kHz bandwidth for the circuit in Fig.13. Assume the voltage and current densities have a flat spectrum (which is not too far from the truth!).

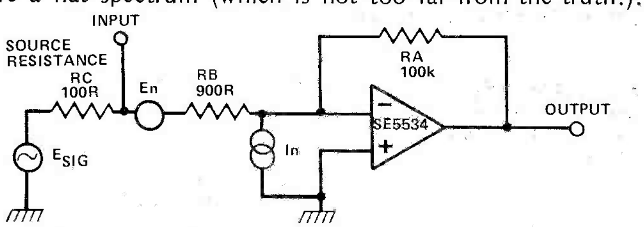


Fig.13. A low noise amplifier.

A. Calculate the individual noise sources.
Resistor Noise
Effective resistor is RA//(RB+RC) 1k0
Therefore thermal noise (from Fig.13b) = 3 nV/$\sqrt{Hz}$
Noise Voltage
a = 4 nV/$\sqrt{Hz}$
Noise Current
c = 0.5pA/$\sqrt{Hz}$
which sets up a noise voltage through (RB + RC). This noise voltage is 0.5pA x 1k0 = 0.5 nV/$\sqrt{Hz}$
Therefore the total noise voltage

$$Eo = \left(\frac{RA+RB+RC}{RA+RB}\right) \times \sqrt{(4)^2 + (0.5)^2 + (3)^2}$$

$$= 101 \times \sqrt{16 + 0.25 + 9}$$

$$= 101 \times \sqrt{25.25}$$

$$500\ nV/\sqrt{Hz}$$

For 20 kHz bandwidth, the output noise = 500 x 141
= 70,500 nV_{RMS}
= 70.5 uV_{RMS}

A 7 mV_{RMS} input signal from, say, a low impedance microphone would result in a 700 mV_{RMS} output signal and give a S/N ratio of 20 Log $\left(\frac{700}{0{\cdot}0705}\right)$ = 80 dB

Note that most dominant source in this circuit is the noise generator En. As long as the input impedance levels are kept low, then it is the noise generator En on its own that can be used as a rule of thumb for calculating absolute and comparative noise performance. For high input impedance applications a FET op amp (with virtually no input noise current) should be used.

Noise Measurements

The noise current voltage psectrums of Fig.12 were measured using a mobile analysing filter (1 Hz bandwidth) plus an RMS meter. A simpler measurement can be performed using the system shown in Fig.14. This will measure the equivalent input noise in a specified bandwidth. The low pass filter should be high order device with a steep roll off slope. If a single pole low pass filter is used, then the RMS reading should be corrected by the following equation,

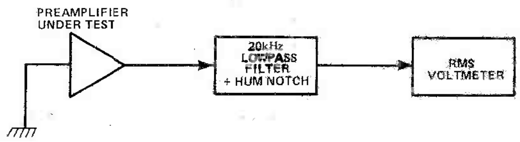


Fig.14. Noise measurement.

'True' RMS noise (for a one pole lowpass filter) = $\sqrt{\frac{\text{measured RMS noise}}{1.57}}$

(An RC 20 kHz low pass filter would be made from an 820 ohms resistor with a 10 n capacitor to ground).

Sometimes the signal to noise ratio is quoted in dBA. This means that the noise measurement has been modified by an A weighted curved.

A short chart of op amp performance has been drawn up in Fig.17. It is difficult to compare device performance merely from the noise voltage at one frequency in the spectrum, as the noise spectrum shapes are different from device to device. It is best to refer to the manufacturing data sheet and then to actually breadboard the devices.

DEVICE	NOISE VOLTAGE AT 1kHz nV/$\sqrt{Hz}$	UNITY GAIN BANDWIDTH MHz	SLEW RATE V/uS
NATIONAL SEMICONDUCTORS LM381A	5.0 NOT OPTIMISED	15	4.7
SIGNETICS SE5534	4.0	10	13
SIGNETICS SE5534A	3.5	10	13
741	20 to 50 NOT USUALLY SPECIFIED	1 to 1.5	0.5
RAYTHEON RC4136	10	3	0.5
RAYTHEON RC4558	10	3	0.5
TEXAS TL071	18 *FET INPUT VERY LOW INPUT NOISE CURRENT 0.01 PA /$\sqrt{Hz}$	3	13
FERRANTI ZN455T	4.5 (Rs = 510R)	15	–

Fig.15. Op amp performance.

Biasing

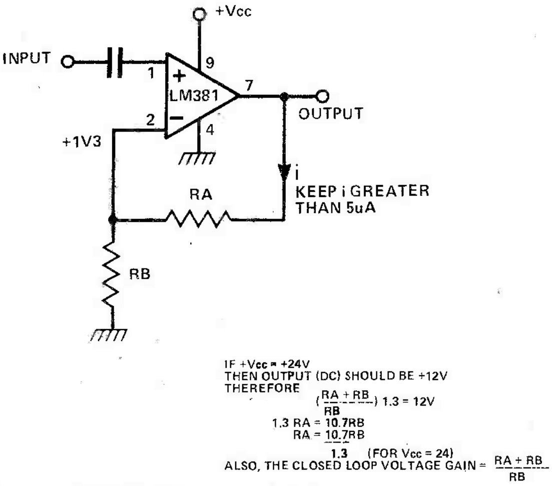


Fig.16. Biasing the LM381 (differential mode).

The base of Q1 is held at +1V3 by a pair of diodes. This preamplifier is often run from a single supply rail and a simple resistor network can be used to bias the output voltage to ½ Vcc (Fig.16). Also a single ended amplifier can be constructed (Fig.17). The resistor pair RA,RB determines the DC output level and gain. To increase the AC gain resistor RB can be shorted to ground with a series R,C network.

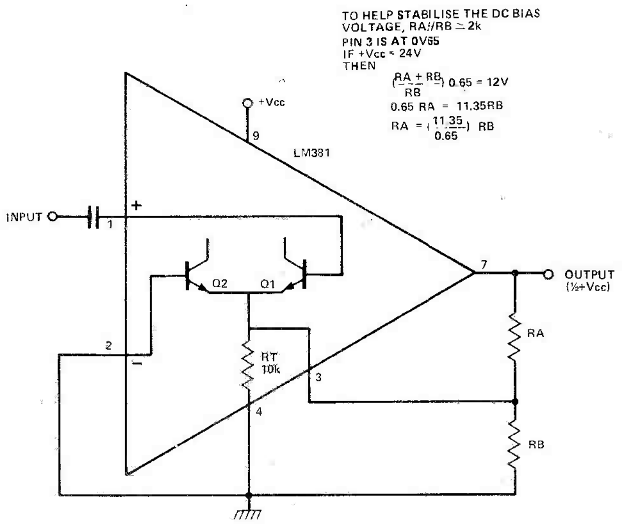


Fig.17. Single-ended biasing.

Design Example

Q. Design a preamplifier using the LM381 with a gain of 30 dB and a low frequency roll off of 20 Hz running from a +24 V power supply.

A. The design calculations are shown in Fig.18.

Record Preamplifier

When replaying a record from a magnetic cartridge it is necessary to have a preamplifier with an RIAA playback equalisation (Fig.19). A magnetic pick up generates a voltage

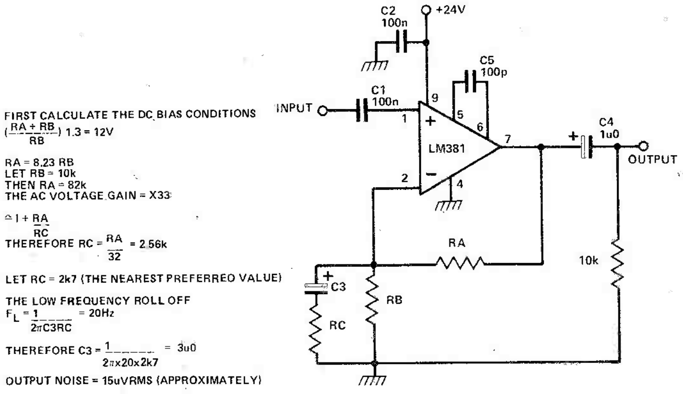


Fig.18. A 30 dB amplifier.

that is proportional to the velocity of the sideways movement of the stylus. So high frequencies produce large outputs and vice versa. Also, to assist replay electronics, the recording is given a 12 dB de-emphasis from 500 Hz to 2120 Hz. Thus, to restore a flat output it is necessary to equalise the signal from the pick up with an RIAA curve. As a rule of thumb,

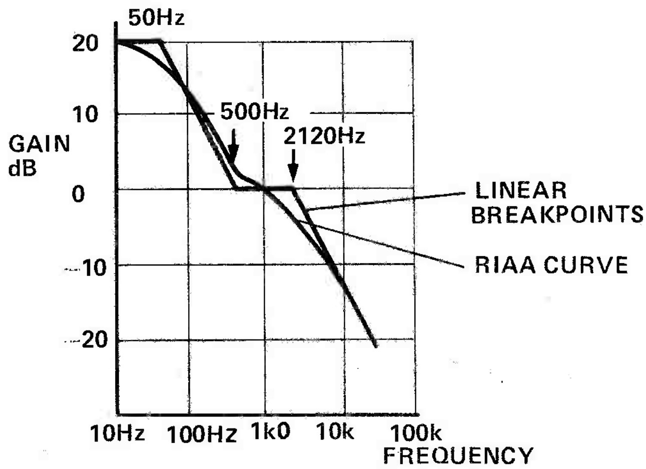


Fig.19. RIAA equalisation.

a typical magnetic pick up will generate 5 mV_{RMS} at 1 kHz, although the recording level and make of pick up will effect this figure.

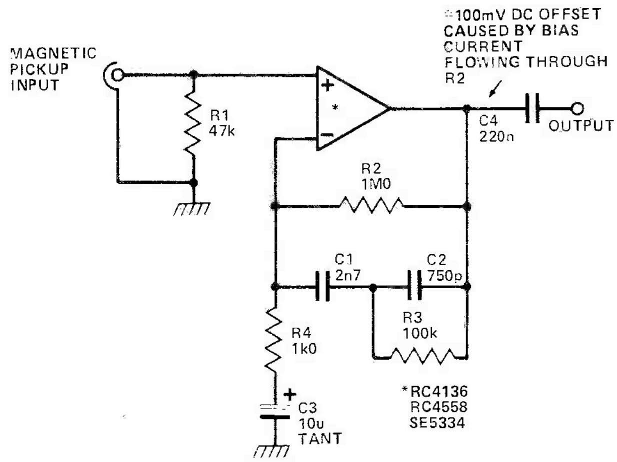


Fig.20. An RIAA-equalised preamplifier.

Low frequency gain $= \frac{R2}{R4} = 60$ dB

Low frequency rolloff $= \frac{1}{2\pi R4C3} = 15$ Hz

50 Hz breakpoint $\frac{1}{2\pi R2C1}$

The gain drops at −6 dB/octave beyond this point
500 Hz breakpoint $\frac{1}{2\pi R3C1}$
Now the gain remains constant until the next breakpoint
AC gain at 1 kHz $= \frac{R3}{R4} = 40$ dB
2120 Hz breakpoint $\frac{1}{2\pi R3C2}$
The gain now falls at −6 dB/octave beyond this frequency.

A 5 mV_{RMS} signal at 1 kHz will result in a 500 mV_{RMS} (1V4 pp) at the preamplifier output. If the amplifier is powered from ±12 V, then there is an overhead margin of

$$\left(\frac{\text{maximum output swing} = 20\text{ V}}{\text{typical swing} = 1\text{V4}}\right) = 14,$$

which is 23 dB. The noise spectrum of the op amp will be multiplied by the RIAA curve which would complicate any noise performance calculations. However, an op amp with an equivalent input noise of 0.5 uV should give a signal to noise performance of better than 76 dB which is superior than that of the disc itself. Because of the large low frequency gain care must be taken to avoid mains hum pick up. Keep the input wiring away from the mains cables and transformers, use low noise screened cable and wire this cable as close as possible to the preamplifiers.

Problems

Often a preamplifier will pick up radio signals. Usually, the radio signal is picked up by the input wiring to the preamplifier and is rectified by the transistor input stage. Then it is amplified by the rest of the audio amplifier and you end up with permanent broad band radio reception. There are several solutions that can be tried, Fig.21. A low pass filter made from an LC or an RC section will attenuate the 'pick up' interference. These devices must be physically close to the op amp. If possible use a PCB ground plane. Also, a conductive metal screen (metal foil is often used) surrounding the preamplifier will help.

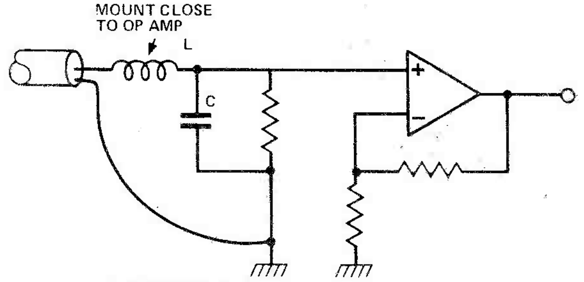
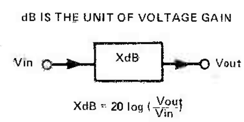


Fig.21. Removing RF interference.

Hum can also be a problem. If the hum is at 50 Hz then the source of it is probably magnetic. Check the wiring to see if any signals pass near to the mains section. Magnetic screening is difficult to implement. The best design solution is to put as much distance between the sensitive input and the mains section as possible. If it is possible try rotating the mains transformer (using a gloved hand, the other hand in your pocket). Often the size of the hum can be reduced by re-orientating the transformer. If the hum is 100 Hz, then the source is either the supply rails or the power supply layout. A larger smoothing capacitor will reduce the power supply ripple. If the hum has a sharp buzz then the problem is probably the charging current pulses in the power supply. If the layout is bad, these current pulses generate voltage pulses that get added into the ground reference voltage, thus causing the hum.

Gain

When designing an audio system it is necessary to know what the normal signal level at any point will be and also the signal gains and attenuations of various units. It has been found that the most useful way to describe levels and gains is with the logarithm decibel, Fig.22. Signal gains in dB are additive. That is, a signal passing through a series of gains of +10, +20, −30, +6 dB will end up with an overall gain of +6 dB.



dB	APPROXIMATE RATIO
+60	1000
+40	100
+20	10
+10	3
+ 6	2
+ 3	1.4
+ 0	1
− 3	0.7
− 6	0.5
−10	0.33
−20	0.1
−40	0.01
−60	0.001

dBm	Vpp	VRMS
+20	21.9V	7.75V
+ 6	4.38V	1.55V
+ 0	2.19V	0.775V
-6	1.09V	0.387V
-20	0.219V	0.077V
−40	21.9mV	7.75mV
−60	2.19mV	0.77mV

dBm IS THE UNIT OF VOLTAGE LEVEL
0dBm IS 1mW OF POWER INTO A 600R LOAD

Fig.22. The dB and dBm story.

A typical audio system is shown in Fig.23. A low impedance microphone might typically give a −50 dBm output signal which will have to be given a 56 dB (x 600) gain to bring it up to line level (about +6 dBm). The line driver should be capable of driving +20 dBm into 600 ohms at 20 kHz without generating significant distortion. Some line drivers are, in fact, capable of driving 30 ohm loads, but these units are small high quality power amplifiers.

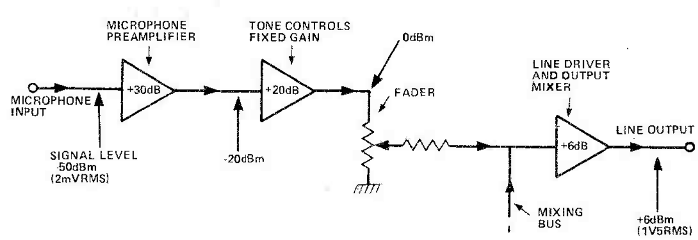


Fig.23. One channel of a mixing desk.

2. LARGE SIGNAL, OR POWER, AMPLIFIERS

A power amplifier must deliver power into a load without generating significant distortion or bursting into oscillation or burning itself out. Power amplifiers are, however, prone to all these effects and great care is needed during their design.

Power

Power is measured in watts and is defined as the product of $V_{RMS} \times I_{RMS}$ (Fig.1c), where RMS is the equivalent DC value. That is, a 2 Vpp sinewave has the DC value of 0V7. The 2 Vpp sinewave will generate as much heat in a load as a 0V7 DC voltage. The chart in figure 1b shows the power dissipated in a load against drive voltage. If you have an amplifier that has a maximum output voltage swing of ±10 V, then the maximum power output will be 12.5 watts into a 4 ohm load (from Fig.1a). Note that the amplifier must be able to deliver a peak current of 2.5 Amps. Whilst dumping power into the load, the amplifier will be dissipating heat itself. Most monolithic devices are documented with design graphs of output power versus amplifier dissipation of power efficiency. These will enable you to determine the amplifier's maximum power dissipation. As a rule of thumb, this equals the maximum sinewave power that can be dumped into the load. A 10 watt amplifier may have to dissipate a maximum of 10 watts of heat, although this level of dissipation would not be normal in general use. Manufacturers information usually gives the thermal resistance of the junction to case. If this was say 3°C/watt then a 10 watt dissipation would raise the junction temperature by 30° above ambient (25° raising to 55°C). This is only true if the case temperature remains at ambient temperature, that is if the case is contact with an infinite heat sink. The heatsink may be anything from nothing (free air dissipation) to near infinite. It is important that the amplifier chip junction does not get very hot (above 100°C). The power chips of the amplifier age very quickly at elevated temperatures suffering from deteriorating characteristics and a short life time. This is why power amplifiers and power supplies are common failures in equipment. When the chip is heated up it expands. The chip is glued to its case and so by expanding it stresses the glue and eventually causes it to fracture. This thermal cycling increases the thermal resistance of the chip to the case and so the chip ends up operating at an even higher temperature.

Other heatsinking materials are used in the construction of power devices such as heat conducting plastics and pastes (Beryllium oxide). Manufacturers often provide design graphs of maximum dissipation versus temperature for various heatsink thermal resistances. These help to select an acceptable heatsink. Often if you are using the chassis as a heatsink it is impossible to calculate the temperature rise and it has to be done by trial and error. (As a rule of thumb I am satisfied if I can place my finger on the device for 5 seconds indicating that case temperature is no more than 80°C).

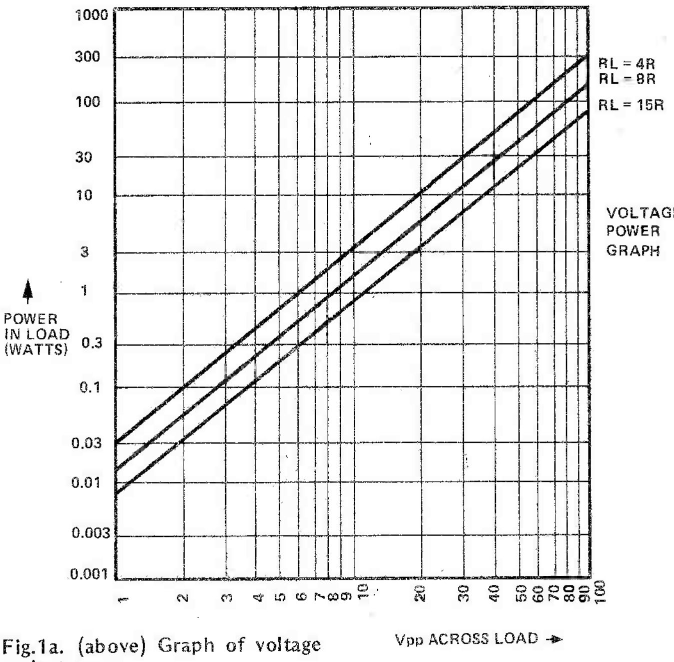
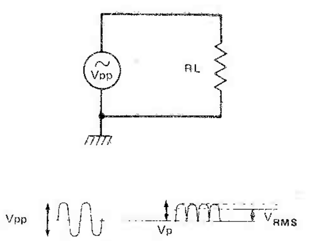


Fig.1a. (above) Graph of voltage against power.

Vpp ACROSS RL	4R	8R	15R
1V	0.031	0.015	0.008
3V	0.28	0.140	0.075
10V	3.125	1.562	0.833
30V	28.15	14.062	7.50
100V	312.5	156.25	83.33

POWER IN RL

Fig.1b. (left) The power dissipated in a load against drive voltage.



$V_p = V_{pp} \times \frac{1}{2}$

$V_{RMS} = V_{pp} \times \frac{1}{2} \times \frac{1}{\sqrt{2}} = \frac{V_{pp}}{2.828} = 0.35\ V_{pp}$

$POWER = V_{RMS} \times I_{RMS} = \frac{V_{RMS}^2}{RL}$

$POWER = \frac{V_{pp}^2}{8 \times RL}$

Fig.1c. (left) The measurement of power.

Distortion

A simple power amplifier is shown in figure 2. An op amp provides the voltage gain and a NPN, PNP transistor pair forms a current amplifier. Any distortions or nonlinearities are ironed out by the surplus loop gain of the op amp. The transfer characteristic of Q1,Q2 shows that there is a dead zone of

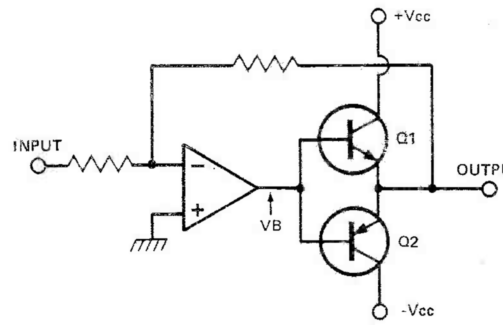


Fig.2. A simple power amplifier.

±0V6 where neither transistor is ON. If a low frequency sinewave is connected to the input (the op amp having a surplus loop gain of 1000 at this frequency) then the output will be a sinewave with a small amount of crossover distortion. The distortion level will be

$$\frac{\pm 0V6}{1000} = \pm 0.6 \text{ mV}.$$

However, as the frequency is increased, the surplus loop gain will decrease causing the distortion to rise. At higher frequencies the slew rate of the op amp becomes noticeable (Fig.3). When the input signal crosses 0 V the output of the op amp has to change from +0V6 to −0V6. If the slew rate is 0V5/uS then the time taken to travel the 1V2 distance is 2.6 uS. Thus a 2.6 uS chunk of the signal is missing out of each half cycle. The problem may be overcome by biasing the

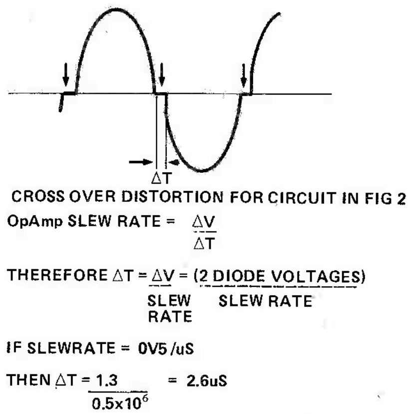


Fig.3. The effect of slew rate at higher frequencies.

two transistors so that they are both conducting. Then the crossover distortion becomes reduced to a reasonable level. The slew rate still needs to be considered. An amplifier delivering a 40 Vpp sinewave at 20 kHz has a fastest slew rate of 2V5/uS (this represents a power of 25 watts into 8 ohms). If the amplifier has not enough slew rate the output will become distorted. Manufacturers generally provide graphs of distortion (THD) versus power output and frequency (Fig. 4). For the power curve, the onset of distortion is caused by the amplifier clipping at its power rails, whereas for the frequency curve the distortion rises as the surplus loop gain falls.

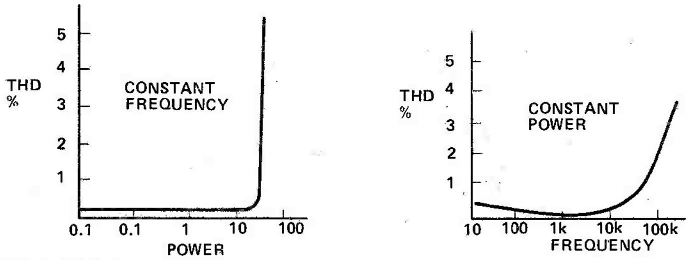


Fig.4. THD versus power and frequency.

Distortion is measured at various power levels and frequencies using the equipment shown in figure 5. A deep notch removes the test sinewave leaving behind the distortion products. Generally 0.1% THD is common for monolithic amplifiers.

Stability

Power amplifier performance is very similar to that of op amps. They have a large open loop gain that is stabilised by resistive feedback (Fig.6). Note that the amplifier described in this graph is normally inverting (180° DC phase shift) but that it suffers a phase shift as the frequency increases. The phase shift at the unity gain frequency is shown as the phase margin. If the phase margin falls to zero anywhere before the unity gain frequency then the amplifier will oscillate. This is simply because the loop phase shift will be zero at a loop gain of greater than unity, which are the conditions for an oscillation. A large phase margin is desireable.

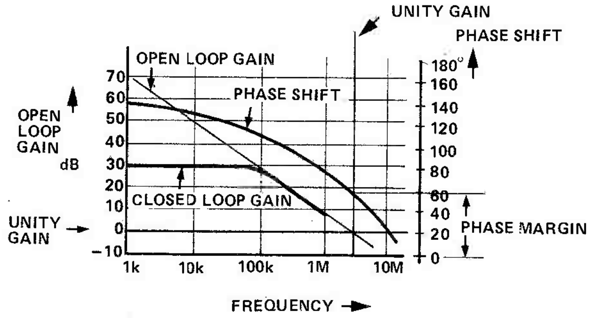


Fig.6. Gain and phase response.

Various techniques are available for preventing instability. Often a series RC network is connected from the amplifiers output to ground. This reduces the high frequency gain and thus reduces the unity gain frequency. Local power supply decoupling should be used. Current loops, whereby the output current generates a voltage in the signal ground wire which gets fed back to the input can cause bursts of high frequency oscillation. Also high input impedances can capacitively pick up the output signal and burst into oscillation. Increasing the closed loop gain may prevent some forms of instability, swearing will not! Figure 7 shows some typical instability problems.

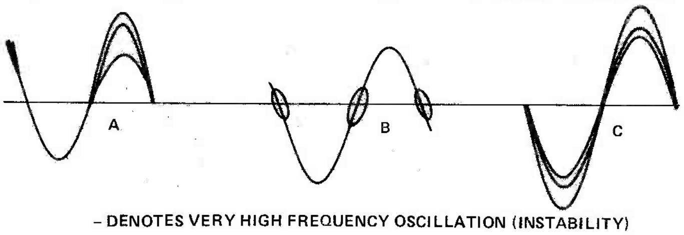


Fig.7. Instability; A, on one half cycle; B, at crossover; C, at all points.

(a) The sinewave oscillates on one half cycle. Really a power amplifier is two amplifiers, one half handling positive signals, the other, negative signals. Thus it is quite possible that the amplifier can be stable for negative signals but not positive ones.

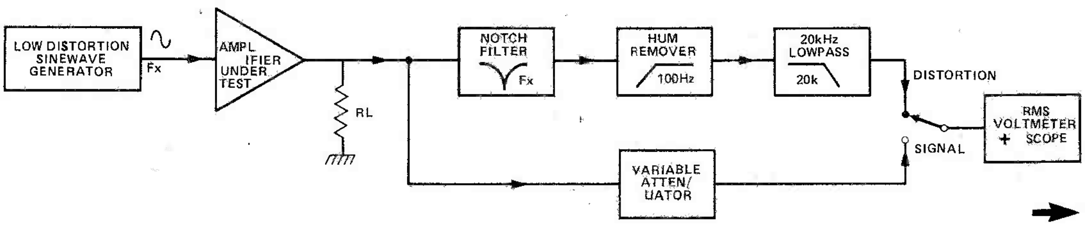


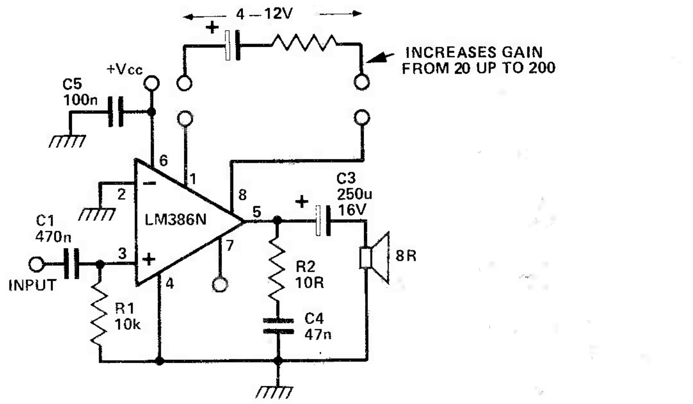
Fig.5. THD measurement.

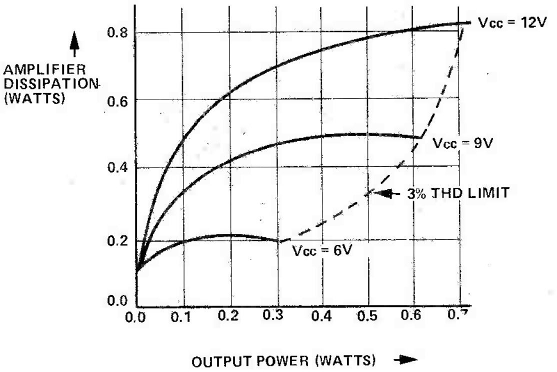
(b) The sinewave is unstable at crossover. This may be caused by the loss of feedback at crossover. Increasing the bias current may eliminate it. Alternatively it might be caused by slew limiting manifesting itself as an extra phase shift.

(c) The amplifier is never stable. Check the layout for current loops, increase the gain, increase the output CR loading, even try removing it, reduce the impedance levels.

You may not hear the effects of high frequency oscillation but it does cause RF interference and generates waste power. It can burn out output stages and even loudspeaker crossovers.

The following five design examples demonstrate how to produce a solution to an amplifier problem. It is now possible to buy an amplifier for most general purpose uses. A wide selection of monolithic devices and modules cover the 0.25 to 100 watt power range. It is rare to have the time or the ability to improve upon this range. The art of designing is to select the most suitable solution on the basis of size, cost and performance.





LM386 DEVICE DISSIPATION VERUS OUTPUT POWER INTO AN 8R LOAD

Fig.8. Low voltage, low power battery operated amplifier. The LM386N operates over a supply range of 4 to 12 V. It can deliver 0.7 watts into 8 ohms at 12 V, although, at this level, some heatsinking would be advisable. The typical battery drain is 4 mA. The voltage can be varied from 20 to 200, as shown it is 20. An AC short across pins 1 and 8 will increase the gain to 200. With a resistor in series the gain can be set to anything from 20 to 200. For gains greater than 20, a bypass capacitor (100n to ground from pin 7) should be used. Even with a supply voltage of only 4 V, there is an output voltage swing of greater than 2 V.

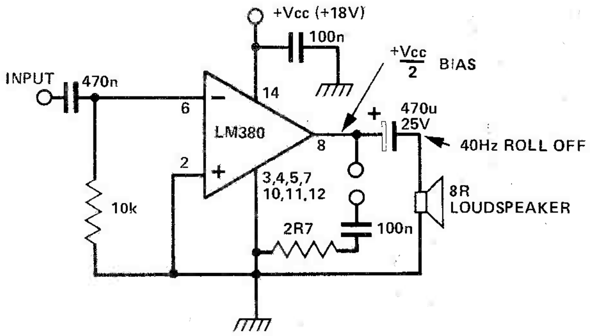
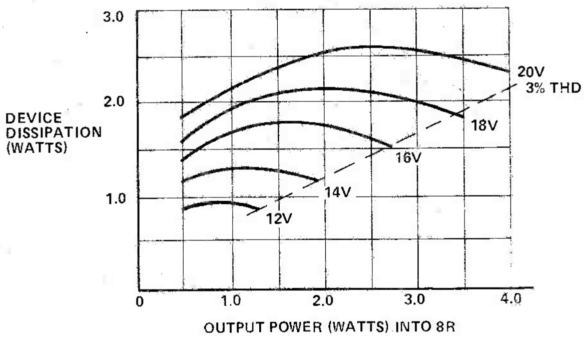
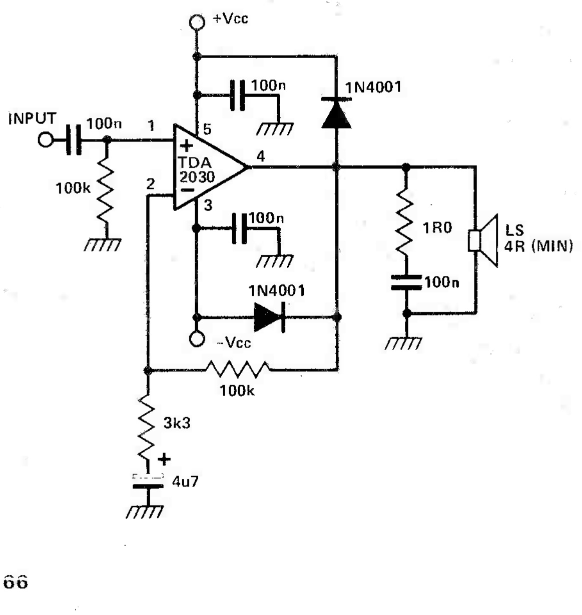


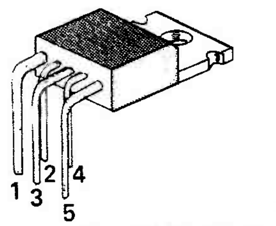
Fig.9. Medium power audio amplifier. The LM380 will work with a supply voltage range of 8 to 22 V. It can deliver 4 watts of power into 8 ohms at 20 V, although a good heatsink is needed for this level. The inputs are ground referenced and the output is automatically biased to ½ Vcc. The voltage gain is fixed at 34 dB. It also has a short circuit proof output and internal thermal limiting.





FEATURES

TO 220 PACKAGE – EASY TO HEATSINK
POWER SUPPLY RANGE ±6 TO ±18V
QUIESCENT CURRENT 40mA
POWER OUTPUT 14 WATT (4R)
9 WATT (8R)
CLOSED LOOP GAIN 30dB



TO 220 PACKAGE

Fig.10. 9 to 14 watt amplifier. The TDA2030 is a Hi-Fi audio amplifier which has short circuit protection and thermal shutdown. It can operate from supply rails of ± 6 to ± 18 V. At a ± 14 V supply the guaranteed output power is 12 watts into 4 ohms and 8 watts into 8 ohms. Harmonic and crossover distortion is low being typically 0.05% at 1 kHz for 7 watts of power output. The recommended closed loop gain is 30 dB. The two diodes protect the amplifier from back EMF voltages from the speaker.

3. OSCILLATORS

It seems to be a fact of life that amplifiers oscillate and oscillators won't! Generally there is little difference between the two. Both devices are amplifiers with feedback. The conditions for stable sinusoidal oscillation are shown in Fig.1. The higher the Q of the resonator the more stable is the resonant frequency, and the purer the sine wave. To stabilise

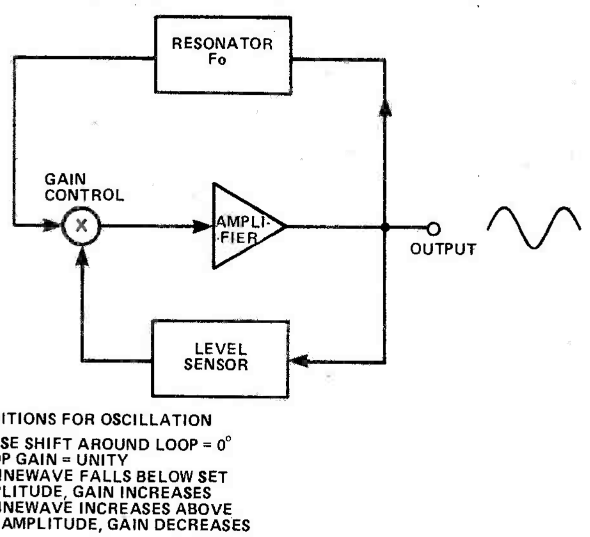


Fig.1. Conditions for a stable sine wave oscillator.

the signal level an automatic gain control circuit is used. This can be anything from simple diodes or thermistors to elaborate AGC systems. The smoothness with which the AGC works will determine the sine wave purity. A thermistor circuit might well introduce distortion at low frequencies by changing its resistance during one half cycle of oscillation. Very pure sine-wave oscillators (better than 0.001% distortion) employ slow acting AGC systems to control the loop gain.

Wien Bridge

The well known Wien Bridge oscillator is shown in Fig.2a. A frequency sensitive feedback network is constructed from R1, C1 and R2, C2. This network has a peak in its amplitude response which also corresponds to zero phase shift. At this frequency the attenuation is x1/3 and so to ensure oscillation

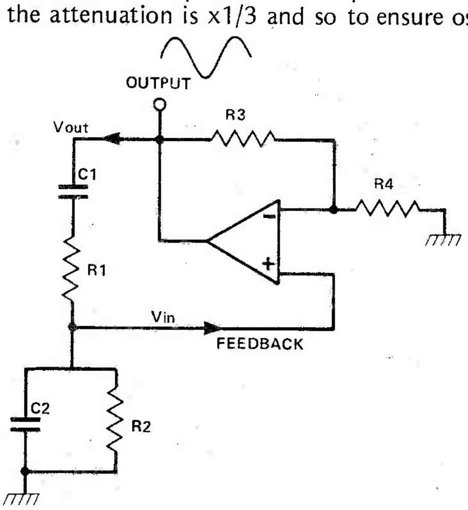


Fig.2a. A Wien Bridge oscillator.

the amplifier must have a voltage gain of at least x3. To stabilise the amplitude a thermistor is used in the feedback

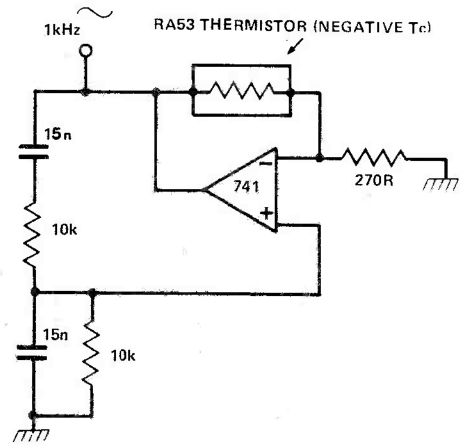


Fig.2b. To stabilise the amplifier a thermistor is used in the op amp feedback loop.

loop of the op amp. As the oscillation amplitude increases, the thermistor heats up, drops in resistance and so reduces the gain. The circuit suffers from amplitude bounce when the frequency is altered. Also, the op amp phase shift, which increases with increasing frequency, must be taken into consideration when designing this oscillator. Another sine wave oscillator is shown in Fig.3. This generates both sine and cosine outputs. The circuit is a state variable filter with posi-

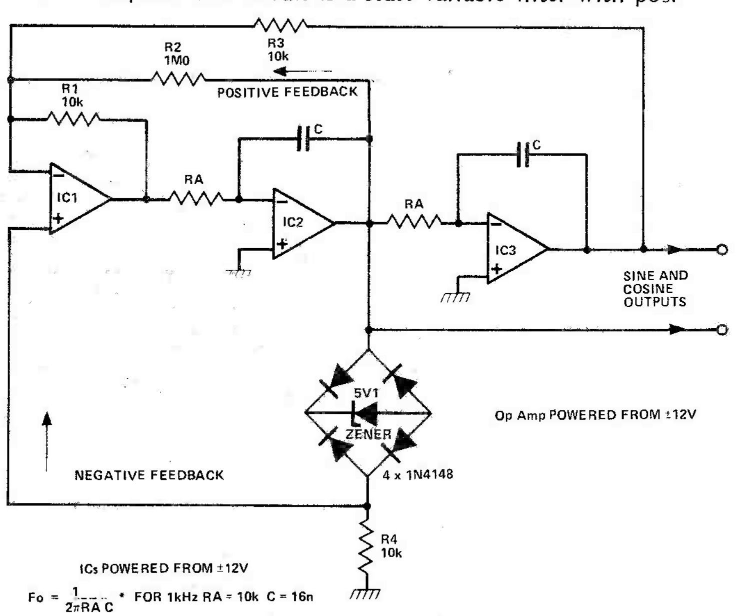


Fig.3. A state variable sine/cosine oscillator.

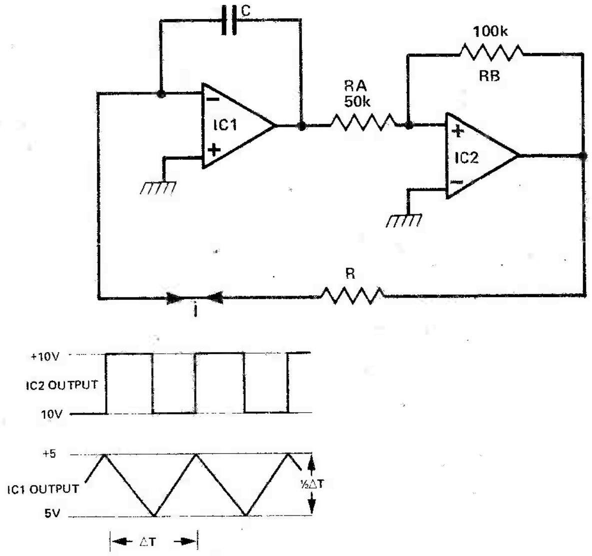
tive feedback (R2) to ensure oscillation and amplitude limiting (the diode bridge) to stabilise the sine wave level. The distortion may be trimmed by adjusting the amount of positive feedback. The oscillation frequency is set by RA and C.

A triangle/square wave oscillator may be constructed from a pair of op amps (Fig.4). IC1 is an integrator, the output of which ramps up and down between the hysteresis levels set by the Schmitt trigger, IC2. If the output of IC2 can swing to ± 10 V then the hysteresis level will be $\pm 10 \times \frac{RA}{RB}$ volts

The oscillation frequency and triangle symmetry is linearly proportional to the output swing of IC2. If a variable frequency oscillator is wanted, then resistor R can be connected to the wiper of a potentiometer fed from IC2 output.

Design Example

Q. Design a triangle oscillator with a 2 Vpp triangle output, oscillation frequency of 1 kHz, operating from ± 12 V power supplies, using circuit in Fig.4.



INVERTING INPUT OF IC1 IS A VIRTUAL EARTH
THEREFORE $i = \pm \frac{10V}{R}$

CURRENT CHARGES AND DISCHARGES CAPACITOR C IN THE INTEGRATOR GOVERNED BY THE RELATIONSHIP

$$C \frac{dV}{dT} = i$$

THEREFORE $\frac{dV}{dT} = \frac{i}{C} = \frac{10}{RC}$

$$\frac{dV}{dT} = \frac{\Delta V}{\Delta T}$$

SO, $\frac{1}{\Delta T} = \frac{dV}{dT} \times \frac{1}{\Delta V} = \frac{10}{RC\,\Delta V}$

WHERE $\Delta V = 20V$ AND $\frac{1}{\Delta T}$ = FREQUENCY OF OSCILLATION Fo

THEREFORE $Fo = \frac{1}{\Delta T} = \frac{10}{RC \times 20} = \frac{1}{2RC}$ Hz

Fig.4. A triangle/square wave oscillator.

A. Assume an output voltage swing at IC2 of ± 10 V.

For ± 1 V Hysteresis,

$$RA = \frac{RB}{10}$$

Let RB = 100k, then RA = 10k

$$Fo = 1\text{ kHz} = \frac{1}{\Delta T} = \frac{i}{i\Delta v} = \frac{10}{C x R x 4}$$

$$\text{Therefore } CR = \frac{10}{4x1000} = 2.5 \times 10^{-3}$$

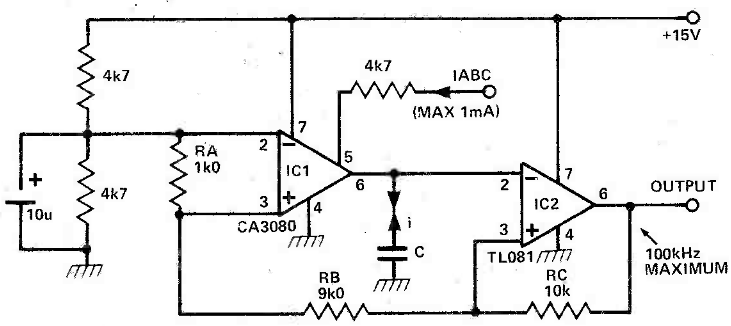
Let C = 100n

$$\text{Then } R = \frac{2.5 \times 10^{-3}}{10^{-7}} = 25k$$

Note that $\frac{\Delta V}{\Delta T}$ is 4000 V/sec. When designing this type of oscillator the slew rate of the integrator and Schmitt trigger need to be considered, although tin this case virtually any op amp will be OK.

Linear VCO

A linear voltage controlled oscillator (VCO) is shown in Fig.5. This again is a triangle square wave oscillator although the squarewave is the only buffered output. The CA3080 is used as a current source for charging and discharging C. The charging current is equal to I_{ABC}, which is true for several



CURRENT i THAT CHARGES C = ± IABC
VOLTAGE AT PIN 3 IC2 IS A 6.5Vpp SQUAREWAVE
THEREFORE, THE TRIANGLE WAVEFORM IS ALSO 6.5Vpp
EQUATION FOR CHARGING C,

$$\frac{\Delta V}{\Delta T} = \frac{i}{C} = \frac{IABC}{C}$$

$$Fo = \frac{1}{\Delta T} = \frac{IABC}{C\,\Delta V} = \frac{IABC}{C \times 6.5 \times 2}\ Hz$$

* IF C = 680p, IABC = 250uA,

THEN $Fo = \frac{250 \times 10^{-6}}{680 \times 10^{-12} \times 6.5 \times 2} = 28.28$ kHz

Fig.5. A linear VCO.

decades of current. The Schmitt trigger uses a TL081 which has a slew rate of 13 V/uS. As the squarewave output voltage is 13 V then the rise and fall times are 1 uS each. This enables the VCO to run at frequencies up to 100 kHz. As this frequency is approached the VCO loses its linearity, due to time delays in the circuits.

Another VCO is shown in Fig.6. This has two buffered outputs, a triangle and a square wave. Again, the oscillation frequency is dependent on the output voltage swing of the Schmitt trigger, IC2. However, if a stabilised power supply is used this circuit behaves very well. Superior performance can be obtained by replacing Q1 with a switching FET. The abberations caused by saturation voltage and storage time are then removed. Also fast FET op amps will improve high frequency performance.

*ASSUME OUTPUT SWING OF IC2 IS ±10V
THEREFORE, IC2 SWING WILL BE ±5V

DURING HALF CYCLE A,

iA = (Vin – 1/3Vin

$$iA = \frac{(Vin - 1/3Vin)}{R1 + R2}$$

$$iA = \frac{Vin}{300k}$$

DURING HALFCYCLE B,

Q1 IS ON AND SO THE JUNCTION OF R1,R2 IS SHORTED TO GROUND

$$iB = \frac{1/3\ Vin}{R2} = \frac{Vin}{300k}$$

THEREFORE, THE CURRENT THAT CHARGES AND DISCHARGES C IS THE SAME MAGNITUDE IN BOTH HALVES OF THE CYCLE

THEREFORE $\frac{\Delta V}{\Delta T} = \frac{i}{C} = \frac{Vin}{300k \times C}$

OSCILLATION FREQUENCY $Fo = \frac{1}{\Delta T} @ \frac{Vin}{300k \times C \times \Delta V} = \frac{Vin}{300k \times C \times 20}$

$$Fo = \left(\frac{Vin}{C} \times 0.166 \times 10^{-6}\right)\ Hz$$

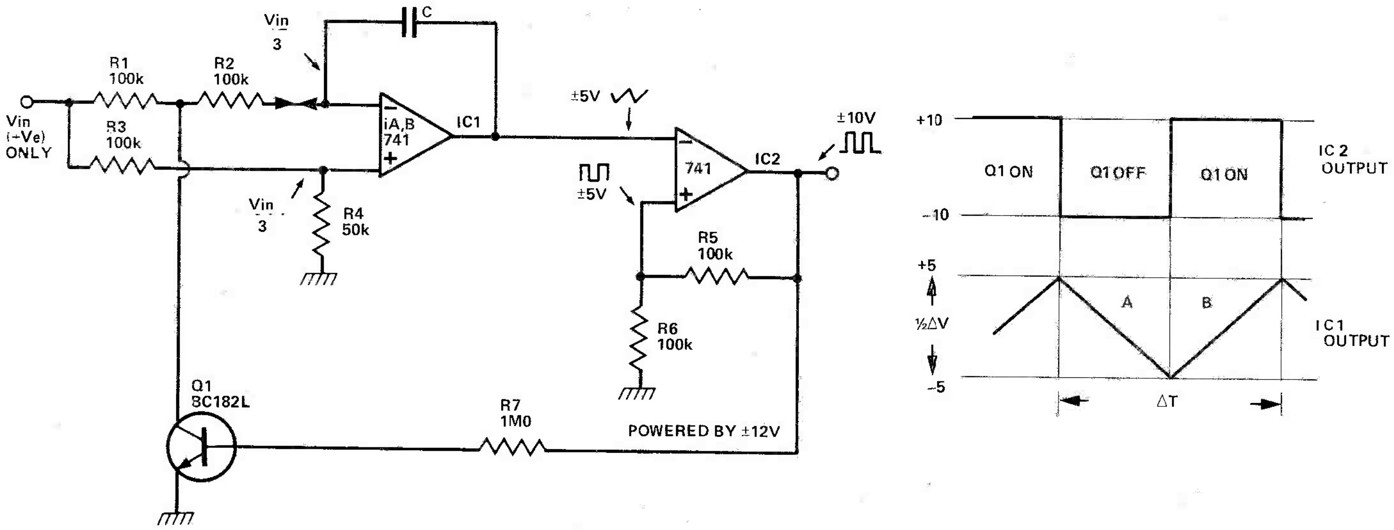


Fig.6. A linear triangle/square wave VCO.

The 555

The 555 timer chip (Fig.7) can be used as an oscillator (Fig.8). Capacitor C is charged up via RA and RB. When the voltage at pin 6,2 reaches 2/3 Vcc the discharge transistor is turned ON. When the voltage falls to 1/3 Vcc the discharge

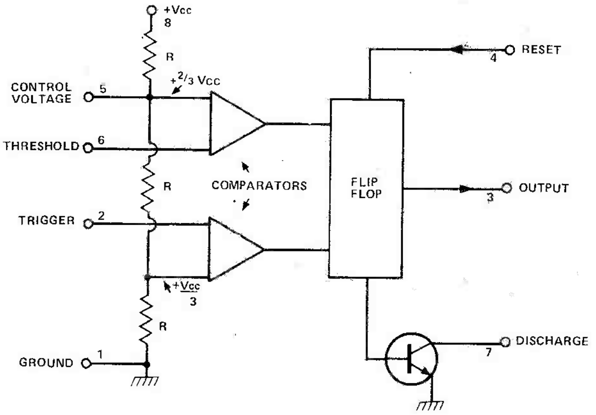


Fig.7. The timer chip.

transistor is turned OFF and the charging process repeats itself. As power supply voltage terms appear in both the numerator and demoninator of the charging equation, it drops out and so the oscillation frequency is hardly effected

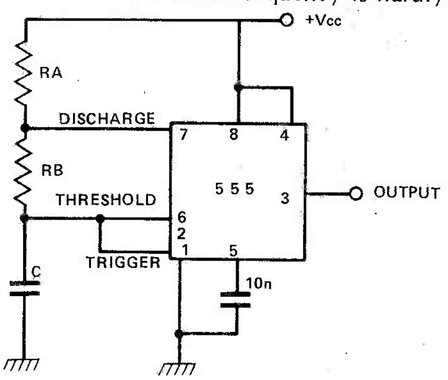
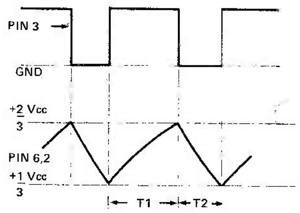


Fig.8. A simple oscillator based on the 555.

by supply voltage changes (typically 0.3%V). Also the temperature stability is good, typically 50 ppm/°C.



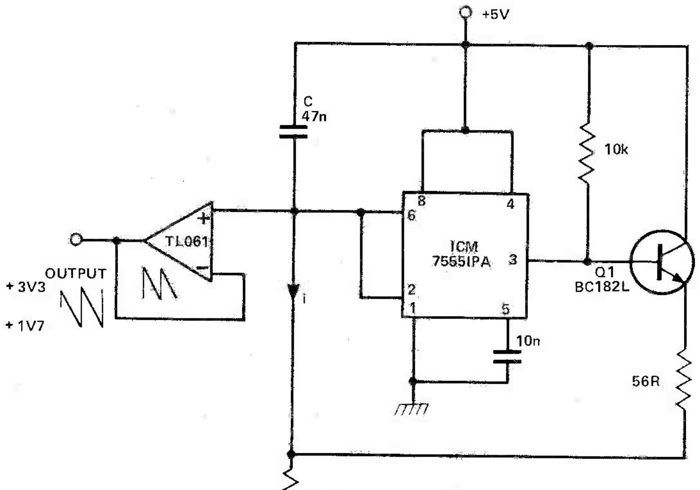
$T1 = 0.693\ (RA+RB)\ C$

$T2 = 0.693\ (RB)\ C$

TOTAL PERIOD = $T1+T2 = 0.693\ (RA+2RB)\ C$

FREQUENCY $Fo = \frac{1}{T1+T2} = \frac{1.443}{(RA+2RB)C}$

A low power 555 oscillator is shown in Fig.9. This employs a CMOS version of the chip which consumes a mere 120 uA. Capacitor C is slowly charged by current i and rapidly discharged by Q1.



$$\frac{\Delta V}{\Delta T} = \frac{i}{C}$$

$$Fo = \frac{1}{\Delta T} = \frac{i}{C\Delta V} = \frac{i \times 3}{C \times Vcc \times 2}\ \mathrm{Hz}$$

Fig.9. A linear VCO built around the ICM7555, the CMOS 555.

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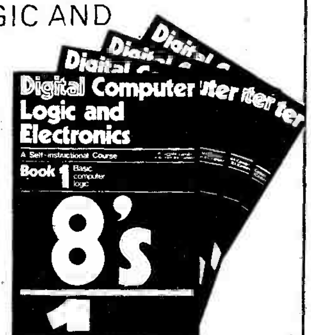

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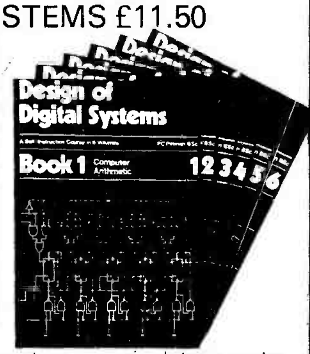

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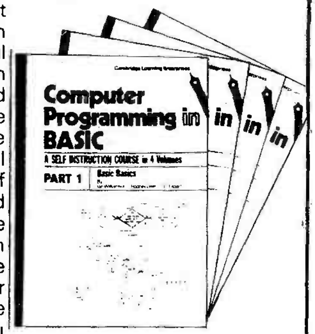

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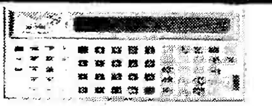

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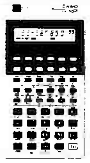

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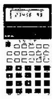

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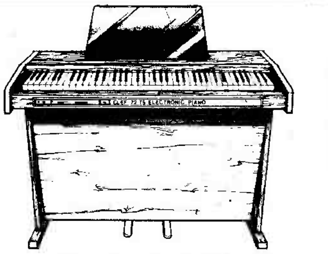

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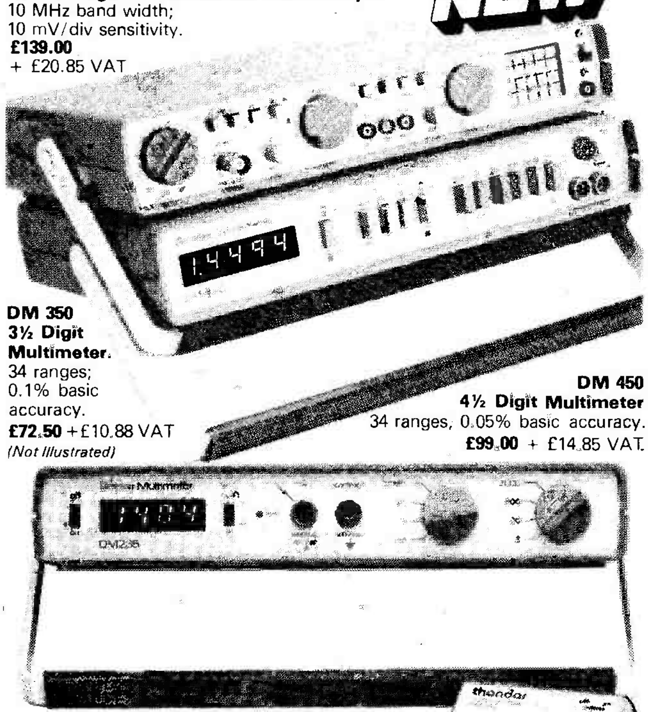

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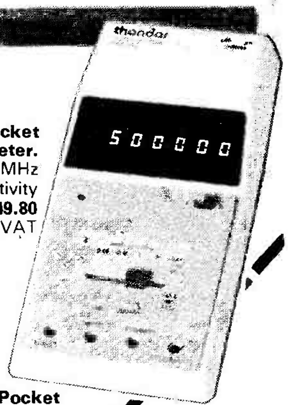

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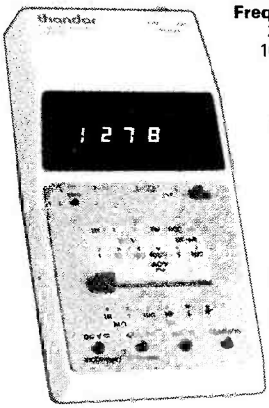

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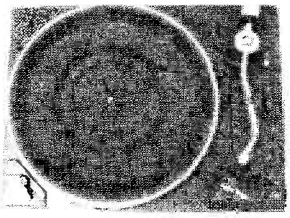

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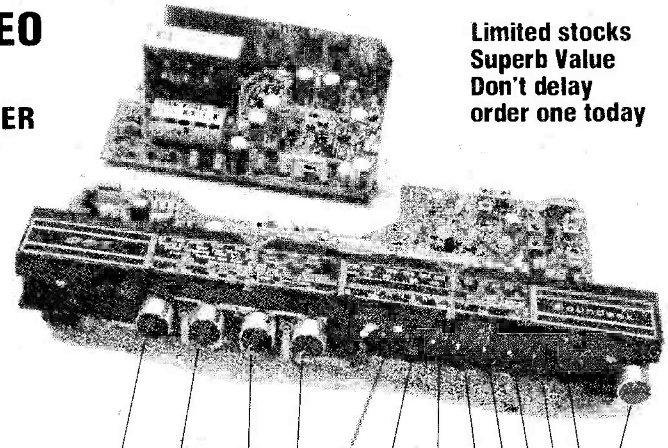

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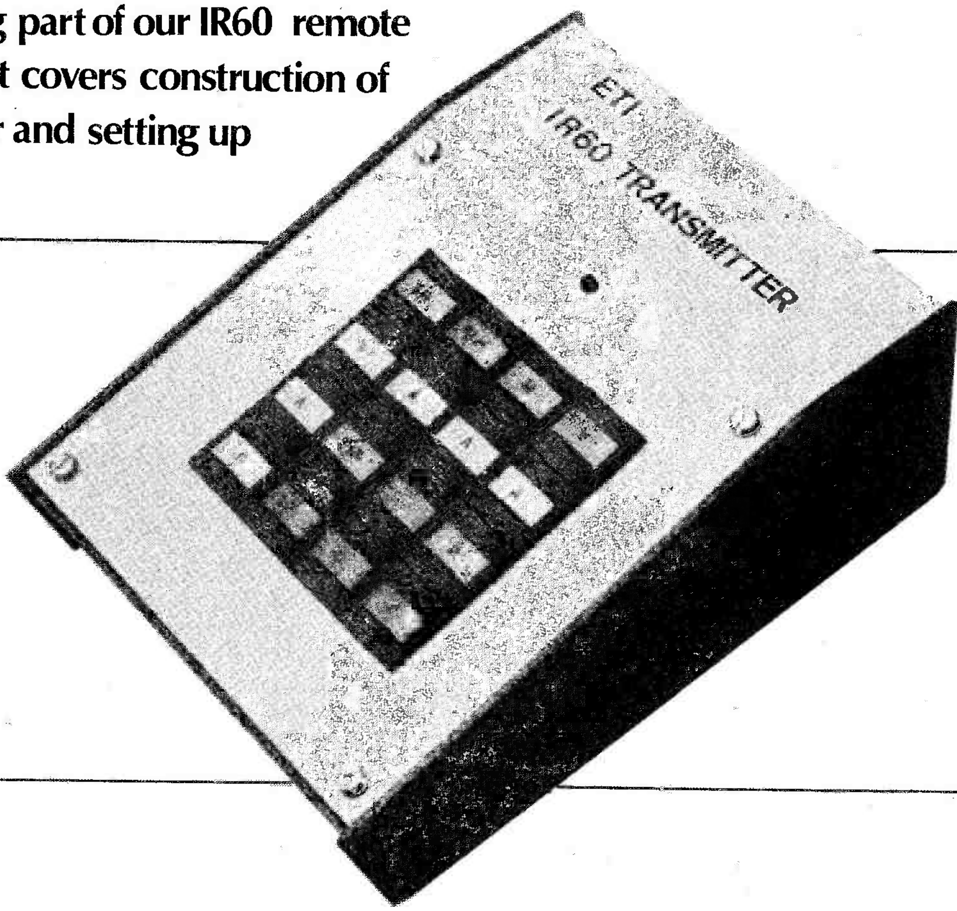
INFRA-RED REMOTE CONTROL

This concluding part of our IR60 remote control project covers construction of the transmitter and setting up the system.



The transmitter circuit is constructed on two PCBs, a single-sided board being used to hold most of the electronic components and a double-sided board being used to hold the matrix of 16 keypad switches. The double-sided board is best tackled first.

The double-sided PCB has 16 pin-through connections, which are used to connect the tracks on different sides of the board and to make external connections. Start construction by fitting Veropins through these 16 positions, remembering to solder the pins on both sides of the board where appropriate. Next, solder diodes D1 to D4 into position on the PCB and then solder the bodies of the 16 keypad switches into place: the switch caps and bezels can now be snapped on to the switch bodies.

The completed keypad assembly can be mounted to the front panel of the transmitter case (see Buylines) via four 12mm x 6BA-tapped stand-off pillars, after first providing a suitable cut out in the front panel. Use ¼ inch 6BA screws to fix the four pillars to the PCB, then pass the keypad through the cutout so that the switch tops protrude slightly and finally epoxy the four pillars to the back of the front panel.

The single-sided PCB can be built next. First, insert all Veropins and the single wire link. Next, fit the resistors, IC socket, semiconductors, capacitors and L1. Note that C1 is a PCB-mounting capacitor with its legs bent at right angles so that it lies flush on the PCB. The completed board can be fitted in the case with stickypads.

The two infra-red transmitter diodes can be fitted next. They are mounted through the back of the case, approximately 32 mms apart. Take special care to fit these diodes in the correct polarity.

The final stage of construction is the inerwiring of the two boards and the LEDs, etc. Take special care here, particularly when wiring the switch board to the main circuit. The battery is wired directly to the transmitter circuitry and can be fitted into the case with stickypads.

When construction is complete, activate each of the 16 keypad switches in turn and check in each case that the front-

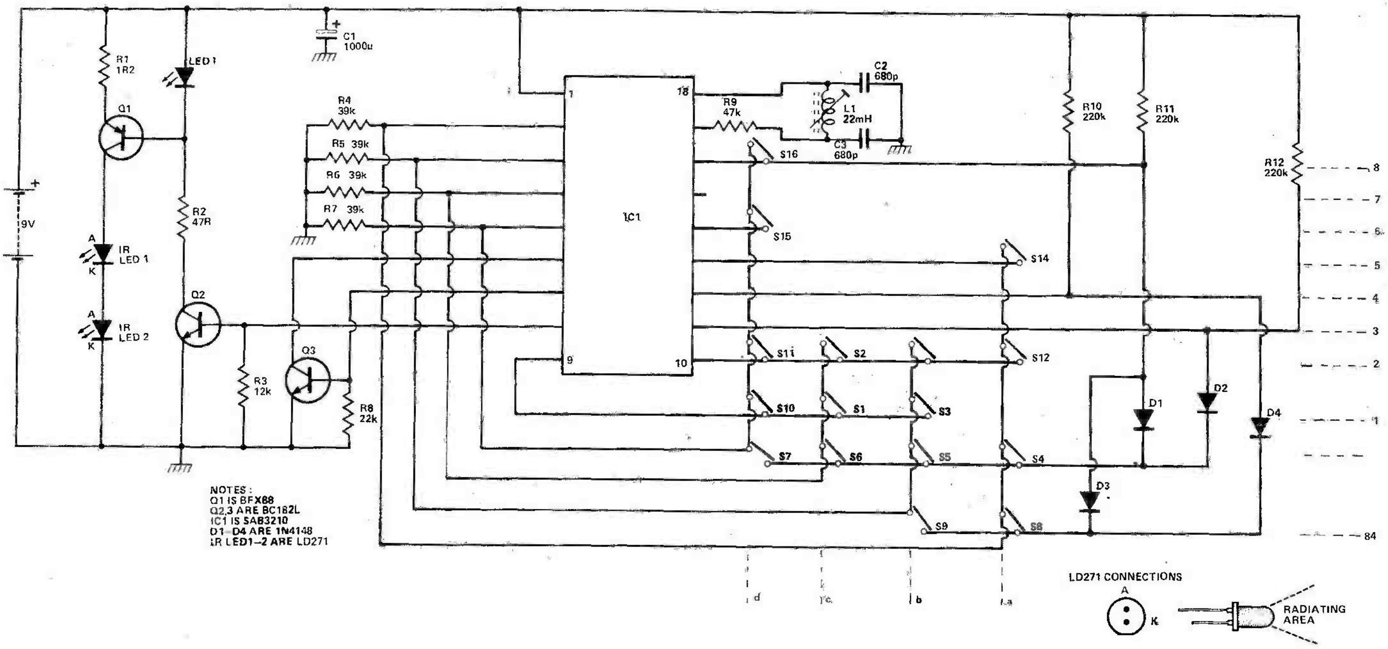


Fig.1. Circuit diagram of the IR60 transmitter unit.

HOW IT WORKS

The heart of the transmitter is IC1, a highly sophisticated P–MOS LSI chip. This chip receives input 'instructions' via an 8-row (pins 9 to 16) by 4-column (pins 2 to 5) matrix that can be activated via contact 'key' switches. The circuit is 'clocked' at about 60 kHz via the R9-L1-C2-C3 oscillator when the IC is active.

When the transmitter is in the quiescent state the IC is disconnected from the battery via turn-on transistor Q3 and the complete circuit (including the clock oscillator) is de-energised. Under this condition the entire circuit draws a total leakage current of only a few microamps from the supply battery. When any of the key switches are actuated, negative potential is applied to one of the 'row' pins via one of the R4 to R7 resistors and pin 7 goes high and turns Q3 on, thus energising the IC and its clock oscillator.

Whenever the IC is energised via a key-switch operation a keyboard scanner comes into operation, detects the 'code' of the actuated key and converts this information into a clock-related serial output code that appears on pin 8. This serial code signal is fed to the infra-red transmitter LEDs via Q2 and Q1.

The transmitter serial code is rather unusual. It consists of a start bit, followed by six information bits, which are read out in biphase code at half the clock frequency. 'Biphase' in this case means that a 'bit' prior to a clock reference point is read as a '0' and a 'bit' after a clock reference point is read as a '1'. The seven-bit serial code signal has a total 'frame' time of about 11 mS and is repeated at a time-base rate of about 130 mS throughout the duration of a key press. When the instruction key is released a single seven-bit 'end of signal' code frame is transmitted and the transmitter is then automatically deactivated again via Q3.

The serial output code from pin 8 is amplified by Q2 and is used to pulse constant-current generator Q1 on and off via R2 and LED 1. Q1 feeds 'on' pulses of several hundred milliamps to the two series-connected infra-red transmitter LEDs, this high current being supplied via storage capacitor C1. Although the PEAK IR LED currents are very high (thus ensuring a good operating range), the MEAN IR LED currents (averaged over one time-base period) amount to only 5 mA or so.

Considering that the transmitter will normally only be required to operate for about half a second per instruction, it can be seen that roughly 100,000 instructions can be transmitted from a single PP3 can be expected to transmit 250 instructions per day for roughly a year. Clever?

panel LED illuminates, indicating that a code signal is being transmitted. If the LED does not illuminate, re-check the circuit wiring.

Setting Up The IR60 System

When construction is complete, set the adjustable core of L1 in the transmitter and in the receiver to mid-position, place the transmitter a metre or so from the receiver and alternatively operate transmitter buttons 1 and 2. With luck, receiver relay RLA will switch alternately on and off, indicating that the system is functioning correctly. If this action is not obtained, try twiddling the core of L1 in the receiver. If you still have no luck, use a 'scope to see if a coded signal is reaching the output of Q1 in the receiver: if not, recheck the transmitter circuitry and the polarity of IRD1 in the receiver.

Once you've got the system working, adjust L1's core in the receiver to find the extreme positions at which control is lost, then reset the core to half way between these two positions. You can then adjust RV1 in the receiver to obtain maximum possible range consistent with reliable operation: our prototype system gives a range of about 15 metres.

Finally, you can use a 'scope or voltmeter to monitor the individual outputs of the receiver while you check that they can be controlled via the transmitter buttons in accordance with the information given in Tables 1 and 2 last month. Your system is now complete and ready for use.

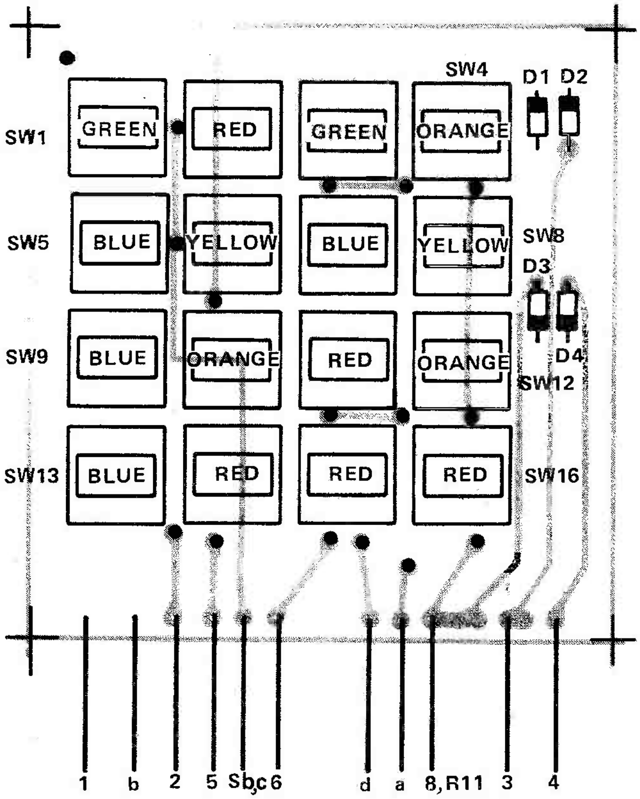
BUYLINES

The case for this project was chosen from the BIM Console range supplied by Boss Industrial Mouldings Ltd. (order code BIM6005 Black).

A full kit of parts including the Mec switches (order SRM plus switch cap colour) can be obtained from Watford Electronics.

Ambit International are suppliers for L1, order as 87BN, 22 mH.

The SAB3210 transmitter IC is available from Electrovalue and Watford.



e.g. GREEN INDICATES COLOUR OF SWITCH CAP

● = PIN THROUGH

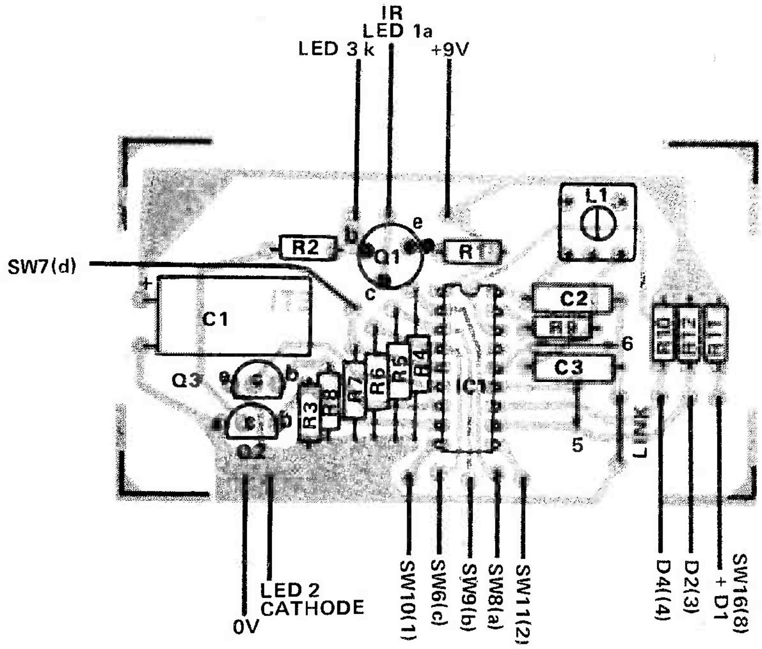
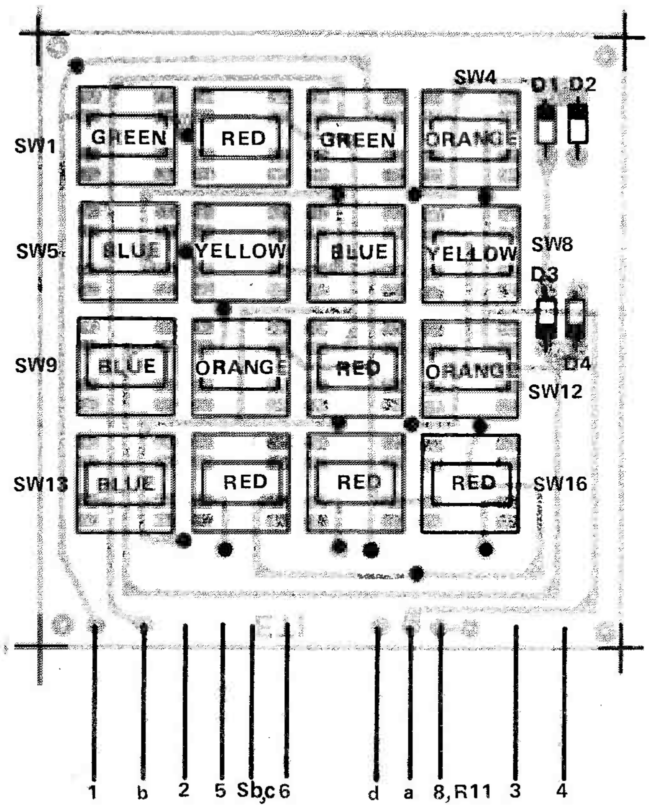


Fig.2. (left) Component overlay for the control board.

Fig.3. (above) Component overlay for the second board.

Fig.4. (below) The mounting positions of the controls on the double sided control board.



e.g. GREEN INDICATES COLOUR OF SWITCH CAP

● = PIN THROUGH

PARTS LIST

Resistors	
R1	1R2
R2	47R
R3	12k
R4,5,6,7	39k
R8	22k
R9	47k
R10,11,12	220k
Capacitors	
C1	1000u 16V electrolytic
C2,3	680p polystyrene
Semiconductors	
IC1	SAB3210
Q1	BFX88
Q2,3	BC182L
IRLED 1,2	LD271
LED 1	0.125" dia. red LED
D1,2,3,4	1N4148

Miscellaneous
SW1–16 momentary switches (see Buylines), PP3 battery, case (see Buylines), L1 22 mH variable, Mec switch cap colour: green(2), red(5), orange(2), blue(4), yellow(2).

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2N3006	**5p**	74C20	**25p**	BC171A	**5p**	2N3053	**15p**
1N4305	**5p**	74C08	**25p**	TIS92	**10p**	BFT60	**5p**
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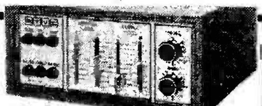

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NOTE: for use with 4 to 8 ohms speakers
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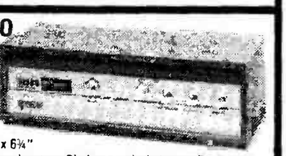
TWO WAY SPEAKER KIT To suit above amp. Comprising 2, 8" approx Phillips base unit, and 2, 3½" approx tweeters with 2 crossover capacitors **£4.95** p&p £1.65.

Available only to first time purchasers of the 12 + 12 kit.

50 WATT MONO DISCO AMP



£30.60 p&p £3.20

Size approx 13⅜" x 5¼" x 6¾"
50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

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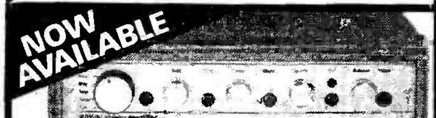

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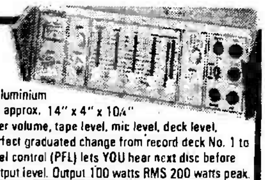

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RAVEN ON

Dave Raven takes the lid off his domestic computer scene and sounds alarm bells for the British computer scene.

Towards the close of 1979 it was announced in China that they had developed high speed emitter-coupled logic circuits that will permit construction of a super computer capable of 20 million operations per second. This is equivalent to ten times faster than any device they have produced to date. It was also announced that they would be exporting computers in the future.

Since this piece of breathtaking information must, by now, have brought you to the edge of your chair I will concentrate the mind further. The significance of China's declaration to enter the international computer market would be lessened if viewed in complete isolation and certainly does not pose any immediate threat to the western computer manufacturers. When, however, it is considered along with that of other emerging nations like Brazil, India and South Africa, who are all eager to develop independent computer industries, it serves to illustrate how different the international computer market will look at the end of the 1980's.

The USA, Europe, Japan, USSR and China will all be aiming to produce computer equipment for their 'in-house' requirements and also capture export markets.

The potential military role of computers is of major significance. However, other sectors of high technology such as telecommunications, aircraft, satellites and nuclear industry are all critical to the maintenance of an industrially based military complex.

Backing Britain

The ability of Britain to maintain our industries in all the above technological areas is vital if we wish to remain independent and it would surely be crazy if we were to waste the years of experience built up in this country in high technology only to import computers made in Brazil or China. Japanese computer manufacturers are already embarking on a long term programme to penetrate the USA computer market. This will be accomplished in much the same way as the establishment of cars in the UK; with good service centres and software requirements fully catered for.

In Britain, after seeing the end to our industry for manufacturing small motorbikes, we are now witnessing a slow takeover of the (cheap) family saloon market. Consumer electronic goods is of course well underway with virtually all the UK manufacturers killed off. Remaining are a few TV producers that will be fighting for their lives now that the PAL patents protection is soon to be lost.

The Video Story

Video Recorders could well reach the sort of sales levels which have been achieved by Colour TVs during the next ten years, since everyone with a TV has an application for a recorder. Guess how many of these quite straightforward pieces of hardware will be made in Britain, 12 million? 5 million? 1,000? How about 100? Sorry, not ONE. With the exception of a few home made models built in garden sheds and by lost souls in university development labs.

Watch This Space

Having debated involving myself in small computers for the last two years, I have at last purchased a home computer. The significance of this is that it is intended primarily for home use and, therefore, had to compete with other domestic demands on my home budget, as distinct from a business expense.

The decision to buy a home computer is not to be taken lightly, even at the knock down price of under £400, since this must be compared against other competing products which are just as attractive. My desire to buy a video recorder has not receded and the demands made by my wife for £400 worth of (quite unnecessary) furniture still continue. So what *was* the final overriding reason that made me rush out and buy a small computer?

Like most enthusiasts of electronics I usually desire new electronic goodies quite early in their evolution and home computers were to be no exception. All the products I have bought to-date such as TV games, digital watches, calculators etc, have all had clearly defined uses. However, a computer takes just a little more justifying as the following script shows:

Picture this domestic scene

Freak "Darling I have decided finally to buy a home computer".

Wife "That will be nice dear".

Freak "I have come to this decision after many months of careful thought and feel it will bring a greater understanding between man and machine. The involvement of the human brain with a computer will expand our memory capacity allowing us to be more creative thinkers".

Wife "That will be nice dear".

Freak "Through the tips of my fingers will be unleashed a storm of interlectual and statistical power man has not previously enjoyed. It can be incorporated with art, music, science, finance and with imagination it will probably iron my shirts".

Wife (looking slightly more interested) "That will be nice dear".

Freak (now standing looking out of the window with a glazed look on his face) "With the right level of software and peripherals it could organise many of our daily needs. A telephone link would enable it to order the shopping. Cooking, cleaning and remembering birthdays could all be carried out with the aid of a little robotics".

Wife "Darling is everything alright?".

Freak (not hearing) "With the right robotic design it could develop a human form. Feelings of compassion and warmth could be available to me at the press of a button. Love and understanding always there to satisfy my every whim".

Wife "But if the computer can be made to do all these things what will be my place in your life?".

Freak (now facing wife with manic expression) "And it all costs less than £400!"

The most frequent question asked by the few remaining people that have not yet bought a computer (sic) is — "What does one use it for?". Well, after going around the houses a few times, I can — with a little arm waving — come up with quite a convincing answer.

Life will of course continue without small computers. However, I doubt if small businesses will after a few more years. The pressures from larger competitors who use all the latest tools to beef-up their profit margins will force smaller competitors to follow suit. Don't ever kid yourselves that small companies are cheaper to operate. It requires nearly the same sized operation to print this one magazine as it does to print half a dozen. Ask the Managing Director of Modmags, if you don't believe me. Small computers can be used to speed the flow of management information required on a daily basis. They can put off the day when it is necessary to increase the size of office premises and produce more output without increasing staff numbers (not a bad objective when one considers that the birth rate is declining in Britain).

Joining The Revolution

Having extolled the virtues of computers and my fears that Britain may not enjoy the full fruits of their manufacture, I am rather excited by the future prospects of our own Prestel system. For once this very British innovation cannot easily be pinched and sold back to us at a cheaper price since it consists of a system rather than a single manufactured product.

My grateful thanks to Rediffusion Manager Tim Jaggard for allowing me to be present at a demonstration of both the Teletext and Viewdata systems. I must openly confess that although I am aware that much has already been written about these new systems, I have previously found it difficult to muster any interest. Perhaps this is because I am more familiar with Teletext, which interesting and useful as it is, remains an extention of the more traditional information services.

Clearly consumers in the next few years will demand Teletext as a standard on their TV sets in the same way that colour is now required. Viewdata (or Prestel), however, is a different ball game which links together a domestic telephone with the television and converts this to a traditional video display unit as used with a computer. At the press of a button connection is made through the GPO exchange to indpendent organisations who contribute information directly from their own offices.

The Post Office, who provides the Prestel computer and exchange equipment are not involved in editing or interfering in any way with the material supplied to the subscriber. The computer is capable of providing over one million pages of information which can also be of a highly confidential nature and only available to subscribers who have access to a certain code — for example, private company information to members of staff, bank statements, credit checks on potential customers for loans. On the direct selling side it is possible for subscribers to book tickets on planes, ships and trains using their credit cards. The possibilities for mail order are endless with customers buying directly after seeing TV adverts and not even leaving their front room.

Small Viewdata printers are available producing a hard copy of what you see on the screen. This is all British, you have to remind yourself, and according to the Post Office by 1986 Prestel services would be called on by 95 per cent of telephone users. One other interesting observation is of the uses which may be made of the three as yet unused Viewdata channels. I cannot see the problem in providing software and memory for use by the consumer — which would rapidly make redundant all the small home computers.

ETI

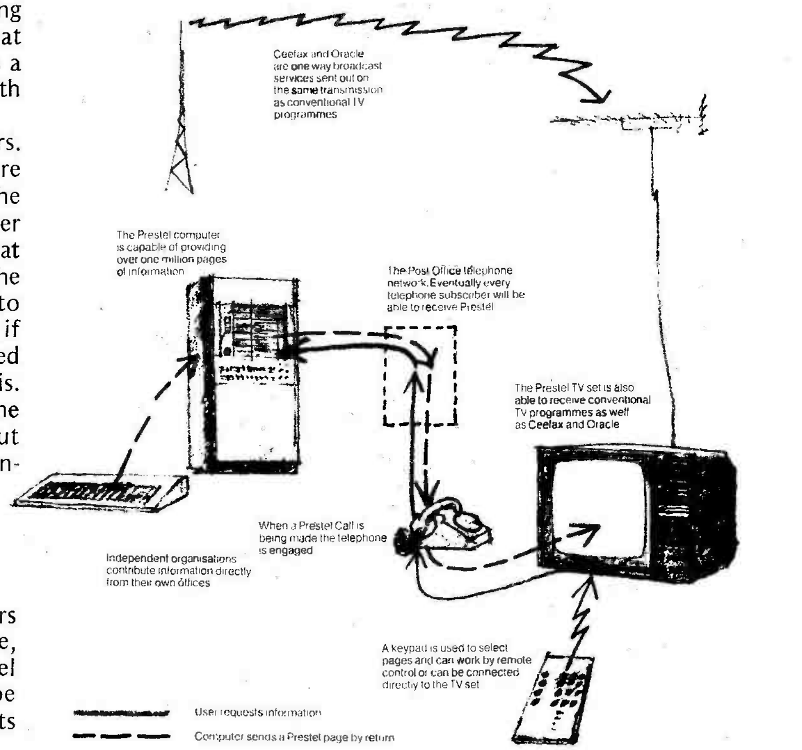

Fig.1. Ceefax and Oracle are broadcast in the same way as TV programmes. Prestel allows independent organisations to put information in. You receive it by telephone and the information is available on your telly at the touch of a button or two.

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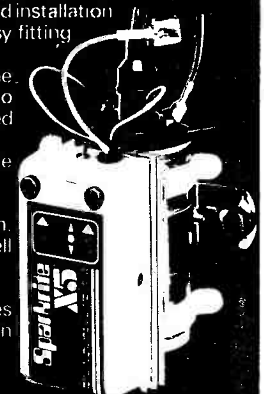

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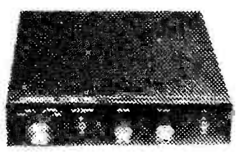

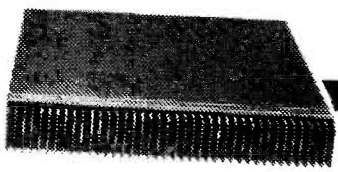

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Fan mounted on two drilled 100mm heatsinks 2×4 C/W 65 max. when used with two 170W *modules*	**£36.00**

THERMAL CUT-OFF, 70C **£1.90**

TOROIDAL POWER SUPPLIES

CPS1 for 2x CE 608 or CE 1004	**£19.50**
CPS3 for 2x CE 1004 or 1/2 x CE 1008	**£23.50**
CPS6 for 1/2 CE 1704 or 1/2 CE 1708	**£30.00**

POWER AMP KIT **£38.80**

PRE-AMP KIT **£39.80**

PRE-AMPS

These are available in two versions — one uses standard components, and the other (the S), uses MO resistors where necessary and tantalum capacitors

CPR 1	**£34.00**
MC1	**£26.00**
CPR 1S	**£44.50**
MC 1S	**£37.50**

ACTIVE CROSSOVER

XO2	**£19.00**
XO3	**£28.35**

POWER SUPPLY

REGI **£9.30** **TR6** **£2.50**

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Obtain up to 340W using, 2x170W [illegible]
BD1 **£7.25**

U.K. — Please allow up to 21 days for [illegible]
Write for free literature or send 50p for [illegible] users manual

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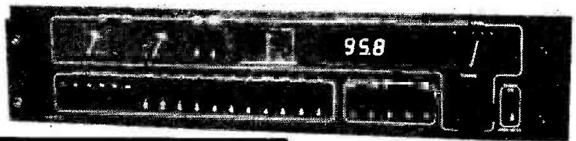
Tel. (0533) 553508

Complete Audio/Tuner Kits



Mk III FM Tuner series

Carriage for Mk III tuner £3 inc

The Mark III series FM tuner has been updated, and now includes a centre zero tuning meter as standard. The instruction manual has been meticulously revised, enabling easy assembly by constructors of various levels of experience - a preview copy may be purchased for £1.00.

Mark III A series 'Reference series' tuner modules ....£171.35 inc.
Mark III B series 'Hyperfi' modules, with switched IF BW, pilot cancel decoder ....£198.95 inc.

A matching synthesiser unit will be made available later this year, and can be retrofitted to either version. All versions include digital frequency readout/clock, VU deviation meters, 6 preset stations, 10 turn pot manual tuning, toroidal PSU, output level adjustment, 110/240v AC input. Full alignment service available.

Power Amplifier

Style and performance - with a real 'belt and braces' PSU design.

After a couple of preview comments, it seems that many of you are waiting to hear about the matching HMOSFET power amplifier for the Mk III tuner. Well, it's out at last - complete with twin toroidal PSUs for comfortable 80W RMS per channel, over 100W peak, but limited by thermal shutdown of the HMOS. 10W-100W log LED output peak indicator, DC offset protection and switch-on pause relay. AC or DC input coupling, direct or relay protected output terminals. The works.
Only one version of this item: Complete kit ....£178.25 inc. Carr. £5.

Preamplifier

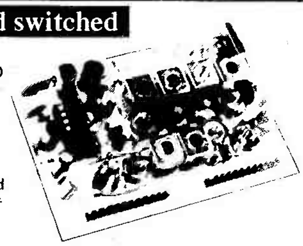
More features and facilities, thanks to DC switching and control design

Previewing the most comprehensive audio preamplifier yet...... DC switching of 7 inputs, plus two tape in/outs. 2 low pass, 2 high pass active filters, genuine volume related loudness, 1dB channel matching, with DC volume, balance, bass and treble controls. Suitable for bus/remote control, tape dubbing, switched monitor etc. 80dB S/N+. THD -75dB or better. Pluggable PU equalization boards, tone control override. Price for complete unit about £149 ex VAT.

Radio/Audio/Communications Modules

LW-MW-SW-SW DC tuned and switched

91072- All switching of bands by a single pin to gnd. Varicap tuned, with LO output for synth. MW/LW version or MW/LW plus 1 or 2 SW bands
MW/LW: £15.58 +1SW £16.73



VHF Tunerheads

Europes largest stock range for broadcast and communications. Probably also the world's – details in the catalogues and PL. Specials are also supplied in the region 30-220MHz.

Pilot Cancel PLL Stereo decoders

Again, Europe's widest range of stereo decoders including pilot cancel PLL types. The pic shows the 944378 - pilot cancel including post decoder 26/38kHz filtering and muting preamp output


944378-2 £26.45

Switched bandwidth FM IF strips

Broadcast FM IF strips for all occasions, including the new 911225 - with diode switched narrow filter option, ultra linear phase ceramic filters, 84dB S/N, and 0.04% THD (40kHz deviation). Plus usual things like AGC, AFC, dev. mute, level meter drive. £23.95 (supplied in screen can with 0.1 edge connection system)
Also the 7230 hyperfi series - as the 911225, but with slope controlled AFC that operates in conjunction with signal level - and an extra IF amp stage for DXing.

Various digital frequency displays

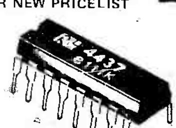
The World's largest range of receiver DFMs is now joined by the DFM7 (shown) - and L shaped version of the DFM3 with remote display mount connector possibility . 1kHz SW resolution with 455kHz or 10.7MHz offsets, 100Hz res up to 3.9999MHz, and VHF to 299.99 MHz in 10kHz steps : £41.75

Semiconductors

Radio/Communications ICs

FOR COMPLETE LISTINGS – SEE OUR NEW PRICELIST

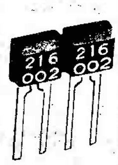
CA3089E	2.11	HA1197	1.61	SD6000	4.31
CA3189E	2.53	CA3123E	1.61	TDA4420	2.59
HA1137W	1.95	TDA1072	3.09	MC1330P	1.38
HA11225	2.47	TBA651	2.53	MC1350P	1.38
HA12412	2.81	TDA1090	3.51	KB4412	2.24
KB4420	1.95	TDA1220	1.61	KB4413	2.24
TBA120S	1.15	TDA1083	2.24	KB4417	2.53
KB4406	0.80	TDA1062	2.24	MC3357P	3.16



SL1610	1.84	SL1626	2.80
SL1611	1.84	SL1630	1.86
SL1612	1.84	SL1640	2.17
SL1613	2.17	SL1641	2.17
SL1620	2.50	SL6600	4.31
SL1623	2.80	SL6640	3.16
SL1624	3.77	SL6690	3.68
SL1625	2.50	MC1496	1.44

VARICAP DIODES........
A section from our PL:

BA102	0.35	16:1 ratio AM tuning	
BB204	0.41	KV1215 9v triple	2.93
BB105	0.41	KV1211 9v dual	2.01
BB109	0.31	KV1225 25v triple	3.16
MVAM2	1.93	BB212 9v dual	2.25



POWER MOSFETS

100W PA's made simple

Since pioneering the 100W complementary MOSFET technique - Hitachi have developed a range of output devices and drivers that ought to revolutionise opinions and attitudes towards the design of all LF amplification systems. We have a new 48 page application note (£1.50 inc) and complete sets of parts, modules and now the new complete PA system (see above).

2SK133	120v N-ch 100W MOSFET	£6.33	2SJ48	Pch complement	£6.33
2SK135	160v N-ch 100W MOSFET	£7.29	2SJ50	Pch complement	£7.39

PA101B Kit for 100W MOSFET PA less Heatsink £16.10. (£23 inc heatsink/bkt)

ULTRA LOW NOISE PU PREAMPLIFIER

The HA12017 is the last word in PU preamps, and general low noise audio design. It is an SIL IC, with 86dB S/N in RIAA configuration, 10v RMS output capability, 0.002% typ THD at 10v RMS output (imagine the overload margin !!). It comfortably supercedes discrete circuit designs in terms of price/performance, and takes the art beyond the TDA1042's capabilities. (Replaces HA1457) £1.80 each - or an RIAA applications PCB with two ICs for £5.75. Complete with Rs&Cs £9.95.

Radio Control ICs

We have various RC ICs, including NE544 NE5044, and two new ones from OKI

KB4445 - 4 channel dig.prop. FM TX IC. 30mW out (amplifyable) -£2.30 inc
KB4446 - 4/5 ch. dig. prop FM RX IC. Suits KB4445 or RCME syst. £2.65.
KB4445/6 pair: £4.75. New 8 page data sheet 35p + SAE. More RC ICs in list

CMOS, LPSNTTL, TTL, MPU: Listings in the new pricelist.

Most CMOS is available in low volume - also LPSN. Standard linears and TTL OK.

Things like ICM7216B, ICL8038, 8080A, 6800P, 2708, NE555, NE556, etc

Coming Soon...........

Contain yourselves, RF fans ! Not yet ready for a full launch until autumn, but previewed here:-

SSB transceiver system : 10kHz to 1000MHz !!

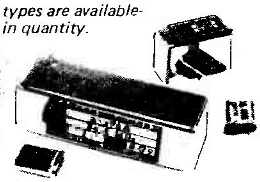
A modular VLF to UHF SSB TX/RX system at last. With the correct first mixer, the basic PCB covers 10kHz to 1000MHz - using LO fed from ext. source (Our 2 IC Mullard synth for instance) and RF PA for TX OP. 0.2uV basic sensitivity in HF, Typ cost for HF synth SSB RX will be less than £200. Add an RF PA for full TRX for another £50. See one in our foyer, and marvel.

Components

Crystal Filters

Most popular types are available ex-stock, and in quantity.

10.7MHz	25kHz Channel spacing 8pole	£16.67
	12½kHz ..	£17.82
	2.4kHz SSB	£19.78
	Monolithic dual roofing filter	£2.30
34.5MHz	1.3dB loss, 80dB stopband HF first filter in synth. RX	£36.80
RC XTALS	FM pairs (no spilts)	£3.74
	AM pairs ..	£3.57
USB/LSB	Xtals for 10.7SSB filter	£2.88 ea



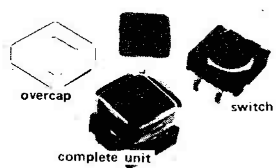
Piezo Sounders

The most efficient warning sounders yet

The latest thing in electro-acoustic efficiency. 1mA of drive from CMOS will give an SPL of 83dB - 10v RMS drive from CMOS uses 3mA for 100dB SPL at 4.8kHz (88dB at 1.65kHz)
The data sheets shows various drive circuits, and give full specifications with regard to broadband responses and power consumption etc. 1 off 44p inc. 100 off 28.75p (25p ex vat)

Keyboard switches and caps

From the world's most widely used switch manufacturers - ALPS - come the biggest and best range of keyswitches, and data entry keyboard switches. The SCM81101 is shown here, with the KT5 2-part cap (with clear top, to enable easy fitting of your chosen legend. Other types are available with built in LED, 90° mounting etc.
SCM81101 : 17p, KT5 : 16p - or 29p/pair



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LCD DVM

Clocks use 1.5v at 15uA only. DVM 9v/1mA

CM161: 7mm LCD 12/24hr, alarms etc £11.44 each
CM172: 13mm, 12hr, alarms, timer etc £14.32 each
CM174: 13mm, 12hr, min/sec stopwatch £14.32 ea
DVM 176: ICM7106 based LCD 3½digit £22.36 each

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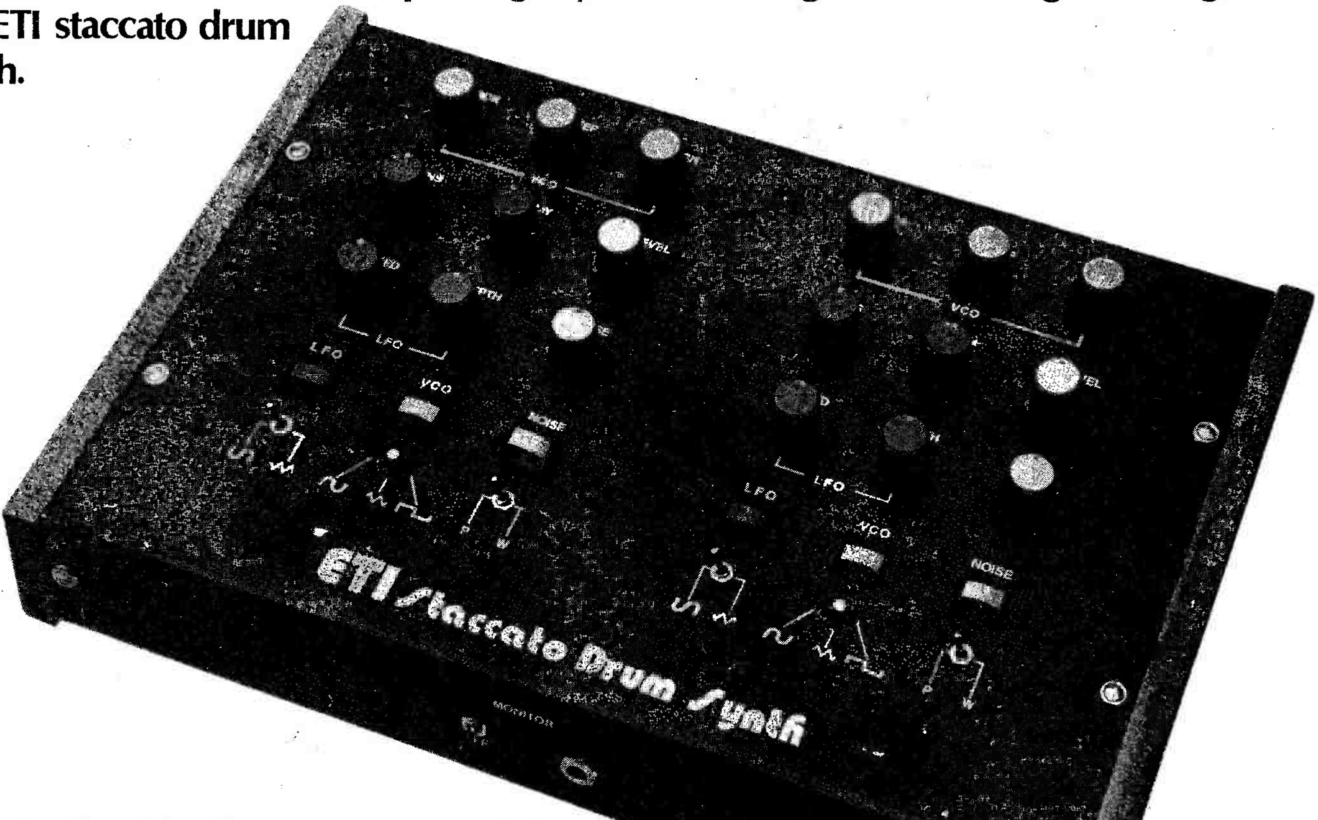
DRUM SYNTHESISER

At last, ETI's own machine which peeoom-peeooms, bim-bams, whizeees or boo-ooms in all its onomatopoeic glory. Here is Roger Shore's original design for the ETI staccato drum synth.

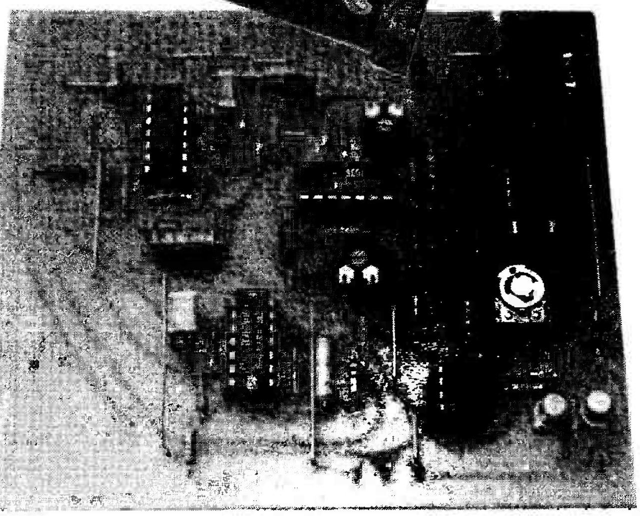


You've all heard the effect on disco or pop records. It was first heard about a year ago and since then, it seems, has grown in popularity so much that no decent, self respecting drummer would let it be known that he hasn't got one. Mind you, they are only obtainable commercially at a price — £180 or so can buy you *one.* A fair price, the enquiring musician might muse in perspective, in order to keep up with the times and the modern music trends. A fair price indeed, until the even more enquiring technical musician takes the lid off and studies the electronic circuitry involved. That's exactly what we did! We decided that this new sound was one to be investigated with a future project in mind and so we took a good look at a major proportion of the available commercial units.

Our first conclusion was that somewhere along the line of manufacturer, middle-man and musician, somebody was ripping off somebody else — and, as usual, it is the end link in the chain having to pay more than the odds.

Our second conclusion was that we could probably do a better job — a design which out-performs available drum synthesisers in both quality and price.

A fairly conservative costing of all components and hardware for the project, which is a two channel synthesiser, forming a stereo output with the added facility of a monitor amplifier circuit to power a pair of stereo headphones (allowing setting up of the synth without being overheard) comes to



All 42 ways of the control board (above) are used. Cut a slot at pin 37 for identification.

around £60. This approximate price is inclusive of what we feel is a very nice housing (see Buylines) suiting the synthesiser down to a tee. A comparable price for a similar commercial unit is over £360 – OUCH.

The modular construction means that any number of channels can be built as required and perhaps the most enterprising of you out there can envisage a complete electronic drum kit of bass, snare, tom-toms, high hat and cymbals for about half the price of a standard kit. Of course the extra drum sounds of the synthesiser are also there as required.

The ETI Staccato is a mains powered device, none of those nasty batteries running out on you half way through a gig. A simple microphone or miniature loudspeaker acts as the trigger sensor and can be positioned inside an existing drum, on the underside of a simple wooden block or, as in the prototype, inside or underneath a practise drum pad. The drum pad is probably the ultimate as it means a permanent and compact method of holding the sensor whilst maintaining a good-looking and functional appearance.

Also featured is a sensitivity control which adjusts for a very wide range of trigger sensors and levels which means that virtually any combination of microphone, or speaker and holder will trigger the synthesiser.

The ETI Staccato Drum Synthesiser

Our aim was to incorporate a systematic approach to interwiring connections, therefore providing a unit that could easily be expanded. The most favoured compromise combined three PCBs; a power supply unit and monitor board, control-circuit and a function board which holds all PC mounting potentiometers, switches and LEDs for a single channel synth.

Begin construction by building the power supply unit and monitor PCB, insert all pins and wire links followed by IC sockets, resistors, diodes, capacitors and semiconductors. Next in line is the control circuit; follow the same procedure as above. Take care when you come to wire the edge connector as all of the 42 ways have been used right down to the last pin! A slot will need to be made at pin 37 of the circuit board to polarise the edge connector.

Construction

Before assembling the function board, it is wise to use it as a template for marking out the front panel. This will give a physical representation of the layout and will enable easy alignment of the potentiometers, etc after drilling. Mount all right angled, inter-PCB sockets (3 ways or 5 ways) around the edge of this board. Be sure to mount all potentiometers from the copper side of the PCB with their tags bent at right-angles. It is highly recommended that the specified switches are used (see Buylines) as they offer various switchable pinouts, especially in the case of SW3. To accommodate the switch bezel, a cutout of 14x14 mms is required. Finally to save any embarrassment whatsoever, check the orientation of all polarised components before switch on!

Now you've built the staccato drum synth how about joining a band? At least one hour's practice should put you 'on the road' – not necessarily to stardom!

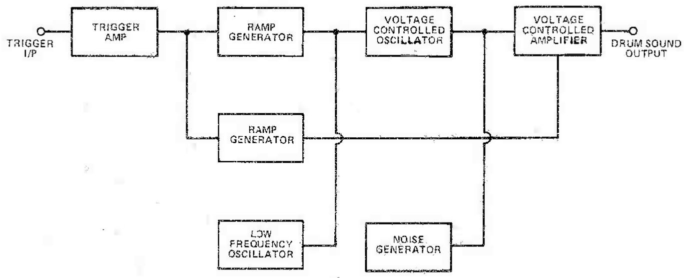
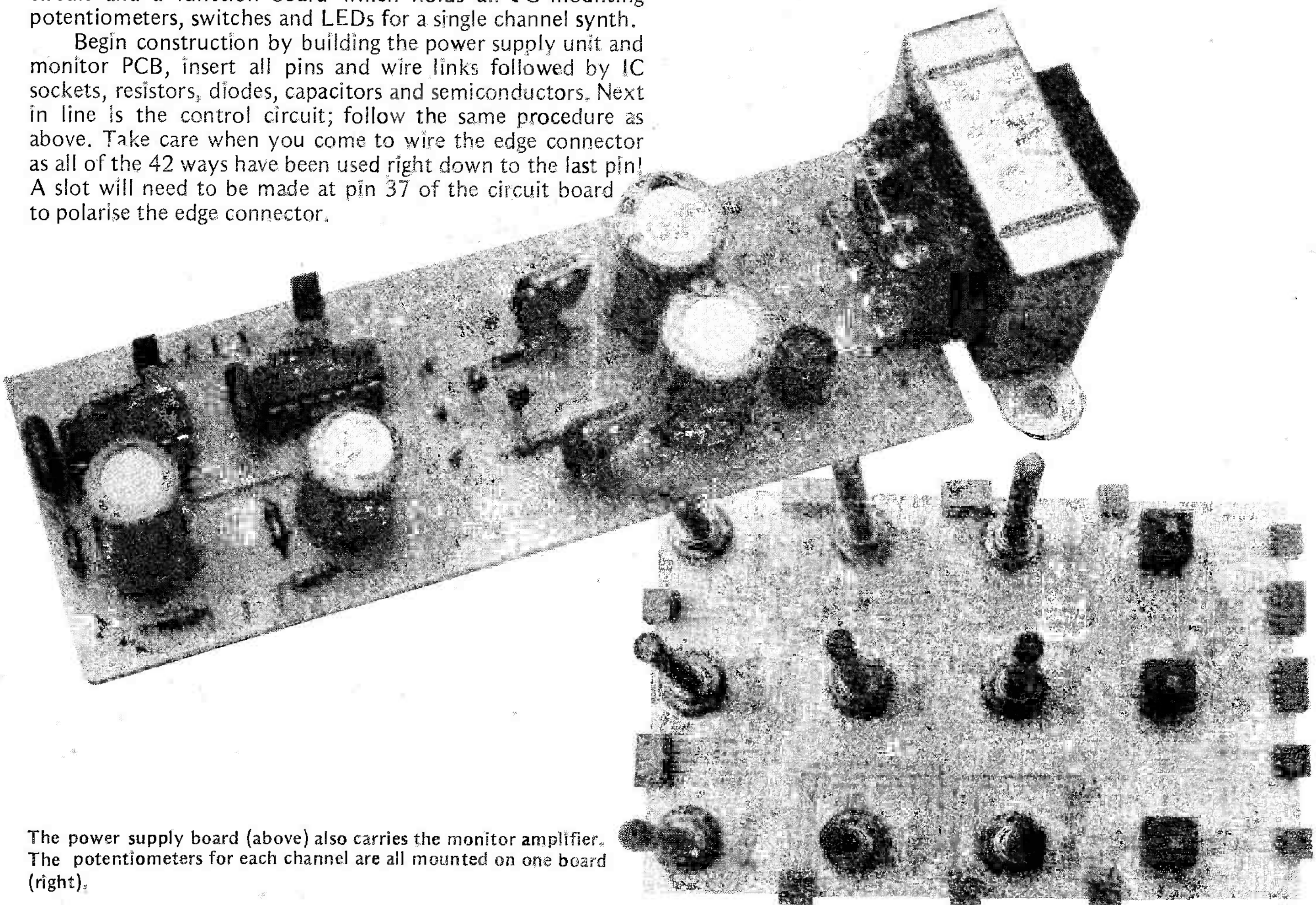


Fig.1. Block diagram of the ETI Staccato.



The power supply board (above) also carries the monitor amplifier. The potentiometers for each channel are all mounted on one board (right).

Setting Up

There are only three presets (RV5, 6 and 7) to adjust. Start by setting them all to mid-position then turn the noise control to minimum and switch the noise on. This effectively disconnects the sine filter from the circuit. Now switch the VCO to sine output. Switch the device on and adjust RV7 preset until a continuous signal is heard at the output. If an oscilloscope is available, adjust RV5 and 6 for minimum sine-wave distortion. If no oscilloscope is available, simply adjust

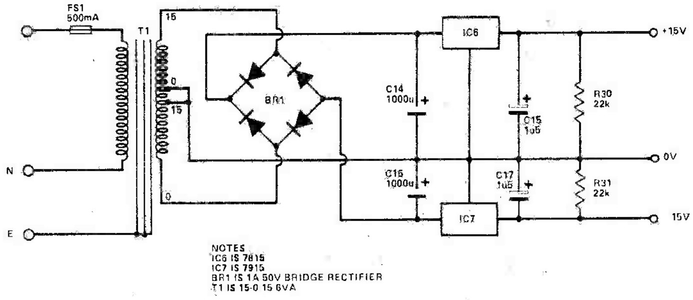


Fig.2. Circuit diagram of PSU.

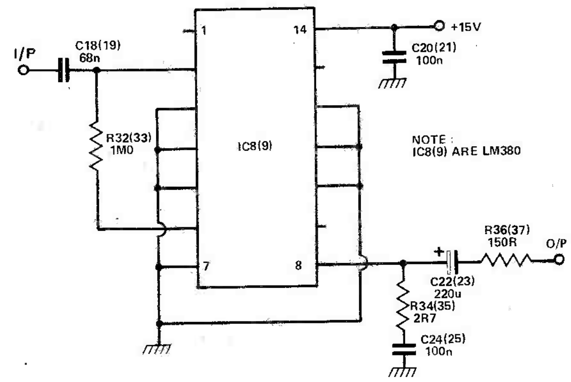
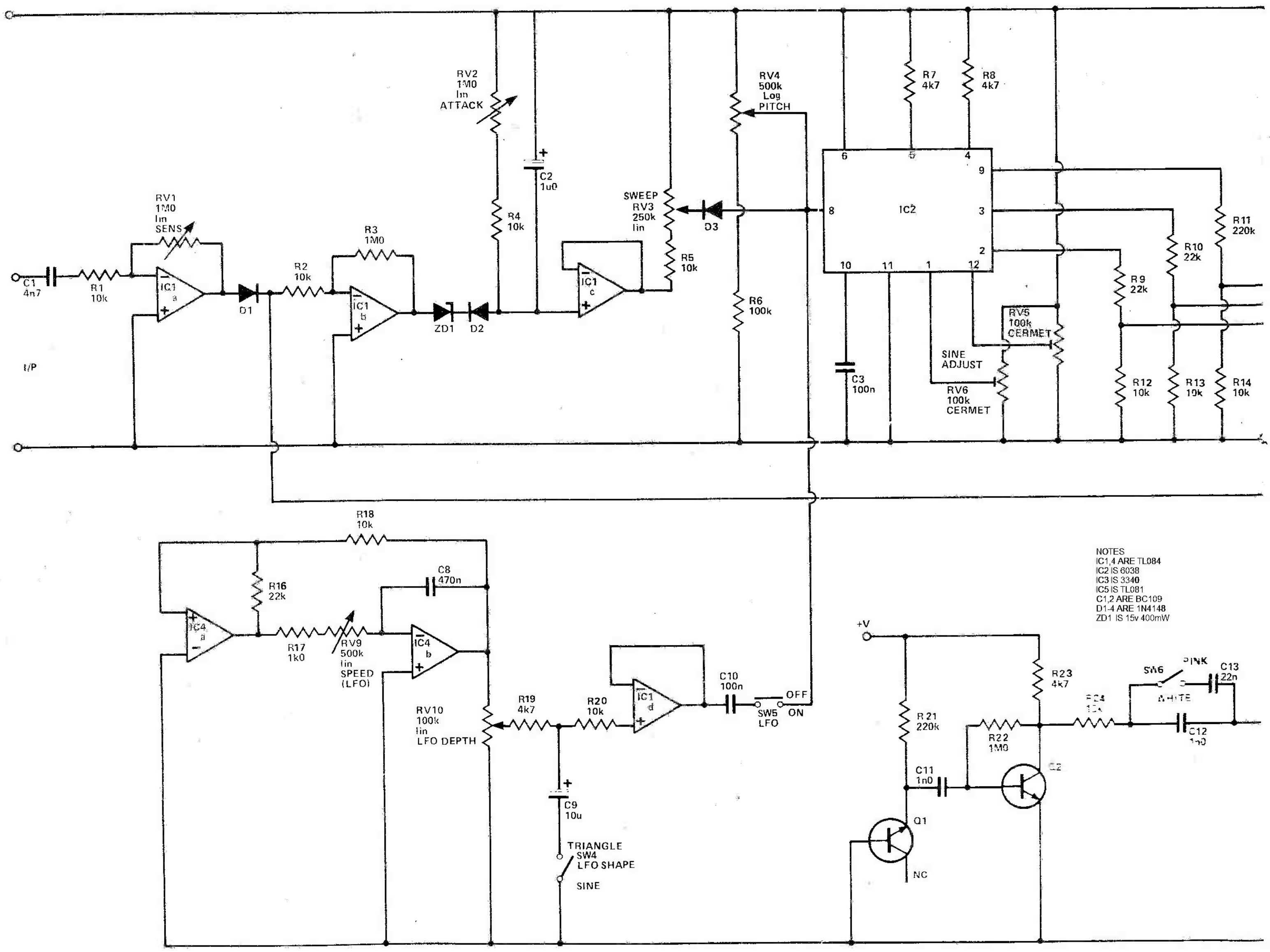


Fig.4. Circuit diagram of monitor amplifier.

the presets for minimum audible distortion. This may seem somewhat haphazard, but the human ear is very discerning where sine distortion is concerned! Once the minimum distortion position has been established, it only remains to adjust RV7 until the signal just disappears from the output . . . . . and that's it!

Now, the golden rule is to experiment. Apart from the sounds for which the drum synth is well known, a whole range



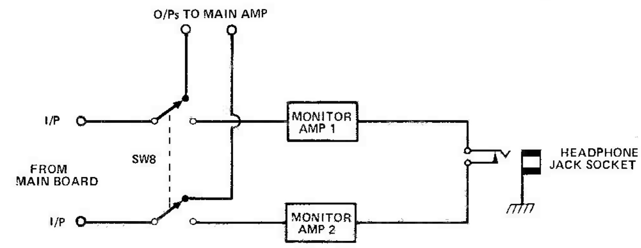


Fig.5. Connecting details of monitor amplifiers.

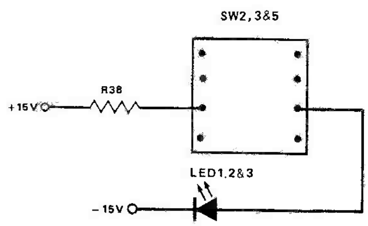
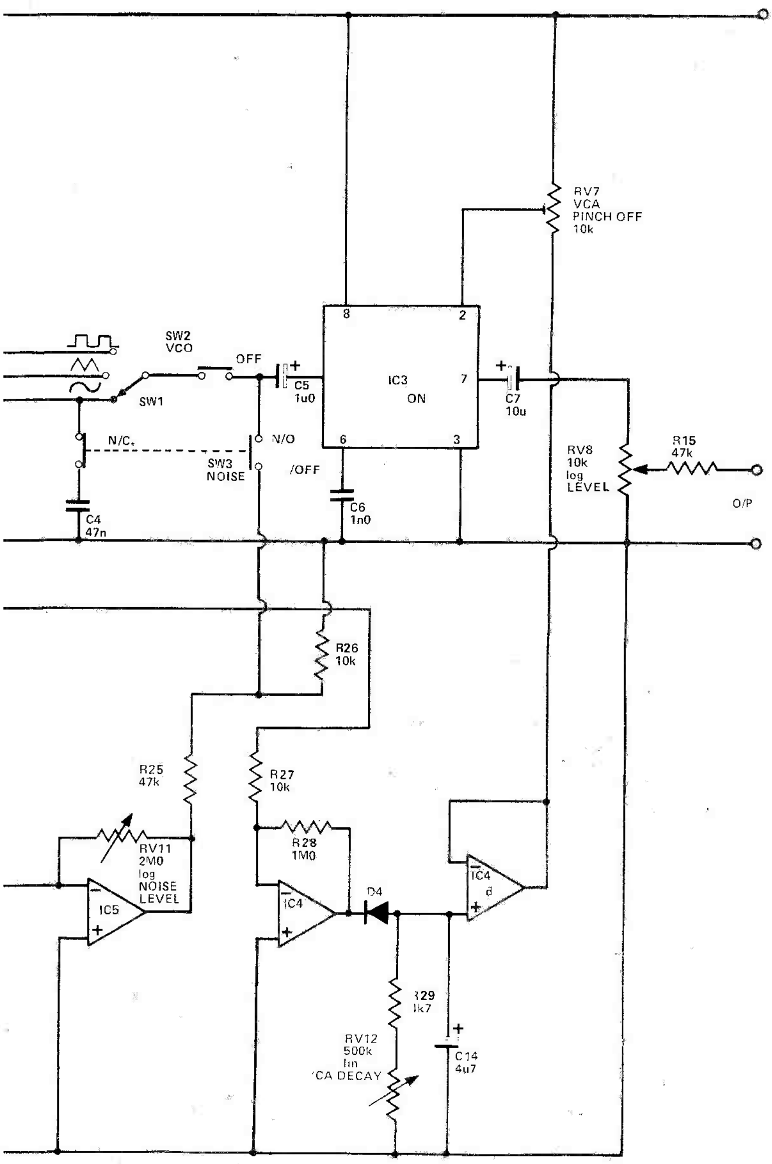


Fig.6. Connecting details of switch LEDs.

Fig.3. Circuit diagram of the ETI Staccato Drum Synth.



of strange and wonderful sounds is possible, particularly if the LFO and noise generator are used. Vibratos, warbles, chimes and gongs are obtained using the LFO. Surf, wind, applause, snare drums and cymbals are obtained using noise.

HOW IT WORKS

The block diagram (Fig.1) shows the main principle of operation of the synthesiser. It can be seen very simply as a voltage controlled oscillator followed by a voltage controlled amplifier. This means that the frequency of the final signal and its amplitude ie its pitch and envelope, are controlled by DC voltages derived from the original trigger. Two separate ramp generator circuits provide these DC voltages and all necessary parameters of these ramps are externally controllable. A low frequency oscillator can be applied to modulate the VCO if desired and a generator produces noise for cymbal or snare sound, etc.

The voltage controlled oscillator is based on the 8038 waveform generator chip, IC2. Its frequency is varied by adjustment of the pitch control RV4, allowing the initial frequency to be set to the required level. Alternatively, the frequency can be controlled by a varying DC voltage applied via D3, from the VCO ramp to be described later. The oscillator works over the frequency range between about 10 Hz and 1k5 Hz. All three output waveforms available from the 8038, sine, triangle and square waves, are used.

The trigger for the synthesiser is provided by a microphone (virtually any microphone will do) fitted inside a suitable drum or holder, even a tin can will do! The signal from the microphone is differentiated by C1, R1, so that surrounding sounds do not cause false triggering. The pulse generated when the drum is struck is then amplified by IC1a, the gain being varied by RV1. The output of this amplifier is then rectified by D1 to provide a positive going pulse which is fed to further amplifiers IC1d and IC4c. These op amps are connected as inverting amplifiers to provide negative going pulses to drive the VCO and VCA ramp generators.

The anode of ZD1 is normally at zero volts and the cathode at +15 volts. When the output of IC1b is driven negative by a trigger pulse the cathode of D2 approaches zero. This negative-going pulse is rectified by D2 and charges C2 rapidly. C2 discharges through RV2 and R4, the value of RV2 varying the rate between a few milliseconds and several seconds. This DC ramp is buffered by IC1c connected as a voltage follower, to prevent RV3 affecting the C2, RV2 discharge time. As both ends of RV3 are normally at +15 volts, D3 is biased off. When the output of IC1c swings negative on receipt of the trigger, D3 is turned on and allows the ramp waveform to control the sweep input of the VCO. RV4 sets the lower frequency of the oscillator and as pin 8 goes more negative, the frequency rises. The range of this frequency sweep is determined by RV3 whose setting limits the negative swing of D3 cathode. However, C2 charges quickly and discharges more slowly. The characteristic falling sine sound of the drum synth is created at the output of the VCO. By use of RV4 pitch, RV3 pitch bend and RV2 slope a whole range of sweeps are possible.

The voltage controlled amplifier is based on the Motorola 3340 voltage controlled attenuator IC. The selected output from the VCO is fed to the IC and the output is fed to the volume control, RV8. The voltage controlling input is fed to pin 2 via RV7, which is preset so that with no trigger present there is no output. The VCA ramp generator functions in a similar manner to the VCO ramp generator. The base-emitter junction of Q1 is reverse biased to provide the noise source. This noise is amplified by Q2 and further amplified by IC5 whose gain is variable via RV11, determining the noise level to be fed to the VCA input.

Notice that when the noise is switched in, the sine filter, C4, is switched out. This is to ensure that when noise and sine are used together, this filter does not attenuate the useful part of the noise spectrum required. Although this marginally increases the sinewave distortion this is not noticeable above the deliberately introduced noise.

The low frequency oscillator uses IC4b as an integrator and IC4a as a Schmitt trigger, together making a triangle wave oscillator. The speed is varied by RV9 between about 0.5 Hz and 1 kHz, and the amplitude is varied by RV10. C9 can be switched in to integrate the triangle wave to provide a sinewave approximation for vibrato effects.

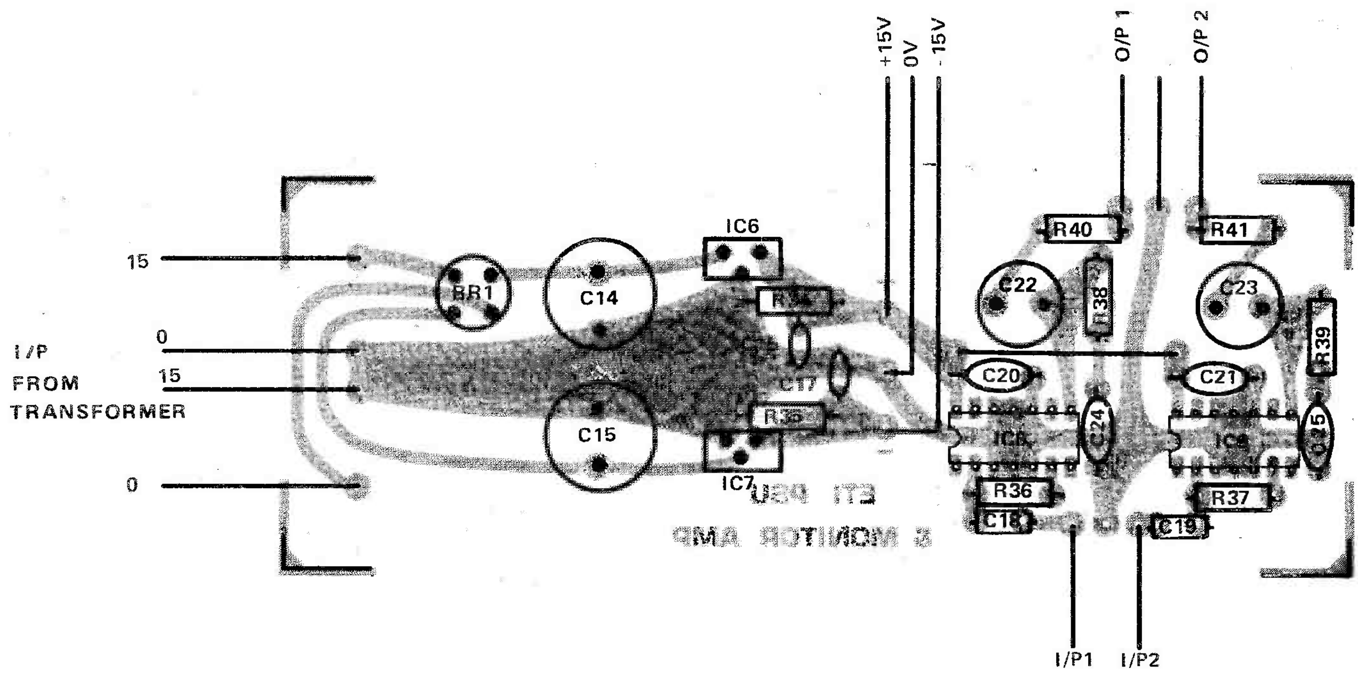
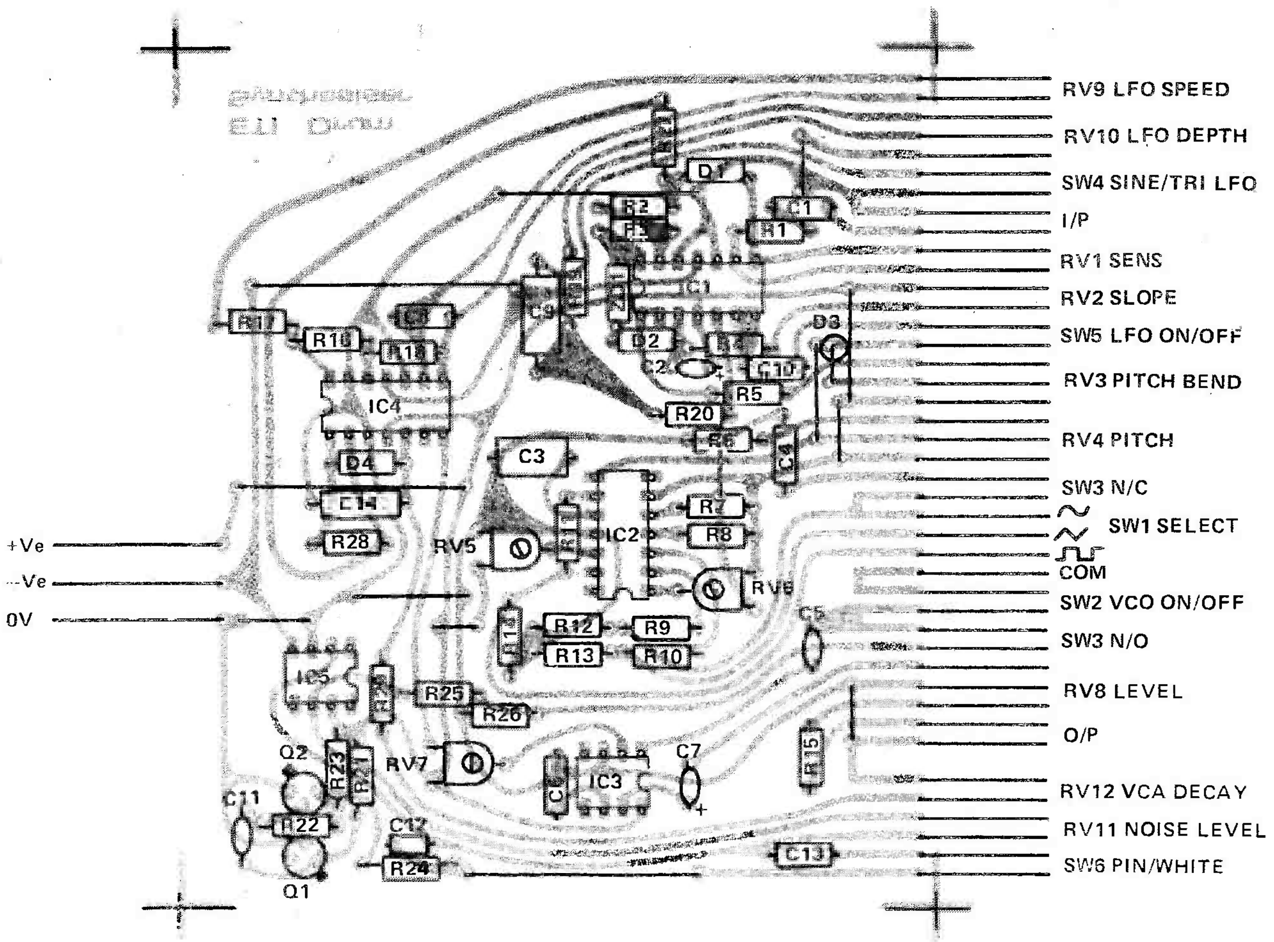


Fig.7. (above) Component overlay of the PSU and monitor amplifier board.

Fig.8. (below) Component overlay of the control circuit board. Take care when wiring the edge connector.



BUYLINES

A varied buylines, as certain components have been selected for easy construction. The exceptional case is part of a range (larger sizes available on request) supplied by Campbell Clarke Cabinets, 2 Arden Court, Church Road, Perry Barr, Birmingham, B42 2LF, Tel: 021-356-0890 — a very stylish wooden ended cabinet which is attractively priced at £11.50.

The MEC switches are only available from Watford Electronics (order code SRL plus colour of switch cap) along with the knobs. Also state cap colour when ordering the knobs. The micro toggle switches can be purchased from Marshall's. Electrovalue stock the PC mounting potentiometers. For the inter PCB sockets, plugs and shells, Technomatic are suppliers. Our Remo practice drum pads were obtained from The Rhythm Box (Drum Store), 5 Denmark Street, WC2 8HLP, Tel: 01-240-3836. A crystal insert fits neatly inside these pads and acts as the trigger sensor.

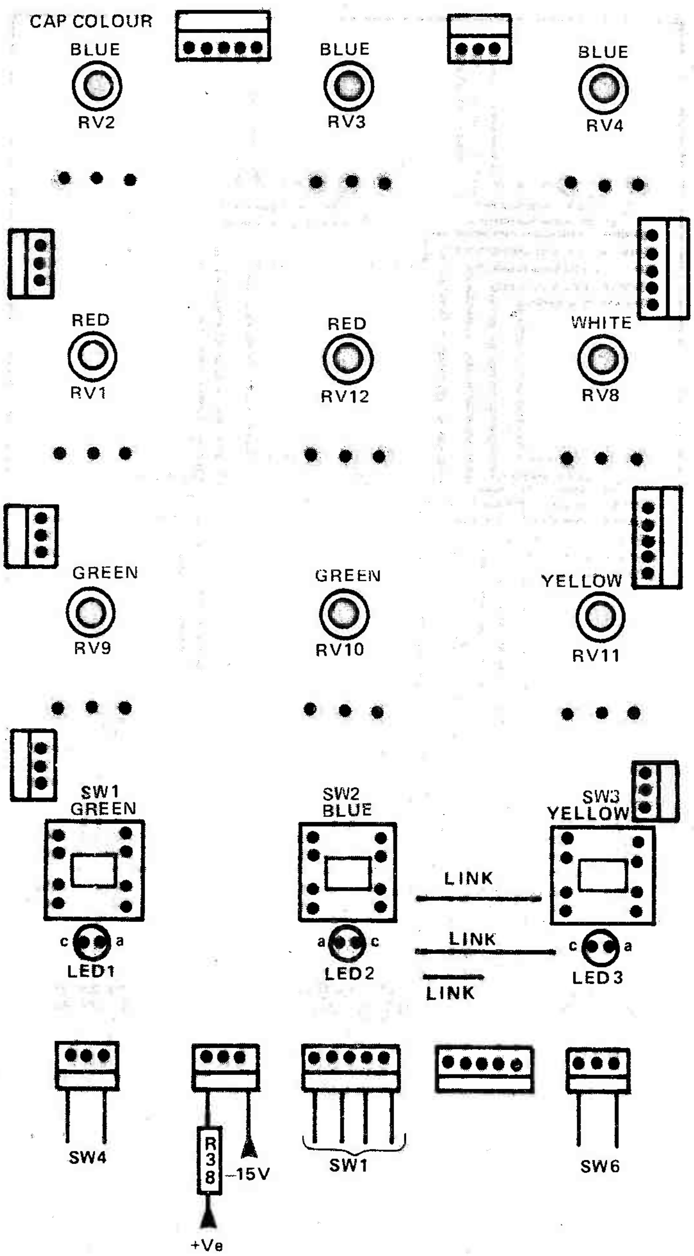


Fig.9. Component overlay of the function board.

PARTS LIST

Components For One Channel

Resistors

R1,2,4,5,12,13,14,18, 20,24,26,27	10k
R3,22,28	1M0
R6	270k
R7,8,19,23,25,29	4k7
R9,10,16	22k
R11,21	220k
R15	47k
R17	1k0
R38	2k2 1W

Potentiometers

RV1,2	1M0 lin PCB mounting
RV3	250k lin PCB mounting
RV4	500k log PCB mounting
RV5,6	100k miniature horizontal cermet preset
RV7	10k miniature horizontal cermet preset
RV8	10k log PCB mounting
RV9,12	500k lin PCB mounting
RV10	100k lin PCB mounting
RV11	2M0 log PCB mounting

Capacitors

C1	4n7 polycarbonate
C2,5	1u0 tantalum 35V
C3	100n polyester
C4	47n polyester
C6,11,12	1n0 polycarbonate
C7	10u tantalum 35V
C8	470n polycarbonate
C9	10u 25V electrolytic axial
C10	100n polycarbonate
C13	22n polycarbonate
C14	4u7 16V electrolytic

Semiconductors

IC1,4	TL084
IC2	8038
IC3	3340
IC5	TL081
D1–D4	1N4148
ZD1	15V 400 mW
Q1,2	BC109
LED 1,2,3	0.125" dia red LEDs

Miscellaneous

SW1, DP 3 position slide switch (one pole used only) SW2,3,5, MEC 2 N/O, 2 N/C latching push button (see Buylines), SW4,6, SPST micro-miniature toggle, 43-way edge connector, 8 x 3-way right angle inter PCB connectors including plugs, sockets, shells, 5 x 5-way right angle inter PCB connectors including plugs, sockets, shells, case (see Buylines), 9 knobs, input and output sockets, 4 6BA tapped spacers (length), 4 6BA plastic spacers, trigger sensor, drum pads (if required), MEC switch cap colour green, blue and yellow, knob cap colour 3 blue 2 red, 2 green, 1 white, 1 yellow for a single channel drum synth.

Additional Components For Two Channels

Resistors

R30,31	22k
R32,33	1M0
R34,35	2R7
R36,37	150R

Capacitors

C14,16	1000u 25V PCB electrolytic
C15,17	1u0 16V tantalum
C18,19	68n ceramic
C20,21,24,25	100n polyester
C22,23	220u PCB electrolytic

Semiconductors

IC6	7815
IC7	7915
IC8,9	LM380
BR1	1A 50V bridge rectifier

Miscellaneous

T1 15-0-15 6VA transformer, SW7,8 DPDT miniature toggle, FS1 500 mA fuse, stereo jack socket, length of 3 core mains cable.

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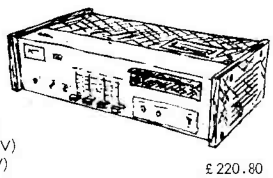
A40 P.A. CENTRE

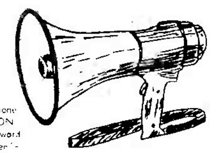


All Solid State
Power: 40W Music
20W RMS
Mono Cassette Deck
Slider Controls
V.U. Meter
Inputs: 2 - Mic (1mV)
1 - Aux (100mV)
1 - Aux (15mV)

£220.80

The "P.A. Centre' has fully comprehensive facilities making it unique equipment for multi-application use in audio, public address, sound and communication systems. Presentation is in a teak sidea cabinet, with black silver deck and control facias, housing the 40W mono amplifier, cassette recorder, internal microphone and speaker. Outputs of 8,16 ohms and 100V line enable a wide range of external loudspeaker systems and P.A. Horns to be used; operation from A.C. mains and 12V car battery further increases the versatility of application, and location possibilities. The "P.A. Centre' can be used as a mixer unit, and the internal condenser microphone or loudspeaker muted as required.

L81 10W MEGAPHONE

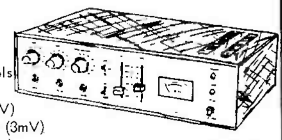


Power: 10W
Range: $\frac{1}{4}$ mile
Batteries: 6 - $1\frac{1}{2}$V

Easy-to-use and hold, this lightweight megaphone has a range approaching a $\frac{1}{4}$ mile. Features ON/OFF switch incorporated in pistol grip and forward facing dynamic microphone. Solid-state S semi-conductor circuit, powered by 6 x $1\frac{1}{2}$v batteries. Attractive red and white case with carrying strap.

£89.70

A56 50W A.C./D.C.

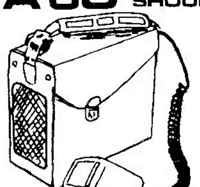


All Solid State
Power: 50W RMS
S.N.R.: 55dB
Rotary & Slider Controls
V.U. Meter
Inputs: 3 - Mic (0.5mV)
1 - Mag Phono (3mV)
1 - Aux (200mV)

£117.30

The A-56 is a 50W A.C./D.C., all silicon solid state P.A. amplifier. Its outstanding performance and versatile operating features make it ideal for use in a wide range of applications, such as in schools, factories, restaurants and shopping centres. The amplifier is housed in a grey finished metal cabinet, well complimented with a black and silver front fascia panel. 3 low impedance microphone inputs are available. The third of these inputs is an alternative to "auxiliary" or 'magnetic phono (R.I.A.A.)" inputs via a selector switch. A 3 position switch marked MUSIC/SPEECH is provided to give Bass Cut. The pre-amplifier output is available through a 5-pin DIN socket, rear mounted. Since the "auxiliary" input is through the same socket, it is possible to use a single connector for recording and playback from a tape recorder.

A60 SHOULDER P A SYSTEM

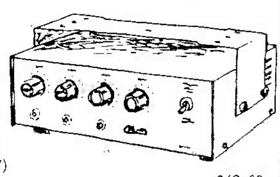


£62.10

Power: 5W RMS, Range $\frac{1}{4}$ mile
Batteries: 6 - $1\frac{1}{2}$V

This is a versatile, complete P.A. system essential for couriers and guides, public speakers, traffic and parking controllers, showground and display attendants and for countless publicity and promotion activities. The neat leather-tone case with adjustable shoulder strap houses a solid-state amplifier, loudspeaker and storage for the "press-to-talk" microphone on self-coiling lead.

A55 MOBILE AMPLIFIER

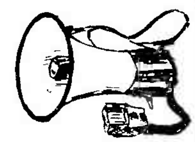


All Solid State
Power: 20W RMS
S.N.R.: 60dB
Pos. or Neg. Earth
Car Mounting Bracket
Rotary Controls
Inputs: 2 - Mic (3mV)
1 - Aux (40mV)

£69.00

Able to operate from both A.C. mains and 12V D.C. this is the ideal solid-state P.A. amplifier for installation in vehicles, caravans, boats, and for exhibitions, demonstration and display purposes. 3 inputs are conveniently front located, individually gain controlled and will accept two microphones plus ceramic or crystal cartridge, radio or tape recorder. Speaker output impedances of 4,8 &16 ohms and 100V line allow for long and complex speaker runs. A two-way chrome mounting bracket stand is provided for easy fitting to dashboards, shelves, panels and control desks. The metal cabinet is finished in grey with black and silver front, incorporating gain controls, tone control and A.C. battery power switch with indicator lamp.

L83 MEGAPHONE (SEP. MIKE)

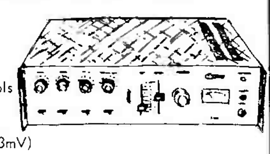


Power: 16W, Range: $\frac{1}{2}$ mile
Batteries: 8 - $1\frac{1}{2}$V

High powered, yet compact and easy to carry and use, this solid state megaphone has a range of $\frac{1}{2}$ mile. The noise cancelling microphone clips onto the base, has a convenient press-to-talk switch, and volume control and is fitted with a self-coiling lead extending to over $1\frac{1}{2}$ metres. This sturdily constructed megaphone can be operated fitted onto a stand using the tapped hole provided, free standing on table and floor, and portably shoulder slung, or strap carried.

£69.00

A70 PROFESSIONAL



All Solid State
Power: 175W RMS
S.N.R.: 55dB
Rotary and Slider Controls
V.U. Meter
Inputs: 4 - Mic (0.5mV)
1 - Mag Phono (3mV)
1 - Aux (200mV)

£276.00

Designed and developed to meet - and surpass - European performance standards, this P.A. amplifier boasts a power handling of 175W (R.M.S.). It is protected against a short circuit output and incorrect battery connections. Each of the four input channels has its own rotary gain control and individual slide switch operating FLAT/LO Filters. Overall Bass and Treble levels are set by slide controls; overall volume level is obtained by observing the inset 2" V.U. meter and operation of the extra large Master control. Operation is from A.C. mains or from 24V D.C. 4 inputs are low impedance with a $\frac{1}{2}$mV sensitivity; magnetic phono input with R.I.A.A. equalisation provided through a 5-pin DIN socket (3mV). An additional input accepts signals from tuners, tape recorders etc. (250mV). Output matching is to 4,8 and 16 ohms, 70V and 100V lines plus booster amplifier socket. The casing incorporates front grab handles and protective feet, and can be used free standing or rack mounted.

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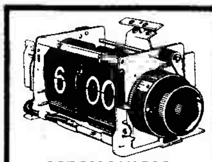

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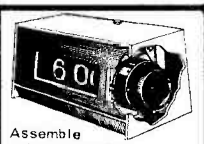

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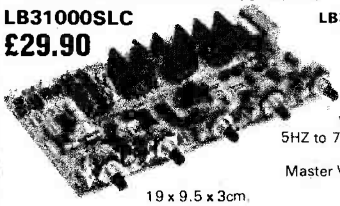

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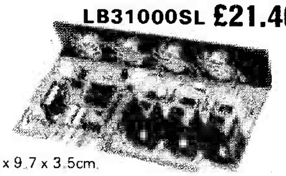

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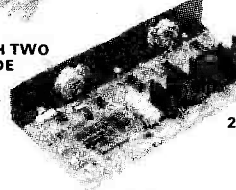
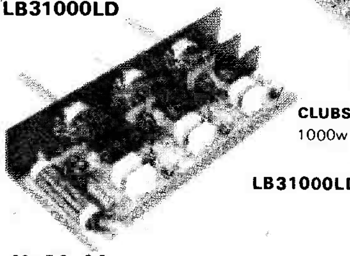


LB41000LS £17.50
20 x 9.2 x 3.5 cm

LB31000LD



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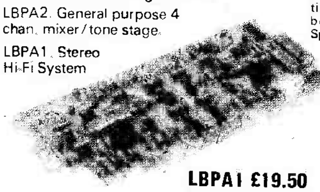

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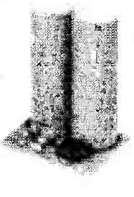

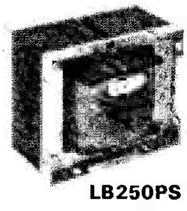

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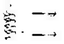

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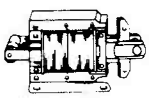
HEAVY DUTY SOLENOID, mf. by Magnetic Devices. 240V. A.C. Intermittent operation. Approx. 20 lb. pull at 1.25 in. Ex-equip. Tested. Price: **£4.75** + 75p. P. & P. (**£6.33** inc. VAT & P.)



A.C. SOLENOID pye ether type 176/2 240 AC. Approx 1lb at ½ inch, intermittent rating. Price **£1** p&p 20p (**£1.38** inc VAT + P).

AG/GT 24V. D.C. 70 ohm Coil Solenoid. Push or Pull. Adjustable travel to 3/16 in. Fitted with mounting brackets and spark suppressor. Size: 100 × 65 × 25 mm. Price: 3 for **£2.40** + 30p. P. & P. (min 3 off.) (**£3.11** inc. VAT & P.)

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12 volt. 11-way, 4 bank (3 non-bridging 1 homing) **£3.00.**

P. & P. 35p (**£3.85** inc. VAT & P.). N.M.S.

Reed Switches. Size 28mmx4mm dia. Price 10 for **£1.00** + p&p 20p (total incl. VAT **£1.38**). 100 for **£8.00** + p&p 30p (total incl. VAT **£9.55**).

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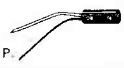
Sub. Min. Honeywell Lever m/s type 311 5m 906t. 10 for **£3.50** post paid (**£4.37** incl. VAT).
These V3 types.
Button type (Pye) 10 for **£3.00** (**£3.80** incl. VAT)
Short Lever type 16amp. rating (Grouzet) **£4.00** (£4.95 incl. VAT)
Roller Type (Bonnella) 10 for **£3.50.** (**£4.37** incl. VAT). N.M.S.

U.P. I. O lever m switch mfg by Cherry Co USA Precious metal low resistance contacts 10 for **£2.25** P. & P. 30p Total inc VAT **£2.93** (min 10).

MERCURY SWITCH



Size 27mm × 5mm. 10 for **£5.00** (inc VAT **£6.12**) min quantity 10. 30p P. & P.
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Crouzet 1 rpm. 115V. A.C. Motor operating 2 Roller Microswitches (4 amp). Can be used on 240V A.C. with either 0.25 mfd 250V Condenser or 5.6K wirewound Resistor 7 watt (supplied). Price £2.50 + 50p P. & P. (£3.45 inc VAT & P).

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Type LS6/L11. Coil 240V 50 Rs. Contacts – 3 make: 600V. 20amp. 1 break: 600V: 20 amp. Price: **£5.50** + 50p P. & P. (**£6.90** inc. VAT & P.).

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SMITH BLOWER, Type FFB. 1706. Small quiet smooth running. 240V. A.C operation. Output aperture 45 × 40cm. Overall size 135 × 165 cm. Flange mounting. Price: **£4.25.** P. & P. 75p. (Total: **£5.75** inc. P. & VAT.) N.M.S.

24 volt. D.C. BLOWER UNIT

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wire ended capacitors N.M.S 10 for **£1.50** p&p 50p (£2.30 inc VAT + p&p) (Min 10)

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Powerful continuously rated a.c. motor complete with 5 blade 6½in. or 4 blade 3in aluminium fan. Price **£3.00.** P. & P. 65p. (**£4.20** incl. VAT & P.).

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200 watt (1 amp inc. a.c. voltmeter	£14.50
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1 KVA (5 amp MAX)	£22.50
2 KVA (10 amp MAX)	£37.00
3 KVA (15 amp MAX)	£45.50
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10 KVA (50 amp MAX)	£168.00
15 KVA (75 amp MAX)	£260.00

3-PHASE VARIABLE VOLTAGE TRANSFORMERS

3KVA (max. 15 amp.)	**£106.43**
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All plus Carriage & V.A.T.

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Suitable case **£11.00** (**£14.30** incl. VAT & P. & P.).

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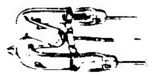

Range available from stock. S.A.E. for details.

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4ft 40 watt £8.70 inc. VAT **£10.00** (callers only) **2ft 20 watts £6.20.** Post 75p **£7.99** inc VAT & P). (For use in standard bi-pin fittings)
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WIDE RANGE OF DISCO LIGHTING EQUIPMENT

S.A.E. (foolscap) for details

PROGRAMME TIMERS 240V AC operation 12 individually adjustable cams **£7.50** + 75p p&p. (**£9.49** inc. VAT).

12 Cam Programmer Timers. 240v A.C. op. Each Cam individually adjustable. Price **£7.50** plus 75p p&p (**£9.49** inc. V.A.T.)
Ditto, 6 adjustable 6 fixed cams Price **£6.00** plus 75p p&p **£7.76** inc.. VAT)

Superior Quality Precision Made NEW POWER RHEOSTATS

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100 WATT 1.5 10 25 50 100 250 500 1kΩ 1.5kΩ/2.5kΩ 3.5kΩ **£5.90** p. & p. 35p (**£7.19** inc. VAT)
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Wide range of AC and DC relays available from stock. Phone or write in your enquiries

Other types available — phone for details N.M.S.
230/240V AC Relays: Arrow 2 c/o 15 amp **£1.50 £1.96** inc VAT & P). T.E.C. open type 3c/o 10 amp **£1.10** (**£1.50** inc. VAT & P).
KMK1 Relay. 230V AC 1 c/o Open type 10 amp contact, mf by "Keyswitch" **80p** + 20p P. & P. (**£1.15** inc VAT). 5 for **£3.75** post paid (**£4.32** inc. VAT).
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Hellermann Deutsch. Hermetically sealed sub-min Relay. 12-24V D.C 2 c/o. 850 ohm coil. 0.2 pitch P.C. MOUNTING L. 20mm. W. 10mm. H. 12mm. Fraction of maker's price **£2.50** post paid (**£2.88** inc. VAT). N.M.S.
Diamond H heavy duty A.C. relay. 230/240V AC two c/o contacts 25 amps res at 250V AC **£2.50** P&P 50p (**£3.45** inc VAT + P. & P.) Special base **50p.** (incl. VAT 58p). N.M.S.

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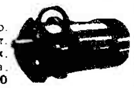
4½rpm SIGMA motors approx. 35lbs inch
7½rpm KLAXON motors approx. 25lb inch
28rpm WYNSCALE motors approx. 20lb inch
71rpm WYNSCALE motor approx. 10lb inch
Above four motors are designed for 110V. A.C. supplied with auto transformer 240V. A.C. operation. **£7.75** p. & p. 75p. Total incl. VAT **£9.78.** N.M.S.

19 rpm FHP 220/240V a.c. reversible torque 14.5kg Gear ratio 144-1 Brand new including capacitors mf **CITENCO.** Price **£14.25** + £1.25 P. & P. (**£17.83** inclus VAT) N.M.S

30 rpm 230/240V a.c 50lb in mf **PARVALUX** Price **£15.00** + £1.50 P. & P. (**£18.98** inclus VAT) N.M.S

56 rpm. 240V a.c. 50lb in 50Hz 0.7 amp. Shaft length 35mm Dia 16mm. Wt. 6kg 600g mf **FRACMO.** Price: **£15.00** + £1.50 P. & P. (**£18.98** inclus. VAT) N.M.S



100 rpm 110V AC 115lb. in 50Hz. 2.8 amp. Single phase split capacitor. Immense power. Totally enclosed. Fan-cooled in-line gearbox. Length 250mm. Dia. 135mm. Spindle dia. 15.5mm, length 145mm. Tested. Price **£12.00** + £1.50 P. & P. (**£15.53** inc.VAT). R. & T. Suitable Transformer for 230-240V op. Price **£8.00** + 75p P. & P. (**£10.06** inc. VAT).

200 rpm 35 lbs in 115V 50Hz Price **£16.00** + £1.50 P. & P (**£20.13** inclus VAT) N.M.S
Suitable Transformer for 230/240V a.c. Price **£8.00** + £1.00 P. & P (**£10.35** inclus VAT) N.M.S

12V. D.C. type SD2 Shunt ⅛ ph continuously rated 4000 rpm Mf. **PARVALUX.** Price **£10.00** + 75p P. & P. (**£12.35** inclus VAT) N.M.S.

1 rpm 230/240V, a.c. Synchronous geared Motor, mf. **HAYDON.** **2 rpm** 230/240V. a.c. Synchronous geared Motor, mf. **CROUZET.** Either type **£2.90** + 30p. P. & P. (**£3.68** inclus. VAT). N.M.S.

1,400 rpm 115V. a.c. Motor. HP ¼ continuously rated. Fitted with anti-vibration cradle mounting. Mf. **FRACMO.** Supplied complete with Transformer for 230/240V a.c. operation. Price: **£10.00** + £1.00 P. & P. (**£12.65** inclus. VAT). N.M.S.

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Direct coupled to 1/3 h.p. 110/115V. A.C. motor 4.2 amp. 1380 rpm. Motor manuf. by A.E.I. or G.E.C. Pump by Williams. Max. Vac. 25" H.G. Max pressure cont. 10 p.s.i. Int. 15 p.s.i. Max. airflow 3 c.f.m. at "O" H.G. Price **£30.00** + £3.00 P. & P. (**£37.95** incl. VAT)
Suitable transformer for 240V op. **£10.00** P. & P. £2.00 (**£13.80** inc. VAT).

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Precision built USA. Horizontally opposed twin head diaphragm type producing 20lbs. approx. P.S.I. per head. 3.5 plus C.F.M. Output virtually pulse free. Powered by 110V A.C. motor size 30x23x15cm. Weight 7 kilos. Price **£24** + **£2** p&p.) (total incl. VAT **£29.90**).
VAT **£12.65.** N.M.S. Suitable transformer for 240V op. **£8.00** P&P £1.50 (**£10.93** inc. VAT).

VERY EXCEPTIONAL OFFER REDUCTION DRIVE GEARBOX

Ratio 72.1 input spindle ¼ × ½in. Output spindle ⅜ × 3in long. Overall size approx 120 × 98 × 68mm. All metal construction. Ex-equip tested. Price **£2.00** + 50p P. & P. (**£2.88** inc VAT & P).

A.C. Wkg. TUBULAR CAPACITORS.

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1.5 mfd. 440V. A.C.	**60p**	7.5 mfd.	200V. A.C.	**£1.00**
2 mfd. 250V. A.C.	**60p**	10 mfd.	250V. A.C.	**£1.00**
2 mfd. 450V. A.C.	**75p**	10 mfd.	400V AC	**£1.75**
2.2 mfd. 440V. A.C.	**75p**	14 mfd.	400V AC	**£3.00**
3 mfd. 440V. A.C.	**£1.00**	15 mfd.	250V AC (block)	**£1.50**
4.1 mfd. 440V. A.C.	**£1.00**			
5 mfd. 400V. A.C.	**£1.25**	19 mfd.	280V AC	**£2.00**
5.3 mfd. 160V. A.C.	**60p**	20 mfd.	250V AC	**£2.25**
5.4 mfd. 280V. A.C.	**75p**	50 mfd.	370V (block)	**£5.00**
6.5 mfd. 280V. A.C.	**£1.00**			

P. & P. up to 2.5 mfd. 25p. 3 mfd to 20 mfd. 50p. 50 mfd. £1.50. All plus V.A.T. N.M.S.

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Venner Type ERD Time switch 200/250V a.c. 30 amp contact 2 on 2 off every 24 hrs at any manually pre set time 36 hour Spring Reserve and day omitting device Built to highest Electricity Board specification. Price **£9.00.** P. & P. 75p (**£11.22**). R. & T.

SANGAMO WESTON TIME SWITCH

Type S251 200/250V a.c. 2 on 2 off ... amps contacts with override switch dia 4 - 3 ... price **£8.00** + ... 50p inc. VAT **£9.78.** Also available with Solar dial ...

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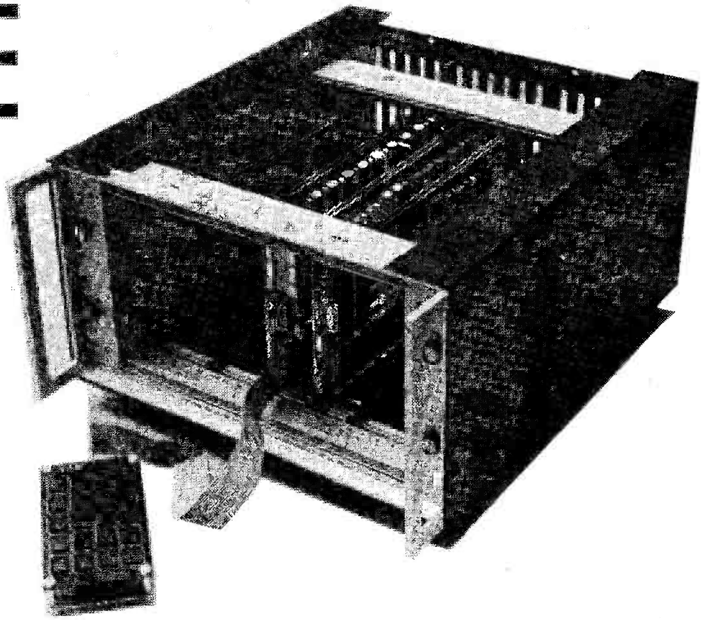
MICROFILE

Henry Budgett leafs through the latest Vero catalogue to case his computer collection.



Welcome, once again, micro-fans to the world of small systems. I see that the ZX 80 topped the ratings for interest value last month, more on that in just a minute. Our busy network of spies has been burrowing deep into the fabric of both government and industry to bring you the following news items at great personal risk.

Micros For Schools

A mole, deep within the echelons of the Department of Industry, has revealed the existence of an intrepid plot to give microcomputers to schools. Naturally there is a catch, or 22, you have to enter a competition. Seriously though, a competition – in essay form – will be shortly announced for secondary schools with, currently, 100 British micros as prizes. Talks are being held with local industry and banking institutions in the hope that more finance – and hence more prizes – will be forthcoming. Your Headmaster should have received details by now and a full Press release will shortly be given so watch this space for further details ..... wild horses wouldn't make us reveal what system is being considered!

The Case For Nascom

One of Microfile's more intrepid investigators recently emerged, smiling, from the latest Vero catalogue. It seems that the range of parts is so vast that you can box and house anything. The outcome of this is that if you order a 3D-N card frame you will be able to house your Nascom (1 or 2) for a mere £24.28. Added extras, such as modules, card fronts, Veroboards, edge connectors and a whole lot more can also be purchased along with a nice case to fit round it all.

Also discovered, and now in full-time use, is a card frame/case to house a Tangerine system along with all the extras such as a module to fit the necessary power supply into. This is a half width, extended System KM4C with card guides for International boards (whew). The same frame can also take Acorns by fitting Eurocard guides and an indirect connector plate. Subtle stuff all this, and much more fun than just asking for "the box"!

Research Into Sinclair

It appears that the author of this column may have been led a trifle astray during his research into the insides of the ZX 80. Shortly after the issue hit the streets a letter arrived from Clive Sinclair which refuted a number of points raised in the item. Here, in its entirety is the letter and readers who seek a fuller insight into the workings of the machine should either stifle their impatience or rush out and buy a copy of June Computing Today, which contains a full review.

Dear Mr. Harris,

The news item in the Microfile column of your April issue says some nice things about our ZX80 computer, for which many thanks, but unfortunately there are one or two errors of fact which I would like to correct.

The first is that the operating language is not Tiny BASIC but quite a powerful true BASIC with, we believe, better editing facilities and greater speed than any of our competitors.

Again, contrary to the news item the ZX80 has full machine code facilities. Although it is true that RAM extension is limited to 16K bytes, this is no small quantity when the tight packing the ZX80 achieves in its RAM is considered. Indeed, I suspect that more lines of BASIC can be accommodated on the ZX80 than on any of the competitors, all of which cost several times the price. At the other extreme the excellent Hewlett Packard machine costing around £3,000 accommodates a maximum of 32K bytes of RAM.

The final remark in the column doubts the practicality of adding new ROM's, extra languages and discs to the machine on the grounds that "the CPU is already rather overworked". The only thing the CPU does in our machine which it does not do in others is to drive the display, thereby saving integrated circuits, board area and costs, which is reflected in our selling price. It is not "overworking" the CPU in any sense as it would otherwise be idle during the display period.

A new plug-in ROM will soon be available at an additional cost of around £20, extending the maths. capability of the computer to include log. and trig. functions, and also increasing the data handling capacity and incorporating a floppy disc facility.

Yours sincerely,
Clive Sinclair.

Science of Cambridge Ltd.
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ETI

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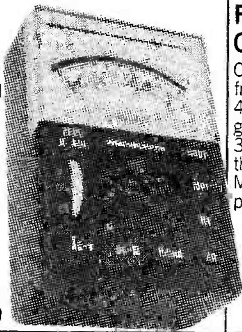
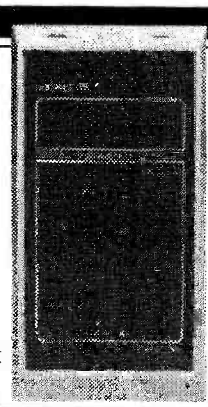


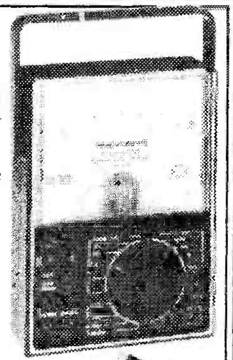
Handy multitester for home and work-shop. Easy-to-read two colour 5cm meter, pin jacks for all 8 ranges. Reads AC and DC volts: 0-15-150-1000 DC current: 0-150 mA. Resistance: 0-100,000 ohms. Accuracy: ± 3% full scale on DC ranges. ± 4% on AC ranges. Complete battery. 22-027. REG. PRICE **£6.95**

6-DIGIT FREQUENCY COUNTER



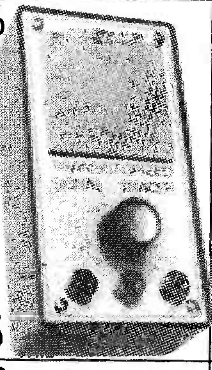
Counts frequencies from 100 Hz to over 45 MHz with 100 mS gate time. Accuracy is 3 ppm at 25°C or less then ± 30 Mkz on 10 MHz! Overload-protected 1-meg input. Sensitivity, 30 mV up to 30 MHz. Req. 9V battery. 22-351. REG. PRICE **£79.95**

MULTITESTER



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

TRANSISTORIZED SIGNAL TRACER

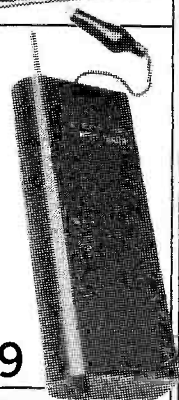


Spot circuit troubles and check RF, IF and audio signals from aerial to speaker on all audio equipment. With 9V battery, instructions. 22-010. REG. PRICE **£9.95**

DIGITAL IC LOGIC PROBE

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

SIGNAL INJECTOR



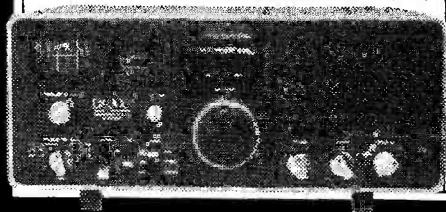
For RF, IF, AF circuits. Maximum accuracy. Easy pushbutton operation. Needs two "AA" batteries. 22-4033. REG. PRICE **£2.79**

AC/DC CIRCUIT TESTER

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

REALISTIC DX 300

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



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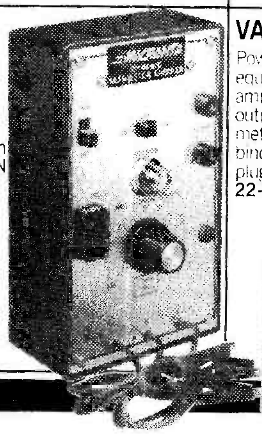

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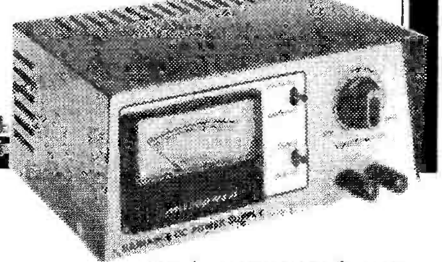

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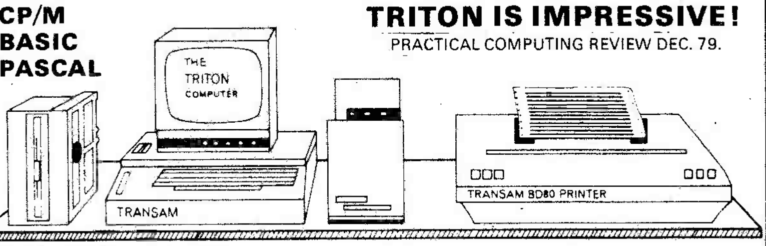

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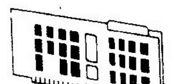

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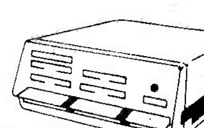

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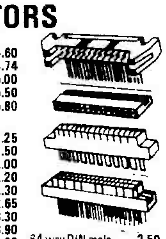

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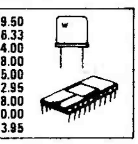

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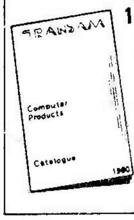

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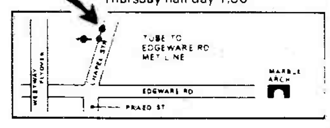

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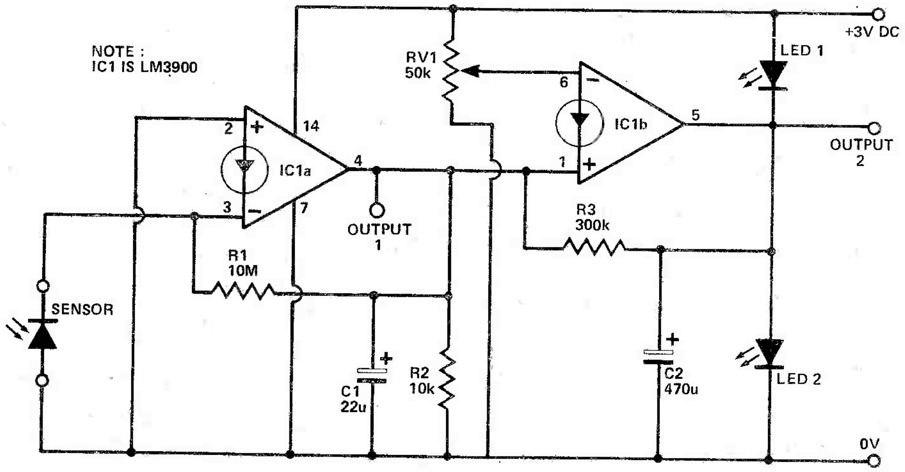
TECH TIPS

Light/Temperature Indicator

M Miller, Reading

Using half a LM3900 quad Norton amplifier, either light or temperature can be monitored with this device. In the light monitoring mode a reverse biased LED was used (a clear type, not opaque) at output 1. The light value can be measured with a high impedance voltmeter, approximately 0-30 V FSD

RV1 sets a threshold voltage to IC1a, so that either LED 1 or LED 2 will be on depending on whether output 1 exceeds the threshold voltage or not. In the temperature mode a 1N4148 diode was used, also reverse biased. Any small glass diode can be used. The amplifier outputs are the same as in the light monitoring mode.

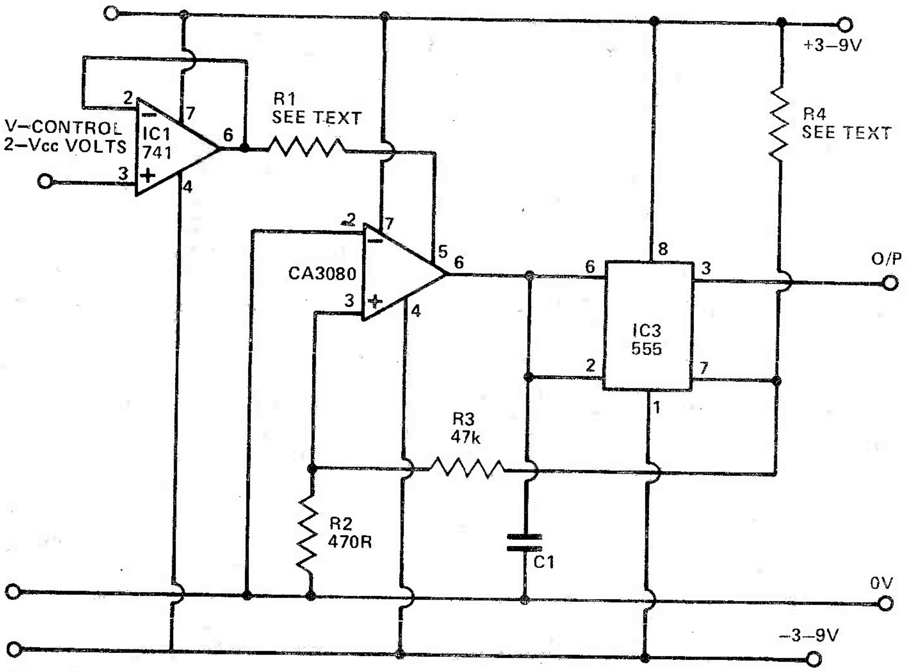


555 Voltage Control

S Draper, Lincoln

This circuit was developed to provide a cheap, reliable and accurate voltage controlled oscillator. It uses readily available components and the control over mark-space ratio common to other 555 circuits is retained. Frequency-voltage response is linear over approximately one decade making the circuit useful in timing applications. Operation is as follows :

IC1 buffers the input voltage and produces the control current for IC2. IC2 is an operational transconductance amplifier and produces an output current proportional to the control current multiplied by the differential input voltage. This output current is used to charge and discharge the capacitor C1 in the normal way. The equation for output high and output low times are given below :



Output high time = $\dfrac{R1C1(47.5+R4)}{9024\,V_{control}}$

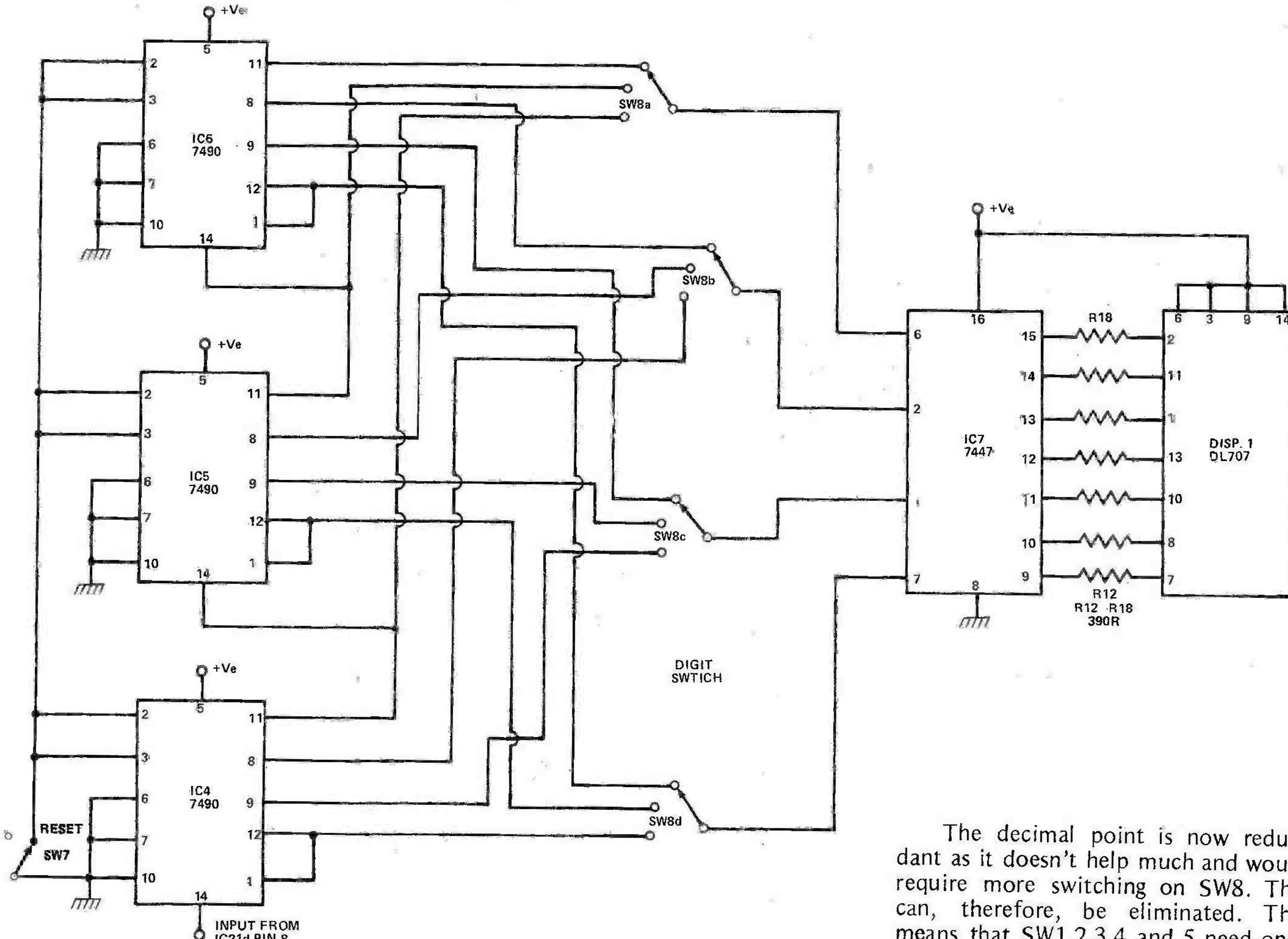
Output low time = $\dfrac{R1C1}{192V_{control}}$

where all resistances are in kilohms and all capacitances are in microfarads.

Current consumption is a miserly 10 mA from a 12 V supply making the unit suitable for battery power.

N.B. – R1 should not be less than 18 k.

Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items. ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.



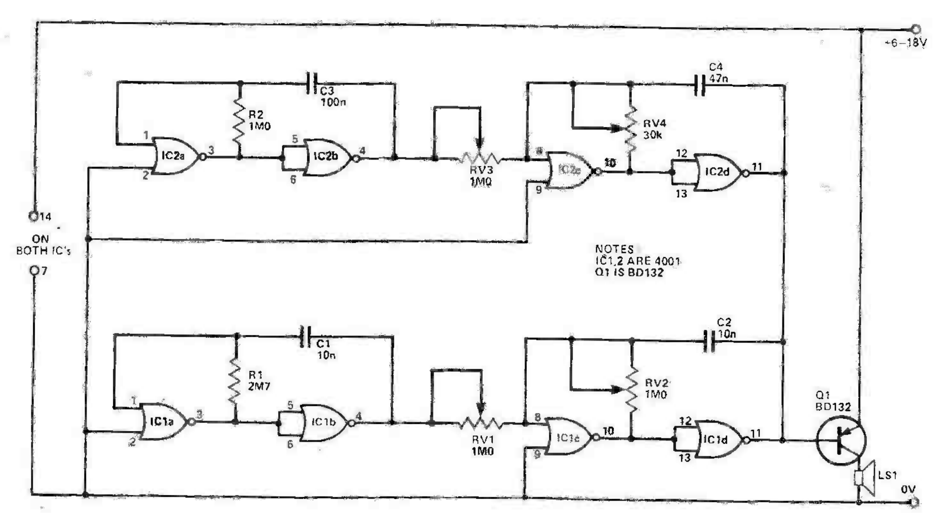
DFM Mods

R Lea, Amersham

This is a simple, cost reducing modification to the DFM published in ETI June 1977. The need for three decoders and displays has been reduced to one.

The outputs from the counters (IC4-6) are switched via SW8 to a single 7447 decoder (IC7) driving a DL707 display. In use, the 'test' button on the original unit is pressed. When counting is complete, SW8 can be cycled through the digits to obtain a reading.

The decimal point is now redundant as it doesn't help much and would require more switching on SW8. This can, therefore, be eliminated. This means that SW1,2,3,4 and 5 need only be two pole, so they can all be incorporated one 2p 6w rotary switch, further reducing cost. These two modifications do make the meter slightly less convenient in use, but this is outweighed by the reduced cost. To modify the existing PCB the tracks to pins 1,2,6 and 7 of IC7 are cut and it is then a simple matter to insert SW8 as shown.



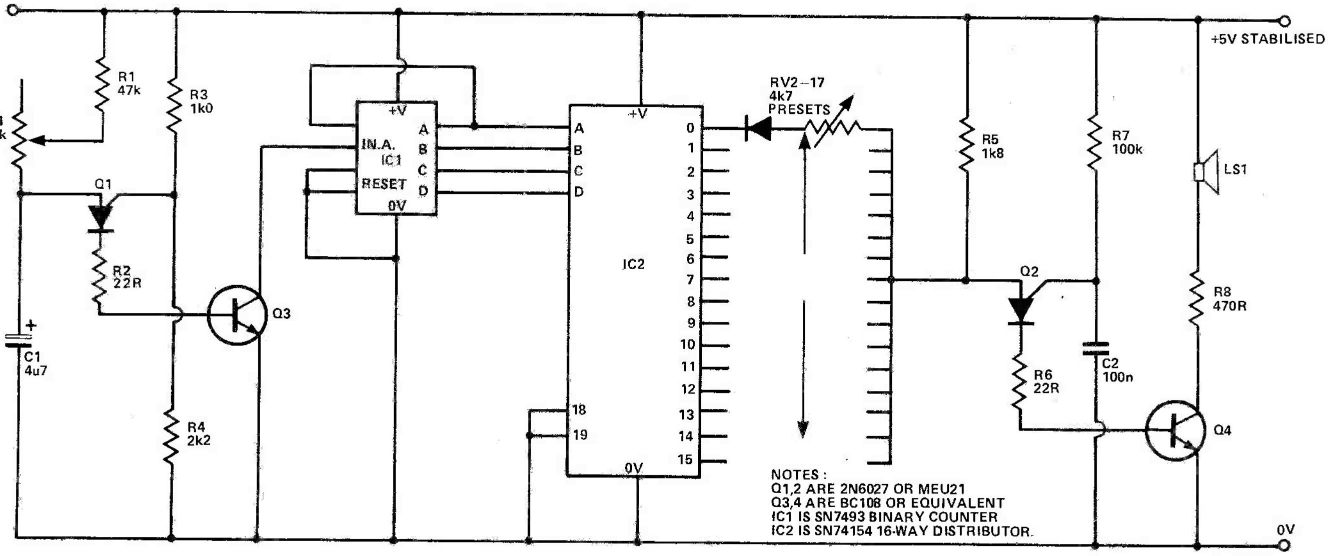
Sound Effects Unit

P Layzell, Sandy

This circuit consists of four CMOS oscillators gated together in a configuration that will produce a multitude of effects from white noise to a multi-banked Trimphone.

Each IC is connected as a warble tone generator and mixed together at the base of Q1. LS1 can be from 8 – 100 R, but the transistor tends to get a bit hot below 30 R, so a small heatsink may be needed.

None of the component values are critical and if desired, RV1,3 can be replaced by ordinary resistors without affecting the variety of sound effects too much.



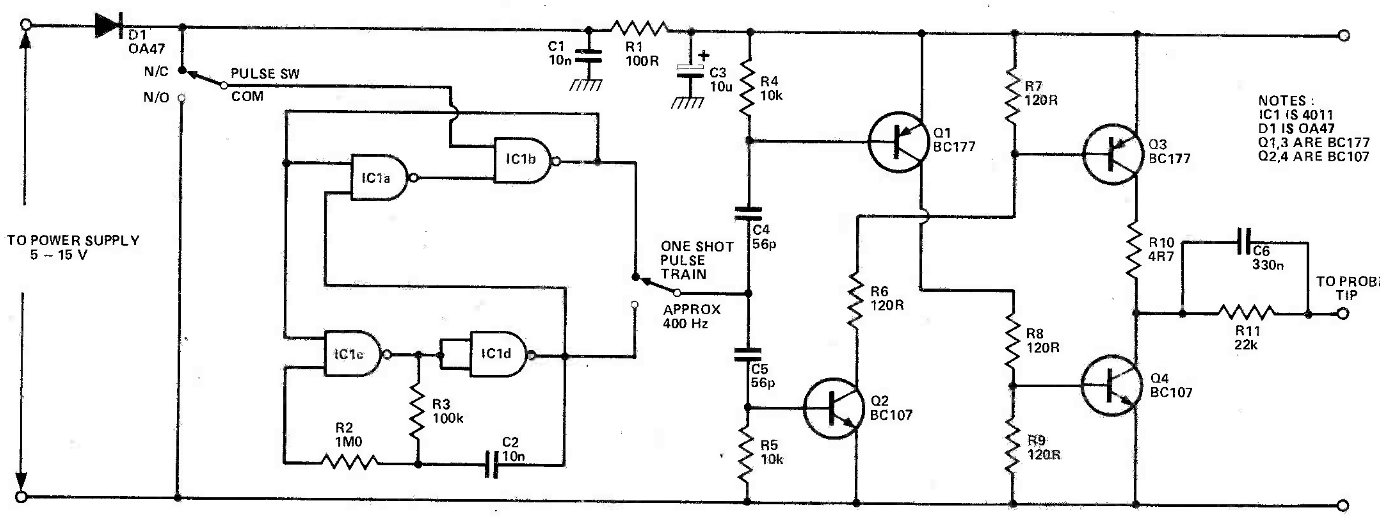
16 Note-Sequencer

P Gatehouse, Buckingham

This circuit is designed to play a repeating sequence of 16 notes which are programmed by variable resistors. IC1 is a binary counter which runs off a PUT oscillator. The oscillator is built around Q1, which can be a 2N6027 or MEU21. The RC time constant connected to the anode charges up, causing the voltage at the anode to rise. At a certain voltage, controlled by R3 and R4, the PUT conducts. This allows the capacitor to discharge through Q3 as a good clean clock pulse. Q3 inverts the pulse to suit the TTL requirements. The frequency of these events is easily changed by altering the time constant – a 100 k variable resistor was used.

IC1 generates a binary count on its four outputs – only if you ground both the reset terminals. IC2 selects a single output line for each of the sixteen possible input combinations. The result is that the presets are connected one-by-one, in sequence. Q1 is the audio frequency oscillator, whose frequency can be changed by altering the resistors which determine the anode voltage of the PUT. Don't be tempted to leave out the diodes in series with the presets as they block the normally 'high' outputs from interfering with the selected 'low' output. The type of diode used is not critical. 1N914s are probably the best (and cheapest).

Interesting results can be obtained by connecting a fairly large capacitor to various parts of the gate terminal of the second (AF) oscillator. Connect the other terminal ground or positive line – watch the polarity, if it's electrolytic. Another oscillator can be connected to the same outputs provided it is fitted with diodes isolating it from the first oscillator. If the outputs are mixed, polyphonic effects are possible.



CMOS/TTL Pulser

C T Morris, Mid Glamorgan

For a small extra outlay, a pulse trian facility can be added to the ETI Pulser that appeared in December 1975. The NAND gates form an astable, which is gated by a flip-flop. When the pulse switch is pressed the flip-flop changes state and turns on the astable. Single shot or pulse trains are selected by a change-over switch connected to the flip-flop and astable outputs.

The OA47 diode protects the pulser against reversal of the power supply leads.