electronics today

JUNE 1979

INTERNATIONAL

50p

ELECTRONIC WARFARE
Mains Seeker
Accentuated Metronome
Triton 8K Extension

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

CHROMATHEQUE 5000

5 CHANNEL LIGHTING EFFECTS SYSTEM

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

COMPLETE KIT ONLY £49.50 + VAT!

This versatile system featured as a construction article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is completely automatic to say the least. You can use 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 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, complete right down to the last nut and bolt.

MPA 200 100 WATT (rms into 8Ω) MIXER/AMPLIFIER

COMPLETE KIT ONLY £49.90 + VAT!

Featured as a construction article in Electronics Today International the MPA 200 is an exceptionally low priced professionally finished general purpose rugged high power amplifier with adaptable built in mixer which takes a wide range of inputs such as dynamic microphone, guitar, etc. There are separate treble and bass controls and a master volume control. Mechanically the design is simplicity to the extreme with minimal wiring making construction very straightforward.

Kit includes fully finished metalwork, fibre glass PCB's, controls, wire. Complete right down to the last nut and bolt.

Kits for bullet power amp module only. PCB, resistors, caps, s/c etc. **£10.60** + VAT

Custom designed toroidal transformer with mounting clamp **£10.50** + VAT

Parts for power supply only (caps, rectifiers, fuses, F holders) **£3.40** + VAT

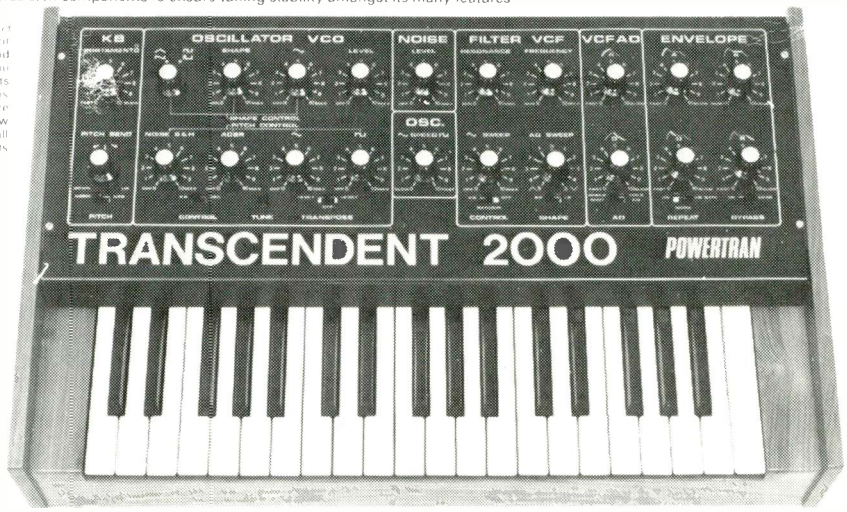
TRANSCENDENT 2000

SINGLE BOARD SYNTHESIZER

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

The TRANSCENDENT 2000 is a 3 octave instrument transposable 2 octaves up or down giving an effective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with 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 vector, 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 1% metal film), 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 with performance and quality comparable with ready built units selling for between £500 and £700!



COMPLETE KIT ONLY £172.00 + 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!

POWERTRAN

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

ORDERING INFORMATION AND MORE KITS ON PAGE 8

electronics today INTERNATIONAL

JUNE 1979 VOL 8 NO 6

More power to your elbow with our tuner amp, p. 30. ETI delves into electronic warfare, p.62

A calculator to wake you up p.97

What to do with your R/C p.87

FEATURES

PROJECTS

INFORMATION

INTERNATIONAL EDITIONS

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Quality audio modules and accessories for

S450

STEREO FM TUNER Fitted with phase lock-loop

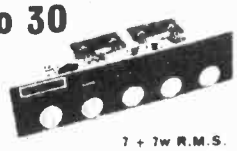
£23·24
+ 40p p&p
+ 12½% VAT

FREQUENCY RANGE	88-108 Mhz
SENSITIVITY	3·0 μV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22·5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm · 110mm · 32mm

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

Stereo 30

COMPLETE AUDIO CHASSIS



£19·18
+ 66p p&p
+ 12½% VAT

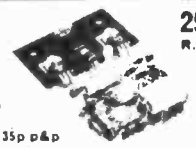
7 + 7w R.M.S.

OUTPUT POWER	7 Watts RMS
LOAD IMPEDANCE	8 ohms
TOTAL HARMONIC DISTORTION	Less than 5% (Typically 3%)
FREQUENCY RESPONSE	50 Hz to 20 kHz ± 3dBs
TONE CONTROL RANGE	± 12 dBs at 100Hz and 10kHz
SENSITIVITY	190 mV for full output
INPUT IMPEDANCE	1 M ohms
TRANSFORMER REQUIREMENTS	22 V A.C. rated at 1A
DIMENSIONS (Less controls and panel)	200mm · 130mm · 33mm

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

AL60

AUDIO AMPLIFIER MODULE 25 Watts RMS



25w R.M.S.

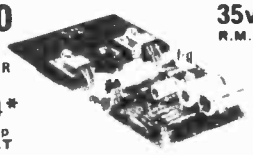
£4·69 + 35p p&p
+ 12½% VAT

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

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25 RMS with distortion levels below 0·1%

AL80

AUDIO AMPLIFIER MODULE



35w R.M.S.

£7·34*
+ 35p p&p
+ 8% VAT

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

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W with distortion levels below 0·1%

AL250

POWER AMPLIFIER

125w R.M.S.

£17·82* + 66p p&p + 8% VAT

OUTPUT POWER	125 Watts RMS continuous
OPERATING VOLTAGE	50-80 V
LOADS	4-16 ohms
FREQUENCY RESPONSE	25 Hz 20 kHz measured at 100 Watts
SENSITIVITY FOR 100 WATTS O/P AT 1 kHz	450 mV
INPUT IMPEDANCE	33 K ohms
TOTAL HARMONIC DISTORTION	
50 WATTS into 4 ohms	0·1%
50 WATTS into 8 ohms	0·06%

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

AL30A

AUDIO AMPLIFIER MODULES

10w R.M.S

£3·79 + 35p p&p
+ 12½% VAT

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

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

SPM80

STABILISED POWER SUPPLY

£4·40 + 35p p&p
+ 12½% VAT

INPUT A.C. VOLTAGE	33-40V
OUTPUT D.C. VOLTAGE	33 V nominal
OUTPUT CURRENT	10 mA-1·5 amps
OVERLOAD CURRENT	1·7 amps approx.
DIMENSIONS	105mm · 63mm · 30mm

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

PA100

STEREO PRE-AMPLIFIER

£16·05
+ 40p p&p
+ 12½% VAT

FREQUENCY RESPONSE	20 Hz to 20 kHz · 1 dB
TOTAL HARMONIC DISTORTION	Less than 1% (Typically 07%)
SENSITIVITY INPUTS 1. TAPE	100 mV/100 K ohms } For an
2. RADIO TUNER	100 mV/100 K ohms } output
3. MAGNETIC P.U.	3·5 mV/50 K ohms } 250 mV
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
BASS CONTROL RANGE	± 15 dBs at 75 Hz
TREBLE CONTROL RANGE	+ 10-20 dBs at 15 kHz
SIGNAL/NOISE RATIO	Better than 65 dBs (All inputs)
INPUT OVERLOAD	Better than 26 dBs (All inputs)
SUPPLY	20 to 40 V
DIMENSIONS	300 · 90 · 33mm (less controls)

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

MPA30

STEREO MAGNETIC CARTRIDGE PRE-AMPLIFIER

£2·98
+35p p&p
+ 12½% VAT

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the MPA 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.

SENSITIVITY	3·5 mV for 100 mV output
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
INPUT IMPEDANCE	50 K ohms
SUPPLY	18 to 30 V—re earth
DIMENSIONS	110 · 50 · 25mm (inc DIN socket)

PA12

STEREO PRE-AMPLIFIER

£7·78
+ 35p p&p
+ 12½% VAT

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

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

PS12 POWER SUPPLY MODULE

Power supply for AL20A-30A, PA12, S450 etc. Transformer T538.

Input A.C. Voltage 15-20V.
Output D.C. Voltage 22-30V approx. (Dependent upon input.)
Output Current 800mA maximum.
Dimensions 60 × 43 × 26mm.

£1·90
+ 12½% VAT + 35p p&p.

BP124 SIREN ALARM MODULE

5 WATTs —

American Police screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer break-down, and other security purposes.

ONLY £3·50
+ 8% VAT + 35p p&p.

MA60 HI-FI AMPLIFIER KIT

Build you own top quality amplifier, save yourself pounds. The MA60 kit comprises the following BI-kits modules, 2 · AL60 amps, 1 · PA100 pre-amp, 1 · SPM80 stab. power supply, 1 · BMT80 transf. giving 15 watts RMS per channel STEREO. All modules covered by the BI-PAK satisfaction or money back guarantee. Details of the above modules are in this ad.
Price £32·00 + 12½% VAT + 62p p&p.

TC60 KIT

A beautifully designed genuine TEAK WOOD veneered cabinet to put the professional touches to your home built amplifier. Full set of parts incl. Front & Back Panels, Knobs, Chassis, Fuses, Sockets, Noen, etc. Ideal for the MA60. Size: 425mm · 290mm · 95mm.
Price £19·85 + 12½% VAT + 86p p&p

TRANSFORMERS

T538. For use with S.450 AL30A MPA30
Order No. **2036** Price: **£3·20 + 55p p&p + 12½% VAT**
T2050. For use with Stereo 30
Order No. **2050** Price: **£3·25 + 55p p&p + 12½% VAT**
BMT80. For use with AL60 SPM80
Order No. **2034** Price: **£5·40 + 86p p&p + 12½% VAT**
BMT250. For use with AL250
Order No. **2035** Price: **£6·35 + £1·10 p&p + 12½% VAT**
2040. For use with AL60
Order No. 2040 Price £5·20 · 80p p&p · 12½% V.A.T.
2041. For use with AL80, AL120 and AL250
Order No. 2041. Price £6·80 · 86p p&p · 12½% V.A.T.

CASES

TEAK 30, 32 × 23 × 8cm. designed mainly for use with our stereo 30 Audio System but has proved very helpful to home constructors. Fitted with solid uncut front and back. o/n 139. £5·95. + 12½% V.A.T. p&p 70p.

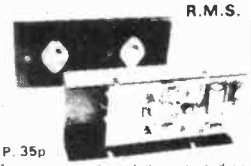
TEAK 60, 42 × 29 × 9cm. for use with AL60/MK60 Audio Kit. Useful for the home constructor requiring an amplifier sleeve — has no front or back panel. o/n 140. £7.00. + 12½% V.A.T. p&p 85p.

Professionals and Enthusiasts from BI-PAK

AL120 — 50W R.M.S.

AUDIO AMPLIFIER
(With integral heat sink and short-circuit protection)

£11.95
+ 8% V.A.T. P. & P. 35p



OUTPUT POWER	50 Watts R.M.S.
SUPPLY	70 Watts
LOAD IMPEDANCE	8-16 ohms
TOTAL HARMONIC DISTORTION	05% Max. (Typically 02%)
FREQUENCY RESPONSE ±1dB	25Hz-20kHz
SENSITIVITY	500mV
MAX HEAT SINK TEMP.	45 deg. C
DIMENSIONS	192 x 89 x 49 mm

Introduced to fulfill the demand for a fully protected power amp. capable of driving high quality speaker systems at up to 50w with distortion levels below 05%. Ideal for domestic use. Discos. P.A. systems, electronic organs etc. The generously rated components ensure continuous operation at high output levels.

SPM120 — STABILISED POWER SUPPLIES

SPM120/45
SMP120/55
SMP120/65

£5-80
+ 12½% V.A.T.
P. & P. 35p

AC INPUTS	
SPM120/45	40-48v
SPM120/55	50-55v
SPM120/65	60-65v
OUTPUT CURRENT	2.5A
RIPPLE	1A 100mV 2A 150mV

SPM120 is a fixed voltage stabiliser available with an output voltage of either 45v, 55v, or 65v. Designed primarily for use in audio applications, the stabiliser which provides output currents up to 2.5A, operates direct from a mains transformer requiring only the addition of 2 Electrolytic capacitors to complete the s/c protection.

GE100 Mk2.

10 CHANNEL MONOGRAPHIC EQUALISER

£20-00
+12½% V.A.T.
P. & P. 35p

Control Range	±12dB
Dynamic Range	110dB
Maximum Output	+15dB
Frequency Response	30Hz-20KHz (+1dB)
Power Supply	15-0-15v
Voltage Handling Input	3v R.M.S.
T.H.D.	005%

Only 155mm x 65mm x 50mm including the 10 x 10K 1in slider potentiometers and knobs which are mounted on a board positioned above the circuitry. In the frequency range of 31Hz to 20KHz you can cut and boost ±12dB with the 10 sliders each of which has its frequency marked on the circuit board. The GE100 has numerous uses including mixers, P.A. systems and discos. It will also greatly improve the sound reproduction of your existing audio equipment. Power Supply for GE100, o/d SG30 £3.80.

VPS30

REGULATED VARIABLE STABILISED POWER SUPPLY

£7.60 +8% V.A.T. P. & P. 35p

AC Input Maximum	25v
Voltage Regulation	2-30v
Regulated Current	0-2A
Incorporating short circuit protection	

This NEW versatile Regulated Variable Stabilised Power Supply with short circuit protection and current limiting is a must for all electronics enthusiasts. It incorporates adjustable voltage from 2v 30v with a current limiting range of 0-2A. With this module there is no need to build a separate power supply for each of your projects, with the simple addition of a transformer (o/d 2033) 0-1ma (o/d 1310 or 1305) plus a suitable shunt, a voltmeter (o/d 1311 or 1306), a 470ohm pot (o/d 1896), a 4K7 pot (o/d 1899) it can be used again and again as a self-contained bench power supply, eliminating the use of batteries and thus saving £'s!

PA200

STEREO PRE-AMPLIFIER

£16.55
+12½% V.A.T.
P. & P. 40p

FREQUENCY RESPONSE	20Hz to 20kHz ± 1dB
TOTAL HARMONIC DISTORTION	Less than 1% (Typically 70%)
SENSITIVITY — INPUTS 1. TAPE	100mV/100 K ohms — For an
2. RADIO TUNER	100mV/100 K ohms — output
3. MAGNETIC P.U.	3.5mV/50 K ohms — 500mV
EQUALISATION	Within + 1dB from 20Hz to 20kHz
BASS CONTROL RANGE	+ 15dBs at 75Hz
TREBLE CONTROL RANGE	+ 10-20dBs at 15kHz
SIGNAL NOISE RATIO	Better than 65dBs (All inputs)
INPUT OVERLOAD	Better than 2dBs (All inputs)
SUPPLY	35 to 706v
DIMENSIONS	300 x 90 x 33mm (less controls)

The PA200 is basically our popular PA100. Modifications have been made to make it compatible with the higher output AL120 and AL250 amplifiers.

HEADPHONES

A top quality headphone with cushioned earpads and headband. Separate balance volume controls. Stereo or Mono switch. Impedance 8 ohms. Frequency 30-18 000Hz **o/n 884. £8.70.** + 12½% V.A.T. p&p 70p.

A brilliant compromise between price and performance. Superb stereo reproduction for the newcomer to Hi Fi. Impedance 8 ohms. Frequency 30-15 000Hz **o/n 885. £4.40.** + 12½% V.A.T. p&p 50p.

BIB HI-FI ACCESSORIES

Parallel Tracking GROOV KLEEN
The very latest in automatic record cleaning. Designed to suit all modern single play decks. Simple to fit, it is extremely efficient. Complete with two types of base and three height extensions **o/n 8101. £3.68.** + 8% V.A.T. p&p 35p.

Cassette Tape Editing Kit
Enables cassette tapes to be edited and joined easily, quickly and accurately. Kit comprises: Tape Splicer (3.2mm), 2 Precision Tape Cutters, Tape Piercer, 9 Self adhesive Labels, Reel of Splicing Tape, 3 Winders and removers and instructions all in a handy wallet **o/n 811. £2.40.** + V.A.T. p&p 35p.

GROOV-STAT
The BIB Groov Stat static reducer neutralises the static charge on records and other plastic surfaces. **o/n 8103. £5.45.** + 8% V.A.T. p&p 35p.

Cassette Head Cleaner
Essential for cleaning of tape heads, capstans and rollers. Pack contains Tape Head Applicator and tape head polisher tools. Plus bottle of special formula cleaning fluid and full instructions. **o/n 832. £0.64.** + 12½% V.A.T. p&p 35p.

METERS

Miniature Balance & Tuning Meter
Miniature moving-coil meter for stereo balance indicator, tuning indicator for FM or similar application. Pointer at centre indicates zero or null position. Robust construction. Sensitivity 100-0-100MA. Dimensions 23 x 22 x 26mm **o/n 1318. £1.95** +8% V.A.T. p&p 35p.

Balance and Tuning Meter
Clear view edgewise meter. Centre zero application. Sensitivity 100-0-100UA. Dimensions 45 x 22 x 34mm. **o/n 1319. £2.00.** +8% V.A.T. p&p 35p.

Miniature Level Meter
Moving coil for accurate level indication for tape recorders, amplifiers etc. Neat design rugged construction will withstand five times rated value. Sensitivity FSD 200UA. OdB 130UA. Dimensions 23 x 22 x 26mm. **o/n 1320. £2.80.** +8% V.A.T. p&p 35p.

Vu Meter
Calibrated -20 to +3 and 0-100%, making it suitable for use as a recording level meter or as a power output indicator. Sensitivity 130uA. Dimensions 40 x 29mm. **o/n 1321. £2.00.** +8% V.A.T. p&p 35p.

ADAPTORS

AC-DC enables a large range of battery powered powered radios, recorders, calculators to be run off the mains. (220-240v AC). Switchable for 6-3v-6v-9v-12v. Current rating 300MA. Polarity reversing switch. Universal plug incorporated. **o/n 137 £3.80** + 12½% V.A.T. p&p 35p.

DC-DC for use in all cars, boats, etc, with pos. or neg. earth for a regulated output of 6, 7.5v or 9 volts DC at 300MA. For radios, recorders etc. **o/n 138. £2.80** + 12½% V.A.T. p&p **35p.**

CROSSOVER NETWORKS

2 WAY channels for high and low frequencies to correct speakers high to tweeters, low to woofers. Complete with instructions. Frequency 3.000Hz **o/n 1904. £1.10.** + 12½% V.A.T. p&p 35p.

2 WAY for 8 ohm speakers up to 30 watts. Frequency 3KHz. o/n 1905. **£1.65.** + 12½% V.A.T. p&p 35p.

3 WAY for 8 ohms speakers up to 30 watts. Frequency 800Hz and 4.5KHz **o/n 1906. £2.95.** + 12½% V.A.T. p&p 35p.

MICROPHONES

DYNAMIC CASSETTE
For equipment requiring a high quality microphone. Sturdy, solid moulded body in black with neat chrome surround. Pick up pattern is omnidirectional. On/Off switch. 1 metre of tough lead with floating 2.5 and 3.5mm plugs. Matching moulded strut. Impedance 200 ohms. Sensitivity 90dB. Frequency 90-10.000Hz. Size 20mm dia x 120mm **o/n 1326. £1.60** + 12½% V.A.T. p&p 35p.

DYNAMIC MICROPHONE
Superior quality portable cassette recorder mike with built in remote control switch and lead fitted with 5-pin 240° DIN plug (remote switch) and 3 pin DIN plug (microphone). Provides a direct replacement for those supplied with recorders. With detachable stand. Omnidirectional. Impedance 200 ohms. Freq. response 100 to 10.000Hz. Sensitivity 79dB at 1.000Hz **o/n 1327. £2.65.** + 12½% V.A.T. p&p 35p.

RE-317 DYNAMIC MICROPHONE
Highly sensitive, high grade desk or hand mike suitable for use with many popular cassette decks. Incorporates On/Off switch and 1 metre lead with moulded standard jack plug. Complete with desk stand. Omnidirectional. Impedance 5.000 ohms. Freq. response 100 at 12.000Hz. Sensitivity (-7dB at 1.000Hz) **o/n 1336. £4.00.** + 12½% V.A.T. p&p 35p.

OMNIDIRECTIONAL CARDIOID
Powered by a 1½v battery located within the aluminium body. Satin silver finish with front disk protection to the diaphragm housing. On/Off switch. Also with Busby type windshield. U bracket and stem and extremely supple cable. Consumption 0.2mA from 1½v battery providing approx. 8-10.000 hours continuous life. Impedance 600 ohms. Sensitivity 70dB. Frequency 30-16.000Hz. Size 23mm dia x 267mm **o/n 1329. £12.80.** 12½% V.A.T. p&p 35p.

UNIDIRECTIONAL CARDIOID
Dual imp. 600 and 50.000 ohms. Response 50 to 14.000Hz. Sensitivity 54dB at 50K ohms. Size 1⅛" dia x 6½" long. Weight approx. 190gm. **o/n 1328. £10.95.** + 12½% V.A.T. p&p 35p.

STANDS

GOOSENECK CHROME FLEXIBLE HOLDERS
Length 320mm **o/n 1333. £2.40.** + 12½% V.A.T. p&p 35p.
Length 515mm **o/n 1334. £3.40.** + 12½% V.A.T. p&p 35p.

FLOOR STAND Heavy chrome. Stow-away feet with rubber ends for maximum stability. Draws to a height of 5' maximum. o/n 1335. + **£9.50.** 12½% V.A.T. p&p 85p.

BOOM ARM for use with the above stand. Heavy chromed metal. It gives 30" reach from the stand. **o/n 1337 £9.20.** + 12½% V.A.T. p&p 70p.

WINDSHIELD COVERS
o/n 1331 Medium per pair **£1.20.** + 12½% V.A.T. p&p 35p **o/n 1332** Large per pair **£1.80.** + 12½% V.A.T. p&p 35p.

AUDIO LEADS

107	FM Indoor Ribbon Aerial	£0.60*
113	3.5mm Jack plug to 3.5mm jack plug. Length 1.5m	£0.75*
114	5 pin DIN plug to 3.5mm Jack connected to pins 3&5. Length 1.5m	£0.85*
115	5 pin DIN plug to 3.5mm Jack connected to pins 1&4. Length 1.5m	£0.85*
116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	£1.10*
117	AC mains connecting lead for cassette recorders & radios. 2 metres	£0.68*
118	5 pin DIN phono plug to stereo headphone jack socket	£1.05*
119	2 + 2 pin DIN plugs to stereo jack socket with attenuation network for stereo headphones. Length 0.2m	£0.90*
120	Car stereo connector. Variable geometry plug to fit most car cassette 8 track cartridge & combination units. Supplied with inline fused power lead and instructions	£0.60*
123	6.6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	£1.50*
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	£0.75*
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	£0.75*
126	5 pin DIN plug to Tinned open end. Length 1.5m	£0.75*
127	5 pin DIN plug to 4 Phono Plugs All colour coded. Length 1.5m	£1.30*
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	£0.80*
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1.05*
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0.68*
131	5 pin DIN plug to 3 pin DIN plug 1&4 and 3&5. Length 1.5m	£0.83*
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£0.98*
133	5 pin DIN plug to 2 phono plugs. Connected pins 3&5. Length 1.5m	£0.75*
134	5 pin DIN plug to 2 phono sockets. Connected pins 3&5. Length 23cm	£0.68*
135	5 pin DIN socket to 2 phono plugs. Connected pins 3&5. Length 23cm	£0.68*
136	Coiled stereo headphone extension lead. Black. Length 6m	£1.75*
178	AC mains lead for calculators etc.	£0.45*

Please add 12½% V.A.T. to all the above leads.

BI-PAK
DEPT. ETI6, P.O. Box 6, Ware, Herts.
Components Shop: 18 Baldock Street, Ware, Herts.

DIGITAL INTEGRATED CIRCUITS

4000 Buffered C-MOS — High Speed

5–15V 'B' Series, Up to 20MHz

HEF4000	14	HEF4046	100	HEF4514	250														
HEF4001	14	HEF4047	87	HEF4515	299														
HEF4002	14	HEF4049	28	HEF4516	90														
HEF4006	95	HEF4050	28	HEF4517	382														
HEF4007	14	HEF4051	69	HEF4518	69														
HEF4008	80	HEF4052	72	HEF4519	55														
HEF4011	14	HEF4053	72	HEF4520	65														
HEF4012	14	HEF4066	37	HEF4521	188														
HEF4013	32	HEF4067	380	HEF4528	99														
HEF4014	84	HEF4068	14	HEF4532	120														
HEF4015	60	HEF4069	14	HEF4534	510														
HEF4016	35	HEF4070	14	HEF4539	110														
HEF4017	55	HEF4071	14	HEF4543	155														
HEF4018	65	HEF4072	16	HEF4555	78														
HEF4019	46	HEF4073	16	HEF4556	78														
HEF4020	88	HEF4075	16	HEF4557	386														
HEF4021	85	HEF4076	85	HEF4585	97														
HEF4022	82	HEF4077	14	HEF4724	171														
HEF4023	14	HEF4078	16	HEF40097	90														
HEF4024	45	HEF4081	16	HEF40098	73														
HEF4025	14	HEF4082	16	HEF40106	62														
HEF4027	32	HEF4085	64	HEF40160	119														
HEF4028	52	HEF4086	64	HEF40161	119														
HEF4029	60	HEF4093	50	HEF40162	119														
HEF4030	46	HEF4094	175	HEF40163	119														
HEF4031	200	HEF4104	166	HEF40174	119														
HEF4035	110	HEF4502	91	HEF40175	119														
HEF4040	68	HEF4505	571	HEF40192	140														
HEF4041	75	HEF4508	51	HEF40193	140														
HEF4042	54	HEF4510	70	HEF40194	119														
HEF4043	79	HEF4511	110	HEF40195	117														
HEF4044	84	HEF4512	98																

7400 T.T.L.

N7400N	9	N7444N	83	N74122N	39	N74190N	60	N74L28N	32	N74LS38N	85	N74LS253N	105						
N7401N	11	N7445N	65	N74123N	37	N74194N	80	N74L30N	16	N74LS39N	85	N74LS257N	104						
N7402N	11	N7446AN	62	N74125N	32	N74195N	79	N74L32N	24	N74LS53N	76	N74LS258N	107						
N7403N	11	N7447AN	51	N74126N	32	N74198N	120	N74L33N	32	N74LS54N	122	N74LS260N	26						
N7404N	12	N7448AN	44	N74128N	74	N74199N	139	N74L37N	24	N74LS55N	80	N74LS261N	300						
N7405N	12	N7450N	13	N74132N	46	N74221N	160	N74L38N	24	N74LS56N	80	N74LS266N	40						
N7406N	25	N7451N	13	N74145N	60	N74279N	116	N74LS40N	22	N74LS57N	54	N74LS273N	130						
N7407N	27	N7453N	15	N74147N	125	N74298N	200	N74LS42N	53	N74LS158N	60	N74LS283N	116						
N7408N	13	N7454N	13	N74148N	83	N74365N	150	N74LS51N	22	N74LS160N	120	N74LS290N	90						
N7409N	13	N7460N	13	N74150N	65	N74366N	150	N74LS54N	16	N74LS161N	78	N74LS293N	100						
N7410N	11	N7470N	26	N74151N	46	N74367N	120	N74LS55N	22	N74LS162N	130	N74LS298N	100						
N7411N	18	N7472N	22	N74153N	55	N74368N	150	N74LS73N	29	N74LS163N	78	N74LS324N	170						
N7412N	17	N7473N	23	N74154N	96			N74LS75N	40	N74LS164N	90	N74LS365N	105						
N7413N	23	N7474N	23	N74155N	53	**74LS**		N74LS76N	33	N74LS170N	200	N74LS366N	105						
N7414N	46	N7475N	28	N74156N	48			N74LS78N	33	N74LS173N	100	N74LS367N	105						
N7416N	22	N7476N	26	N74157N	49	N74LS00N	15	N74LS83AN	97	N74LS174N	100	N74LS368N	105						
N7417N	23	N7480N	43	N74158N	54	N74LS01N	16	N74LS85N	70	N74LS175N	100	N74LS373N	150						
N7420N	11	N7483N	63	N74160N	74	N74LS02N	16	N74LS86N	33	N74LS181N	320	N74LS374N	150						
N7421N	26	N7485N	65	N74161N	74	N74LS03N	16	N74LS90N	45	N74LS190N	91	N74LS375N	100						
N7425N	27	N7486N	23	N74162N	74	N74LS04N	16	N74LS92N	70	N74LS191N	95	N74LS378N	160						
N7426N	22	N7490N	30	N74163N	74	N74LS05N	23	N74LS93N	45	N74LS192N	128	N74LS386N	35						
N7427N	22	N7491AN	60	N74164N	65	N74LS08N	16	N74LS95BN	65	N74LS193N	130	N74LS390N	170						
N7428N	30	N7492N	33	N74165N	65	N74LS09N	22	N74LS96N	116	N74LS194N	150	N74LS393N	170						
N7430N	11	N7493N	31	N74166N	93	N74LS10N	16	N74LS107N	38	N74LS195AN	120	N74LS395N	180						
N7432N	21	N7494N	74	N74170N	134	N74LS11N	22	N74LS109N	38	N74LS196N	80	N74LS490N	130						
N7433N	30	N7495AN	48	N74173N	111	N74LS12N	23	N74LS112N	40	N74LS197N	110	N74LS670N	170						
N7437N	21	N7496N	46	N74174N	63	N74LS13N	38	N74LS113N	38	N74LS240N	160								
N7438N	21	N74100N	88	N74175N	62	N74LS14N	74	N74LS114N	38	N74LS241N	160								
N7439N	60	N74107N	25	N74180N	80	N74LS15N	24	N74LS125N	40	N74LS242N	160								
N7440N	12	N74109N	42	N74181N	165	N74LS20N	16	N74LS126N	40	N74LS243N	160								
N7442N	40	N74116N	148	N74182N	69	N74LS21N	22	N74LS132N	80	N74LS244N	160								
N7443N	79	N74121N	23	N74192N	65	N74LS22N	24	N74LS136N	37	N74LS251N	90								

LINEAR INTEGRATED CIRCUITS

CA3011	92	NE592K	162
CA3018	75	RC4136	130
CA3020	191	TBA120S	79
CA3028A	86	TCA580	346
CA3046	76	TCA730	450
CA3048	245	TCA740	450
CA3080E	70	TDA1008	326
CA3089E	253	TDA1022	648
CA3130E	90	TDA1028	338
CA3140E	38	TDA1029	338
CA3189E	266	TDA1034B	217
LM301AN	30	TDA2581	266
LM308N	95	TDA2640	292
LM318N	200	TL081CP	75
LM319N	216	TL084CN	140
LM324N	70	UA709CT	46
LM339N	71	UA709CN	40
LM381N	110	UA710CN	41
LM381AN	180	UA711CN	65
LM382	120	UA741CT	42
		UA741TN	18
		UA747CN	50
		UA748CN	35
MC1458N	35		
MC1496N	97	**Voltage Regulators**	
NE531	119	LM309DA (K)	108
NE536T	216	UA723CN	38
NE540	225	UA7805CU	65
NE555N	25	UA7812CU	65
NE556N	60	UA7815CU	65
NE560N	351	UA7905CU	86
NE561N	427	UA7912CU	86
NE562N	461	UA7915CU	86
NE565N	120	UA78L05CS	32
NE566N	155	UA78L06CS	32
NE567N	170	UA78L12CS	32
NE570N	405	UA78L15CS	32
NE571N	459		

OPTO ELECTRONICS

			Order Code
Light Emitting Diodes, Individual			
.125" (3mm)	Red	14	CQY54
	Green	17	CQY95
	Yellow	19	CQY97
Panel Mounting Clip to suit.		3	LED3 Clip
.2" (5mm)	Red	15	CQY24A
	Green	17	CQY94
	Yellow	19	CQY96
Panel Mounting Clip to suit.		5	LED5 Clip
Light Emitting Diodes — 7 Segment Display			
.3" (7.6mm)	C. Anode R.H. Decimal Pt. Red	160	XAN3061
	C. Anode R.H. Decimal Pt. Green	199	XAN3051
	C. Cathode R.H. Decimal Pt. Red, Low current drain	160	XAN3074
.6" (15.2mm)	C. Anode L.H. Decimal Pt. Red	230	XAN6620
	C. Anode L.H. Decimal Pt. Green	230	XAN6520
	C. Cathode L.H. Decimal Pt. Red	230	XAN6640
Photoresistors			
ORP12		90	ORP12
ORP61		90	ORP61
Phototransistors			
OCP71		180	OCP71
BPX25		175	BPX25
BPX29		175	BPX29
Photocoupler			
FCD820		150	FCD820

SWITCHES

				Order Code
Miniature Toggle — Honeywell				
SPDT		2A/250V A.C., 5A/28V D.C.	58	SW 8A1011
SPDT	C/Off		67	SW 8A1021
SPDT	Double Bias To Centre		75	SW 8A1041
SPDT	Single Bias To Centre		75	SW 8A1051
SPDT	Bias		70	SW 8A1061
DPDT			86	SW 8A2011
DPDT	C/Off		92	SW 8A2021
DPDT	Double Bias To Centre		102	SW 8A2041
DPDT	Single Bias To Centre		102	SW 8A2051
DPDT	Bias		96	SW 8A2061
Miniature Push — C & K				
SP	Push To Make, Momentary	0.5A/250V A.C., 1A/28V D.C.	54	SW 8531
SP	Push To Break, Momentary		54	SW 8533
Slide — Switchcraft				
DPDT	Standard Actuator		36	SW 46206
DPDT	Slot Actuator, Voltage Change, Marked 110/240		43	SW 46206F

SEMICONDUCTORS

Diodes

1N827	193	1N4006	7	BB110G	61	OA202	9
1N914	4	1N4007	8	BY127	15		
1N916	5	1N4148	3	BYZ06	34		
1N4001	4	1N5402	15	BYX10	19	**Microwave**	
1N4002	4	1N5404	16	OA47	10		
1N4003	6	SAX13	5	OA90	7	BAW95D	1091
1N4004	6	BAY38	27	OA91	7	CL8960	2592
1N4005	7	BB106(4)	122	OA200	9	CXY11C	1280

Zener Diodes

400mW C4V7-C33 — 1.3W C7V5-C75
BZY88/BZX79 + Voltage 8 — BZX61 + Voltage 16

Transistors

2N929	37	2N4427	206	BC478	24	BSX88	18
2N1893	30	2N4856	158	BC547	12	MJE340	48
2N2218A	28	2N4858	134	BC548	10	MPF102	32
2N2222	21	2N4860	122	BC548B	15	OC28	107
2N2369	19	2N5294	43	BC549	12	OC35	95
2N2369A	20	2N5416	108	BC549B	20	OC45	82
2N2646	42	2N5457	35	BC557	14	OCP71	180
2N2894	49	2N5458	30	BC558	14	TIP29A	41
2N2895	28	2N5459	32	BC559	17	TIP29C	53
2N2904	24	2N6258	432	BCY34	97	TIP30A	44
2N2904A	24	40673	80	BCY70	14	TIP30C	57
2N2905	22	AC188	22	BCY71	14	TIP31A	43
2N2905A	24	AD161	38	BCY72	15	TIP31C	58
2N2906	19	AD162	38	BD131	35	TIP32A	49
2N2907	22	BC107	10	BD132	35	TIP32C	63
2N2907A	25	BC107B	14	BD135	38	TIP41A	59
2N2918	330	BC108	10	BD136	37	TIP41C	69
2N2926G	11	BC108B	14	BD137	38	TIP42A	59
2N3053	17	BC108C	16	BD138	39	TIP42C	69
2N3054	50	BC109	10	BD139	35	TIP2955	68
		BC109B	17	BD140	35	TIP3055	54
2N3055	50	BC109C	18	BF115	28	TIS43	32
2N3055		BC147	7	BF180	37	ZTX109C	14
Full ISB Test	88	BC148	9	BF181	37		
2N3340	30	BC149	8	BF257	35		
2N3442	141	BC157	10	BF258	32		
2N3702	8	BC158	9	BF259	36		
2N3703	11	BC159	11	BFR90	303		
2N3704	8	BC177	15	BFS21	428		
2N3705	9	BC178	15	BFX13	23		
2N3706	9	BC179	18	BFX84	26		
2N3707	9	BC182	10	BFX85	26		
2N3708	9	BC182L	11	BFX86	30		
2N3709	11	BC183	10	BFX87	22		
2N3773	270	BC183L	11	BFX88	26		
2N3819	20	BC184	10	BFY50	15		
2N3820	39	BC184L	11	BFY51	15		
2N3866	97	BC212	10	BFY52	18		
2N3903	20	BC212L	11	BFY90	97		
2N3904	8	BC213	10	BLX65	238		
2N3905	12	BC213L	11	BLY35	1889		
2N3906	12	BC214	10	BLY93A	2706		
2N3962	95	BC214L	11	BPX25	175		
2N4347	227	BC327	17	BPX29	175		
2N4401	20	BC328	15	BRY39	45		
2N4403	20	BC337	16	BSW69	33		
2N4416	86	BC338	14	BSX20	19		

SEMICONDUCTORS

Rectifier Bridges		Order Code
1A 400V S.I.L.	93	BY179
1.4A 60V S.I.L.	84	BY164
1.5A 100V D.I.L.	33	VM18
1.5A 400V D.I.L.	35	VM48
1.5A 100V	45	W01
1.5A 400V	52	W04
2A 100V	89	VS148
2A 400V	109	VS448
6A 100V	143	VH148
6A 400V	183	VH448
10A 100V	172	VJ148
10A 400V	201	VJ448
15A 100V	215	VL148
15A 400V	226	VL448
30A 100V	242	VK148
30A 400V	260	VK448
S.C.R.'s		
4A 400V	54	C106D
12A 400V	108	TIC126D
Triacs		
10A 500V	124	BT136-500
15A 500V	177	BT139-500
23A 500V	492	BTW41-500

MAINS TRANSFORMERS

Order Code

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

6VA — Clamp Type Construction

Approx. 18% Regulation. F.C. 54, H36, W35

0-4.5V, 0-4.5V Secondaries	220	Trans 6VA	45
0-5V, 0-6V			60
0-12V, 0-12V			120
0-15V, 0-15V			150
0-20V, 0-20V			200

20VA — Clamp Type Construction

Approx. 16% Regulation F.C. 70, H48, W46

0-4.5V, 0-4.5V Secondaries	335	Trans 20VA	45
0-6V, 0-6V			60
0-12V, 0-12V			120
0-15V, 0-15V			150
0-17.5V, 0-17.5V			175
0-20V, 0-20V			200

55VA — Clamp Type Construction

Approx. 10% Regulation F.C. 92, H64, W57

0-6V, 0-6V Secondaries	540	Trans 55VA	60
0-12V, 0-12V			120
0-15V, 0-15V			150
0-20V, 0-20V			200
0-30V, 0-30V			300

100VA — Frame Type Construction

Approx. 6% Regulation H87, W74, D64

0-25V, 0-25V Secondaries	825	Trans 100VA	250
0-40V, 0-40V			400

COMMUNICATIONS INTEGRATED CIRCUITS — PLESSEY

SL360C	242	SL641C	384								
SL362C	302	SL650C	865								
SL610	230	SL651C	786								
SL611C	230	SL652C	329								
SL612C	230	SL680C	230								
SL613C	394	SL701C	220								
SL620C	347										
SL621C	347	SL1610C	166	SL1623C	251	SL1680C	170	SP8629	446	SP8690	907
SL622C	854	SL1611C	166	SL1625C	225	SL6600C	890	SP8630B	1361	SP8760B	680
SL623C	629	SL1612C	166	SL1626C	251	SL6640C	401	SP8655B	1058	SP8790B	454
SL624C	321	SL1613C	193	SL1630C	166	SL6650C	378	SP8657B	1058	SP8794B	454
SL630C	218	SL1620C	225	SL1640C	193			SP8659B	907		
SL640C	384	SL1621C	225	SL1641C	193			SP8660B	907		

POWERTRAN

FOR ELECTRONIC KITS OF DISTINCTION

PSI 4002 STUDIO MODEL

cabinet size 17.2" x 17.2" x 6.7"

200 + 200 watt AMPLIFIER

As featured in Electronics Today International

400W rms continuous — 800W peak!
0.03% THD at FULL power!
PLUS all the following features too!

- ★ Each channel totally independent with its own stabilised power supply driven by custom designed TOROIDAL transformers!
- ★ Inherent reliability — monster heat sinks for cool running at the hottest venues — electronic open and short circuit protection!
- ★ Ultra low feedback (an incredible low 14dB overall!), super high slewing rate (20V/μs), 200W rms continuous to 4 ohm from EACH channel, input sensitivity 0.775V (0dB).
- ★ Professional quality components, sturdy 19" rack mounting chassis complete with sleeve and feet for free standing work too.
- ★ Easy to build — plenty of working space with ready access to all components, minimal wiring, extensive instruction suitable for both experience constructors and newcomers to electronics.
- ★ Value for money — quality and performance comparable with ready-built amplifiers costing over £600!

COMPLETE KIT ONLY £196.90 + VAT

READ THE REVIEW
IN SOUND INTERNATIONAL DEC. '78 !

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%.

WIRELESS WORLD FM TUNER £70.20 + VAT

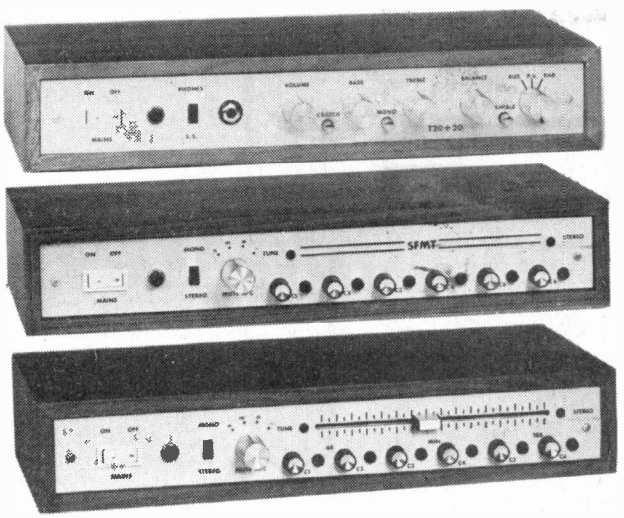
A pre-aligned front-end module makes this Wireless World published design very simple to construct and adjust without special instruments. Features include an excellent a.m. rejection, push-button station selection as well as infinitely variable tuning and a phase locked loop stereo decoder incorporating active filters for "birdy" suppression.

LINSLEY-HOOD CASSETTE DECK £79.60 + VAT

This design, published in Wireless World, although straightforward and relatively low cost provides a very high standard of performance. There are separate record and replay amplifiers and switchable equalisation together with a choice of bias levels are also provided. The mechanism is the Goldring-Lenco CRV with electronic speed control.

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.



POWERTRAN SFMT TUNER £35.90 + VAT

This is a simple low cost design which can be constructed easily without special alignment equipment but which still gives a first-class output suitable for feeding any of our very popular amplifiers or any other high quality audio equipment. A phase-locked-loop is used for stereo decoding and controls include switchable afc, switchable muting and push-button channel selection (adjustable by controls on the front panel). This unit matches well with the T20 + 20 and T30 + 30 amplifiers.

WWII TUNER £47.70 + VAT

This cost reduced model of our highly successful Wireless World FM Tuner kit was designed to complement the T20 + 20 and T30 + 30 amplifiers and the cabinet size, front panel format and electrical characteristics make this tuner compatible with either. Facilities included are pre-aligned front-end module, switchable afc, adjustable switchable muting, LED tuning indication and both continuous and push-button channel selection (adjustable by controls on the front panel).

COMPLETE KITS: Our complete kits really are complete. All of the projects shown on this page are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cables, nuts, bolts, etc., and full instructions — in fact everything!

All of the kits shown on this page are available as separate packs (except the Powertran SFMT Tuner) for those customers who wish to spread their purchase or perhaps make their own cabinets or metalwork. Prices are given in our FREE CATALOGUE.

PRICE STABILITY. Order with confidence. Irrespective of any price changes. We will honour all prices in this advertisement until July 31st, 1979, if the June, 1979 issue is mentioned with your order. Errors and VAT rate changes excluded.

EXPORT ORDERS: No VAT. Postage charged at actual cost plus 50p handling and documentation.
U.K. ORDERS. Subject to 12½% surcharge for VAT*(i.e. add ⅛ to the price). 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 your kit from the factory, call at Sales Counter (at rear of factory). Open 9 a.m.-4.30 p.m. Monday-Thursday.

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

POWERTRAN ELECTRONICS

PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SP10 3NM

ANDOVER
(STD 0264) 64455

news digest.....

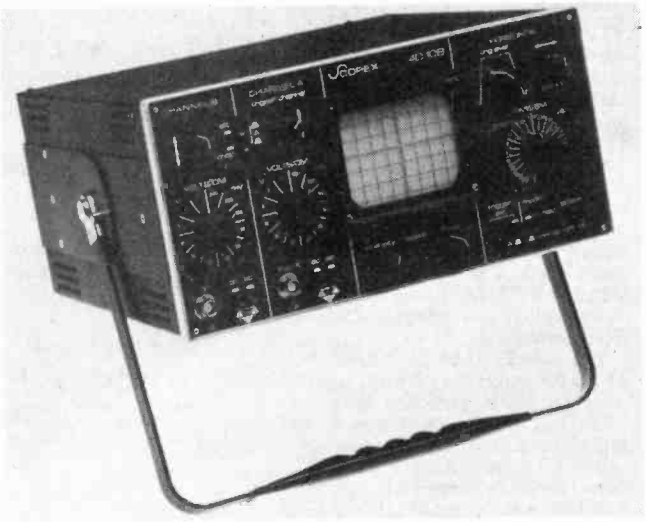
XY AND Z SCOPE

Succeeding the earlier Scopex 4D10A range, the 4D10B boasts full XY operation and Z modulation.

The 4D10B retains the high accuracy (±3%) and 10MHz bandwidth of the previous range. New features are made possible by the latest CMOS integrated circuit technology.

In the XY mode channel A is switched into the horizontal deflection system giving fully matched sensitivities for both X and Y axes over the entire 10mV to 50 V per cm range. When used in the conventional YT mode, the vertical amplifiers are complemented by a fully triggered 16 range timebase of 1uS to 100mS per cm.

The Scopex single trigger control is retained. The XY mode is easily selected on just one position of the timebase switch.



The 4D10B is about £188 + VAT from Scopex Sales, Pixmore Avenue, Letchworth, Hertfordshire SG6 1JJ.

OOPS

We have to admit that the component numbering on the overlay for the Guitar Effects Unit (April ETI) was less than perfect. R7 should read R8, R8 should read R9, and so on up to R14, which should read R7. The PCB foil pattern on page 111 has been printed reversed.

In the May edition Double Die project, you may have noticed that the circuit diagram does not correspond with the component overlay. In fact, both the circuit diagram and the PCB layout given work. We mixed up two versions of the same circuit and printed the circuit diagram of one and the component overlay of the other. Sorry for any inconvenience caused.

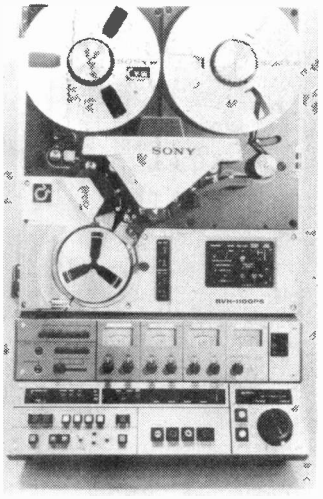
BATTLESTAR GALACTICA

Cylons, daggits, tylium and Ovions — these are the things of which Battlestar Galactica is made. You want a translation? Referring to my interstellar dictionary — well, basically the Cylons are the sub-human baddies; tin men who take their orders from a lizard in a high chair. A daggit is a dog-like creature which is the cause of the boy meets girl bit of the action (every film should have one). Tylium is mined on the planet Carillon by insect-like creatures called Ovions, which are slightly more sinister than they seem. The Battlestar Galactica itself is an enormous star ship that makes the USS Enterprise look like a Sputnik.

The film opens amidst the closing stages of peace treaty negotiations between the twelve colonies of mankind and the Cylons. However, it isn't long before war is back in style again.

It's impossible to review this sort of film without making comparisons with Star Wars. Battlestar Galactica's special effects don't quite come up to the immaculate standard of Star Wars, but Sensurround can make up for a lot. The rather weak storyline ends in the middle, leaving the way clear for a sequel. However, it's worth seeing, if only as an exercise in special effects miracles.

news digest



VTR PALs

The new Sony BVH-1100PS VTR which operates on both PAL and SECAM, has been developed from the BVH-1000 production recorder. The new VTR features optional dynamic tracking, giving broadcast quality replay over a speed range of one fifth normal speed in reverse through still frame, to twice play speed forward. Also featured are insert and assemble editing between two recorders with edit point trimming and memory, confidence video replay and an optional fourth audio track. The portable version, the BVH-500PS, has a new colour playback adaptor for field monitoring.

The new BVU-50 high-band U-matic recorder, weighing only 5.6 kg, is a record only VTR, but with a confidence replay head checking the presence of a recording on the tape. Available in PAL and SECAM versions, the BVU-50 is compatible with other Sony Broadcast high-band U-matics, the recording format offering two programme audio tracks plus a time code track. Important operating parameters are monitored by an alarm system, with operator visual and audible alarms. The recorder incorporates back space editing, with editing transitions occuring in the vertical interval. Further details of these new VTRs, which will be shown at the eleventh television symposium in Montreus, Switzerland (27 May to 1 June), from Sony Broadcast Ltd, City Wall House, Basing View, Basingstoke, Hampshire RG21 2LA.

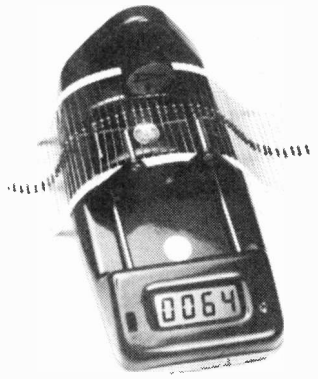
COUNTED OUT

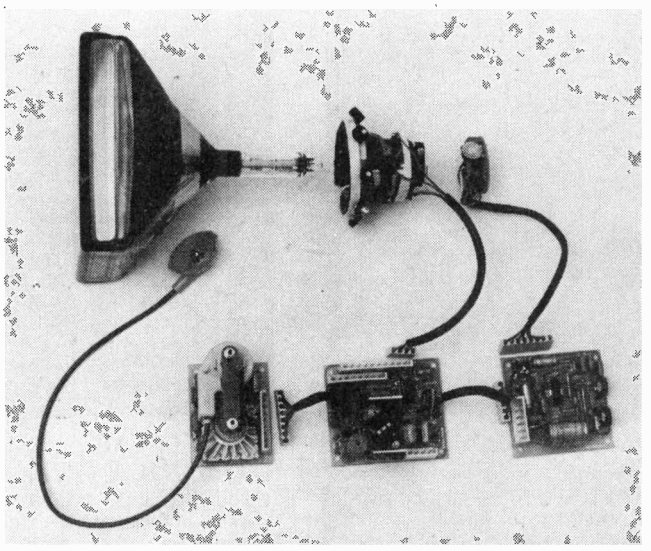
Semtor Electronics are introducing a new counter for bandoliered components.

The machine, which has a forward and reverse counting facility, has an LCD readout. Bandolier widths from 45 to 115mm can be accommodated, and the battery/mains machine comes complete with a mains adaptor and battery charger unit.

The unit counts by detecting component leads. Almost any type of bandoliered components may be used e.g. resistors, capacitors, rectifiers, etc.

Technical data and details of demonstrations are available from Semtor Electronics Ltd., Miton House, 6 High Street, Yiewsley, West Drayton, Middlesex.





TV BUILDING BRICKS

A series of kits from Digivision represent a totally new modular CRT electronic system. The five plug-in modules enable a designer with little experience of TV circuitry to produce a design for a data display system.

Visionpak comprises the main interface unit, the horizontal scanning module, connected to the line output transformer module, which produces the auxiliary voltages required by the system. This module is connected to the vertical time base module.

A video amplifier module is mounted with the CRT base connector on a small PCB, while the scanning yoke assembly is fitted to the neck of the CRT. The scanning yoke assembly will fit most 20mm CRTs in the 7 to 14 inch size range. For further details of Visionpak contact Digivision Ltd, 82 Cannock Road, Leicester LE4 7HR.

SITTING COMFORTABLY

Is the seat in your motor a bit lumpy, or a bit too high. Maybe the seat back isn't quite right. Your troubles could be over, with the new experimental, computerised, push-button seat adjustment system from National Semiconductors and RECARO, the custom seat specialists.

The system uses National Semiconductor's low power COP410L four bit microcontroller chip, containing all system timing, internal logic, 4096 bits of ROM for program storage, 128 bits of RAM for user programmable data storage and 19 lines to incoming and outgoing information.

The system will be fitted to the RECARO 'C' seat, the ultimate in car seat design, adaptable to the particular physique of each driver. The driver can adjust the seat for eight different positions — up/down, forward/backward tilt, seat forward/backward and seatback tilt. As if that wasn't enough two additional memory keys are provided on the keyboard to allow the positions of two different drivers to be stored.

The system is jointly developed by RECARO and National Semiconductor (UK) Ltd, 301 Harpur Centre, Horne Lane, Bedford.

Measure Resistance to 0.01Ω ...
At a Price that has no resistance at all

New ELENCO PRECISION Digital Multimeter M1200B
USA

ONLY £55 (+£3 p&p + VAT £4.64 = £62.64)

*FULLY GUARANTEED FOR 2 YEARS

*METAL CASE

*EX STOCK DELIVERY (Subject to availability)

THE ULTIMATE IN PERFORMANCE - MEASURES RESISTANCE TO 0.01 OHMS, VOLTAGE TO 100 MICROVOLTS, CURRENT TO 1 MICROAMPS AT LOWEST EVER PRICE!

FEATURES

- 3½ digits 0.56" high LED for easy reading
- 100μV, 1μA, 0.01Ω resolution
- High input impedance 10 Megohm
- High accuracy achieved with precision resistors, not unstable trimpots
- Input overload protected to 1000V (except 200mV scale to 600V)
- Auto zeroing, autopolarity
- Mains (with adaptors not supplied) or battery operation-built-in charging circuitry for NiCads
- Overrange indication
- Hi Low power ohms, Lo for resistors in circuit, Hi for diodes

SPECIFICATIONS:

DC Volts	Range 200mV, 2V, 20V, 200V, 1000V Accuracy 1% ± 1 digit, Resolution .1mV Overload protection 1,000 volts max
AC Volts	Range 200mV, 2V, 20V, 200V, 1000V (Response 45Hz to 5KHz) Accuracy 1.5% ± 2 digits, Resolution .1mV Overload protection 1000V max, 200mV scale 600V
DC Current	Range 2mA, 20mA, 200mA, 2amp. Accuracy 1% ± 1 digit, Resolution 1 Microamp Overload protection -- 2 amp fuse and diodes
AC Current	Range 2mA, 20mA, 200mA, 2 amp Accuracy 1.5% ± 2 digits, Resolution 1 Microamp Overload protection – 2 amp fuse and diodes
Resistance	Range 20, 200, 2K, 200K, 2 Meg. 20 Meg. Accuracy 1% ± 1 digit, Resolution .01 ohms
Environmental	Temp coefficient 0° to 30° C ± .025% °C Operating Temp 0° to 50° C Storage – 20° to 60° C
General	Mains adaptor: 6 - 9 Volts @ 200mA (not supplied) 4C size batteries (not supplied) Size 8¼ x 5¼ x 2¼ Weight 2½ lbs.

At £55, M1200B is the best buy among DMM's currently available. Its 0.01 ohms resolution allows you to detect shorted windings in coils, transformers or motors. It is also useful in checking low contact resistance in switches, relays or connectors. Poor solder connections can also be spotted. The low power ohms function permits accurate measurements of in circuit resistance without forward biasing semiconductor junctions.

You have been waiting a long time for a digital multimeter with all these features at a price like this. Now its yours.

Also available from retail shops:
Audio Electronics, 301 Edgware Rd, London W2
Z & I Aero Services, 85 Tottenham Court Road London W.1

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38 Mount Pleasant, London WC1XOAP
Tel.01-837 1165 or Hemel Hempstead (0442) 832 966
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ET16

To: Maclin-Zand Electronics Ltd
1st Floor, Unit 10, East Block
38 Mount Pleasant, London WC1X OAP

Please send me _____ DMM M1200B
@ £62.64 inc. p & p + VAT (overseas £60).

I enclose cheque/P.O./Bank Draft for £ ____

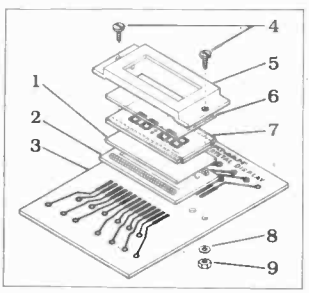
Name _____ (BLOCK
Address _____ LETTERS
_____ PLEASE)

.....news digest.....

DIY

Beckman Instruments have introduced an LCD designer's kit for constructors who want to experiment with large area liquid crystal displays.

The kit includes a Beckman



1 rear polarizer and reflector 2 connector 3 pc board 4 screws 5 bezel 6 front polarizer 7 model 739-0432-0 LCD 8 washer 9 nut

half inch, four digit liquid crystal display, an easy to mount connector/bezel assembly, PCB, full spec and applications information. Also included is a list of manufacturers who provide integrated circuits with LCD interfaces.

The LCD kit is available for £10 from Beckman Instruments Ltd, Queensway, Glenrothes, Fife KY7 5PU.

MIGHTY MINI RELAY

Despite a body size of only 28.1mm by 7.5mm the Erg AXM1 high reliability reed relay can switch inductive loads of up to 20W.

Two versions of this axial leaded, miniature component are available — type A, SPST (normally open) and type C, SPDT (changeover). Operational life at full inductive load switching rating is over one million operations.

A 10W version offers coils of 5,12 or 24V DC. Type A can switch 200V DC or AC peak at 0.5A (resistive load).

Optional extras include external magnetic shielding. Prices are from £1.08 (100 rate), from Erg Components, Luton Road, Dunstable, Beds. LU5 4LJ.

LOW FREQUENCY JACKPOT

Judge Browne, sitting as Trial Judge in the Trial Division of the United States Court of Claims, has recommended to the Court of Claims a finding that Decca Limited is entitled to judgment against the United States in the amount of US $39,355,715 up to March 31st 1979, plus additional delay compensation at the rate of US $5,436 per day for each day from April 1st 1979 to the date of payment.

This recommendation, which both parties are entitled to oppose arose out of an action brought by Decca as a result of the US Government's deployment of transmitting stations for the "Omega" System of radio navigation. Such stations transmit very low frequency signals to provide navigational aids to ships and aircraft throughout the world.

Judge Browne's recommendation follows earlier findings of validity and infringement in Decca's favour by the Court of Claims in 1976.

Come to the Great British Electronics Bazaar

"ALLY PALLY"
Thursday–Saturday
28th–30th June.

FREE!

(AND WAIT TILL YOU SEE OUR SEMINAR PROGRAMME)

The Great Big 'Bazaar' for the hobbyist, amateur, and small buyer.

There's never been an event like this before.

First, the very scale of the exhibition is huge. Virtually all the companies you're used to hearing about (and buying from) will be there. Companies like Fluke and Gould showing off their low cost multimeters; smaller but important manufacturers like Lektrokit and Chromasonics; and even the R.S.G.B. who will have a station 'on the air' throughout the 'Bazaar.'

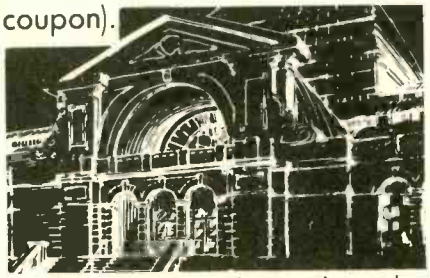
Then there are the suppliers of low-cost components and equipment. Plus almost all the journals in the business. Plus, oh, so many more interesting people catering for your needs (including computer kits!).

And you get in FREE if you send an s.a.e. (see alongside).

The Seminars

If you would like to hear just what the experts have to tell you, a *season ticket* for three whole days can be yours for only £1.50.

Send an s.a.e. and we'll give you all the information (just use the coupon).



Our home for three days – Alexandra Palace, where it all began. (Our seminars are sited alongside the organ – for those who know this unique hall.)

When?

Between Thursday to Saturday 28th–30th June.

You'll be in very good company; some ten thousand enthusiasts – and over a hundred stands displaying all that you want to see.

You'll come?

Eyes down for the appropriate coupon.

SEMINAR TICKETS

£1.50.

I'd like to sit in at your seminars. (And like a free ticket to the exhibition.) Send me full details, please, and I enclose a large-ish s.a.e.

Name: .....

Address: .....

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Post to: 'The Bazaar,' 34/36 High Street, Saffron Walden, Essex.

THE GREAT BRITISH ELECTRONICS BAZAAR

Our Symbol. We think it tells you just what the Bazaar is all about.

.....news digest.....

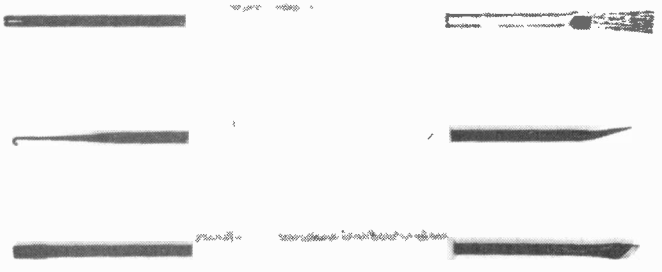
SOLDER TOOLS

Adcola have come to the aid of solderers all over the country with the introduction of three double-ended soldering tools.

The knife-scraper, spike/hook and brush/fork are made of non-tinning steel with white plastic hexagonal handles.

How do you use them? The fork/brush tool can be used for wire twisting, unwinding and cleaning components and PCBs, prior to soldering. The hook/spike tool can be used to clean out holes and for chassis marking. The knife/scraper is useful for general repairs and removing surplus solder.

The solder aid tool set is available at £2.50 from Adcola Products Ltd., Adcola House, Gauden Road, London SW4 6LH.



WINTER TIMER

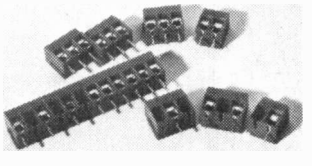
The Lake Placid Olympic Organizing Committee have chosen two new versions of the Heuer Microsplit LCD stopwatch as the official stopwatches of the 1980 Olympic Winter Games.

Both provide 1/100sec readout with split function and measure time up to 59 minutes, 59.9 secs. with split memory. Accuracy is 0.001% at room temperature. Further information from Heuer-Leonidas S.A., Veresiusstrasse 18, CH-2501, Biel/Bienne, Switzerland.

WIRE TRAPPERS

West Hyde Developments are introducing a new range of Kaffka PCB connectors. Consisting of six types, made in 5mm or 10mm spacing, they dovetail together to form a connector of any desired configuration.

The body is made of zinc-plated brass with leaf springs to avoid conductor damage from the clamping screws. Behind each screw there is a hole for a 2mm test prod. The 13 amp connectors will accept cables to 2½mm², with temperature range from −30°C to +120°C. Further details from West Hyde Developments Ltd, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET.



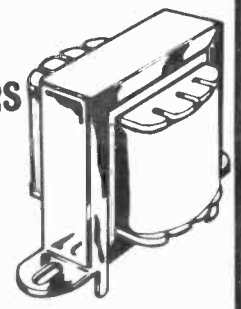
STEVENSON
Electronic Components

REGULATORS

78L05	30p	7805	60p	79L05	70p	7912	80p
78L12	30p	7812	60p	79L12	70p	7915	80p
78L15	30p	7815	60p	7905	80p	LM723	35p

HARDWARE

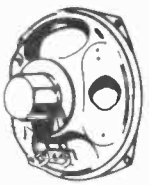
MINIATURE TRANSFORMERS



240 Volt Primary

Secondary rated at 100mA.
Available with secondaries of:
6 - 0 - 6, 9 - 0 - 9 and
12 - 0 - 12. 92p. each.

LOUDSPEAKERS

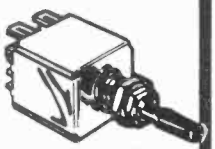


56mm dia. 8 ohms 70p
64mm dia. 8 ohms 75p
64mm dia. 64 ohms 75p
70mm dia. 8 ohms 100p
70mm dia. 80 ohms 110p

TERMINALS

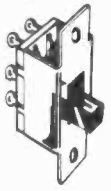
Rated at 10A. Accepts 4mm plug, black, blue, green, brown and red . . . 22p

SWITCHES



Subminiature toggle. Rated at 3A 250V.
SPDT 70p SPDT centre off 75p
DPDT 80p DPDT centre off 95p

Standard toggle
SPST 34p DPDT 48p

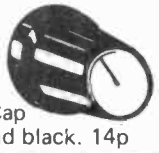


Wavechange switches.
1P12W, 2P6W, 3P4W or 4P3W all 43p ea.

Miniature switches (non-locking)
Push to make 15p Push to break 20p

Slide switches (DPDT)
Miniature 14p Standard 15p

CONTROL KNOBS



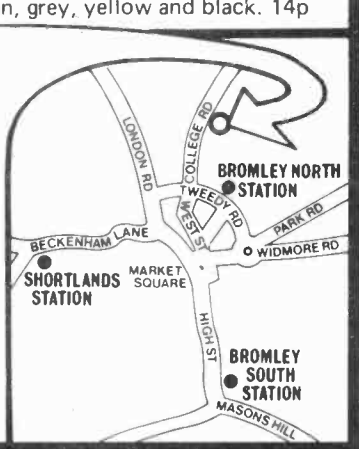
Ideal for use on mixers etc. Push on type with black base and marked position line. Cap available in red, blue, green, grey, yellow and black. 14p

WHY NOT VISIT OUR

NEW SHOP

We welcome callers at our new premises at the address below (5 mins. from High St.) We are open Mon - Sat, 9am - 6pm. Special offers available.

Express telephone order service. Orders received before 5pm. are shipped first class on that day. Contact our Sales Office now! Tel: 01-464 2951/5770.



ORDERS DESPATCHED BY RETURN POST

Quantity discounts on any mix TTL, CMOS, 74LS and Linear circuits: 100+ 10%, 1000+ 15%. Prices VAT inclusive. Please add 30p for carriage. All prices valid to April 1980. Official orders welcome.

BARCLAYCARD & ACCESS WELCOME.

Mail orders to: STEVENSON (Dept ET)

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AC127	17p	BCY71	14p	ZTX109	14p
AC128	16p	BCY72	14p	ZTX300	16p
AC176	18p	BD131	35p	2N697	12p
AD161	38p	BD132	35p	3N1302	38p
AD162	38p	BD135	38p	2N2905	22p
BC107	8p	BD139	35p	2N2907	22p
BC108	8p	BD140	35p	2N3053	18p
BC109	8p	BF244B	36p	2N3055	50p
BC147	7p	BFY50	15p	2N3442	135p
BC148	7p	BFY51	15p	2N3702	8p
BC149	8p	BFY52	15p	2N3704	8p
BC148	9p	MJ2955	98p	2N3705	9p
BC177	14p	MPSA06	20p	2N3706	9p
BC178	14p	MPSA56	20p	2N3707	9p
BC179	14p	TIP29C	60p	2N3708	8p
BC182	10p	TIP30C	70p	2N3819	22p
BC182L	10p	TIP31C	65p	2N3904	8p
BC184	10p	TIP32C	80p	2N3905	8p
BC184L	10p	ZTX107	14p	2N3906	8p
BC212	10p	ZTX108	14p	2N4058	12p
BC212L	10p			2N5457	32p
BC214	10p			2N5458	30p
BC214L	10p			2N5459	32p
BC477	19p			2N5777	50p
BC478	19p				
BC479	19p				
BC548	10p				
BCY70	14p				

DIODES

1N914	3p	1N5401	13p
1N4001	4p	BZY88ser.	8p

Full spec. product.
1N4148 £1.40/100. £11/1000

LINEAR

THIS IS ONLY A SELECTION!

709	28p	CA3140	38p	NE555	21p
741	16p	LM301AN	26p	NE556	50p
747	40p	LM318N	85p	NE565	85p
748	30p	LM324	45p	NE567	170p
CA3046	55p	LM339	45p	SN76003	200p
CA3080	70p	LM380	75p	SN76013	140p
CA3130	90p	LM382	120p	SN76023	140p
		LM1830	150p	SN76033	200p
		LM3900	50p	SN76477	220p
		LM3909	65p	TBA800	70p
		MC1496	60p	TDA1022	650p
		MC1458	32p	ZN414	75p

CAPACITORS

TANTALUM BEAD

	each
0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 & 2.2uF @ 35V	8p
4.7, 6.8, 10uF @ 25V	13p
22 @ 16V, 47 @ 6V, 100 @ 3V	16p

MYLAR FILM

0.001, 0.01, 0.022, 0.033, 0.047	3p
0.068, 0.1	4p

POLYESTER

Mullard C280 series

0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1	5p
0.15, 0.22	7p
0.33, 0.47	10p
0.68	14p
1.0uF	17p

CERAMIC

Plate type 50V. Available in E12 series from 22pF to 1000pF and E6 series from 1500pF to 0.047uF 2p

RADIAL LEAD ELECTROLYTIC

63V	0.47	1.0	2.2	4.7	10	5p
			22	33	47	7p
	100					13p
			220			20p
25V	10	22	33	47		5p
	100					8p
		220				10p
				470		15p
	1000					23p

CONNECTORS

JACK PLUGS AND SOCKETS

	screened	unscreened	socket
2.5mm	9p	13p	7p
3.5mm	9p	14p	8p
Standard	16p	30p	15p
Stereo	23p	36p	18p

DIN PLUGS AND SOCKETS

	plug	chassis socket	line socket
2pin	7p	7p	7p
3pin	11p	9p	14p
5pin 180°	11p	10p	14p
5pin 240°	13p	10p	16p

1mm PLUGS AND SOCKETS

Suitable for low voltage circuits, Red & black. Plugs: 6p each Sockets: 7p each.

4mm PLUGS AND SOCKETS

Available in blue, black, green, brown, red, white and yellow. Plugs: 11p each Sockets: 12p each.

PHONO PLUGS AND SOCKETS

Insulated plug in red or black	9p
Screened plug	13p
Single socket 7p Double socket	10p

74LS

		LS73	25p	LS156	60p
		LS74	25p	LS157	48p
		LS75	30p	LS164	65p
LS00	13p	LS76	25p	LS174	48p
LS01	13p	LS78	35p	LS175	48p
LS02	13p	LS83	35p	LS190	62p
LS03	13p	LS85	70p	LS192	60p
LS04	13p	LS86	30p	LS193	60p
LS08	15p	LS90	36p	LS196	60p
LS10	13p	LS93	38p	LS251	50p
LS13	28p	LS95	45p	LS257	50p
LS14	45p	LS123	70p	LS258	50p
LS20	13p	LS125	38p	LS266	30p
LS30	13p	LS126	38p	LS283	60p
LS32	16p	LS132	60p	LS290	60p
LS37	24p	LS136	28p	LS365	40p
LS40	17p	LS138	50p	LS366	40p
LS42	40p	LS139	50p	LS367	40p
LS47	90p	LS151	50p	LS368	40p
LS48	70p	LS153	50p	LS386	35p
LS54	15p	LS155	55p	LS670	140p

TTL

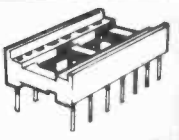
		7454	12p	74132	45p
		7473	20p	74141	55p
		7474	22p	74148	90p
		7475	25p	74150	55p
7400	10p	7476	20p	74151	40p
7401	10p	7485	55p	74156	40p
7402	10p	7489	135p	74157	40p
7404	12p	7490	25p	74164	55p
7408	12p	7492	30p	74165	55p
7410	10p	7493	25p	74170	100p
7413	22p	7494	45p	74174	50p
7414	39p	7495	35p	74177	50p
7420	10p	7496	45p	74190	50p
7427	20p	74121	25p	74191	50p
7430	10p	74122	38p	74192	50p
7442	38p	74123	38p	74193	50p
7447	45p	74125	35p	74196	50p
7448	50p	74126	35p	74197	50p

CMOS

		4018	55p	4050	25p
		4023	12p	4066	35p
		4024	40p	4068	18p
4001	12p	4026	90p	4069	12p
4002	12p	4027	30p	4071	12p
4007	12p	4028	48p	4081	13p
4011	12p	4029	50p	4093	45p
4013	28p	4040	60p	4510	65p
4015	50p	4042	50p	4511	65p
4016	30p	4046	90p	4518	65p
4017	48p	4049	25p	4520	60p

FULL DETAILS IN CATALOGUE!

SKTS



Low profile by Texas

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

Soldercon pins: 100:50p. 1000:370p

OPTO

	0.125in.	0.2in	each	100+
LED's				
Red	TIL209	TIL220	9p	8p
Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		

DISPLAYS

DL704	0.3 in CC	130p	120p
DL707	0.3 in CA	130p	120p
FND500	0.5 in CC	100p	80p

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	0.8p
0.5W	1.5p	1.2p	1p

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res) 0.5W £7.50. 0.25W £5.70.

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	3.5p	3.2p

PLEASE WRITE FOR YOUR FREE COPY OF OUR NEW 64 PAGE CATALOGUE OF COMPONENTS. CONTAINS OVER 2500 STOCK ITEMS.

76 College Road, Bromley, Kent, England

.....news digest.....

THREE IN ONE SCOPE

Gould's Biomation DTO-1 is a completely new type of microprocessor-basedinstrument for production testing and troubleshooting of complete electronic systems. The DTO-1 combines normal oscilloscope functions with those of comparison tester and a time-domain logic analyser to automate the testing of digital equipment.

This digital testing oscilloscope handles digital circuitry like a logic analyser, analogue circuitry like an oscilloscope and automates go/no go testing procedures with its built-in comparison tester functions.

No special software is required for programming, since the DTO-1 stores reference logic signals in an integral miniature magnetic tape cartridge unit.

Firmware includes 14K of ROM with RAM provided for recording digital signals and transcribing test records and sequences.

The storage facility allows complete catalogues of test sequences to be maintained and updated. Users will be able to do without other test equipment such as oscilloscopes or frequency counters because many of these functions are built into the DTO-1.

Further details of the DTO-1 from Gould Instruments Division, Roebuck Road, Hainault, Essex.

DOMINUS DISC AMP

Stereo Disc Amplifier 3 from Dominus is a self-contained mains powered unit intended for disc playback and tape transfer of the highest quality.

I tproduces equalised outputs from magnetic cartridges suitable for driving unbalanced line and DIN level inputs of control centres and mixers.

The unit is based on the Surrey Electronics Stereo Disc Amplifier 2, which is widely used in broadcasting, and offers selectable cartridge load capacitance and resistance. Externally adjustable presents enable a wide range of cartridges to be matched to any system. High clipping point and low circuit noise combine to maximise dynamic range.

Further details of Stereo Disc Amplifier 3 are available from Dominus, PO Box 1, Cranleigh, Surrey.

REED THIS ONE

Hamlin Electronics are offering a new range of open-frame reed relays offering a wide range of switching configurations and packaging and mounting options.

The HE400 Series is designed for printed circuit mounting on 0.1 in. matrix, and is available with a selection of metal or plastic covers, which can be potted, if required, for added protection.

Switching combinations range from single pole to 5 pole. The reed switches from the Hamlin range include dry (HE420), high voltage (HE450), high power (HE460) and mercury-wetted (HE430 and HE440 types). Standard coil voltages are 5, 12, 24, 48 volts. Non-standard voltages can be supplied to customer requirements on request.

Further details of the HE400 Series are available from Hamlin Electronics Europe Ltd., Diss, Norfolk IP22 3AY.

TTLs by TEXAS

7400	13p
7401	14p
7402	14p
7403	14p
7404	14p
74S04	90p
7405	18p
7406	32p
7407	32p
7408	17p
7409	19p
7410	15p
7411	24p
7412	20p
7413	30p
7414	50p
7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	34p
7425	30p
7426	40p
7427	34p
7428	36p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
7442A	60p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	80p
7448	80p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	34p
7474	30p
7475	36p
7476	35p
7480	50p
7481	100p
7482	84p
7483A	70p
7484	100p
7485	90p
7486	30p
7489	210p
7490A	30p
7491	80p
7492A	48p
7493A	30p
7494	84p
7495A	70p
7496	85p
7497	180p
74100	130p
74104	85p
74105	65p
74107	34p
74109	55p
74110	55p
74111	70p
74116	200p
74118	130p
74119	210p
74120	110p
74121	25p
74122	48p
74123	48p
74125	55p
74126	60p
74128	75p
74132	75p
74136	75p
74141	70p
74142	200p
74145	90p
74147	190p
74148	150p
74510	100p
74151A	70p
74153	70p
74154	100p
74155	90p
74156	90p
74157	70p
74159	190p
74160	90p
74161	90p
74162	90p
74163	90p
74164	100p
74165	130p
74166	140p
74167	200p
74170	240p
74172	720p
74173	120p
74174	85p
74175	85p
74176	75p
74177	75p
74178	160p
74180	93p
74181	150p
74182	90p
74184A	150p
74185	150p
74186	600p
74190	90p
74191	90p
74192	80p
74193	90p
74194	100p
74195	85p
74196	85p
74197	80p
74198	150p
74199	150p
74200	£10
74221	160p
74251	140p
74259	250p
74265	90p
74278	290p
74279	110p
74283	190p
74284	400p
74285	400p
74290	150p
74293	150p
74294	200p
74298	200p
74365	120p
74366	120p
74367	120p
74368	120p
74390	200p
74393	180p
74490	225p

74LS SERIES

74LS00	13p
74LS0.	14p
74LS04	14p
74LS05	25p
74LS08	22p
74LS10	20p
74LS11	40p
74LS13	38p
74LS14	70p
74LS20	20p
74LS21	40p
74LS22	28p
74LS27	38p
74LS30	22p
74LS32	27p
74LS42	95p
74LS47	90p
74LS55	30p
74LS7.	00p
74LS73	50p
74LS74	40p
74LS75	45p
74LS83	90p
74LS85	100p
74LS86	40p
74LS90	60p
74LS92	72p
74LS93	60p
74LS96	75p
74LS107	45p
74LS112	100p
75LS123	65p
74LS124	180p
74LS125	80p
74LS132	95p
74LS133	60p
74LS136	55p
74LS138	60p
74LS139	60p
74LS148	140p
74LS151	100p
74LS153	60p
74LS154	140p
74LS157	50p
74LS158	120p
74LS160	130p
74LS161	100p
74LS162	140p
74LS163	110p
74LS164	120p
74LS165	160p
74LS166	180p
74LS173	110p
74LS174	90p
74LS175	110p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	140p
74LS193	140p
74LS194	90p
74LS195	140p
74LS196	120p
74LS221	140p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	195p
74LS245	195p
74LS251	140p
74LS253	140p
74LS257	120p
74LS258	250p
74LS259	160p
74LS266	50p
74LS27.	130p
74LS279	140p
74LS298	249p
74LS3. .	200p
74LS365	160p
74LS367	160p
74LS368	160p
74LS37.	180p
74LS374	195p
74LS377	180p
74LS378	200p
74LS390	160p
74LS393	180p

FULL 74LS SERIES AVAILABLE

4000 SERIES

4000	15p
4001	17p
4002	17p
4006	95p
4007	18p
4008	80p
4009	40p
4010	50p
4011	17p
4012	18p
4013	50p
4014	84p
4015	84p
4016	45p
4017	80p
4018	80p
4019	45p
4020	100p
4021	110p
4022	100p
4023	22p
4024	50p
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	58p
4049	40p
4050	48p
4051	80p
4052	80p
4053	80p
4054	150p
4055	125p
4056	135p
4059	600p
4060	115p
4063	120p
4066	55p
4067	450p
4068	22p
4069	20p
4070	30p
4071	22p
4072	22p
4073	22p
4075	22p
4076	107p
4081	22p
4082	22p
4093	80p
4094	175p
4098	120p
4411	£11
4502	120p
4503	70p
4507	55p
4510	99p
4511	150p
4514	250p
4516	110p
4518	100p
4520	90p
4528	100p
4532	140p
4543	180p
4553	450p
4556	90p
4560	250p
4583	90p
4584	90p
14411	£11
14412V	£11
14433	£11
14500	£7
14599	290p

INTERFACE ICs

MC1488	100p
MC1489	100p
75107	160p
75150	175p
75154	175p
75182	230p
75324	375p
75325	375p
75451	72p
75491/2	96p
8T26	250p
8T28	300p
8T95	150p
8T97	180p
81LS95	120p
81LS96	140p
81LS97	120p
81LS98	140p
9601	140p
9602	220p
9603	60p

93 SERIES

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

LINEAR ICs

*AY1-0212	600p
*AY1-1313	668p
*AY1-1320	320p
*AY1-5050	200p
*AY5-1315	600p
*AY5-1317A	635p
*CA3019	80p
*CA3046	70p
*CA3049	225p
CA3080E	72p
CA3086	48p
*CA3089E	225p
*CA3090AQ	375p
CA3130E	100p
CA3140E	70p
CA3160E	100p
CA3161E	150p
CA3162E	450p
FX209	750p
ICL7106	850p
ICL8038	340p
LF356P	95p
LF358P	75p
LM301A	30p
LM311	120p
LM318	200p
LM324	70p
LM339	75p
LM348	90p
LM377	175p
LM380	75p
LM381AN	160p
LM389N	140p
LM709	38p
LM710	50p
LM725	350p
LM733	100p
LM741	20p
LM747	70p
LM748	35p
LM3302	80p
LM3900	70p
LM3911	130p
LM4136	120p
*MC1310P	150p
MC1458	85p
MC1495L	350p
*MC1496	100p
*MC3340P	120p
*MC3360P	120p
MK50398	750p
NE531	110p
*NE540L	200p
NE543K	225p
NE555	25p
NE556	70p
NE5618	425p
NE5628	425p
NE565	130p
NE566	155p
NE567	175p
*NE571	425p
*SAD1024A	£15
SFF96364	1150p
*SN76003N	175p
*SN76013N	140p
*SN76018	140p
*SN76013ND	120p
*SN76023N	140p
*SN76023ND	120p
*SN76131	110p
*SN76033N	175p
SN76477	250p
*SP8515	750p
*TAA621	275p
*TBA641811	225p
*TBA651	200p
*TBA800	90p
*TBA810	100p
*TBA820	90p
*TCA940	175p
*TDA1004	300p
*TDA1008	320p
*TDA1022	600p
TDA1034B	250p
*TDA2020	320p
TL071	70p
TL072	95p
TL074	150p
TL084	130p
TL170	60p
ULN2003	100p
XR2206	350p
XR2207	400p
XR2211	600p
*XR2216	675p
XR2240	400p
*ZN414	90p
ZN424E	135p
ZN425E	400p
ZN1034E	200p
95H90	800p
IIC90	£14

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		−ve	
5V	7805	75p	7905	90p
12V	7812	75p	7912	90p
15V	7815	75p	7915	90p
18V	7818	90p	7918	100p
24V	7824	90p	7924	100p

100mA	TO-92			
5V	78L05	35p	79L05	80p
12V	78L12	35p	79L12	80p
15V	78L15	35p	79L15	80p

OTHER REGULATORS

LM309K	135p	LM320T-12	90p
LM317T	200p	LM340T-12	75p
LM323K	625p	78HO5KC	675p
LM723	37p	78MGT2C	135p

OPTO-ELECTRONICS

2N5777	45p	OCP71	130p
ORP12	90p	ORP60	80p
ORP61	90p	TIL78	70p

LEDS

0.125		0.2	
TIL32 I.R.	75p	TIL220 Red	15p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	MV5491 TS	120p
TIL216 Red	18p	Clips	3p

DISPLAYS

3015F	200p	FND500	120p
DL704	140p	FND507	120p
OL707 Red	140p	MAN3640	175p
707 Gr	140p	TIL311	600p
DL747 Red	225p	TIL312/3	110p
747 Gr	225p	TIL321/2	130p
FND357	120p	TIL330	140p
		7750/60	200p

DRIVERS 9368/9370 200p

VEROBOARD 0.1 0.15 (copper clad)

2½ x 3¼	41p	33p
2½ x 5	49p	45p
3¾ x 3¾	49p	45p
3¾ x 5	55p	50p
2½ x 17	152p	121p
3¾ x 17	195p	163p
4¾ x 17	252p	—

Pkt of 35 pins 30p
Spot face cutter 85p
Pin insertion tool 99p

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

TRANSISTORS

AC126	25p
AC127 8	20p
AC176	25p
AC287 8	25p
AF116 7	30p
A0149	70p
AD161 2	45p
BC107/8	11p
BC109	11p
BC109C	13p
BC117	20p
BC147 8	9p
BC149	10p
BC157 8	10p
*BC159	11p
*BC169C	12p
BC172	12p
BC177 8	17p
BC179	18p
BC182L	10p
BC182 3	10p
BC183L	10p
BC184L	11p
BC187	30p
BC212L	11p
BC212 3	11p
BC213L	11p
BC214	12p
BC461	36p
BC477/8	30p
BC516 7	50p
BC547B	16p
BC548C	16p
BC549C	18p
BC557B	16p
BC558B	16p
BC559C	18p
BCY70	18p
BCY71 2	22p
BCI31 2	50p
BD135 6	54p
BD139	58p
BD140	60p
BD242	70p
BDY56	200p
BF200	32p
BF244B	35p
BF256B	70p
BF257 8	32p
BF259	36p
BFR39	30p
*BFR40	30p
BFR41	30p
BFR79	30p
BFR80	30p
*BFR81	30p
BFX29	30p
BFX30	34p
BFX84 5	30p
BFX86. 7	30p
BFX88	30p
BFW10	90p
BFY50	22p
BFY51/2	22p
BFY56	33p
BFY90	80p
BRY39	45p
8SX19/2020p	
BU104	225p
*BU105	190p
*BU108	250p
BU109	225p
*BU205	200p
*BU208	200p
*BU406	145p
MJ481	175p
MJ491	200p
MJ2501	225p
MJ2955	100p
MJ3001	225p
*MJE340	65p
MJE2955	100p
MJE3055	70p
*MPF102	45p
*MPF103/4	40p
*MPF105	40p
MPSA06	30p
*MPSA12	50p
*MPSA56	32p
*MPSU08	63p
*MPSU56	78p
OC28	130p
OC35	130p
*R2008B	200p
*R2010B	200p
*TIP29A	40p
*TIP29C	55p
*TIP30A	48p
*TIP30C	60p
*TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
*TIP2955	75p
TIP3055	70p
*TIS43	34p
*TIS93	30p
*ZTX108	12p
*ZTX300	13p
*ZTX500	15p
*ZTX502	18p
*ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N698	45p
2N706A	20p
2N708A	20p
2N918	45p
2N930	18p
2N1131/2	20p
2N1613	25p
2N1711	25p
2N2102	60p
2N2160	300p
2N2219A	22p
2N2222A	20p
2N2369A	18p
2N2484	30p
2N2646	60p
2N2904/5	25p
2N2906A	24p
2N2907A	30p
*2N2926	9p
2N3053	22p
2N3054	85p
2N3055	48p
2N3442	140p
2N3553	240p
*2N3565	30p
*2N3643/4	48p
*2N3702/3	12p
*2N3704/5	12p
*2N3706/7	14p
*2N3708/9	12p
*2N3773	300p
*2N3819	25p
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*2N3905/6	20p
*2N4036	65p
2N4058/9	12p
*2N4060	12p
*2N4061/2	18p
*2N4123/4	22p
*2N4125/6	22p
*2N4289	20p
*2N4401/3	27p
2N4427	90p
*2N4871	60p
*2N5087	27p
*2N5089	27p
*2N5172	27p
2N5179	90p
2N5191	83p
2N5194	90p
*2N5245	40p
*2N5296	55p
*2N5401	50p
*2N5457/8	40p
*2N5459	40p
*2N5460	40p
*2N5485	44p
*2N6027	48p
2N6247	190p
2N6254	130p
2N6290	85p
2N6292	85p
3N128	120p
3N140	100p
3N141	110p
3N201	110p
40290	250p
40360	40p
40361/2	45p
40364	120p
40408	70p
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7403	.15	7486	.25	75491	.50	74LS08	.35
7404	.10	7489	1.05	75492	.50	74LS09	.35
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7408	.15	7493	.35	74H05	.20	74LS21	.35
7409	.15	7494	.75	74H08	.35	74LS22	.35
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7411	.25	7496	.80	74H11	.25	74LS37	.35
7412	.25	74100	1.15	74H15	.45	74LS38	.45
7413	.25	74107	.25	74H20	.25	74LS40	.40
7414	.75	74121	.35	74H21	.25	74LS42	.75
7416	.25	74122	.55	74H22	.40	74LS51	.45
7417	.40	74123	.35	74H30	.20	74LS74	.45
7420	.15	74125	.45	74H40	.25	74LS76	.50
7426	.25	74126	.35	74H50	.25	74LS86	.45
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7430	.15	74141	.90	74H52	.15	74LS93	.65
7432	.20	74150	.85	74H53	.25	74LS107	.50
7437	.20	74151	.65	74H55	.20	74LS123	1.20
7438	.20	74153	.75	74H72	.35	74LS151	.85
7440	.20	74154	.95	74H74	.35	74LS153	.85
7441	1.15	74156	.70	74H101	.75	74LS157	.85
7442	.45	74157	.65	74H103	.55	74LS160	.95
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7444	.45	74163	.85	74L00	.25	74LS193	1.05
7445	.65	74164	.60	74L02	.20	74LS195	.95
7446	.70	74165	1.10	74L03	.25	74LS244	1.70
7447	.70	74166	1.25	74L04	.30	74LS367	.95
7448	.50	74175	.80	74L10	.20	74LS368	.95
7450	.25	74176	.85	74L20	.35	74S00	.35
7451	.25	74180	.55	74L30	.45	74S02	.35
7453	.20	74181	2.25	74L47	1.95	74S03	.25
7454	.25	74182	.75	74L51	.45	74S04	.25
7460	.40	74190	1.25	74L55	.65	74S05	.35
7470	.45	74191	1.25	74L72	.45	74S08	.35
7472	.40	74192	.75	74L73	.40	74S10	.35
7473	.25	74193	.85	74L74	.45	74S11	.35
7474	.30	74194	.95	74L75	.85	74S20	.25
7475	.35	74195	.95	74L93	.55	74S40	.20
7476	.40	74196	.95	74L123	.85	74S50	.20
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METRONOME

For any up and coming musicians a sense of timing is of great importance (something not easily acquired by most of us). The ETI Metronome will at least keep you in strict tempo and save the physical efforts of tapping your feet to keep in time.

THE TEMPO RANGE of the instrument is variable over the 10:1 range of approximately 300 to 30 beats per minute via RV1, and thus fully spans the musical tempo range of Largo (40 beats per minute) to Presto (208 beats per minute). The tempo range can be adjusted, if required, by changing the value of C1. Increasing the C1 value lowers the whole range, and decreasing C1 raises the range.

Music To Your Ears

RV1 can be calibrated in terms of conventional musical tempo names by using a watch with a second hand to compare the number of metronome beats per minute against the information in the following table:

Tempo Name	Tempo Span Beats/Min	Mid range Tempo Beats/Min
Largo	40-60	**50**
Larghetto	60-66	**63**
Adagio	66-76	**71**
Andante	76-108	**92**
Moderato	108-120	**114**
Allegro	120-168	**144**
Presto	168-208	**188**

The instrument can be used as either a normal metronome, or as an accentuated beat metronome. Our design allows for four basic rhythmic patterns in the time signatures of 2-4, 3-4, 4-4, and 6-8.

The tone of the non-accentuated beats is variable via RV4, that of the accentuated beat via RV3, and the beat length via RV2.

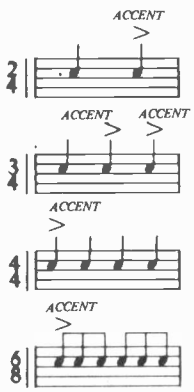


Fig. 1. The accented beat of the bar.

Construction

Construction of the metronome should not pose any special problems providing the overlay is followed carefully and correct orientation of all electrolytic capacitors and diodes is observed.

The type of switch used is a matter of personal choice; either a bank of interlocking push button switches, as used on our prototype, or a rotary switch may be employed, this being the cheaper.

The switch assembly is mounted directly onto the front panel with stand off pillars to give the correct recessed depth, all interwiring to each switch is taken via a six-way wafercon socket.

After checking that all is well the setting up procedure may now be carried out.

Calibration

Setting up the metronome is quite straightforward. Rotate RV2 (located on the rear panel) fully anti-clockwise, then select the normal mode of operation. Switch on the ▶

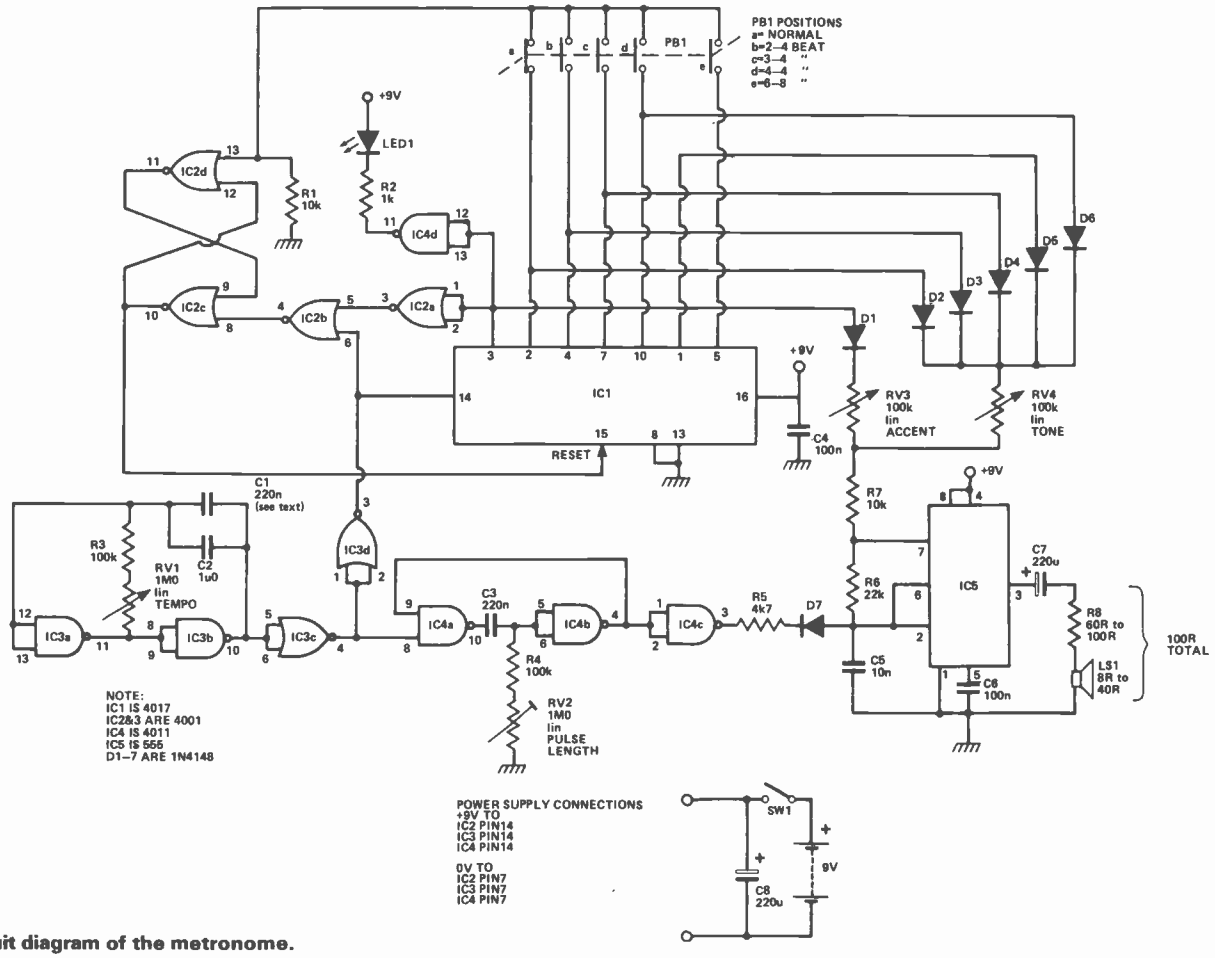


Fig. 2. Circuit diagram of the metronome.

HOW IT WORKS

IC3a and IC3b form the Tempo generator, and are wired as a free-running astable multivibrator with it's operating frequency variable over the approximate range 30 to 3000 cycles per minute via RV1: the range of the generator can be adjusted to cover this precise range, if required, by adjusting the value of C1.

The output of the Tempo generator is used to clock counter IC1 via buffer gates IC3c and IC3d, and simultaneously to trigger a monostable multivibrator or pulse generator that is formed from IC4a and IC4b. The output of this monostable is used to gate on the circuit's tone generator, which is built around IC5, via inverting buffer stage IC4c and via R5 and D7.

The frequency of the IC5 tone generator is controlled by either RV3 or RV4, which are selected via gate diodes D1 to D6 from the output of the IC1 counter. When the unit is used as a normal metronome the tone is controlled by RV3 only, and the circuit generates a brief 'tick' or 'tock' tone (depending on the setting of RV3) each time the tempo generator completes an operating cycle. The duration of this tone is variable via RV2.

IC1 is a 4017 decade counter with ten decoded outputs. Output '0' is used to control the ACCENT of the IC5 tone generator via D1 and RV3, and also to activate beat-indicating LED via IC4d, and outputs '1' to '5' are used to control the TONE via D2-D6 and RV4. Outputs '1', '2', '3', '4', or '6', are used to control the counting model of IC1 via SW1 and a logic network designed around IC2. This network causes the counter to reset after each clock cycle which the unit is used in the normal metronome mode, or after each alternate cycle in the 2-4 beat mode, or after every third cycle in the 3-4 mode, or after every fourth cycle in the 4-4 mode, or after every sixth cycle in the 6-8 mode.

Readers should not that, when the instrument is used in the accentuated beat mode, the apparent or illusory position of the accented note can be shifted to the start or end of a beat sequence by merely altering the relationships of the Tone and Accent frequencies. The sound 'dee-dah-dah' (accent at the start of the beat) is clinically identical with 'dah-dah-dee' :accent at the end of the bat) in a continuously repeating time sequence, although the change of accent position is not necessarily noticeable to the human ear: when frequencies are transposed, however, the latter sound becomes 'dee-dee-dah', and the accent clearly appears to be at the end of the beat.

PARTS LIST

RESISTORS	
R1, R7	10k
R2	1k
R3, R4	100k
R5	4k7
R6	22k
POTS	
RV1	1MO Lin
RV2	1MO preset (knob operation)
RV3, RV4	100k Lin
CAPACITORS	
C1, C3	220n polyester
C2	1uo polyester
C4, C6	100n polyester
C5	10n polyester
C7, C8	220u elect
SEMICONDUCTORS	
IC1	4017
IC2, IC3	4001
IC4	4011
IC5	NE555
LED 1, 0.2in dia	D1-D7, 1N 4148

MISCELLANEOUS

PB1 — 5 off change over push button, (interlocking action). Rotary switch may be used instead.
40R Loudspeaker 2½in dia.
SPST miniature toggle.

unit — the down beat LED should be permanently on and a steady pulse heard from the loudspeaker.

For the accentuated beat to fall on the correct note of each bar, an approximate setting for the accent and tone controls should be adjusted as follows:
(set tempo according to time signature used)

Beat	Accent	Tone
2/4	Fully clockwise	Fully anti-clockwise
3/4	Fully anti-clockwise	Fully clockwise
4/4	Fully clockwise	Fully anti-clockwise
6/8	Midway	Fully anti-clockwise

That just about completes the construction and calibration for the unit.

Hopefully our metronome will serve it's purpose as you acquire your sense of rhythm, even to the more complex arrangements that will follow. ETI

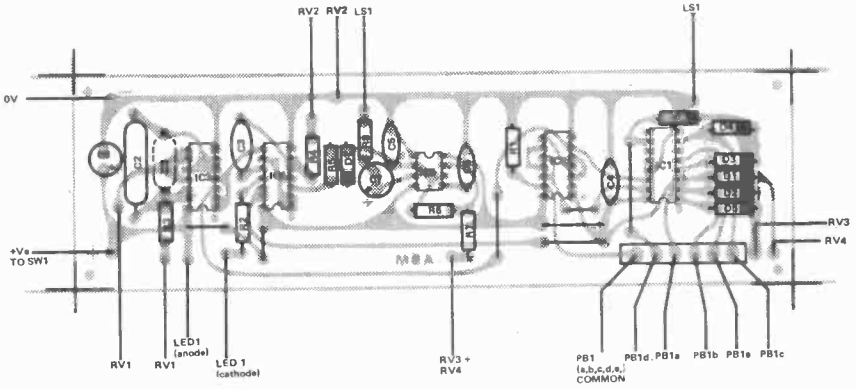
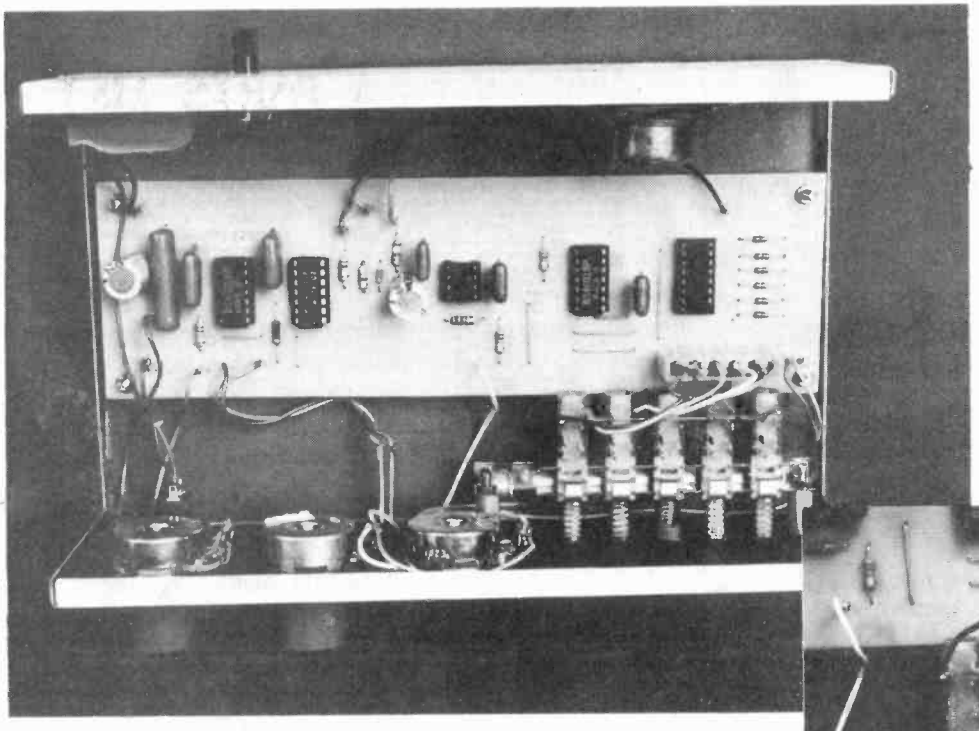
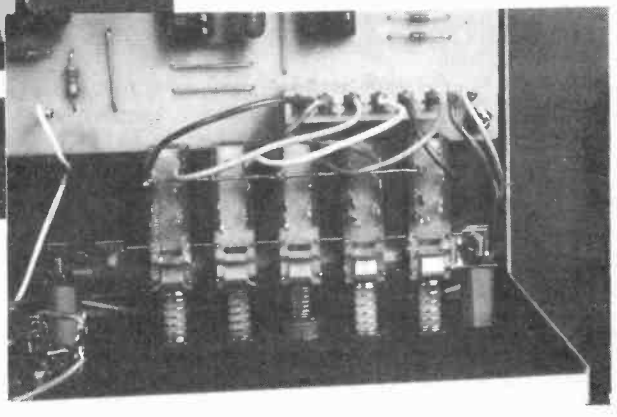


Fig. 3. Component overlay.



Internal view of metronome showing PCB layout and connections to the front panel.



Connections to the front panel switch assembly.

BUYLINES

All components for the metronome should be readily available from most component shops.

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PRINTED CIRCUIT BOARDS and KITS FOR ETI PROJECTS

Mag. Issue	Project	Kit. Ref.	P.C.B.	Kit.	Kit. contents (see key)
Sep. 77	*Graphic Equaliser	601	2.50	23.75	BFGH
Sep. 77	*Graphic Equaliser P.S.U.	602	.90	2.50	BFG
Oct. 77	*Watchdog	604	1.20	21.95	BEGHL
Oct. 77	*Watchdog P.S.U.	605	1.10	7.45	BEH
Aug. 77	*Sweep Oscillator	606	4.00	41.95	BFGHL
Sep. 77	*Stereo Simulator	607	1.05	6.95	BEGHL
Dec. 77	*Freezer Alarm	608	.85	8.45	BFHL
Nov. 76	*General Purpose Preamp	609	1.00	4.85	BEG
Jul. 77	*GSR Monitor	612	1.10	19.75	BEGHL
Apr. 77	*Burglar Alarm	613	1.10	10.85	BEGH
Feb. 77	*Bench Amplifier	615	1.15	13.20	BEGHL
Nov. 77	*Compander	617	2.55	27.35	BEGHL
Mar. 77	*50 watt High Power Amp	618	2.10	9.75	BE
Mar. 77	*100 watt High Power Amp	619	2.10	12.80	BE
Mar. 77	*High Power Amp P.S.U.	620	1.65	8.70	BEJ
Oct. 77	*Digital Thermometer	621	1.70	21.85	BFGHL
Feb. 77	*LED Dice	624	.90	7.10	BEGHL
	*Active Crossover (2 pcbs)	625	3.30	15.30	BFGHL
	*Marker Generator	626	1.20	8.40	BEGHL
Nov. 77	*Skeet	627	2.55	21.90	BEGHL
	*Flash Trigger	628	1.10	6.25	BEGJ
	*Disco Light Show	629	4.25	25.95	BFGJ
	*Pink Noise Generator	630	1.05	4.30	BEL
Nov. 76	541 Train Controller	T001	1.35	18.85	BEHL
Jan. 77	444 5 watt Stereo (2 pcbs)	T002	3.10	26.95	BEGK
Feb. 77	448 Disco Mixer	T003	2.35	19.40	BEJ
Dec. 77	Clock B	T004	3.30	16.75	BE
Jan. 78	House Alarm A	T005	3.20	30.50	BEHM
	House Alarm B	T006	1.50	5.50	BE
Feb. 78	Metal Locator Mk. II	T007	1.60	22.60	BEHL
March 78	Frequency Shift P.S.U.	T008	1.10	5.95	BE
	Frequency Shifter	T009	2.50	24.95	BEL
	L.C.D. Meter	T010	1.60	27.95	BEG
	Light Dimmer	T011	.90	8.60	BEH
Apr. 78	Gas Monitor	T012	1.40	15.95	BEHL
May 78	Star Trek Radio	T013	1.55	9.80	BFH
	Stars & Dots	T014	3.00	T.B.A.	BEHL
June 78	Spectrum Analyser (2 pcbs)	T015	13.90	76.95	CEHM
	Wein Oscillator	T016	1.45	17.20	BEHL
	Torch Finder	T018	.75	2.40	BE
	Temperature Meter	T019	1.60	27.70	BEG
Aug. 78	Etiwet Plant Waterer	T020	1.30	6.10	BEH
Sept. 78	Cross Hatch Generator	T021	2.10	14.95	BEGHL
	Stac Timer	T022	3.00	27.45	BEJL
	Wheel of Fortune	T023	1.55	9.80	BEHL
Oct. 78	Complex Sound Generator	T024	3.95	25.75	BEH
	R.F. Power Meter	T025	1.60	15.30	BEHL
	Power Bulge	T026	.85	3.65	BEHL
	Telephone Bell Extender	T027	1.25	11.40	BEHL
Oct. 78	Proximity Switch	T028	2.30	15.35	BEGH
Feb. 78	Ultra Sonic Receiver	T029	1.00	10.75	BEH
Feb. 78*	Ultra Sonic Transmitter	T030	.90	5.65	BEH
Nov. 78	Cuts Cassette Interface	T031	2.70	14.95	BEH
	Audio Oscillator (2 pcbs)	T032	4.60	39.95	BEHL
Dec. 78	Car Alarm (2 pcbs)	T033	2.50	6.95	BEJ
	Wine Temperature Meter	T034	1.30	—	—
	Curve Tracer	T035	1.20	10.95	BEHL
	Eprom Programmer	T036	2.65	23.35	BEH
	Eprom Programmer P.S.U.	T037	1.70	6.25	BE
Jan. 78	Car Tachometer	T038	2.50	12.20	BF
	Digital Module A & B (2 pcbs)	T039	2.55	21.55	BE
	Digital Dial (Excl. T039)	T040	1.40	8.90	BE
	Log Converter	T041	3.60	26.75	BE
Feb. 79	Tape Slide Synchroniser	T042	2.30	20.95	BEHL
	Tape Noise Limiter	T043	.80	3.70	BEHL
	Light Activated Tachometer	T044	2.65	35.85	BEH
Mar. 79	Headlight Delay	T045	.75	6.75	BEHL
	Logic Trigger	T046	2.70	18.95	BEH
	Stage Dimmer Control Module	T047	2.95	47.95	TBA
	Stage Dimmer Module 10 amp	T048	6.30	TBA	—
	Stage Dimmer Module 20 amp	T049	6.30	TBA	—
	Audio Power Meter	T050	3.45	72.45	BEH
Apl. 79	Click Eliminator	T051	4.55	TBA	—
	Wind speed indicator	T052	3.40	TBA	—
	Guitar effect unit	T053	1.20	TBA	—
May 79	Double Die	T054	1.65	TBA	—
	Headphone amp.	T055	2.75	TBA	—
	Car immobiliser	T056	1.20	TBA	—
	Ambush (3 pcb's)	T057	8.65	TBA	—

ADDITIONAL PRINTED CIRCUIT BOARDS

Pcbs are available for all projects from September 1976 (except where copyright restrictions exist).

1976		
Mar	Audio Level Meter	1.60
May	Audio Exp/Compressor	4.70
Sep.	560 ABC VDU (Set 3)	7.55
	710 2m Power Amp	1.50
Oct.	241 Double Dice	2.10
	252 1-2 Hour Timer	1.10
	152AB TV Pattern Gen (Set 2)	3.80
Nov.	543AB STD Timer (Set 2)	3.10
Dec.	544 Heart Rate Monitor	1.65
	447 Audio Phaser	2.15
	446 Audio Limiter	1.85
1977		
Jan.	570 Reaction Tester	2.25
	549 Metal Locator I25 Patch Detector	1.55
	Heads or Tails	.80
Feb.	448A Headphone Amp	.85
	449 Balanced Pre-Amp	.95
	449A VU Meter	1.15
	Door Bell	1.50
Mar.	155 ABCD Digital Voltmeter (Set 4)	6.10
	Drill Controller	1.05
	Function Generator	1.25
	Temperature Alarm (Set 2)	1.75
Apr.	Fuzz	.85
	630 Hex Display	1.00
	P.S.U.	.85
	804 TV Game	2.30
May	Metronome (Simple)	0.80
	Inject Tracer	1.00
June	Digital Freq. Meter (Set 4)	5.35
	Bass Enhancer	3.15
Jul.	081 Tachometer	.85
	Micro Amplifier	.85
	Alarm Alarm	.80
Aug.	Moisture Indicator	1.20
	Bongas	1.15
	Egg Timer	1.10
Sep.	Loud Hailer	1.10
	Continuity Tester	.90
Oct.	Spirit Level	1.45
	3 Channel Tone Control	1.00
Nov.	Clock A	1.80
	Rev. Monitor	1.65
Elect	CMOS Switched Pre Amp Set 2)	5.10
To-morrow	132 Experimenters P.5	1.30
	555 Timer pcb	0.90
1978		
Jan.	Hammer Throw (Set 3)	7.45
	Race Track	2.00
Feb.	Acc. Beat Metronome	1.05
	Porch Light	1.20
	588 Shutter Timer	2.00
Mar.	RMS Meter	1.60
	Line Follower	1.05
Apr.	Rain Alarm	1.60
May	Electronic Ignition	1.50
	Helping Hand (Set 2)	3.25
1979		
Jan.	Digital Module A	1.55
	Digital Module B	1.00
	Digital Module C	1.05
Feb.	VCT	1.70
	Twonky	2.55

SYSTEM 68

631	3.35
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VDU B	4.30
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TTY	3.70
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F. As E but with exclusions. Please ask for details.
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J. As H but with exclusions. Please ask for details.
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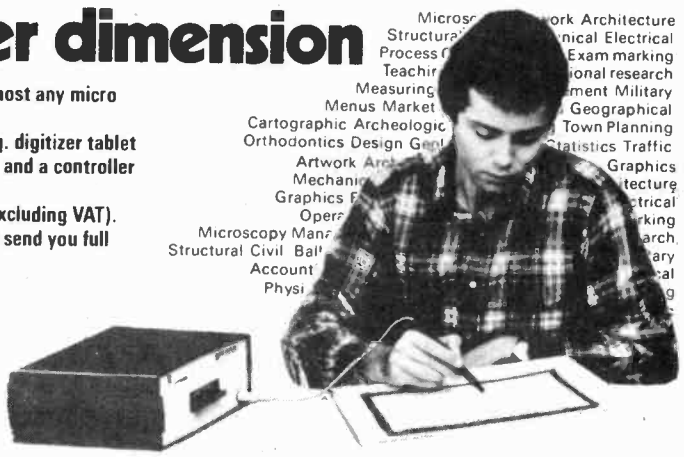

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TRANSISTOR OPERATING POINT

Designing a transistor amplifier? Take the guessing out of finding the correct DC or static operating point of a transistor with this simple approach by W. R. Masefield.

IN THE DESIGN of transistor amplifiers, one of the first considerations is to establish the correct DC or static operating point for the transistor. Probably the most common method used by the amateur is that of having a guess, followed by trial and error juggling with components on the breadboard.

There is no need for that; there *is* a way of predicting the operating point and finding some of the circuit component values to be optimised before leaving the drawing-board. Nor is any advanced mathematics used, but it is as well to have a calculator with logs to base facility.

Common Law

Whatever circuit configuration is used, common emitter, common base, common collector (emitter follower), the fact does not alter that there is a certain relationship between the base-emitter voltage V_{BE} and the emitter current I_E. This relationship is exponential, and, because of this, a plot of $\ln I_E$ against V_{BE} is a straight line as in fig. 1.

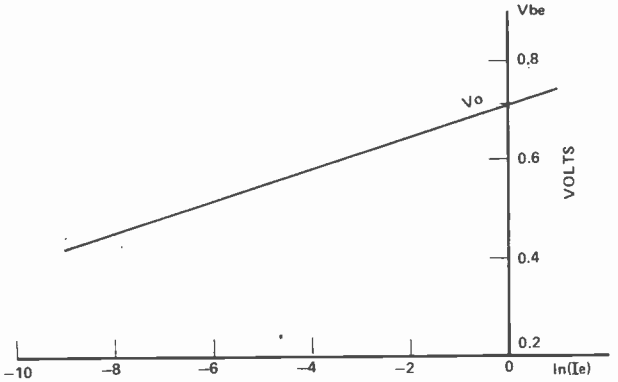


Fig. 1. As the I_E, v_{be} relationship is exponential, and graph of ln I_E against V_{BE} is a straight line.

It is a simple matter to verify this, using the circuit of fig. 2. The voltmeter must have a high impedance, otherwise the value of I_E will be incorrect.

As the graph is a straight line, it can be described by the linear equation:

$$V_{BE} = m(\ln I_E) + V_0 \quad \ldots\ldots\ldots\ldots \quad (1)$$

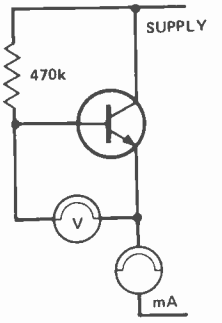


Fig. 2. The circuit used to verify the relationship between I_E and V_{BE}.

This equation is extremely useful, and it is worthwhile determining the slope, m, and the intercept, V_o for any transistor to be used in the circuit under development.

As the graph is a straight line, only two points are needed to determine it. One point is given by the intercept on the V_{BE} axis. This is V_o and is the base-emitter voltage when the $\log_e$ of the emitter current is zero, i.e. when I_E = 1 mA.

If the emitter current is now changed to I_E, and the corresponding base-emitter voltage is V_{BE}, then the slope, m, is given by

$$m = \frac{V_0 - V_{BE}}{\ln 1 - \ln I_E} \quad \ldots\ldots\ldots\ldots \quad (2)$$

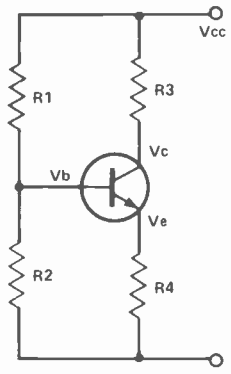
This turns out to be of the order of 30×10^{-3} when V_{BE} is in volts and I_E is in mA.

The only other parameter required is h_{FE}. Note that this is *not* h_{fe} which is the dynamic forward current transfer. h_{FE} is the static forward current transfer, and can be determined by measuring I_c and I_b. Then:

$$h_{FE} = \frac{I_c}{I_b} \quad \ldots\ldots\ldots\ldots \quad (3)$$

Armed with these three parameters, m, V_o and h_{FE}, the operating conditions in any circuit can be found. These are summarised below. The resistor suffixes have been so chosen to make things easier when writing a calculator program for speeding up the calculations. ▶

Fig. 3 Common Emitter Mode with base potential bias



The given conditions will be supply rail voltage, V_{cc}, the desired collector voltage V_c, generally half rail voltage, the collector load, R_3, to give a suitably low output resistance and economical I_c, and the potential divider R_1, R_2 to take a current that is likely to swamp the base current and so give a fixed reference voltage, usually about 2V at the base. Then:

$$V_B = \frac{V_{cc} \cdot R_2}{R_1 + R_2} \quad \ldots\ldots (4)$$

$$I_c = \frac{V_{cc} - V_c}{R_3} \quad \ldots\ldots (5)$$

$$I_E = I_c\left(1 + \frac{1}{h_{FE}}\right) \quad \ldots\ldots (6)$$

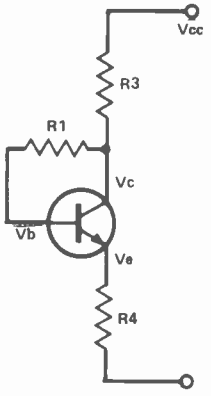
$$V_{BE} = m(\ln I_E) + V_0 \quad \ldots\ldots (7)$$

$$V_E = V_B - V_{BE} \quad \ldots\ldots (8)$$

$$R_4 = \frac{V_E}{I_E} \quad \ldots\ldots (9)$$

This sequence therefore enables the critical resistor R_4 to be determined accurately.

Fig. 4 Common Emitter with Base-Collector Resistor Bias



Given the supply rail voltage, V_{cc}, the collector voltage V_c about half V_{cc}, and the emitter voltage, V_E generally 1 volt, the load R_3 is again chosen as a compromise between low output resistance and low collector current, then:

$$I_E = I_c = \frac{V_{cc} - V_c}{R_3} \quad \ldots\ldots (10)$$

$$R_4 = \frac{V_E}{I_E} \quad \ldots\ldots (11)$$

$$I_B = \frac{I_E}{1 + h_{FE}} \quad \ldots\ldots (12)$$

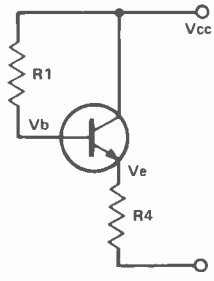
$$V_{BE} = m(\ln I_E) + V_o \quad \ldots\ldots (13)$$

$$V_{R1} = V_c - V_{BE} - V_E \quad \ldots\ldots (14)$$

$$R_1 = \frac{V_{R1}}{I_B} \quad \ldots\ldots (15)$$

This sequence enables both R_1 and R_4 to be determined accurately.

Fig. 5 Common Collector (Emitter Follower)



Given the supply rail voltage, V_{cc}, the emitter voltage, V_E, usually half the rail voltage, and the emitter load, R_4 is chosen to give a compromise between low output resistance and economical emitter current, then:

$$I_E = \frac{V_E}{R_4} \quad \ldots\ldots (16)$$

$$V_{BE} = m(\ln I_E) + V_0 \quad \ldots\ldots (17)$$

$$V_B = V_E + V_{BE} \quad \ldots\ldots (18)$$

$$I_B = \frac{I_E}{1 + h_{FE}} \quad \ldots\ldots (19)$$

$$R_1 = \frac{V_{cc} - V_B}{I_B} \quad \ldots\ldots (20)$$

This sequence allows R_1 to be found accurately.

Although on paper the above sequences look laborious, if a programmable calculator is available, it is possible to put all of them into program memory, and all data in the data registers, then try different values of resistors until optimum values are found. At this stage the breadboard may be prepared, in the knowledge that the values obtained will be close to those actually needed.

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M5

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£24.65

M6

SOLAR QUARTZ LCD Chronograph with Alarm Time Zone Facility

Constant LCD display of hours and minutes, plus optional seconds or date display, plus day of the week and am/pm indication. Perpetual calendar, day, date, month and year. 24 hour alarm with on/off indication. 1/10 second chrono graph measuring net, lap and first and second place times. Dual time zone facility night light. Only 9mm thick.

£27.65

M7

QUARTZ LCD Alarm Chrono

22 function, 6 digit. Hours, mins., secs., date, day of week, stopwatch, split time, alarm, second watch (dual time), back-light. FRONT BUTTON OPERATION.

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METAC ★ PRICE

M8

SOLAR QUARTZ LCD Chronograph

6 digit, 11 function. Hours, mins., secs. 1/100, 1/10 secs., mins. Split and lap modules. Auto calendar and back light. Powered from solar panel with battery back-up.

£13.65

M9

SEIKO Alarm Chrono

LCD, hours, mins., secs., day of week, month, day and date, 24 hour Alarm, 12 hour chronograph, 1/10th secs., and lap time. Back light, stainless steel, HARDLEX glass.

List Price £130.00

METAC PRICE

£105.00

M10

SEIKO Chronograph

LCD, hours, mins., secs., day of week, month, day, date, 12 hour chrono-graph, 1/10th secs. and lap-time. Back light, stainless steel water resistant, HARDLEX glass.

List Price £85.00

METAC PRICE

£68.00

M11

SOLAR QUARTZ LCD 5 Function

Genuine Solar

Solar panel with battery back-up. Back light and auto calendar. Hours, mins., secs., day, date. Quality metal bracelet.

£ 9.95

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M12

HANIMEX Electronic LED Alarm Clock

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

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M13

QUARTZ LCD Ladies Slim Bracelet

5 function.

Hours, mins., secs., day, date and back light and auto calendar. Elegant metal bracelet in silver or gold. State preference.

£15.95

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M14

QUARTZ LCD Ladies 5 Function

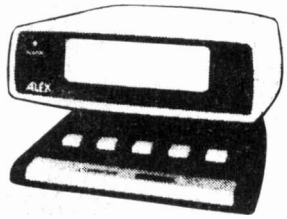
Only 25 x 20mm and 6mm thick. 5 function. Hours, mins., secs., day, date and back light and auto calendar. Elegant metal bracelet in silver or gold. State preference.

£9.95

Guaranteed same day despatch.

M15

DIGITAL LED CLOCK



Automatic brightness control. Weekend alarm cancel.

Features and Specification:
Hour/minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on-off control. Display flashing for power loss indicator. Repeatable 9-minute snooze. Automatic brightness control. Weekend alarm cancel.

£10.95

Guaranteed same day despatch.

M16

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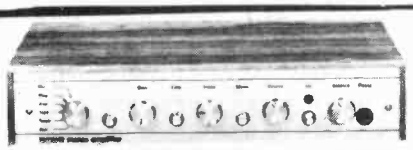

20 x 20 WATT STEREO AMPLIFIER

Viscount IV unit in teak simulate cabinet. Silver finish rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic, magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features two mains outlets DIN speaker and input sockets plus fuse 20x20 watts RMS 40x40 watts peak. For use with 8 to 15 ohm speakers.

£29.90 £2.50 p&p

30x30 WATT AMPLIFIER IN KIT FORM

For the experienced constructor complete in every detail, same facilities as Viscount IV, but with 30x30 output 60x60 watts peak. For use with 4.15 ohms speakers.

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SPECIAL OFFER

30 x 30 WATT AMPLIFIER KIT

with BSR P200 belt drive deck and Shure M75 cartridge.

£55.00 + p&p £5.00

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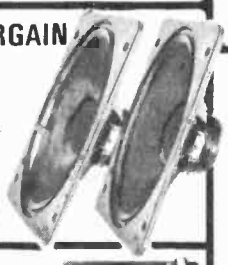

Stereo pair 350 kit. System consists of 13" x 8" approx. woofer with rolled surround, 2½" approx. Audax tweeter, crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS. 20 watts max. 8 ohm impedance.

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Per stereo pair + £3.40 p&p

BSR P200

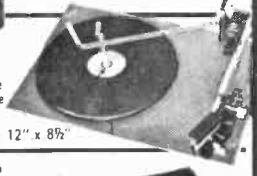
Belt drive chassis turntable unit semi automatic, cueing device. **£24.95** p&p £2.55

A.D.C. QLM 38 Mk III Magnetic Cartridge to suit. **£7.75**

BSR Manual single play record deck with auto return and cueing lever, fitted with stereo ceramic cartridge 2 speeds with 45 r.p.m. spindle adaptor ideally suited from home or disco use.

OUR PRICE **£10.95** p&p £2.55

GARRARD DECK MODEL CC 10A



Record changer with cueing device fitted with stereo ceramic cartridge ready to fit into your own plinth

£7.95 p&p £2.00 Size 12" x 8½"

SANYO Nic/cad. battery, with mains charger equivalent in size and replaces 4 SP11 type batts. Size 3¾"x 1¼" x 2" approx.

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AVAILABLE ALSO TO PURCHASERS OF THE 10 + 10 AMPLIFIER KIT

ACCESSORIES

Suitable mains power supply parts, consisting of mains transformer, bridge rectifier, smoothing capacitor and set of rotary stereo controls for treble, bass, volume and balance. **£2.90** plus £1.50 p&p

Two Way Speaker Kit

Comprising of two 8" x 5" approx. 4 ohm bass and two 3½" 15 ohm mid-range tweeter with two cross-over capacitors. **£3.95** per stereo pair plus £1.50 p&p

10 + 10 AMPLIFIER KIT

An opportunity to buy a 10 watts per channel stereo amplifier kit which is suitable for use with a ceramic cartridge. The amplifier utilises proven Mullard modules and is available at a very competitive price. The amplifier kit comes complete with instructions and includes: a Mullard LP1183 stereo preamplifier module, two LP1173 power amplifiers with integral heatsinks, a power supply, Zobel networks, front and back mounting panels, a finished fascia panel, all control potentiometers (bass, treble, volume and balance), switches, input, output and headphone sockets, wire, and an easily assembled wrap around cabinet to house the finished unit.

Size approximately 9¾" x 8¾" x 4" p&p £2.05 **£11.95**

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OPPORTUNITY AT **£9.95** ONLY

50 WATT MONO DISCO AMP

£29.95

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.

70 & 100 WATT MONO DISCO AMP

Size approx. 14" x 4" x 10¼"

Brushed aluminium fascia and rotary controls.

Five vertical slide controls, master volume, tape level, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level.

Output 100 watts RMS 200 watts peak

70 watt **£57**

140 watt peak p&p £4.00

100 watt **£65**

For personal shoppers only

DUO II SPEAKERS

Attractive teak finish, modern design, incorporating 2 speaker units—8" approx. woofer and 2½" approx. tweeter. 45 to 1800 Hz. Impedance 8 ohms. Power 15 watts RMS. 20 watts max. Per stereo pair

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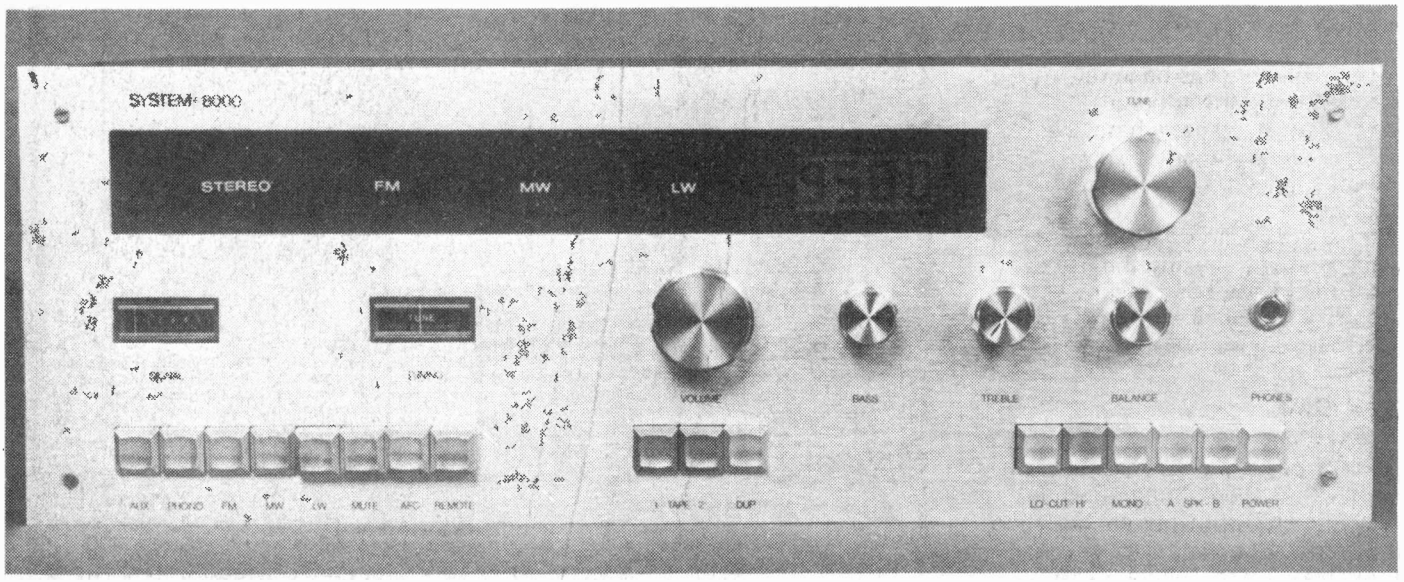
TUNER~AMPLIFIER



This Hi-Fi DIY project brings you 70 watts per channel of your favourite jingles from a high quality tuner-amplifier designed to ETI's stringent specifications. VFET power amp and digital tuner put this unit in the top bracket of today's listening.

SYSTEM 8000 was designed in an attempt to answer the problems of two groups of people. Those desiring the highest quality of music reproduction without all the unnecessary expense of unwanted 'frills' and those people wanting to build their own hi-fi to the highest standards available.

The tuner-amplifier, or receiver, has made a good market for itself since changes in the tax laws some years ago began to make it more economic. Putting everything in one box is an attractive cosmetic proposition too as interwiring can be eliminated entirely. Flexibility need not be sacrificed.

An important part of the design brief for this unit was to include — where relevant to improvement in quality — the latest advances in the field. Accordingly a FET power amp, various tuning and digital frequency read-out can all be found behind the fascia. In addition the design is 'remote-control ready' but more of that later.

Ins And Outs

The final preamplifier design was decided upon only after much heated discussion. The case for good filters has been iterated many times, and need not be stated again here.

Those included here, of 12dB, are designed for minimum phase error and are in fact never out of circuit — their turnover is simply shifted beyond the audio range. This means that the rumble filter blocks sub-sonic signals which would otherwise cause undesirable effects at the speakers.

A mono control is included — mainly for FM listening in difficult conditions.

The tone controls are the active Baxandall type, giving 12db of cut and boost at 50 Hz and 10 kHz. Careful attention was paid to ensure that this stage would not be overlooked by sudden musical peaks, and the gain has been distributed in such a way as to avoid this. The position of the volume control before the tone controls also helps.

The balance control is incorporated into the final gain stage, giving a high degree of positional adjustment.

Getting Taped

Of particular importance are the tape-recorder facilities, reflecting the growing usage of the tape-recorder as a hi-fi medium. Two inputs are provided, with comprehensive switching between them. Each input/output has it's own preamp, with adjustable level controls, enabling virtually any tape-recorder to be used with the System 8000. Use of the dubbing switch permits information to be transferred from tape-to-tape whilst listening to another input — and use of this switch, and its associated socket, breaks the connection between inputs, and tone controls. Thus a quadraphonic unit, or graphic equaliser, may be introduced here.

The auxiliary input feeds direct to the rumble filter.

The magnetic input is an example of where discrete devices surpass ICs. The vital design criterion for a magnetic preamplifier are accurate equalisation, large overload margin, a high signal-to-noise ratio, and low distortion. The qualities of the particular design employed should satisfy the most critical of listeners.

The tuner reflects as much as possible of current thinking. However, there are constraints for a kit-based project, not least being able

to ensure supply of the devices employed.

The prototype has been revamped twice following the sudden non-availability of certain devices (—one more argument for using discrete transistors wherever possible).

Another constraint is difficulties with alignment, making the use of a pre-aligned tuner head essential. For reasons of flexibility, varicaps are used to tune both FM and AM.

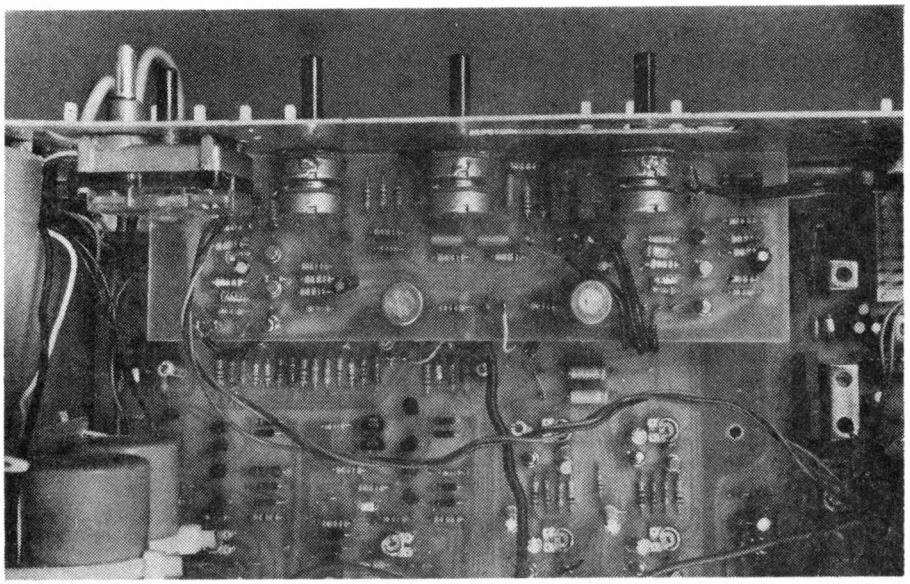
Head Start

The FM tuner head is a dual MOSFET design with three-tuned stages. Sensitivity is good, image rejection adequate, and strong signal handling excellent. The use of varicaps has permitted the introduction of an interesting option — a tuneable preamplifier, to be fixed to the aerial, and deriving tuning volts and AGC volts from the System 8000. The design uses a further five MOSFETS and tuned stages, raising the tuner-head performance from the good to the superb.

Details of this innovation will be published at a later date, and operation of the System 8000 is not preamp dependant in the meanwhile.

The output from the tuner head is fed to a complex filter and preamp stage, and then to the FM IF IC, the CA3189. This device is a significant improvement over the earlier CA3089.

A double-tuned detector is used for minimum distortion, and the AFC ▶



An internal view showing the PCB layout, showing the positions of the front panel controls.

SPECIFICATION

POWER OUTPUT	— 70 watts RMS per channel into 8 ohm (higher output is possible from a larger transformer)
THD & TID	— 0.01% at all frequencies, and all levels
FREQUENCY RESPONSE	— ± 1kb 20HZ-25kHZ
S/N RATIO	— Better than 70db, all inputs
INPUT SENSITIVITY	— 100mv Aux, and phono 3 mV tape variable
TREBLE CONTROL	— ± 12db at 10kHZ
BASS CONTROL	— ± 12db at 50 HZ
HI FILTER	— 12db, turnover at 10kHZ
LO FILTER	— 12db turnover at 40 HZ
OVERLOAD MARGIN	— better than 30db all inputs

FM

FREQUENCY RESPONSE	— 20 HZ-15kHZ. ± 1db
SEPARATION	— 45db at 1kHZ
DISTORTION	— 0.05% or better at all frequencies
19kHZ REJECTION	— 65db
38kHZ REJECTION	— 80db
IMAGE REJECTION	— 50db
SENSITIVITY	— 10V for a 30db S/N ratio

when using aerial preamp:

IMAGE REJECTION	— 100db
IF REJECTION	— 100db
AM REJECTION	— 100db
SENSITIVITY	— 0.5 uV for a 30db SN ratio

AM

MW	— 550-1640kHZ
LW	— 180-250kHZ
IF	— 470kHZ
SENSITIVITY	— 5UV for a 20 db signal to noise ratio
AGC RANGE	— 70 db for a 10 db audio change

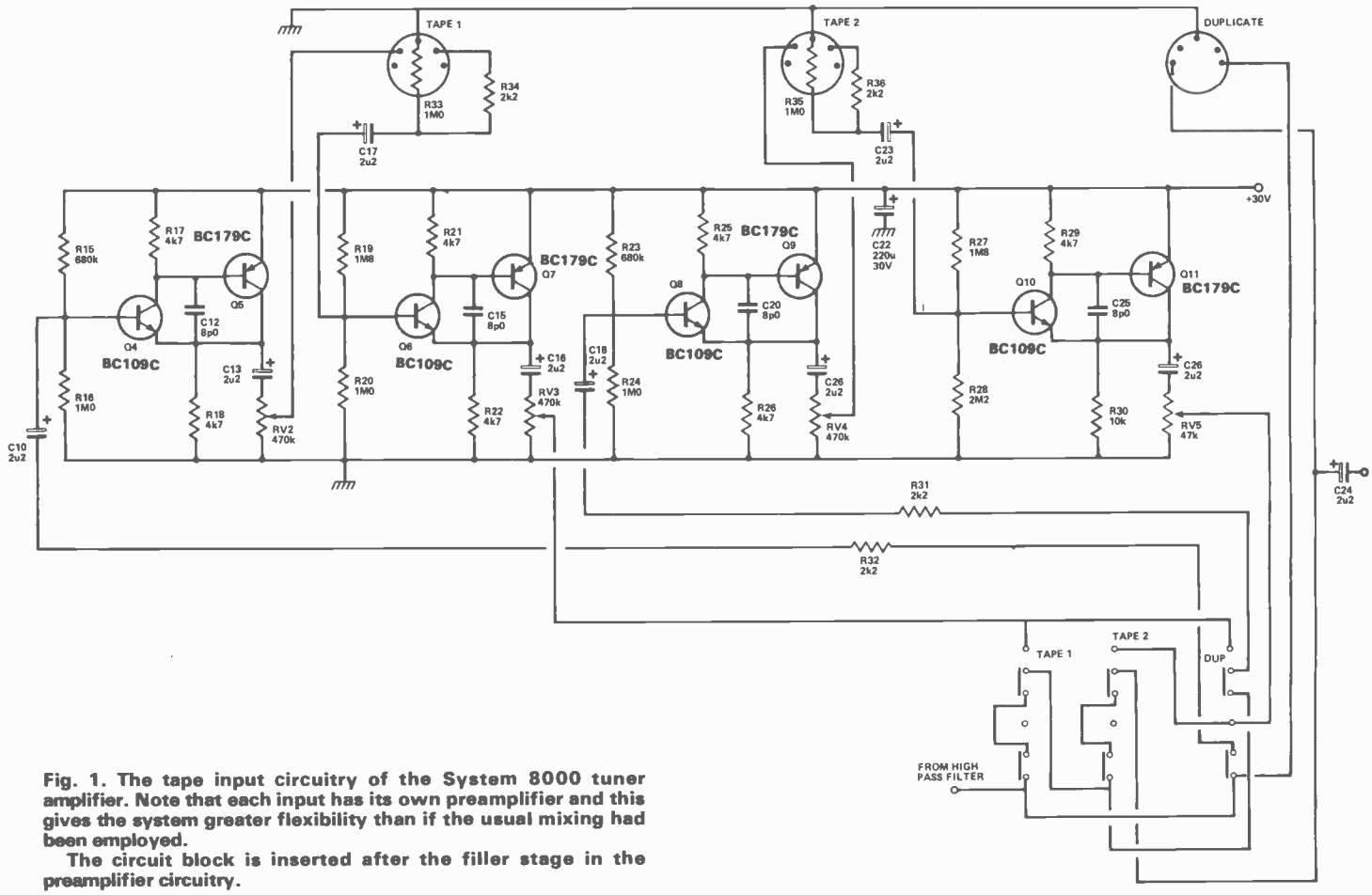
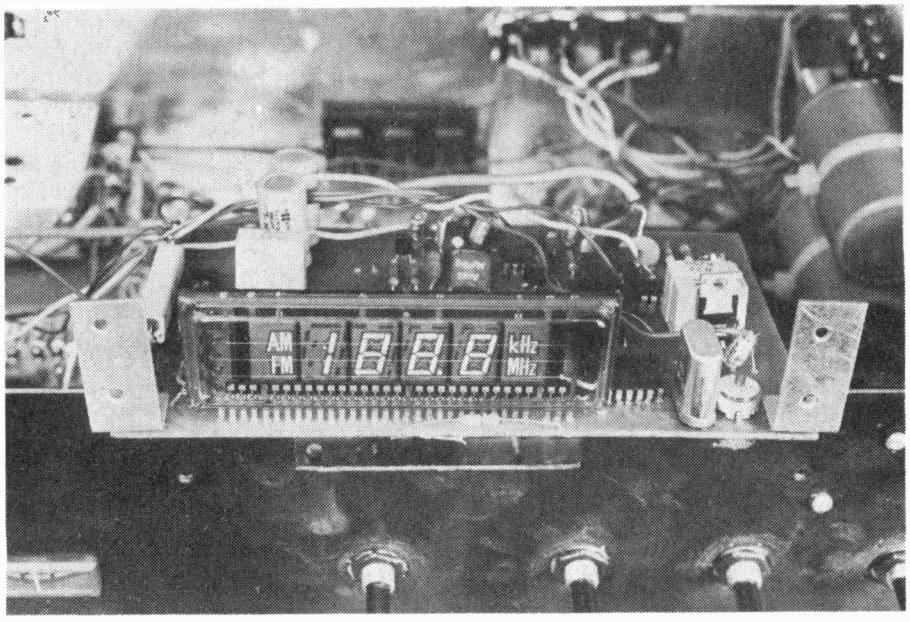


Fig. 1. The tape input circuitry of the System 8000 tuner amplifier. Note that each input has its own preamplifier and this gives the system greater flexibility than if the usual mixing had been employed.

The circuit block is inserted after the filler stage in the preamplifier circuitry.



A view of the front panel, showing the mounting of the digital frequency read-out, which serves both AM and FM. This circuit block is to be featured in much greater detail in next month's final part of the System 8000 article. An LCD display was rejected early in the design, due to its much lower visibility.

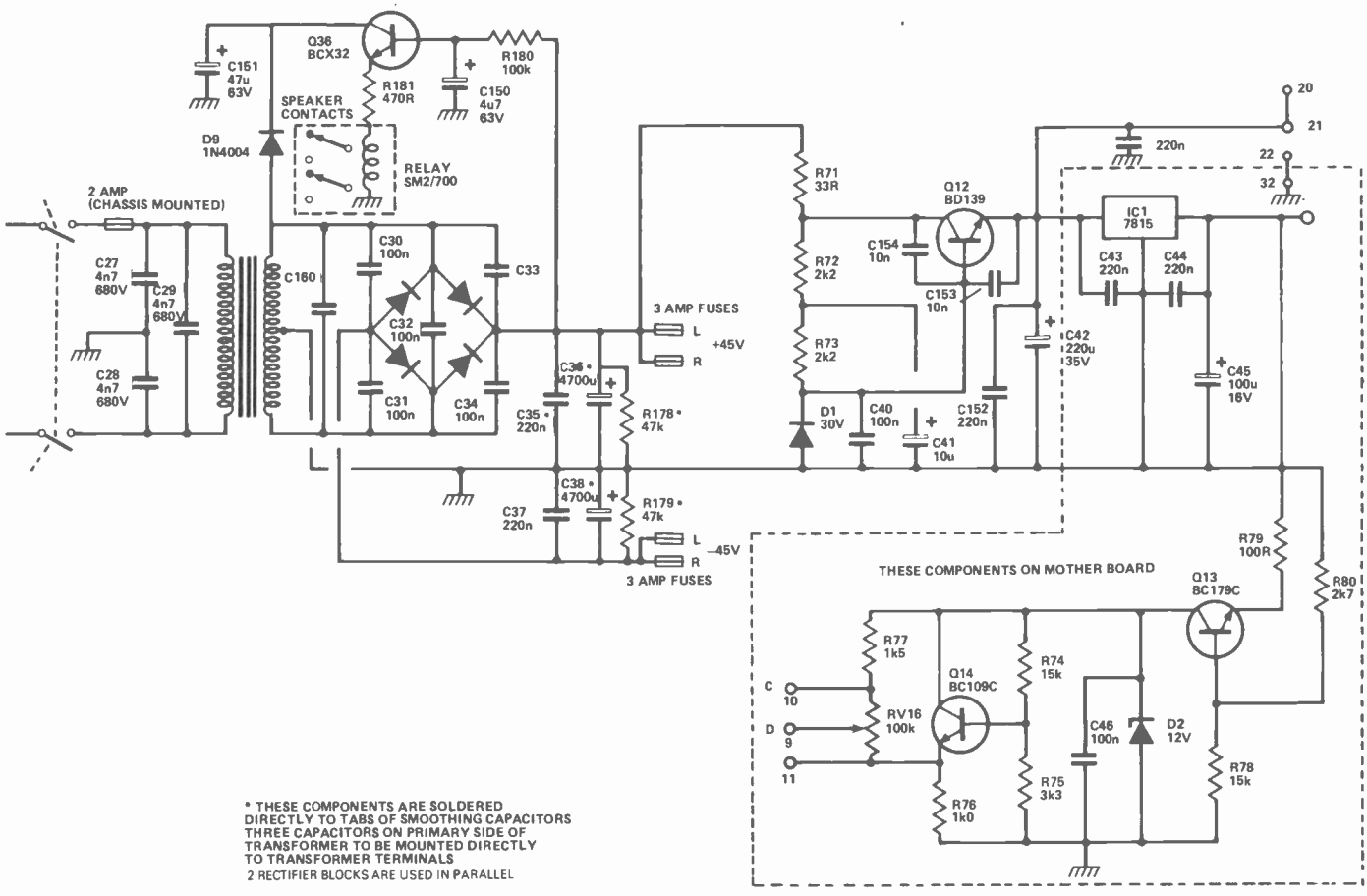
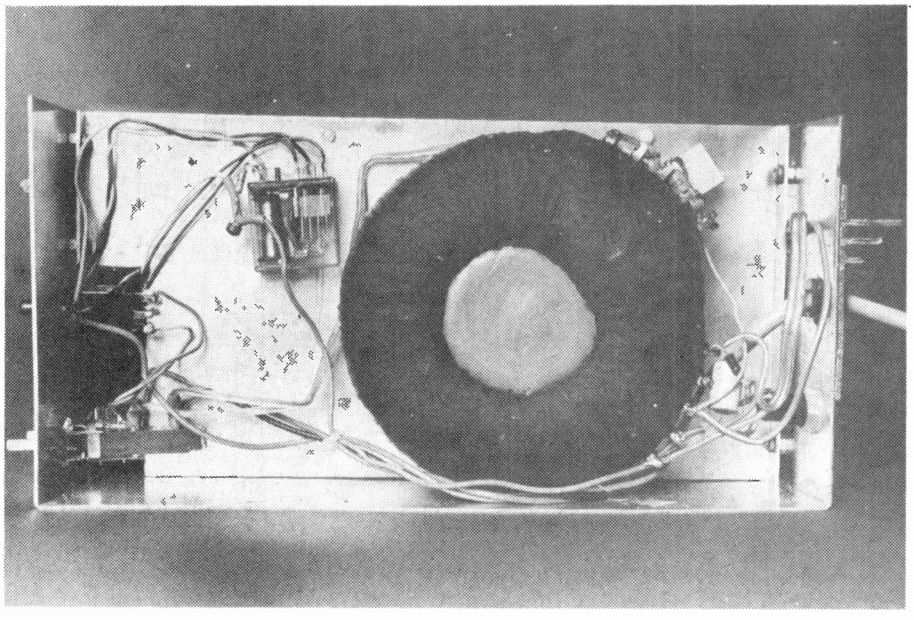


Fig 2. (Above) the power supply and speaker protection components and associated circuitry. Note that some components mount directly onto the main PCB and not onto the separate PSU board.

Below: the power supply section, showing the screening and the special transformer for the design.



voltage is used to alter the varicap line rather than pull the oscillator.

The audio signal derived from the FM IF passes through a low-pass filter and then to the latest in stereo-decoder IC's, a phase-lock loop device based on the popular MC1310. This new IC has increased separation, very much lower distortion and a high degree of pilot tone suppression. Following this stage with a multiplex filter block also removes the 38 kHZ tone.

The Long And the Medium

The AM section has five wavebands, medium and long.

Three stage tuning is used for improved selectivity, and the use of the CA3123 IC gives good sensitivity and excellent AGC characteristics. A discrete stage has been added to ▶

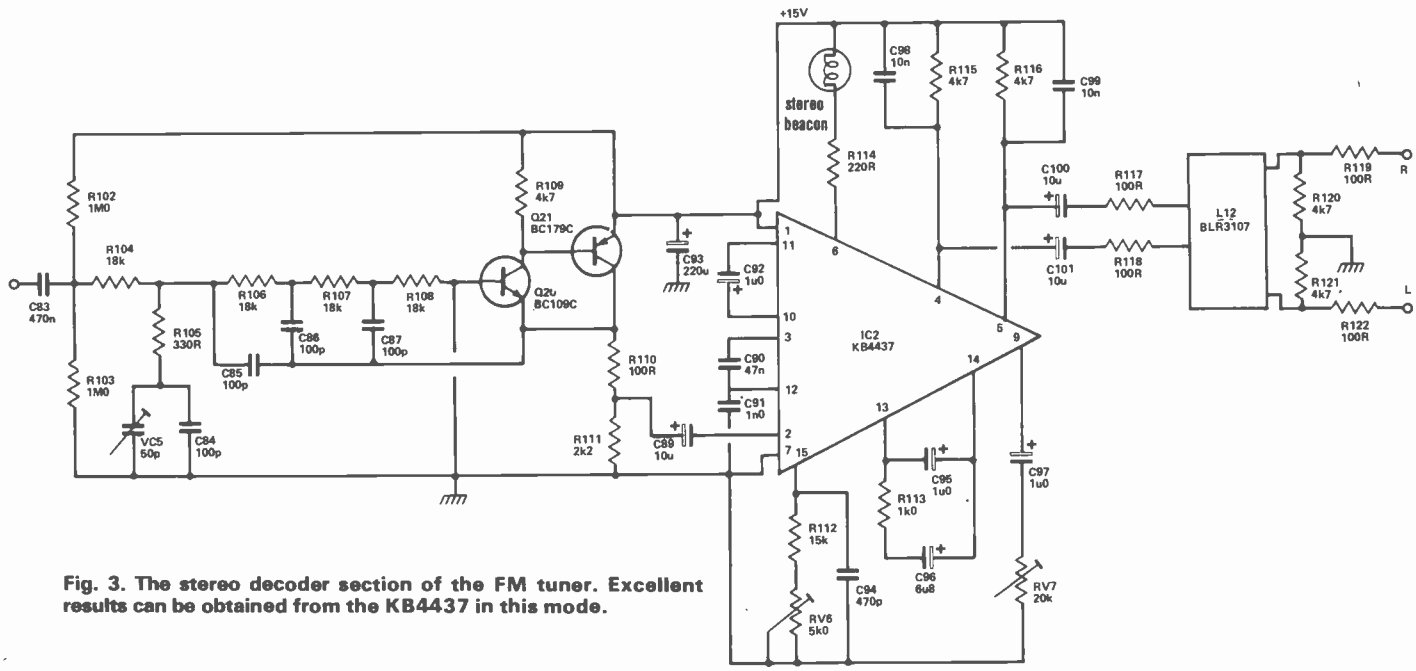
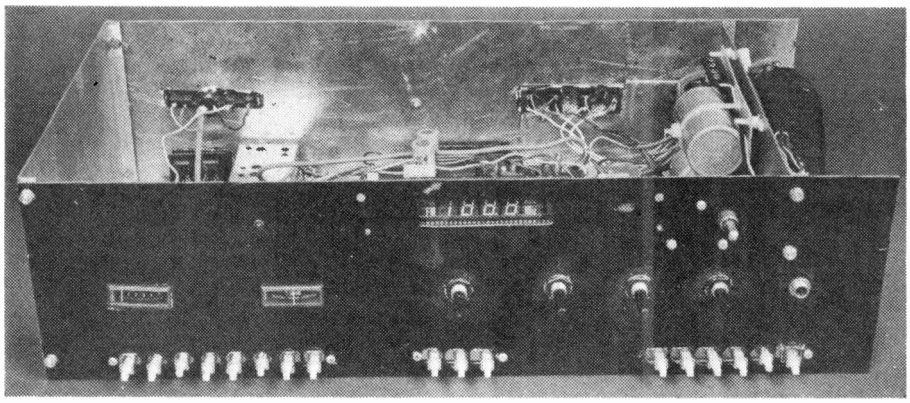


Fig. 3. The stereo decoder section of the FM tuner. Excellent results can be obtained from the KB4437 in this mode.



A front view of the tuner amp chassis with the digital frequency meter and panel controls in position, before mounting the fascia in place.

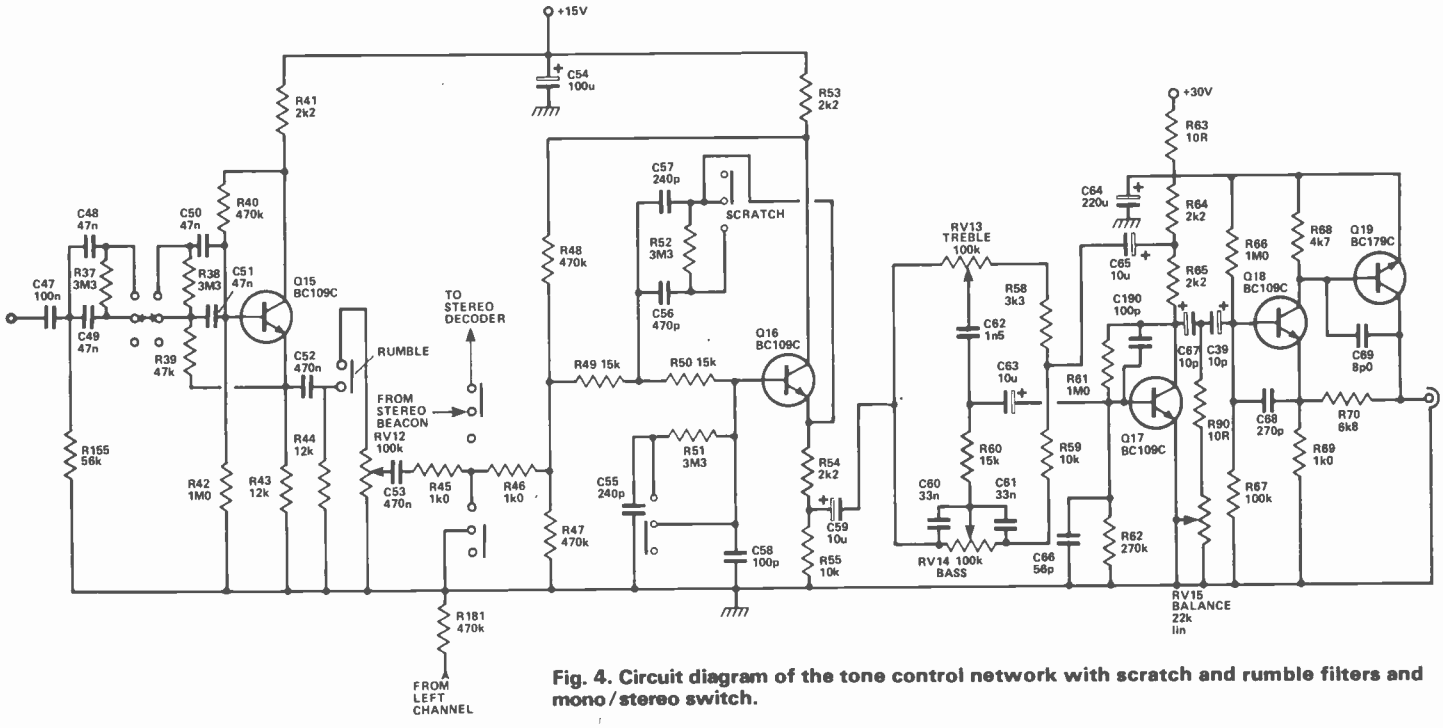


Fig. 4. Circuit diagram of the tone control network with scratch and rumble filters and mono/stereo switch.

PARTS LIST

RESISTORS (all ¼W 5% unless marked)

R1,155	56k
R2,89,101	680R
R3	47R
R4,40,47,48	470k
R5,67,152,160,180	100k
R6,17,18,21,25,26,29,68,109,115,116,120,121, 148,149,154,171	4k7
R7	270R
R8,49,50,60,74,112,147,164,162	15k
R9	68k
R10,83,85,88,92, 146	22k
R11,170	8k2
R12,79,110,117,118,119,122,169,173	100R
R13,144	3k9
R14,137,141,151,168	33k
R15,23,175	680k
R16,24,33,35,42,61,66,82,102,103,177	1M
R19,27	1M5
R20,28	2M2
R22,30,55,57,59,124,128,133,135,142,156	10k
R31,32,34,36,41,53,54,64,72,73,111	2k2
R37,38,51,52	3M3
R39,178,179	47k
R43,44,129,130,176	12k
R45,46,69,76,81,113,127,132,158,165	1k
R56,58,75,86,87,100,157,159,172,174	3k3
R62	270k
R63,90,99	10R
R65,80,143,153	2k7
R70	6k8
R71	33R
R77,84,140,150	1k5
R91	27R
R93,131,134,139	150R
R94,114	220R
R95,96,145,181	470R
R97	4R7
R98 (1 watt)	4R7
R104,106-8	18k
R105,123,126,136,138,161,163,166,167	330R

POTENTIOMETERS

RV1	1k
RV2,4,11	470k
RV3,5,10	47k
RV6	5k
RV7	20k
RV8	4k7
RV9	100R

CAPACITORS

C1	470n 16V tant.
C2,56,94	470p polyester
C3	22p polyester
C4	100u 3V tant
C5	27p polyester
C6	10u 3V tant
C7,98,99	10n mylar
C8,81	22n mylar
C9	220u 6V electrolytic
C11,39,65,59,63,67,89,100,101, 121.132.133.138.143.144	10u 25V electrolytic
C10, 13, 16-18, 21, 23, 26, 6, 116, 118, 123	2u2 16V electrolytic
C12,15,20,25,69,72,79,80,161	8p polystyrene
C22,42,64,93	220u 30V electrolytic
C27-29	4n7 600V AC
C30-34	100n 100V
C35,37,43,44,77,75,124,128, 131,152	220n 100V
C36,38	4700u 63V electrolytic
C40,46,160	100n 50V mylar
C41	10u 40V electrolytic
C45,54	100u 16V electrolytic
C47,105,139,140	100n mylar
C48-51,60,61	33n mylar
C52,53,83	470n mylar
C55,57,137	140p polystyrene
C58,78,84-87,142,190	100p polystyrene
C62	1n5 mylar
C66,141	56p polystyrene
C68,71,122,126,136	270p polystyrene
C70,74,76	4u0 63V electrolytic
C73	100u 6V electrolytic
C82,90	47n mylar
C88	50p polystyrene
C91	1n0 mylar
C92,95, 97	1u0 16V electrolytic
C96	6u8 16V electrolytic
C102-104,106-111,119,120, 129,130,134,146-9,153,154	10n ceramic
C112-114	22n ceramic
C125	1n0 ceramic
C127	10p polystyrene
C145	50n ceramic
C150	4u7 63V electrolytic
C151	47u 63V electrolytic

SEMICONDUCTORS

Q1,5,7,9,11,13,19,21,25	BC179C
Q2	MPSA12
Q3,4,6,8,10,14-18,20,26,29	BC109C
Q12	BD139
Q22-24	BF395
Q27,28	BF256
Q30-32	BC556A
Q33	BFR79
Q34,35,36	BCX32
Q37	25K134
Q38	25J49
D1	C30V 400mW
D2	C12V 400mW
D4-8	1N914
VCD1	KV1210
IC4	CA3189E
IC5	CA3123E
IC2	KB4437
IC1	7815

INDUCTORS

L1	KACS4520A
L2	220K
L3	34342
L4	34343
L5,7	6A6408
L6,8	1A350
L9	18576
L10	CFU050P
L11	YHCS11100
L12,13	10mH
L14	BLR3107
L15	12turns 24SWG (wound on resistor)

VARIABLE CAPACITORS

CV1,2,4	25p
CV3,5	50p

CERAMIC FILTERS

F1-3	CFSE10.7

MISCELLANEOUS Tuner Head VT02/3, 36-0-36 secondary transformer, metalwork to suit, 3A fuses with clips (4) relay ( ).

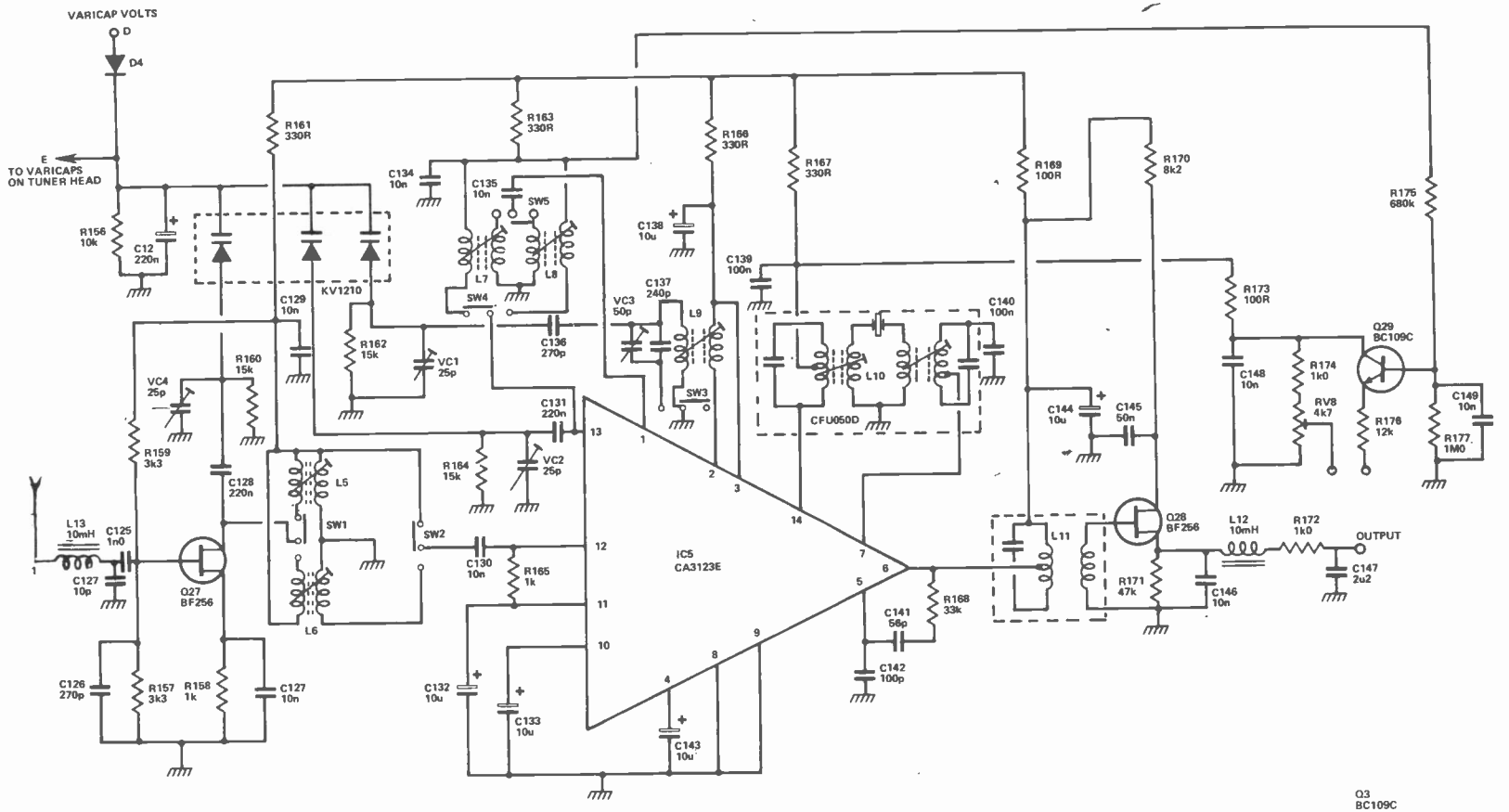


Fig. 5. (above) circuit diagram of the AM tuner, based on the CA3123 chip with its own internal RF amplifier.

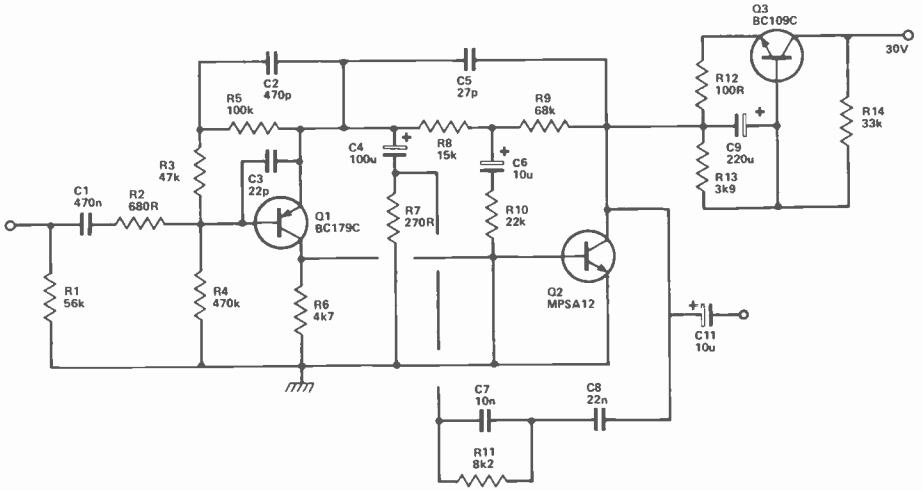


Fig. 6 (right). Circuit diagram of the preamp section for the magnetic cartridge input used in this design. The use of discrete components gives better quality here than a corresponding IC circuit.

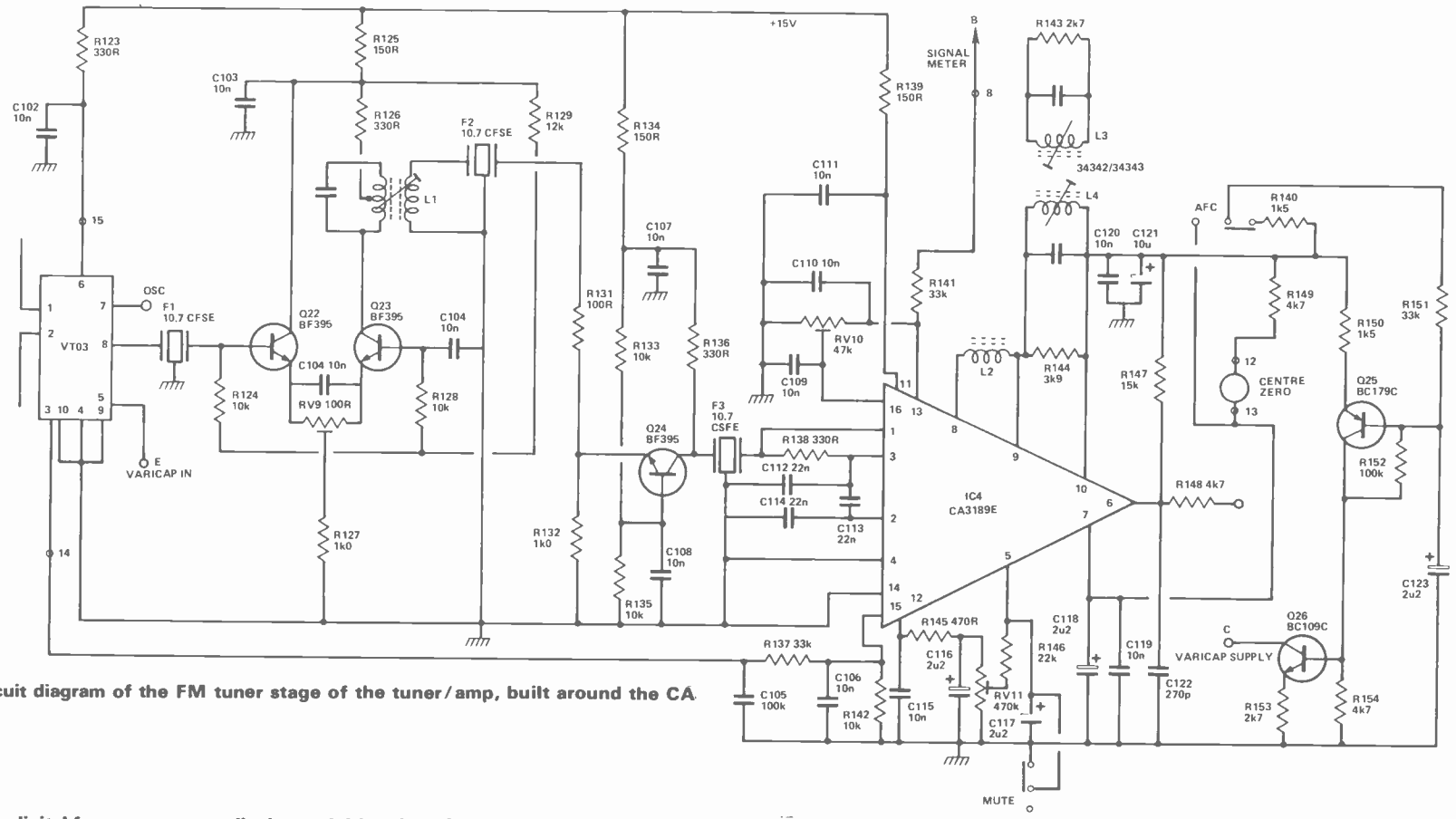
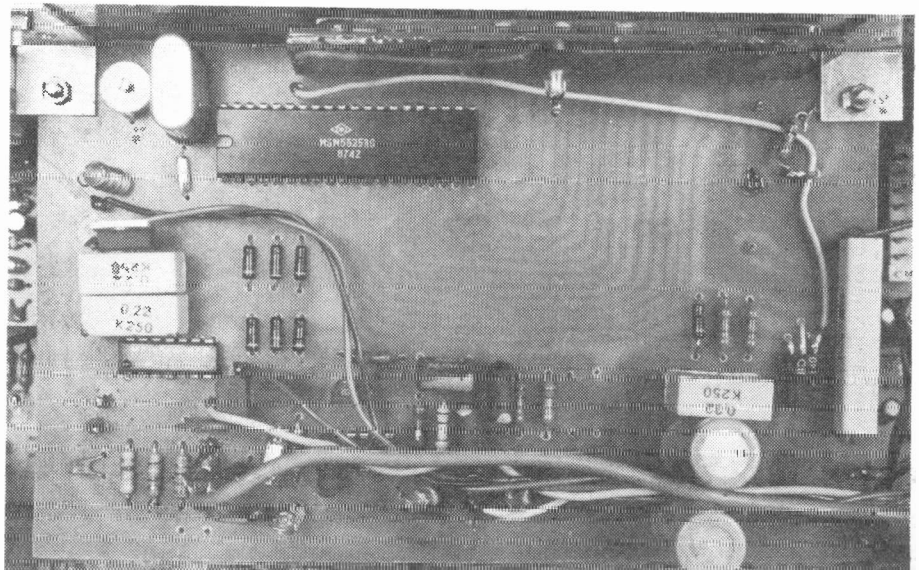
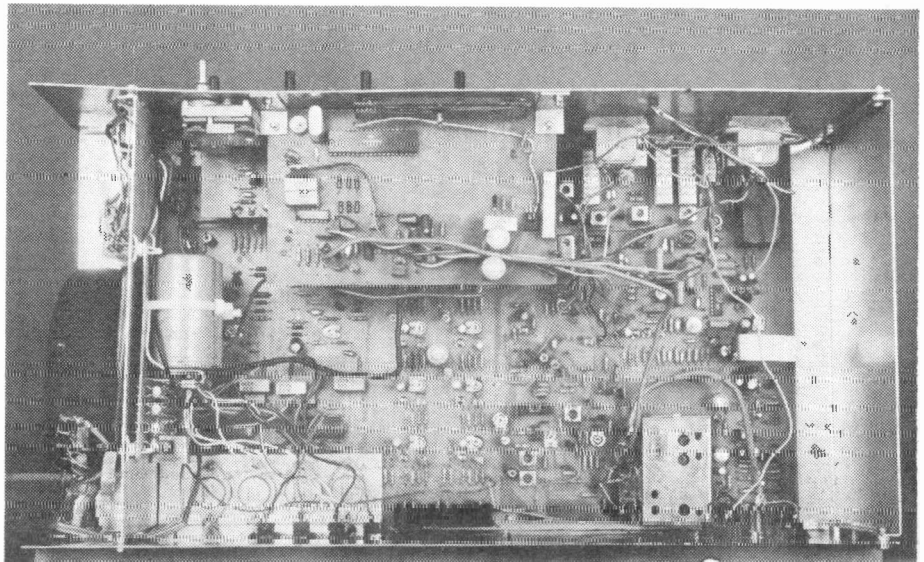


Fig. 7. Circuit diagram of the FM tuner stage of the tuner/amp, built around the CA 3189E IC.

(Below) The digital frequency meter display and driver board.



(Below). We suggest you lock yourself away for a fortnight to build this one.



enable a signal-strength meter to be used, also shared by the FM. An infinite impedance detector gives superior audio characteristics, and a length of wire is used as an aerial, to avoid all the adjustment problems associated with ferrite-rods. The IF uses a double-tuned ceramic filter for good selectivity.

Use of a digital frequency readout complements the advanced tuner design, far more accurate than mechanically strong scales. It eliminates once and for all backlash!

There is one further switch, a remote / local button. At some future date it is intended that a remote control facility is introduced, and details will be published as soon as the right method becomes available.

Quite a Switch

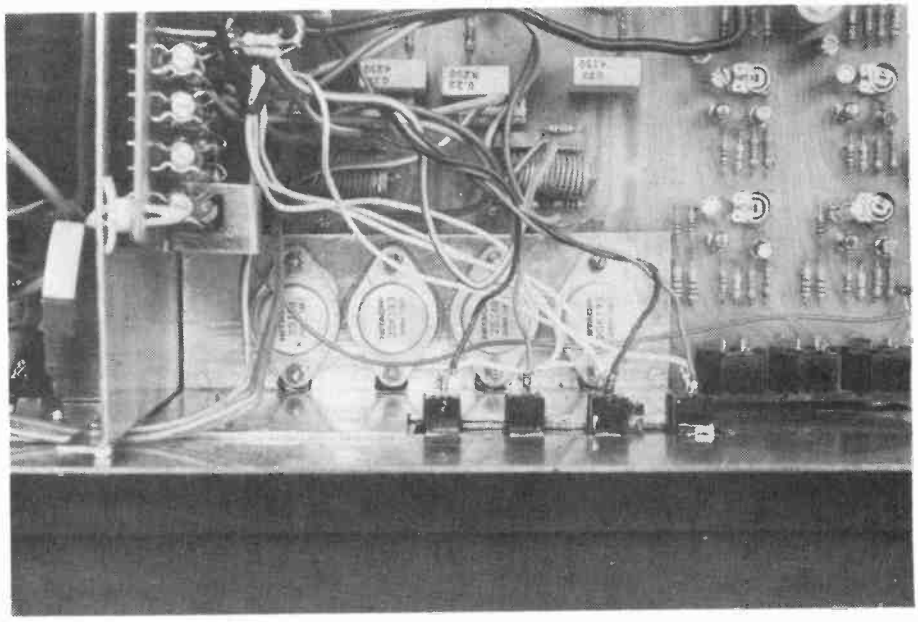
All input switches takes unused signals to earth, avoiding stray pickup. The whole system is largely built on one PCB to avoid the bulk of wiring normally associated with this kind of project. However, for cosmetic reasons, and anticipating remote control, the tone controls, volume and balance are an additional board, and the digital readout another. The power-supply components are also on a separate PCB — supply wiring to power amplifiers does not allow for compromise!

Construction

Because of the complexity of a project like this, we cannot recommend it as a beginners enterprise. Although only three PCBs are employed, the sheer size of the main one caused it to be held over until next month. Accordingly we are presenting the System 8000 in two parts. Next month will conclude the project with the component overlays, alignment details, and, of course, constructional notes.

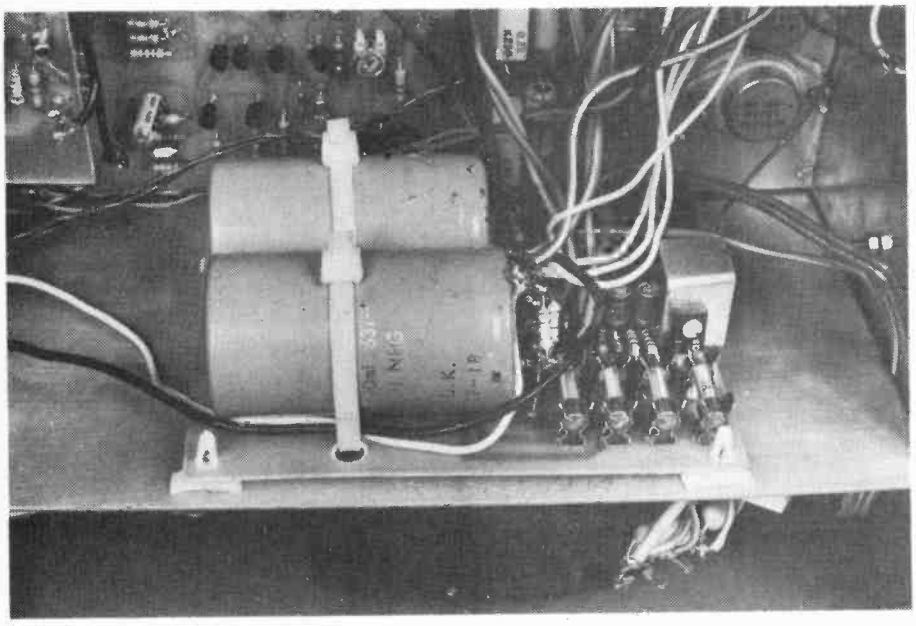
The circuit details here are complete, and if you don't intend to use our boards you may as well get started — good luck and don't call us, we'll call you! A complete kit of parts is being marketed for this design — see Buylines for details.

ETI



Close up of the Hitachi power FETs on their heatsinks. Their presence lends something special to the power amplifier.

A battery of fuses to protect your interests, and some healthy reservoir capacitors to keep things smooth!



BUYLINES

All the parts for this project will be available from UNI Electric Ltd, 182-184 Addington Road, South Croydon, Surrey.

A complete kit of parts is available for £175 aligned (or £165 unaligned) including VAT and postage. A metalwork kit is available at £35 plus £2 postage and a set of PCBs will cost you £14.50 including postage.

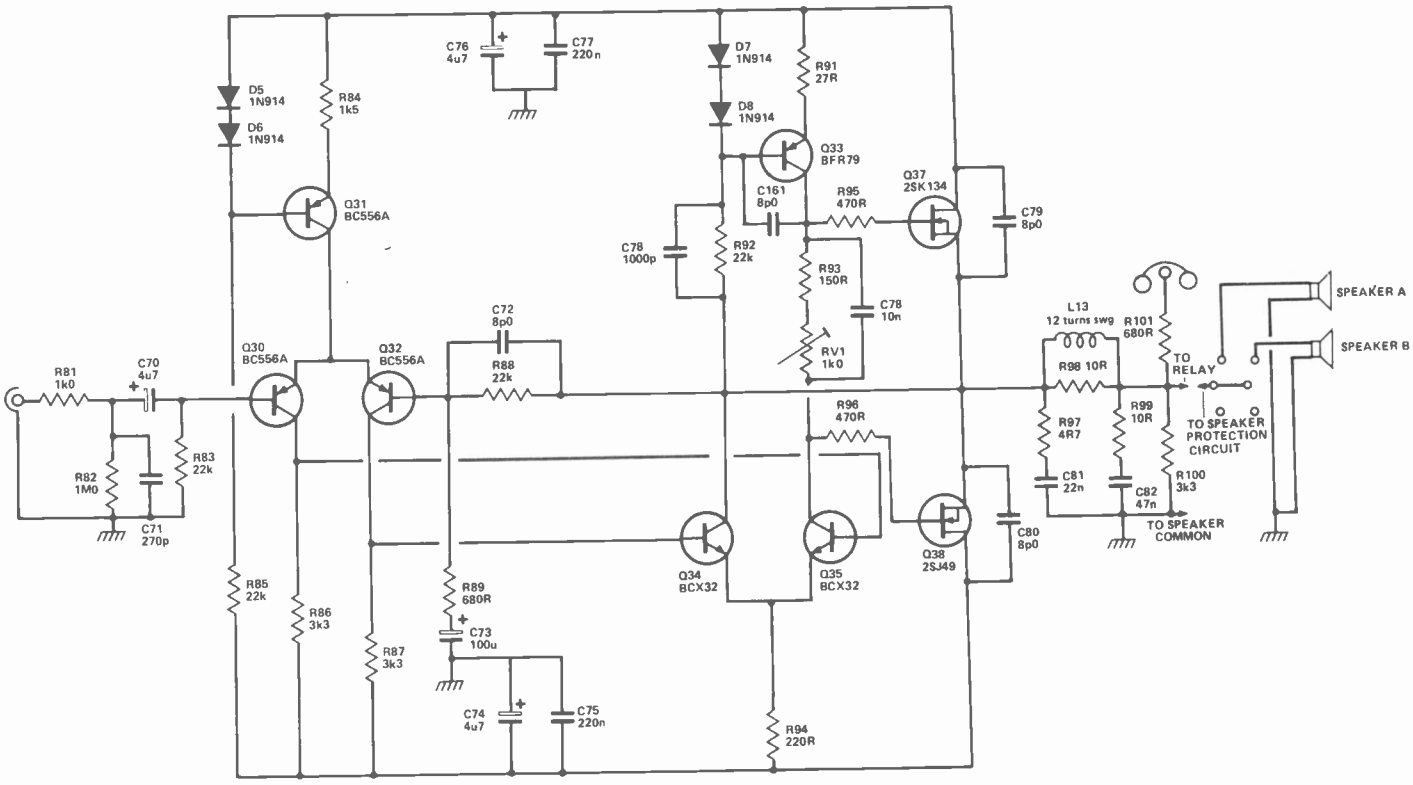


Fig. 8. The power amplifier stages of the system 8000 receiver. That strange little symbol in the output stages is a power FET!

HOW IT WORKS

Magnetic Cartridge
Q1 feeds a super Darlington, Q2, giving low noise, and high overload threshold.

Q3 is a constant current source with high AC rejection, and it is this which gives the low distortion characteristics.

Auxiliary
No circuitry associated with this, feeds straight through to the rumble filter.

FM Tuner
VTO3 is a prealigned twin head with a 10.7 MHz output. Q22 and Q23 form a limiting stage, fed by a ceramic filter and feeding a ceramic filter. L1 enables the precise tuning of the passband so that the 3 ceramic filters used can be 'tuned' for minimum distortion. Q24 is a common base configuration, in order that the source input and output impedances better match the third ceramic filter to the CA3189. L3 and L4 form a quadrative detector, the double tuning being necessary for low distortion. AGC is obtained from pin 15 and fed to the tuner head (so that the mixer is not overloaded). RV10 decides when AGC action starts. RV11 sets the mute, which can be switched out. AFC is derived within the IC, and is used to adjust the varicap volts, rather than pull the FM oscillator — an output on the tuner head feeds the digital frequency display.

The audio output is fed to the active, low pass filter stage, with 18 dB per octave cut to remove 'birdies'. The output of this is fed to the stereo decoder KB4437. RV6 is set for stereo, RV7 for the maximum 19kHz rejection. The output is fed through a 19kHz and a 38kHz filter block, to remove all unwanted signal.

AM Tuner
Signals are obtained from a wire antenna, and fed to an active stage formed around L5/L6, and Q27. This is fed to the internal RF amp of the CA3123, which is tuned by L7/L8. KV1210 is a triple varicap block, two being used in the RF stages, and the third tuning the oscillator coil L9.

The output of the internal counter is fed by the double tuner coil to the IF amp within the IC. The output is tuned to the 470kHz by the L11, and an infinite impedance detector informed around Q28. AGC is derived from the IF output, and is used to control the RF amp.

No signal level facilities are included in the IC, so the current drawn by the RF amp is detected and amplified by Q29, and fed to a signal strength meter. This is shared with the FM signal strength output, RV8 giving some adjustment. MW/LW switching changes RF coil, and puts the padding capacitor across the oscillator coil L9. CV3 may be used to adjust the oscillator for correct positioning of the LW band.

When the input is selected, all other inputs are switched to earth. Selecting FM/MW/LW switches the 15V power-line, and hence the FM/AM on the digital frequency display.

The output of these stages is fed to a rumble filter (12dB per octave) formed around Q15 — the output of which feeds the tape switching network. Each tape input/output has a unity gain (adjustable) stage, consisting of a super NPN transistor. The output/input suit standard impedance DIN.

After the switching is situated the volume control. The output of the pot feeds the mono switch which removes power from the stereo LED, and combines the L and R audio channels. This feeds a 12dB active scratch filter — note that both the scratch and rumble filters are always in the circuit, the turnover point being shifted by adding capacitors. The 3M3 resistors ensure the same DC levels across these capacitors, so that the switching produces no shifts.

The tone control stage features an active network placed around Q17. The split collector load gives this a gain of two (the position of the volume pot ensures that this stage cannot be overloaded). The output of Q17 feeds a 22k pot, dual ganged and connected for adjustment of balance.

Q18 and Q19 form a variation on the super NPN transistor, with a gain of six. Thus the tone control board has a gain of 12, with distortion below 0.1%. The output of this stage feeds direct to the power amp.

DESIGNER'S NOTEBOOK

A monthly look at the notebook of ETI's chief design engineer, project editor Ray Marston.

THE ETI PROJECT TEAM turns out an average of seven or eight new designs each month. These range from simple circuits such as 555 timer projects, which appear in our sister journal Hobby Electronics, to fairly advanced designs such as the Click Eliminator and the Ambush game that appeared in recent issues of ETI. No matter how simple or complex a project is, its actual circuit design invariably evolves in the following sequence of four major steps.

1. The project is presented to one of the team's design engineers in the form of a precisely defined design problem.

2. The designer postulates a solution to the design problem.

3. The designer implements his solution in the form of a practical wire-up.

4. The designer debuggs the bits of his circuit that are not working correctly, and then completes his final circuit design diagram.

First Steps

The debugging stage of the design sequence is the most interesting of all, because it is the stage in which the designer really learns valuable lessons about practical electronics. On the one hand, he learns about the weaknesses of those circuits that did not work quite as well as expected, and on the other hand he learns about alternative circuits that give a better performance than his original design. A good designer always jots these hard-learned lessons down in a mental or physical notebook, but then, regrettably, often keeps his notebook locked away, for no one else to see.

Here at ETI we've decided to open up my personal design notebook each month, and show you some of the lessons that were learned during the development of various projects. We'll tell you about the strengths and weaknesses of some of our published and unpublished designs, and try to keep you up to date with new designs that we are developing. We are sure that all aspiring designers amongst you will find the notebook worth reading.

Precision Gating Of a 555 Astable Circuit

This month's first design problem came up during the design of that Metronome. I was using a 555 chip in the astable mode, as a tone generator, and needed to gate the circuit on and off periodically via a narrow control pulse. One standard way of doing this is to feed the control signal to the pin-2 'trigger' terminal of the IC, but I found that this method did not give the fast switching action that I required.

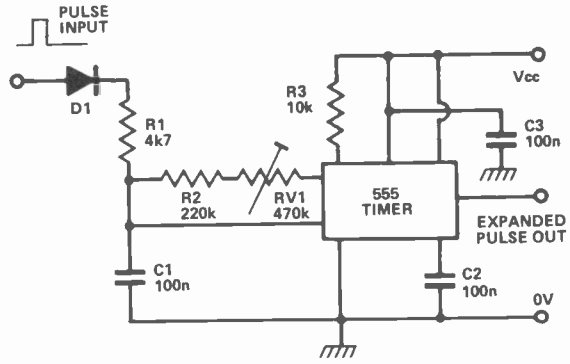


Fig. 1. Using a 555 chip as a tone generator. The control signal is applied directly to the 555's timing capacitor.

The answer to the problem was to use the circuit of figure 1, in which the control signal is applied directly to the 555's timing capacitor. When the control signal is at logic level 0, the timing capacitor is discharged via D1 and R3, and the astable is inoperative. When the control signal is at logic level 1, D1 is reverse biased and the astable functions in the normal way. This control system gives a very fast response, providing that R3 has a value that is low relative to R1.

CMOS 555 Monstable Circuits

One of the jobs that I tackled this month was the design of an R / C motor speed controller. In this circuit we generate a fixed 1.5 ms pulse, compare it's width with that of an ▶

incoming 1-2mS pulse, take the difference between the two signals, and then feed the resulting narrow pulse, which has a width that is variable between 0 and 0.5 mS to a times-40 pulse-expander circuit. The resulting pulse is then used to switch power to an electric motor.

My first reaction to this project was to use the CMOS circuit of fig 2 as the fixed 1.5 mS pulse generator, but I rapidly learned that it's pulse width versus supply voltage characteristics made it totally unsuitable for this particular application. The circuit was intended to operate over the

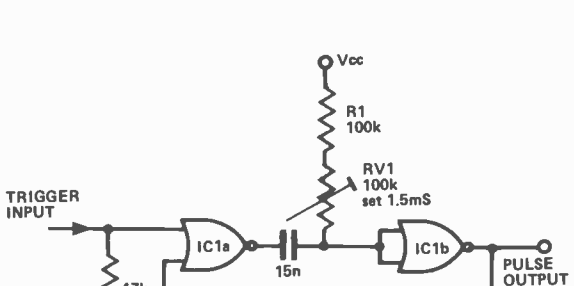


Fig. 2. A CMOS pulse expander circuit — not suitable for this application.

supply voltage range 4 V to 6 V. When I tested the circuit, I found that it's pulse width varied from +4% to -6% of a normallised 5 V value over this voltage range, as shown in the graph of fig 3.

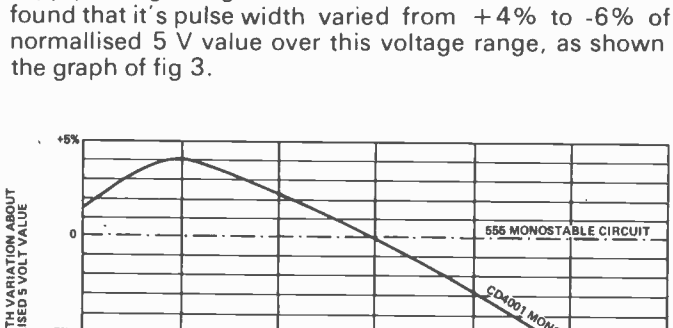


Fig. 3. Variation in pulse width against supply voltage for the CMOS pulse expander.

I then tested the 555 monstable circuit of fig 4 to see how well it performed at different supply voltages. I was unable to detect any variation in it's pulse width over the specified supply voltage range, as also shown in the graph of fig. 3, so used this circuit as the 1.5 mS pulse generator in the final version of the R/C motor speed controller.

Digital and Analogue Pulse-Expander Circuits

I developed both digital and analogue pulse-expander circuits when designing the R/C motor speed controller. The digital version of the expander is shown in fig. 5. Here, IC1 is a 555 astable, and IC2 is a CD4029 up/down counter that is used in it's binary mode and is thus capable of counting in 16 steps. The output of the counter is taken from the 'carry

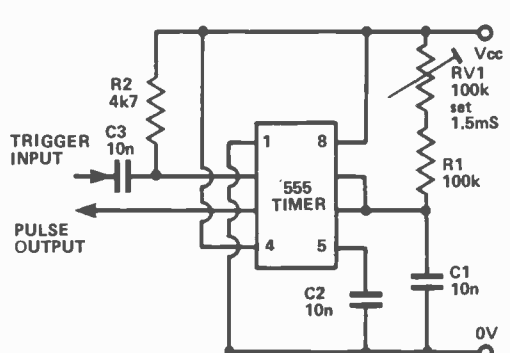


Fig. 4. A 555 monostable circuit — constant pulse width over supplies of 4V to 6V.

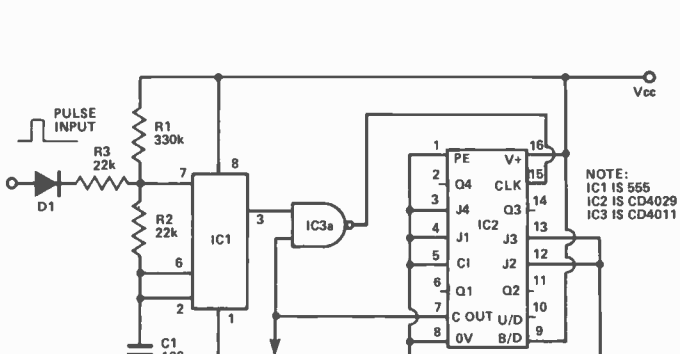


Fig. 5. A digital version of the pulse expander circuit.

out' terminal, which is normally at the logic 1 state but goes to logic 0 when the counter reaches it's maximum count in the 'up' mode or it's minimum count in the 'down' mode. this carry out signal is also used to gate the clock signal via IC3, and so prevent the counter from overspilling.

To understand the circuit operation, assume that the counter has reached the empty state in the 'down' mode, so that the carry out signal is at logic 0. When the input pulse arrives at the circuit it sets the counter to the 'up' mode, causing the 'carry out' pin to go high and enable the clock gate: simultaneously, the 555 astable is set to a fast clock rate via D1 and R3, so the counter clocks up rapidly for the duration of the input pulse. If the component values are right, the counter will be slightly short of it's 'full' state when the input pulse terminates.

Terminal Count

When the input pulse terminates, it automatically sets the counter to the 'down' mode, and enables the 555 astable to clock at its normal slow rate via R1-R2 and C1, so the counter then clocks slowly downwards until it eventually reaches the 'empty' state, at which point it's carry out terminal goes to logic 0 and completes the operating sequence.

The output of the counter is thus an expanded version of

the input pulse, but expands in a maximum of sixteen discrete steps. The expansion ratio is proportional to the 'fast' and 'slow' speed ratios of the 555 clock generator.

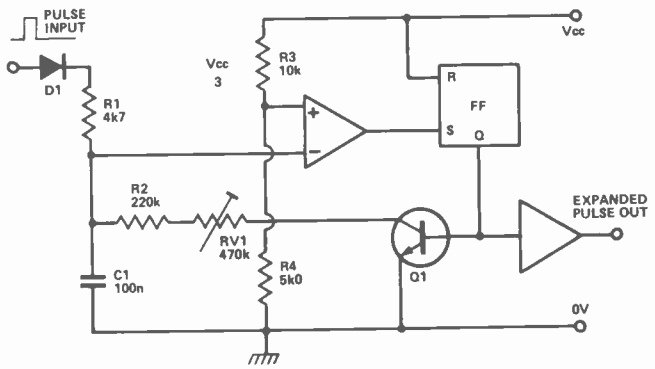


Fig. 6. An analogue version of the pulse expander circuit.

The basic circuit of the analogue pulse expander is shown in fig. 6. Assume at the outset of operations that Q1 is off, C1 is discharged, and the circuit output is low. When the input pulse arrives it starts to charge C1 rapidly via D1 and R1. As the C1 voltage rises above Vcc/3 the output of the circuit is driven high via the op-amp, the flip-flop, and the non-inverting amplifier: simultaneously, Q1 is driven on, but has little effect on C1, since the values of R2 and RV1 are large compared with R1, so C1 continues to charge via R1. If the component values are right, C1 will be short of the Vcc value when the input pulse terminates.

When the input pulse terminates, C1 starts to discharge via R2-RV1 and Q1. Eventually, when the C1 voltage falls just below Vcc/3, the op-amp turns Q1 off via the flip-flop, and the output of the circuit switches low. The operating sequence is then complete.

The output of this circuit is thus an expanded version of the input pulse, and the circuit has an expansion ratio that is roughly proportional to the ratios of R1 and R2-RV1. Fig. 7 shows the practical implementation of this circuit, using a 555 timer chip. This is the circuit that was used in the final version of the R/C motor speed controller. The fig. 5 digital circuit was rejected purely on grounds of costs for this project. Other designers may, however, find the circuit useful in some applications. ET

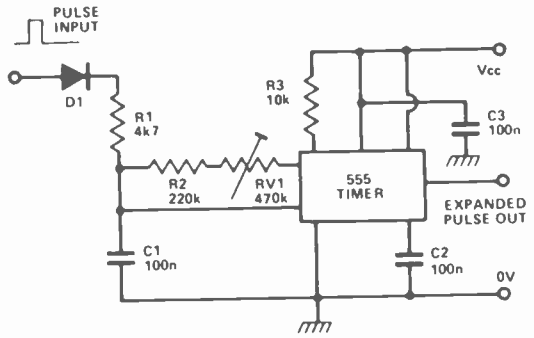


Fig. 7. The circuit finally chosen for use in the radio control motor speed controller.

electronics today international

What to look for in the July issue: On sale June 1st

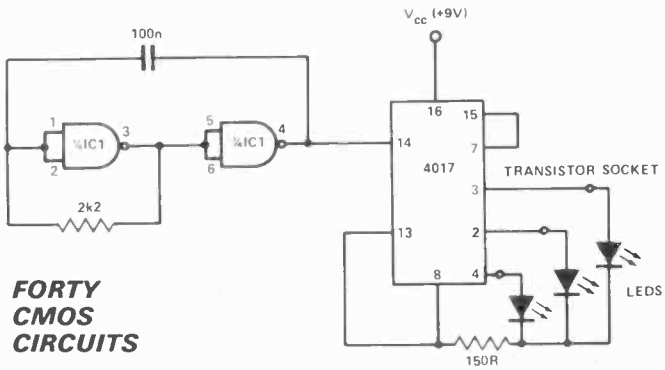
TELETEXT BOX

ETI goes Teletext next month. A full spec design including full colour and double height characters. Remote control is by ultrasonics, so there is no need to move from your armchair to change the page. The circuit is based upon the Mullard chip set — long awaited that is.

Emphasis has been placed upon ease of construction — the PCBs are plated through and silk screened and everything mounts to the board. With all this offer and with commercial units running at £200 plus you'd expect this kit to cost the earth would you not? Well it will set you back under £160 complete and we don't think that's bad! Don't miss this.

POLYPHONIC KEYBOARD CONTROLLER

We've struck the right chord here. Give up those one note wonders and take up polyphonics — you can't get arrested for it and it'll make your oscillators warble for joy. Play away up to 8 times simultaneously and don't feel guilty about it!

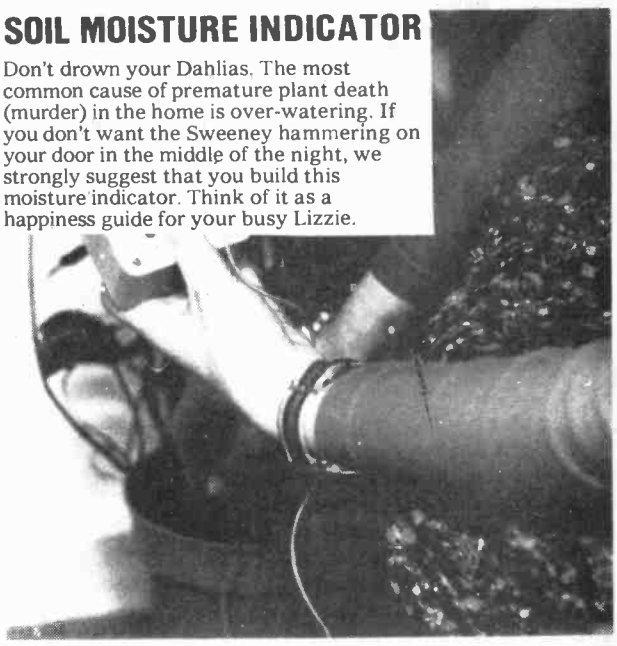


FORTY CMOS CIRCUITS

Another family size, bumper bundle of goodies from our bionic project editor, Ray Marston. In past issues he's covered 555s and 741s. This time it's the turn of CMOS circuits. He's got forty, yes forty, of the little beauties for you. You can't afford to miss them.

SOIL MOISTURE INDICATOR

Don't drown your Dahlias. The most common cause of premature plant death (murder) in the home is over-watering. If you don't want the Sweeney hammering on your door in the middle of the night, we strongly suggest that you build this moisture indicator. Think of it as a happiness guide for your busy Lizzie.



MAINS SEEKER

ETI's latest offering to the DIY person: a mains seeker that will find wires that other seekers can not trace.

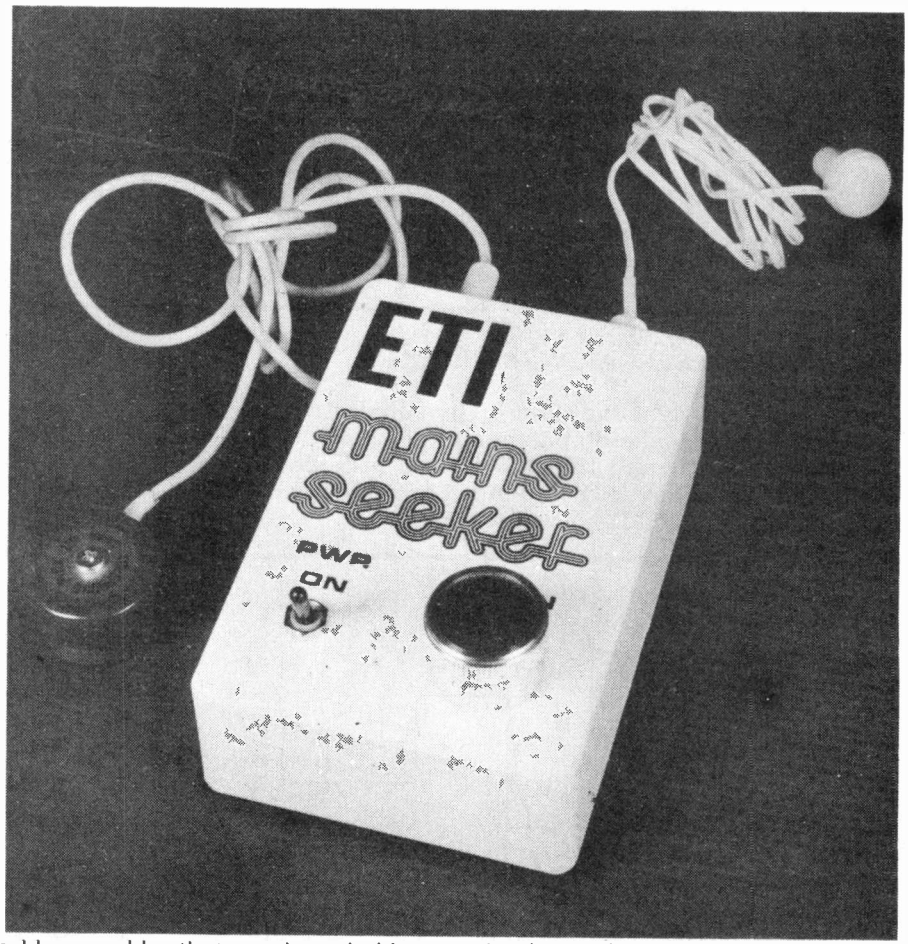
IF YOU HAVE EVER done a complete or partial rewire of a house, or have found yourself lumbered with jobs like drilling holes or knocking masonry nails into interior walls, you'll appreciate just how useful and reassuring it can be to know exactly where live mains wiring is hidden beneath the wall plaster. ETI's mains seeker is designed to help give you that reassurance and will help you trace those hidden wires that most other 'seekers' can not find. No licence is needed to operate the device.

BFO Mains Seekers

There are two basic types of mains-seeking device. The most common of these is the BFO metal-detecting type of unit. Fig. 1 shows the circuit diagram of one simple version of this type of device, which in this case is supposed to be used in conjunction with a hand-held pocket radio. The fig. 1 circuit is a simple L-C oscillator, tuned to about 120 kHz. Coil L1 is a long-wave aerial coil, wound on a ferrite rod.

In use, the fig. 1 circuit and the radio are both turned on and held close together. Their controls are then adjusted to obtain a beat note from the receiver. When any kind of metal comes near the end of the L1 ferrite rod it causes the inductance of the coil, and thus the frequency of the oscillator and the tone of the beat note, to change. Metal that is buried beneath plaster can thus be located by simply moving the above ferrite rod and radio slowly across the 'search' area of the plaster.

The BFO type of mains seeker is very good at locating old-style wiring that is shrouded in metal conduit, and old style metal plumbing, but is not very good at locating unshrouded cables or cables that are shrouded in modern plastic conduit. The wise handyman is never the less advised to build one of these simple units, but to build the new ETI mains seeker as well.



The ETI Mains Seeker

The theory behind the ETI mains seeker is quite elementary. All current-carrying wire generates a magnetic field about itself. Wiring that is carrying mains current generates a magnetic field at mains frequency and the intensity of the field is proportional to the magnitude of the current being carried. Mains currents above a hundred milliamps or so generate quite significant magnetic fields, so live mains wiring can easily be traced by applying it to a load (switching on the lights, etc), and then using a field-detecting and indicating instrument to trace the

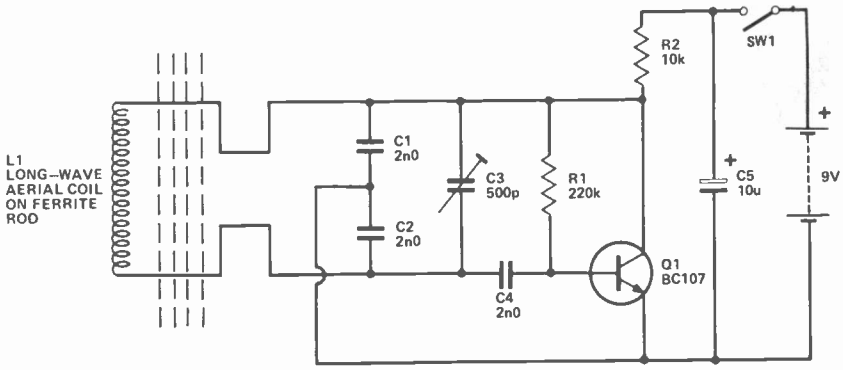


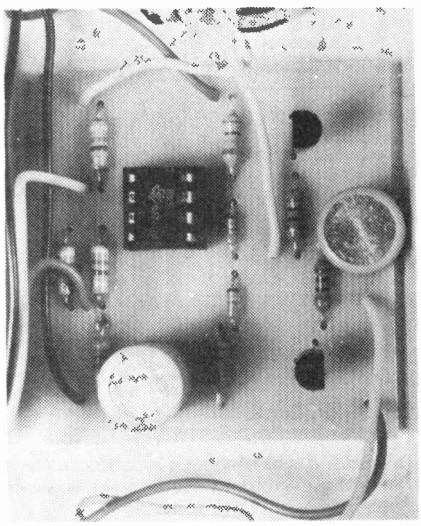
Fig. 1. Circuit diagram of one simple version of a BFO metal detector.

HOW IT WORKS

THE ETI MAINS SEEKER works by detecting the weak magnetic field of any current-carrying mains wiring and amplifying this signal up to a level that is adequate for driving a magnetic earpiece. The unit uses a telephone pick-up coil to detect the magnetic field.

IC1 is a type-741 op-amp, biased for linear operation from a single-ended supply via potential divider R2-R4, which has its junction decoupled to AC via C1. The op-amp is configured as a variable-gain inverting amplifier, and directly drives the Q1-Q2 complementary emitter follower output stage which is used to drive a magnetic earpiece via limiting resistors R7 and R8 and via C2. Components R5, D1, D2 and R6 are used to bias Q1 and Q2 into the linear mode. Note that the Q1, 2 stage is incorporated in the negative feedback loop of the op-amp.

The input to pin 2 of the op-amp is derived from a telephone pick-up coil, which is highly sensitive to magnetic fields and typically has an impedance in the order of 1k to 5k. The overall voltage gain of the circuit is approximately equal to the ratio of this impedance to that of the R1-RV1 negative feedback network and typically can be varied from near unity to about 50 dB via RV1. This degree of gain is sufficient to produce strong audible signals in the earpiece even from quite weak magnetic fields in the vicinity of the pick-up coil.



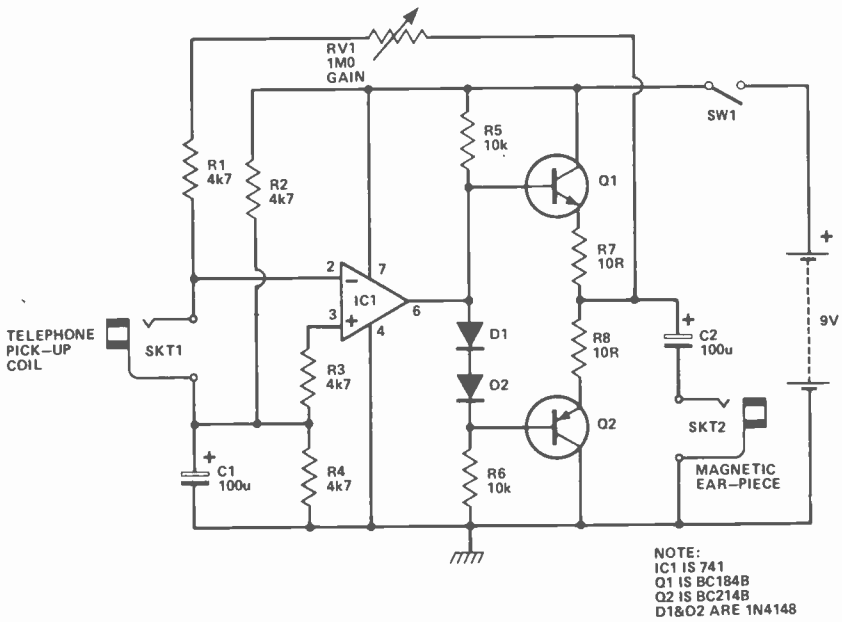


Fig. 2. Circuit diagram of the ETI Mains Seeker.

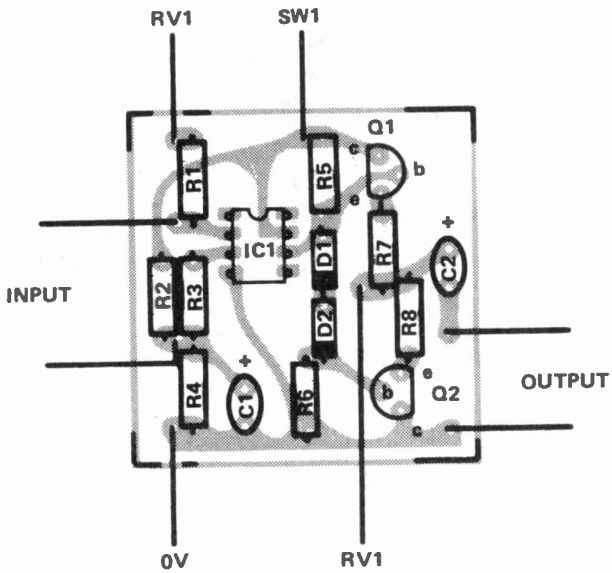


Fig. 3. Component overlay.

PARTS LIST

RESISTORS	
R1, 2, 3, 4	4k7
R5, 6	10k
R7, 8	10R
CAPACITORS	
C1, 2	100p
POTENTIOMETERS	
RV1	1MO lin
SEMICONDUCTORS	
Q1	BC184B
Q2	BC214B
IC1	741
D1, 2	IN4148
MISCELLANEOUS	
SW1	SPST
2	3.5mm jack sockets
PP3	
Case to suit	
telephone pick-up coil	
personal earphone 8Ω	

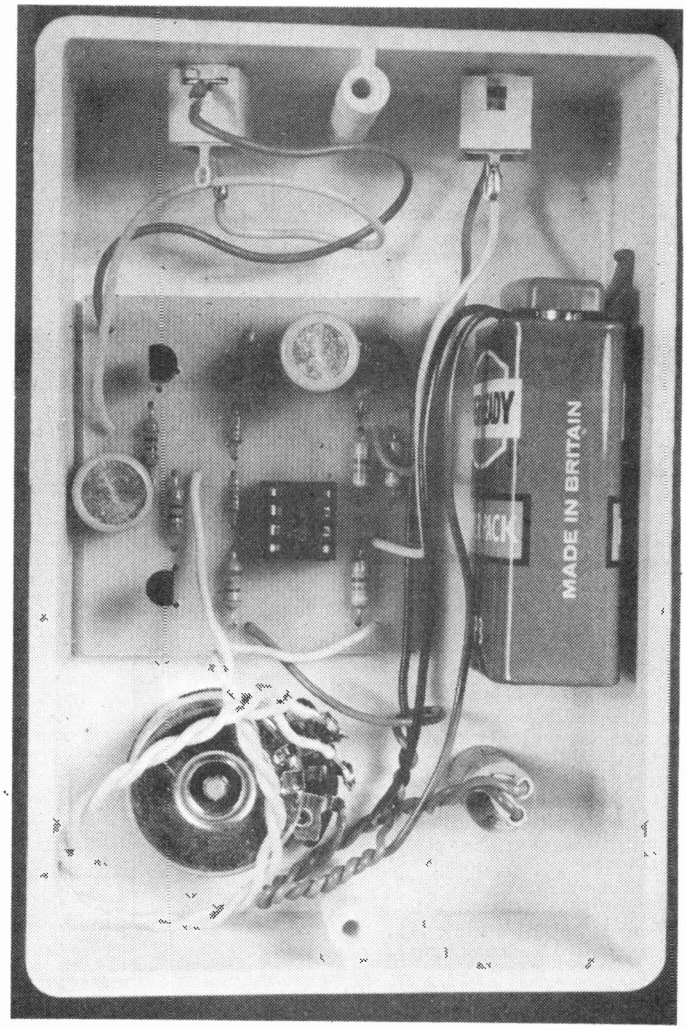
wiring route.

In the ETI mains seeker we use a standard telephone pick-up coil (as used with tape recorders) to detect the mains-frequency signal, which is then amplified and fed to a magnetic earpiece via a variable high-gain op-amp and transistor stage. The resulting instrument easily traces buried cables that are either unshrouded or are buried in plastic or non-ferrous conduit, or are hidden in non-ferrous metal channelling, but is not so good at tracing cables that are shrouded in old-style ferrous conduit. Circuits of the fig. 1 type are more suitable for the latter application.

Construction

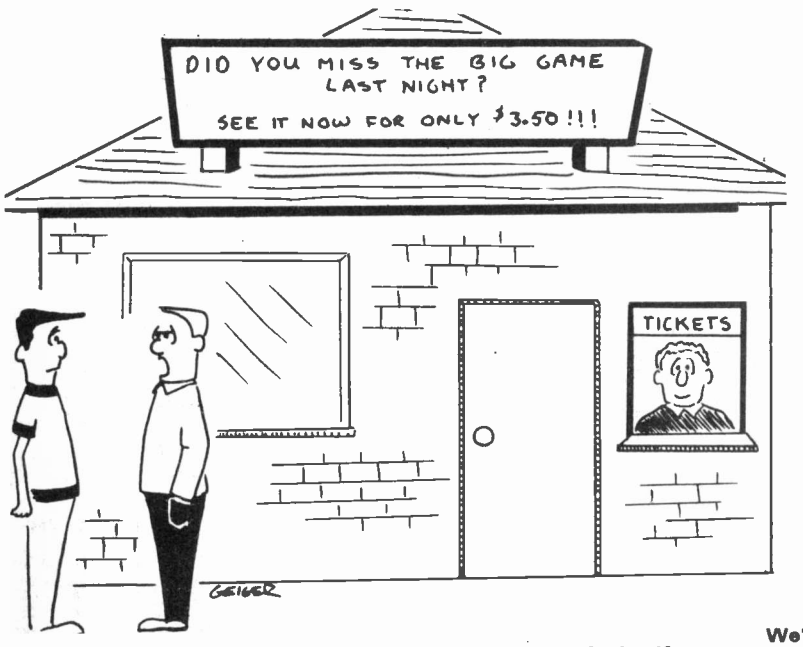
Construction should present no problems at all, since the circuit uses relatively few components, most of which are mounted on the PCB.

We housed our prototype unit in a plastic Verocase with outside dimensions of approximately 3 × 4½ × 1½ inches, but any roughly similar case is suitable. The pick-up coil and the earpiece are connected to the unit via jack sockets.



BUYLINES

There should be few problems in buying the parts for this project. The earpiece can be any magnetic type. Earpieces and pick-up coils are available from Maplin Electronic Supplies Ltd.



George figures he can make his new video recorder pay for itself in a few weeks.

We're in luck, Fred; It's a warning that the place is protected by a burglar alarm, which means the owner was too cheap to buy a burglar alarm, so he bought a warning sticker instead.

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M1000 Galvo 600 Hz 0 34 mA/cm	25
M1600 Galvo 1000 Hz 0 4 mA/cm	25
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Oscillostore 4 channel digital storage system with UV recorder	3300
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TG150DM 1 5 Hz-150 kHz 2.5 V	45
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COMARK	
1604BLU Analogue thermometer 0-100 °C	55
LEE-DICKENS	
HP5 Humidity probe	130
HUMIGUN Temp/humidity probe with meter	215
RAYTEK	
T1000 Infra-red thermoprobe	275
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BRADLEY	
CT471C AC/DC/Ω/current multimeter	350
HEWLETT PACKARD	
427A AC/DC/Ω multimeter	295
3406A 10 kHz-1.2 GHz	395
KEITHLEY	
610B Electrometer recorder O/P	330
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M2B DC/AC 10 Hz-500 kHz	50
MARCONI	
TF2603 AC voltmeter to 1.5 GHz	375
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U-Function Dual channel peak/RMS meter	495
PHILIPS	
PM2454B AC voltmeter to 12 MHz	300
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ADVANCE	
DMM3 1999 FSD AC/DC/Ω/current	85
DANA	
5230 119999 FSD AC/DC	175
BOONTON	
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8300A 119999 FSD DC only	150
8300A OP1 119999 AC/DC	185
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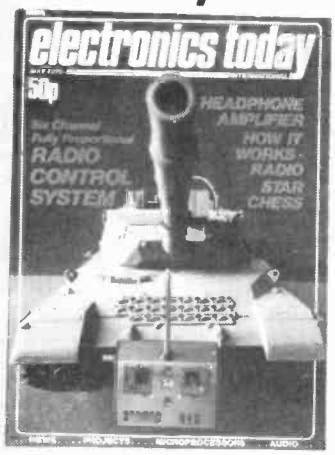

than any other electronics magazine. Why?

Most magazines have their circulations independently audited according to very strict rules and ETI has just taken over as the largest selling magazine in the field in Britain. Starting as a small "also-ran", ETI has now overtaken mags originally selling four times the number of copies.

Find out why ETI is No. 1 for yourself. Could it be something to do that it's better than the competition?

ETI MA

CLOCK RADIO

You probably won't believe us as we're selling the goods but we're going to tell you anyway! We have *rejected* eight clock radios for Marketplace, they were all cheap enough but the quality was so poor that we couldn't have lent our name to them. However, we are now able to offer a portable LCD Clock Radio to you which meets our standards.

The clock is a 12-hour one with AM/PM indicated and a back light. The radio is Medium Wave and FM with very nice quality for a small speaker — for FM there's a telescopic aerial. The alarm can be either a 'beep-beep' type or the radio, there's also a snooze facility.

The case is sensibly rugged and is printed on the back with a World Time Zones map, a bit of a cheek really, especially as the time is relative to Japan!

We won't even mention the RRP — but just check on comparable prices — you'll find ours a bargain.

An example of this Clock Radio can be seen and examined at our Oxford Street offices.

£20.50

(Inclusive of VAT and Postage).

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CLOCK RADIO Offer,
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Please find enclosed my cheque/PO for £20.50 (payable to ETI Magazine) for my Clock Radio.

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THIS IS THE THIRD digital alarm clock that we are offering (we regret the earlier versions are no longer available). We have sold thousands and thousands of these and our buying power enables us to offer a first rate branded product at a really excellent price.

The Hanimex HC-1100 is designed for mains operation only (240V/50Hz) with a 12 hour display, AM/PM and Alarm Set indicators incorporated in the large display. A switch on the top controls a Dim/Bright display function.

Setting up both the time and alarm is simplicity itself as buttons are provided for both fast and slow setting and there's no problem about knocking these accidentally as a 'locking' switch is provided under the clock. A 9-minute 'snooze' switch is located at the top.

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RKET PLACE

LCD CHRONO

We feel we've got to tell you carefully about this offer which we're introducing for the first time. Why? Because our price is so enormously lower than anywhere else you may suspect the quality.

The exact same watch is currently being offered by another magazine as a special at £24.95 — some of the discounters are selling it at £29.95, the price to ETI readers for exactly the same watch is £12.95.

The display is LCD and shows the seconds as well as the hours — and minutes — press a button and you'll get the date and the day of the week.

Press another button for a coujple of seconds and you have a highly accurate stopwatch with hundredths of a second displayed and giving the time up to an hour. There is a lap time facility as well — and of course a back light.

Our Chrono comes complete with a high grade adjustable metal strap and is fully guaranteed.

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It includes all the facilities expected in a good design — fast, slow setting, snooze facility, etc plus two unusual features — automatic brightness control and a weekend alarm cancel.

An example of this clock can be seen and examined at our Oxford Street offices.

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ALARM-CHRONO LCD

This new addition to our unbeatable selection of bargains is no ordinary LCD watch. It's a slim, multi-function, dual time chronograph alarm watch, no less.

This model will show hours, minutes, seconds, date, day of the week, stop watch, split time, alarm and alternate dual time zone — not all at once, of course. There is also a night light.

Hours, minutes, seconds and day of the week are displayed continuously, while the date will appear at the touch of a button. The day of the week is indicated by a flag. When used as a stopwatch, the maximum count is 0.1secs. short of thirteen hours.

An example of this watch can be seen and examined at our Oxford Street offices.

£22.95

(Inclusive of VAT and Postage)

To:
ALARM/CHRONO LCD WATCH Offer,
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25-27 Oxford Street,
London W1R 1RF.

Please find enclosed my cheque/PO for £22.95 (payable to ETI Magazine) for my Alarm/Chrono LCD watch.

Name .....

Address .....

.....

.....

Please allow up to 28 days for delivery.

audiophile

From pizza to words via cassettes. A place to eat where your ears can join in, a book to avoid and two nice new decks from Hitachi. Ron Harris joins them all together in the name of Audiophile!

LET US BEGIN with the nice bits. A piece of paper floating across my besieged desk attracted attention to itself by bearing the words 'pizza', 'Wharfedale' and 'Crimson Elektrik' all on one page.

Apparently there is a new restaurant, at Hanover Square London, which has fitted itself out with a high hi-fi system as a reaction to musak. They have employed large numbers of Wharfedale E50s, eighteen in fact, and five bass bins — operable below 150 Hz — to set up areas of stereo sound no larger than a living room.

Adjacent stereo pairs are arranged in reverse configuration so that the imagery is not confused anywhere and there is no less than 1200 M of speaker cable.

Ample Fare

Amplification comes from two GAS units down to 150Hz, and five Crimson 170W modules below that. The pre-amp is also Crimson. Sound source (sauce?) is either a pair of Dual C939 cassette decks or a Dual 721/V15 IV record playing system. In order to avoid playing 'Dark Side' 1000 times a day no doubt, and to preserve the American atmosphere, the output from Chicago's WBBMFM Dolby radio station is 'creamed' the previous week and recorded for use as material.

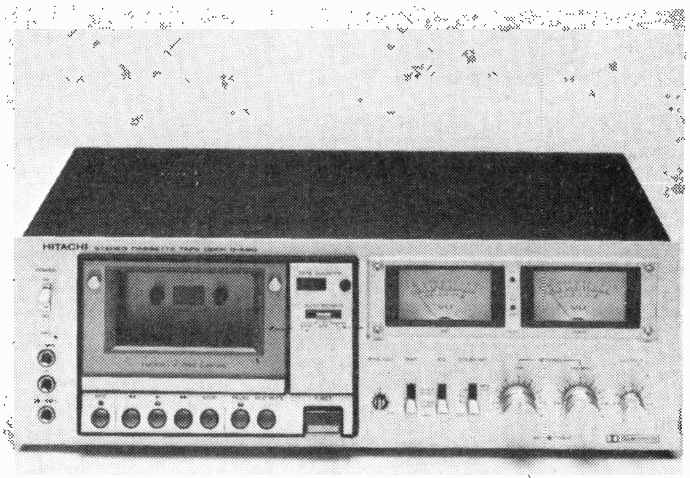
That makes more sense when you hear that the restaurant is called the Chicago Pizza Pie Factory, and as soon as I can find my 'A to Z London' I'll be out to report on the frequency response of their pizzas . . .

Decked Out

First news in a long time from Hitachi. Rumours were they'd all died. These two new decks look very interesting indeed technically — no chance of a listen yet. The D560 has a flourescent display (á la Sony) instead of VU meters. Somewhat unusual in a deck of this price range are the excellent mixing facilities and a fine bias control. Specifications include a frequency response up to 15,000 Hz using normal tape, and a wow and flutter of 0.06% WRMS. Signal to to noise ratio is 63dB and the whole lot costs £179 all inc.

The D580 is somewhat more expensive at £219, but can offer a lower wow and flutter and logic control of the drive system, which is two motor, for the money. An auto rewind facility is fitted, which will allow you to go back and play a particular track again . . . . and again . . . . and again . . . . and again . . . . and again . . . . and again . . . . and again . . . . and again . . . . and again . . . . and again . . . .

Above: the Hitachi D560 cassette deck. The fluorescent display is interesting, as is the fine bias control.



Above: the D580 from those same Hitachi type people. This one has a built-in elephant so that it never forgets where you started recording, and will rewind these upon demand.

Book Your Enclosures

There are flocks — word carefully chosen, of books about audio-explaining, expounding, extending and generally varying the theme. Spring is lambing time anywhere you go, and we get quite a few woolly efforts appearing on the bookstands at this time of year.

One such offering — "Master Hi-Fi Loudspeakers and Enclosures" by D. Berriman — came to light this week. It is difficult to see what market the book is aimed at. For the complete tyro, a fourteen page romp from zero to complete mastery of Sound Hearing and Measurement (Chapter 1) is hardly sufficient. For the more cogniscent the statement that "Applying goo to the cone will help damp out these break-up resonances but too much goo will add mass thus resulting in a lowered efficiency . . ." (p.49) will hardly kindle the fires of technical enlightenment.

I know that quoting out of context is always unfair, but how else to convey the tone of the text? It is basically well written but fatally unsure of whom it is written for, and in consequence oscillates between over simplification and unnecessary complication.

Mr Berriman's *next* book will undoubtedly be a volume well worth the perusal and I look forward to reading it.

Sorry David Berriman, but I didn't like this one at all.

Ear Say

Interesting incident.

Great credence is placed in panel listening tests these days, and indeed the technique does seem to be the best way we have of conveying subjective impressions, but how does the collective mind function? Certainly not as the sum of the parts. Witness this—

Some time ago I ran a series of cartridge tests with five different top flight units, and a Sony EL7 Elcaset machine. The original scheme was to run a 'standard' sort of affair to place the cartridges in order of merit. However, it became more interesting due to a foul-up on the monitor switch!

Finish Tape

Throughout the test the members of the panel had, between them, identified the tape machine about 80% of the time upon direct comparison. (That figure is beguiling in itself is it not?) Inserting a taped version of one of the cartridges into the list as a 'sixth unit,' however, led to its being identified as the cartridge which had been recorded IN EVERY CASE.

Not one member of the group realised it was hearing a recording. Mind you not one of them would admit it later — typical of the kind of people I have to deal with!

These were all folk involved in the audio field and as such could be considered 'professionals'.

The final touch however was added when discussing this later with one of the panel concerned. The faithful EL7 was quietly playing away — a recording of Thelma Houston's direct cut disc — and to prove his point the gentleman made a reference to the cartridge then in use.

You see the arm was over the deck (raised I hasten to add) and the front of the EL7 is not visible from where he sat. The assumption was easy to make. Wrong, but easy to make. One to the tape machine.

Rest Easy

Since then I have repeated the, initially unintended, deception on every member of that panel. Moreover, upon direct comparison — individually — the identification of tape against source went down to barely 60%.

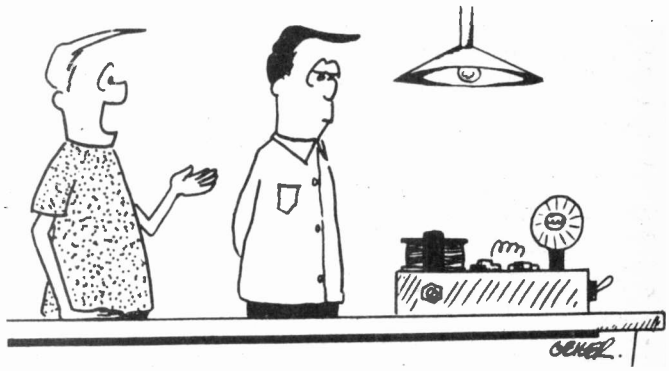
The EL7 is a very high quality tape reader, and the results it produces can be as good as any. However, the point would seem to me the variation present in those figures. As a group 80%, one by one 59%.

Small variations in audio signals would seem to be detected somewhat unreliably on the whole. If a panel of 'experts' can come up between them with one set of results, and individually with a totally *different* set — what price the conclusions?

Operating in a group always leads to collaboration — let us call it discussion — in which the strongest personalities will triumph. I would suggest therefore that there is a strong possibility that a group result will depend for more heavily upon the (pre-formed?) opinions of the strongest rather than the collective impression of the whole.

Opinions please. ETI

Benjamin Franklin flies a kite in a thunderstorm and discovers electricity — I fly a kite in a thunderstorm and discover that it's stupid to fly a kite in a thunderstorm.



. . . it emits a bright flash of light every 5 seconds — I'm thinking of marketing it as a hazard warning light or a strobe for a senior citizens' disco.

7400	10p	7460	12p	74137	90p	74195	50p	4055	130p	CA 3140	60p	LM 3909 N	65p	TBA 480 Q	200p
7401	10p	7470	25p	74138	100p	74196	50p	4056	120p	LF 356	80p	MC 1310 P	140p	TBA 520 Q	200p
7402	10p	7472	20p	74141	50p	74197	50p	4060	100p	LF 357	80p	MC 1312 P	150p	TBA 530 Q	200p
7403	10p	7473	25p	74142	180p	74198	100p	4066	35p	LM 211 H	250p	MC 1314 P	190p	TBA 540	200p
7404	12p	7474	25p	74143	270p	74199	100p	4069	12p	LM 300 TR5	170p	MC 1315 P	230p	TBA 550 Q	250p
7405	12p	7475	25p	74144	270p	74293	90p	4070	12p	LM 301 AN	30p	MK 50398	650p	TBA 560 C	250p
7406	25p	7476	25p	74145	55p	74L500	18p	4071	12p	LM 304	200p	MM 5314	380p	TBA 641 A12	250p
7407	25p	7480	40p	74147	100p	745112	80p	4072	12p	LM 307N	65p	MM 5316	480p	TBA 700	180p
7408	12p	7481	85p	74148	90p	**CMOS**		4081	12p	LM 308 TO5	100p	NE 529 K	150p	TBA 720 Q	225p
7409	12p	7482	75p	74150	65p	4000	12p	4082	12p	LM 308 DIL	100p	NE 555	25p	TBA 750 Q	200p
7410	12p	7483	75p	74151	45p	4001	12p	4093	70p	LM 309 K	100p	NE 556	90p	TBA 800	80p
7411	15p	7484	70p	74153	45p	4002	12p	4510	60p	LM 310 TO5	150p	NE 562 B	400p	TBA 810	100p
7412	15p	7485	60p	74154	70p	4006	80p	4511	70p	LM 311 TO5	150p	SAD 1024	1500p	TBA 820	100p
7413	25p	7486	25p	74155	45p	4007	14p	4516	65p	LM 317 K	325p	SL 917 B	650p	TBA 920 Q	280p
7414	45p	7489	130p	74156	45p	4009	30p	4518	65p	LM 324	70p	SN 76003 N	150p	TCA 270 Q	220p
7416	25p	7490	25p	74157	45p	4011	12p	4520	65p	LM 339	60p	SN 76013 N	110p	TCA 270 S	220p
7417	25p	7491	40p	74160	55p	4012	12p	4528	80p	LM 348 N	90p	SN 76013 ND	125p	TCA 760	300p
7420	12p	7492	35p	74161	55p	4013	30p	4583	70p	LM 380	60p	SN 76023 N	110p	TCA 4500 A	450p
7421	20p	7493	30p	74162	55p	4015	50p	**LINEAR**		LM 381 N	90p	SN 76023 ND	125p	TDA 1008	350p
7422	15p	7494	70p	74163	55p	4016	30p	AY3 8500	450p	LM 382	90p	SN 76033 N	150p	TDA 1034	450p
7423	20p	7495	45p	74164	60p	4017	50p	CA 3039	70p	LM 391	180p	SN 7627 N	160p	TDA 2002	300p
7425	20p	7496	45p	74165	60p	4018	55p	CA 3046	60p	LM 555	25p	SN 76228 N	180p	TDA 2020	300p
7426	22p	7497	120p	74166	75p	4019	40p	CA 3060	225p	LM 709 C	40p	SN 76660 N	75p	TL 084	120p
7427	22p	74100	80p	74167	160p	4020	50p	CA 3065	200p	LM 710 TO5	60p	TAA 300	100p	XR 320	250p
7428	25p	74104	40p	74170	100p	4022	50p	CA 3076	250p	LM 710 DIL	65p	TAA 350	190p	XR 2206	450p
7430	12p	74105	40p	74173	80p	4023	12p	CA 3080	75p	LM 723 TO5	40p	TAA 550	35p	XR 2207	450p
7432	20p	74107	25p	74174	60p	4024	40p	CA 3084	250p	LM 723 DIL	40p	TAA 570	220p	XR 2208	600p
7433	28p	74108	100p	74175	60p	4025	12p	CA 3085	85p	LM 733	120p	TAA 661B	140p	XR 2216	650p
7437	20p	74166	75p	74176	50p	4026	80p	CA 3086	60p	LM 741	20p	TAA 700	350p	XR 2567	250p
7438	20p	74109	25p	74177	50p	4027	30p	CA 3088	190p	LM 748	40p	TAA 790	350p	XR 4136	150p
7440	12p	74118	75p	74178	75p	4028	45p	CA 3089	160p	LM 1303 N	100p	TAD 100	150p	XR 4202	150p
7441	45p	74120	80p	74179	120p	4029	50p	CA 3090 AQ	360p	LM 1458	100p	TAD 110	130p	XR 4212	150p
7442	40p	74121	25p	74180	90p	4030	30p	CA 3123 E	130p	LM 3080	75p	TBA 120 S	60p	XR 4739	150p
7443	60p	74122	35p	74181	130p	4032	80p	CA 3130	100p	LM 3900	55p	TBA 120 T	85p	ZN 414	100p
7444	60p	74123	40p	74182	50p	4033	100p								
7445	65p	74125	35p	74184	120p	4040	60p								
7446	50p	74126	35p	74185	100p	4043	60p								
7447	50p	74128	60p	74188	320p	4046	90p								
7448	50p	74130	120p	74190	70p	4047	80p								
7450	12p	74131	90p	74191	70p	4048	50p								
7451	12p	74132	45p	74192	60p	4049	25p								
7453	12p	74135	90p	74193	60p	4050	25p								
7454	12p	74136	80p	74194	55p	4054	100p								

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ULTRASONIC REMOTE CONTROL DIMMER

Submitted by Jonna Kats of London

EVER WANTED TO turn the lights down from the comfort of your armchair? With this dimmer you can do just that. Press a button and up goes the light. Press another button and down it goes again.

Control of the unit is afforded by the two front panel push buttons. External buttons (as many as you like) may be connected in parallel. There is no danger of getting a shock, because the control electronics are isolated from the mains. It is also possible to alter the rate at which the light dims.

Controlling It

It was decided that the hand control (transmitter) should be as simple as possible and the receiver should be very safe. Also, all components should be readily available and cheap, and the circuits should be uncritical and reliable.

As only one channel is required, a carrier modulated by a tone fits the bill. The next step is to decide on the data link. To keep the GPO happy, one is limited to either infra-red or ultrasonic transmission. The author decided to use ultrasonics.

The means of communication is a 40 kHz carrier plus a carrier modulated at 400 kHz. This makes the transmitter very simple as can be seen from the circuit diagram.

Now for the dimmer. When you don't have a pot in the circuit acting as a memory, you need some form of electronic memory. The charge on a capacitor is one way of doing it. However, you need a very high Z sample and hold circuit and lots of guard tracks on your PCB, and you have to keep it dry. The smallest amount of moisture in the air and you're leaking all over the place. Even then, the charge isn't going to stay there all day. The alternative is a digital memory or rather a four bit up/down counter. This gives you 16 different levels — enough for domestic light control. With half a dozen resistors we then get a voltage out.

How do we control the triac? Zero crossing isn't possible for an incandescent lamp. Therefore, we have to use phase control. The standard circuit using a PUT with a transistor in the charging circuit was tried. It worked, but it was non-linear and difficult to get a reasonable range on the control voltage into it.

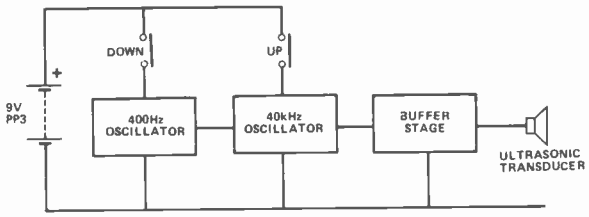


Fig. 1a Block diagram of the transmitter.

Three Into One

To gain phase control of a mains load, a voltage controlled monostable synchronous with the AC mains should do the trick. In its basic form it consists of three cheap transistors and one 741 op amp, together with their resistors, capacitors, etc. — less than £1.

Fig. 1a shows a block diagram of the transmitter and fig. 1b the receiver/control.

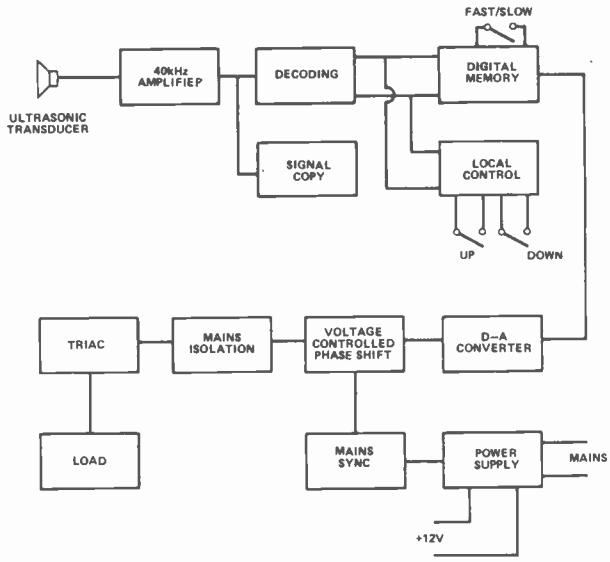


Fig. 1b Block diagram of the receiver/control circuit.

Getting It Together

The prototype was built on Veroboard. With safety in mind components that have mains across them are connected so that live and neutral or any other potential ▶

HOW IT WORKS — THE TRANSMITTER

As can be seen from Fig. 2a the simple transmitter consists of only one IC — a hex inverter 4069. Inverters a and b form a low frequency oscillator which gates the 40 kHz oscillator formed by inverters c and d. Inverters e and f form a buffer driver for the ultrasonic transducer. Because the transducer is driven by an out of phase signal twice the supply voltage appears across it. When SW2 is pressed, supply goes straight to IC1 and D1 is reverse biased so that a and b oscillate and, via D3, gate the 40 kHz. If SW1 is pressed D1 conducts supply to IC1 and D2 holds the input to inverter a high. This means that the output of b is high and D3 is reverse biased. Therefore, it has no effect on the 40 kHz oscillator, so carrier is produced. The alternative circuit for the transmitter uses slightly more space because it contains two 4011 packages (which are cheaper than one 4069) and has the advantage that, with the inverters, D3 is required to gate the oscillator on and off. Unfortunately, when it is reverse biased it still has a slight effect and so the 40 kHz oscillator doesn't quite run at 40 kHz, which means that maximum power is not produced by the transducer. This doesn't happen with the NAND gates. D2 stops the signal from being higher than the supply i.e. OV6.

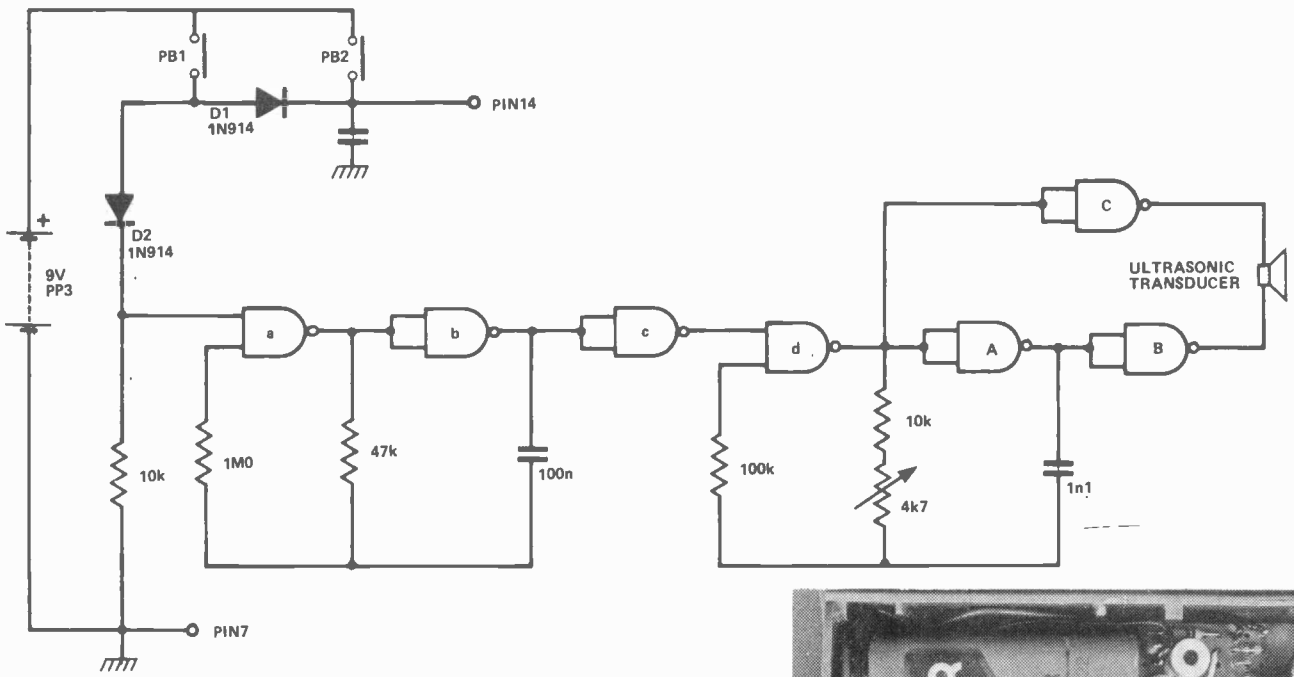
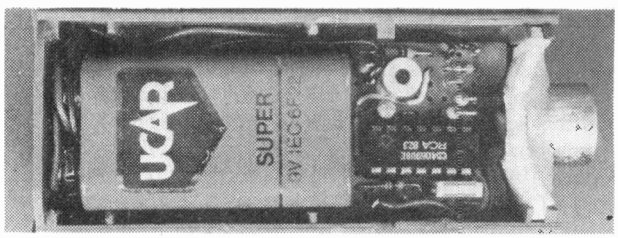
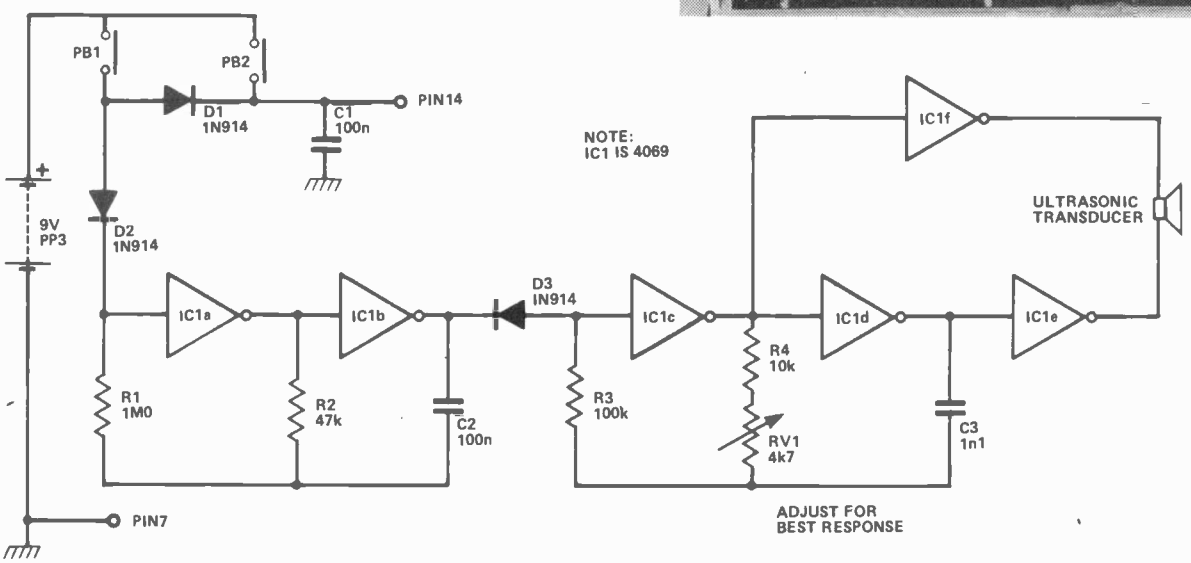


Fig. 2a Circuit diagram of the transmitter.





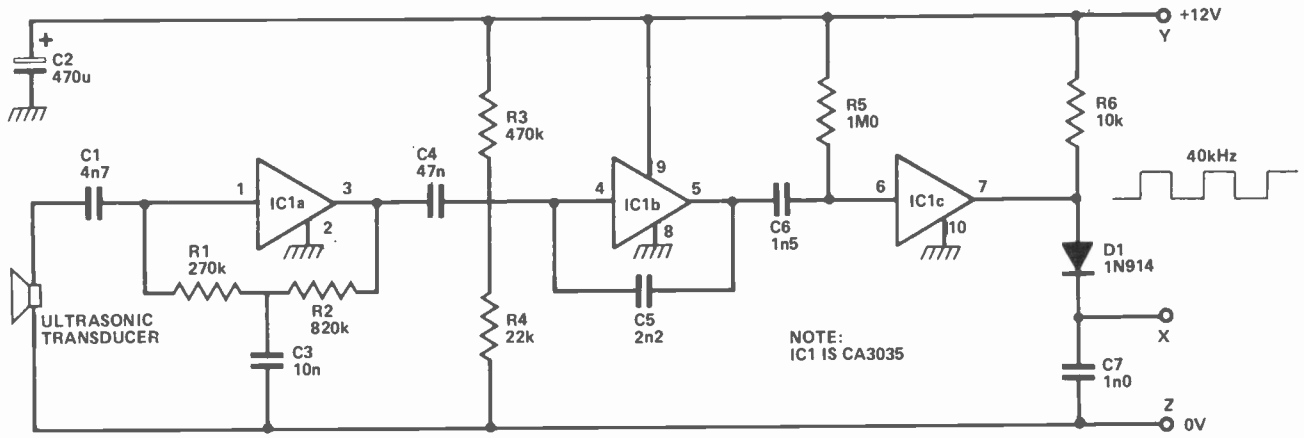
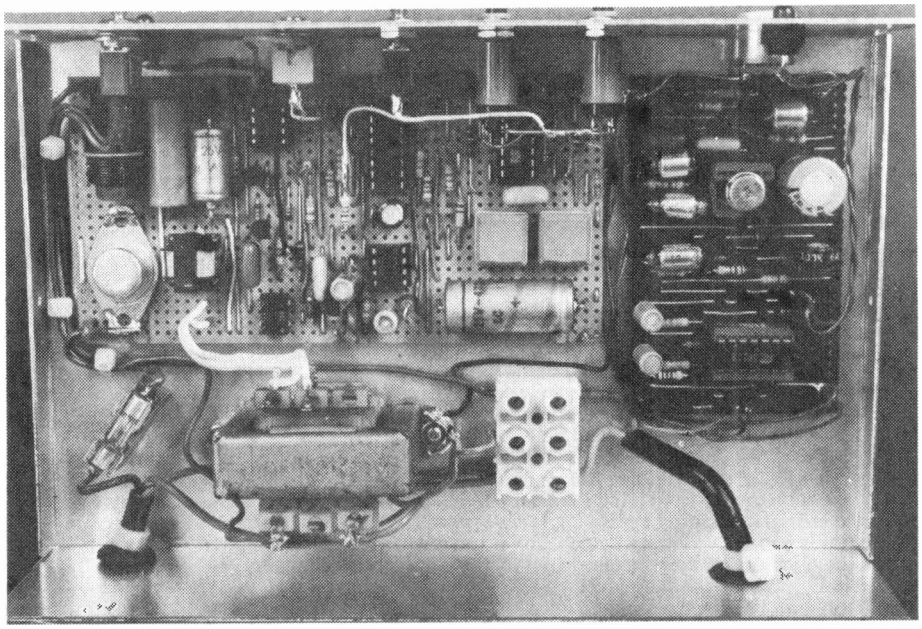


Fig. 3 Circuit diagram of the receiver.

Below: internal view of the prototype



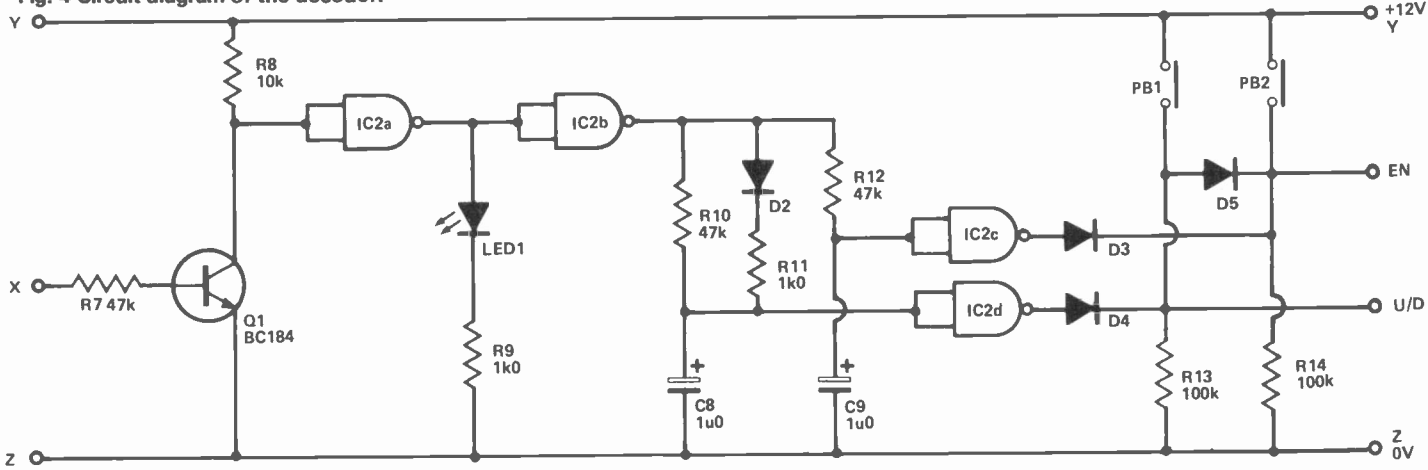
Left: the hand hold transmitter exposed!

HOW IT WORKS — THE RECEIVER AND DECODER

The signal is picked up by the ultrasonic transducer and is AC coupled to the input of the first amplifier in the CA3035 array. R1,2,3,4,5,6, bias the internal stages for maximum gain. C3 decouples low frequency signals and is all the timing that is required, as the transducer itself is only sensitive to signals in a narrow band. C5 prevents oscillation. When a signal is present C7 charges up via D1 with the result that Q1 switches on, providing a little more gain in the system.

Thus, when a signal is received, the output of IC2b which is normally high, either goes low for the duration of the signal, or, if the carrier is intermittent, a square wave appears for the duration. LED1 driven by inverter IC2a, lights to indicate that a signal of sufficient strength is available. C8,9, which are charged up, start to discharge via R10,12. For a continuous signal they both discharge so that the outputs of inverters IC2c, d both go high, D3,4 conduct so that the outputs EN (enable) and U/D (up/down) go high. The same result is achieved by pressing SW1. (D3,4 are required to prevent the outputs of inverters IC2c,d being shorted to supply by SW1,2). If a square wave appears at the output of IC2b then C9 discharges to a point that will make IC2c go high, but, because of D2 and the low value of R11, C8 is continually being charged up faster than it is being discharged, so inverter IC2d remains low and only an enable signal is produced. The U/D line remains low.

Fig. 4 Circuit diagram of the decoder.



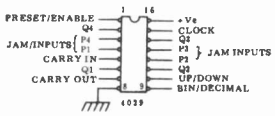


Fig. 5b Top view of the 4029 pin out arrangement.

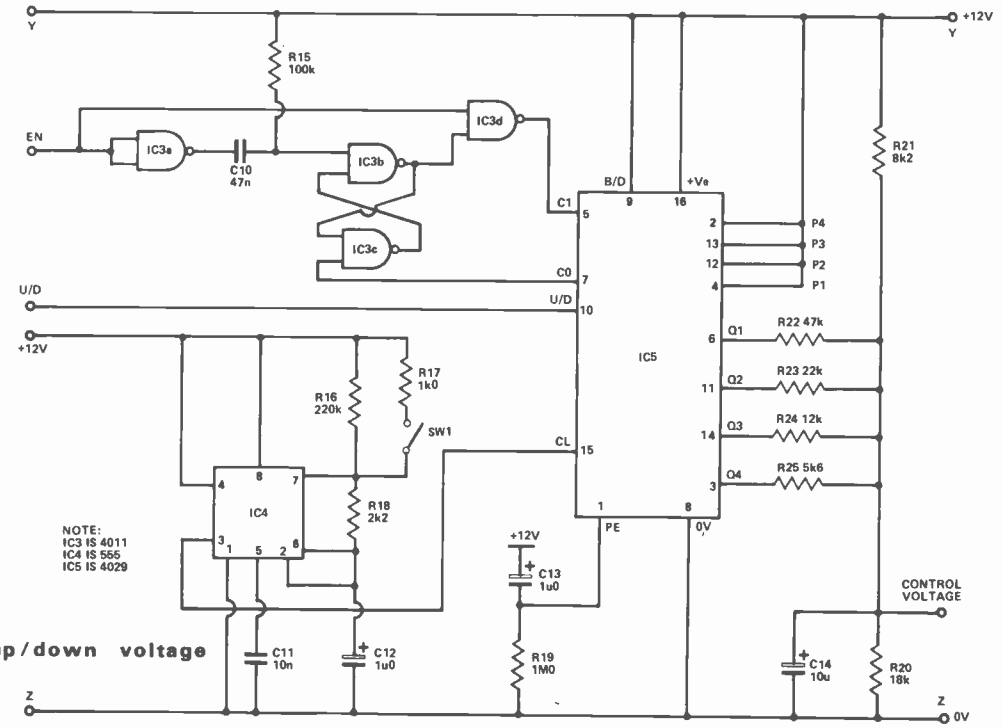


Fig. 5a Circuit diagram of the up/down voltage generator/memory.

HOW IT WORKS

THE UP/DOWN VOLTAGE GENERATOR/MEMORY

From the previous stage we now have three signals i.e.

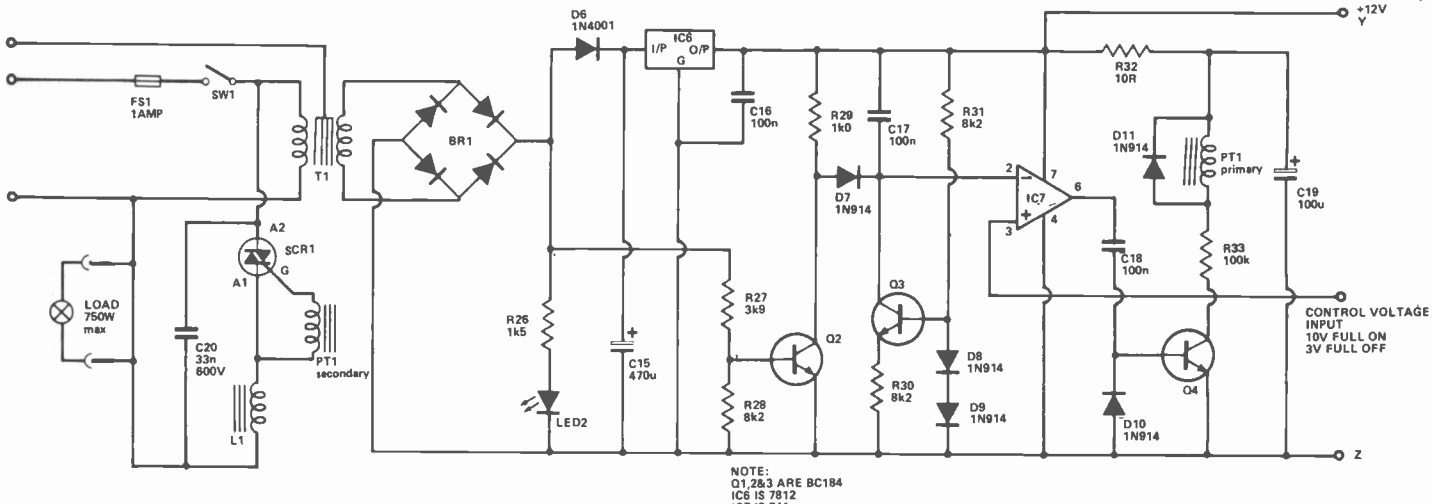
FUNCTION	EN	U/D
Do nothing	0	0
Go down	1	0
Go up	1	1

The up/down line goes straight to the up/down pin of the 4029 four bit counter. However, the enable signal has to be combined with the Carry Out signal from the counter, so that when it gets to either the bottom or top of its count it stops. Otherwise, when the light was at full brightness, it would go off and start going up again.

The basic function is that of a NAND, but because the Carry Out signal is only available when the Carry In (used as an enable) is present, if a single NAND gate were used, the instant the Carry Out signal appeared the Carry In would disappear and, therefore, so would the Carry Out. (Yes, you've guessed it — a strong candidate for oscillation). Therefore, we have to latch the Carry Out and NAND it with the enable signal in IC3d. IC4 is a 555 working as a clock. SW1 gives the choice of a slow or fast ramp of IC5. R16,17 and SW1 could be replaced by a pot of around 250k or more, but 220k is a good compromise for speed.

C13 and R19 form a power on preset that sets the outputs Q1-4 to the state set on inputs P1-4 i.e. all high, so that the light always comes on full brightness, but if you want it to come on at half brightness take P1,2,3 to ground instead.

The outputs from the counter are resistively summed by R22-25 to produce a staircase ramp, which is smoothed by C14. Because the 4029 will sink and source equal currents, the summing point can be taken to a potential divider R20,21 to taylor the range of the output voltage to suit the requirements of the next stage without losing linearity.



NOTE:
Q1,2&3 ARE BC184
IC6 IS 7812
IC7 IS 741
BR1 IS 1A 100V
T1 IS 12V 100mA
L1 40 turns 26swg 1"x¼"
PT1 10 TURNS
primary/secondary

Fig. 6 Circuit diagram of the voltage controlled dimmer.

HOW IT WORKS
VOLTAGE CONTROLLED DIMMER

The power supply is slightly different from the standard circuit in that D6 is introduced to isolate C10 and all the other supply smoothing. This means that the output of the bridge, if loaded, will vall to 0 V every 10 mS (100 Hz) i.e. at every zero crossing of the mains. This switches Q2 off. When this happens R18 discharges C12 via D7 to the positive rail. This takes about 500 uS. When Q2 switches on again its collector goes down to saturation level and D7 is reverse biased. Q3, R19, 20 and D8,9 form a "reasonably" constant current sink of about 0.1 mA so that, at the inverting input to the 741, there is a negative ramp waveform syncronous with the mains. If we now put a DC voltage on the non-inverting input, the output of the 741 will be a square wave, the mark space of which will depend on the DC voltage as it is varied from 10 V to 3 V.

The rising and falling edge of this square wave is coupled to Q4 so that a fast pulse appears in the primary of pulse transformer PT1. R32 limits the current of this pulse. For a higher output current the triac will require a harder gate drive so this resistor can be adjusted. D10 protects Q4 from reverse base-emitter breakdown and D11 protects it from the inductive back emf frmo the pulse transformer. R21 and C14 decouple the rest of the supply from the high current spikes. The 7812 regulator could be replaced by a 12 V zener and a resistor as not much current is drawn by the whole circuit.

The secondary of the pulse transformer is mounted across the gate and A1 terminals of the triac. C15 and L1 help to reduce the RF interference produced by the triac switching. C2,10 provide the smoothing after D6. Rather than using one 1000 u capacitor it is sometimes better to use more, small values where they'll do the most good.

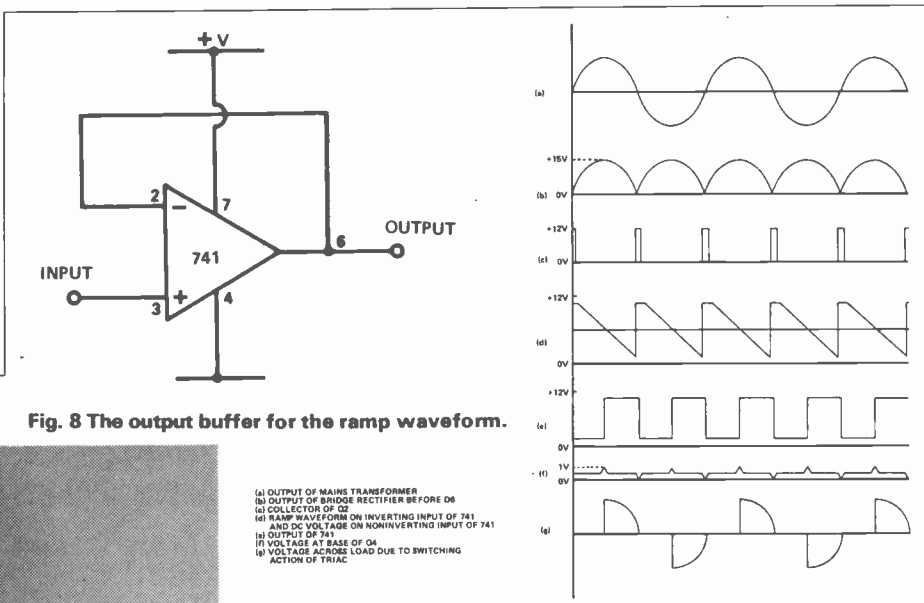


Fig. 8 The output buffer for the ramp waveform.

(a) OUTPUT OF MAINS TRANSFORMER
(b) OUTPUT OF BRIDGE RECTIFIER BEFORE D6
(c) COLLECTOR OF Q2
(d) RAMP WAVEFORM ON INVERTING INPUT OF 741 AND DC VOLTAGE ON NONINVERTING INPUT OF 741
(e) OUTPUT OF 741
(f) VOLTAGE AT BASE OF Q4
(g) VOLTAGE ACROSS LOAD DUE TO SWITCHING ACTION OF TRIAC

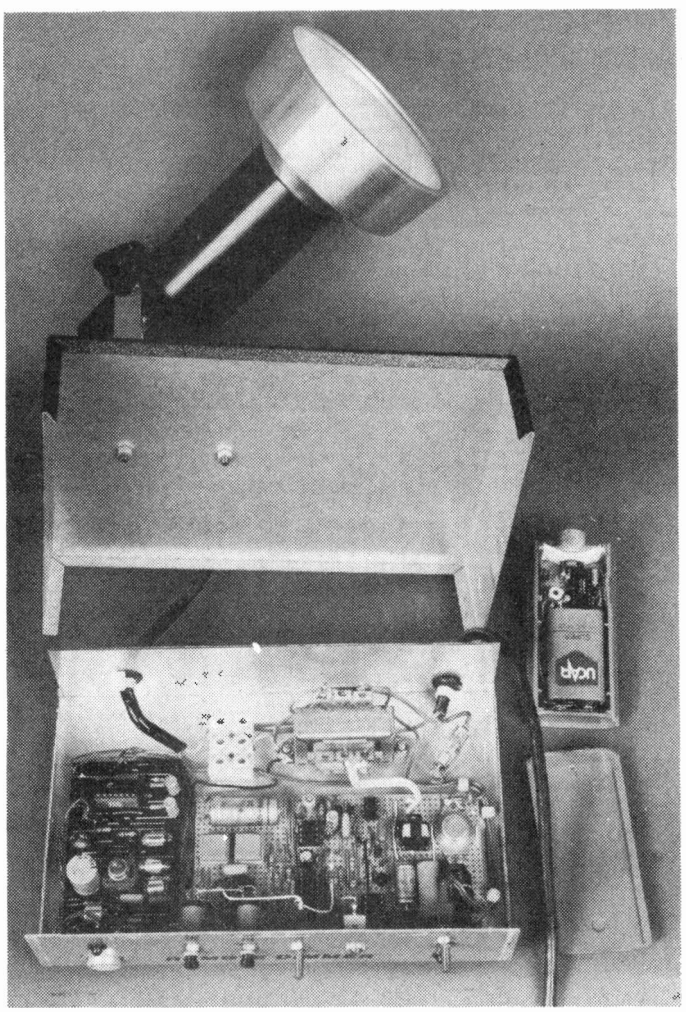


Fig. 7. Waveforms associated with the voltage controlled dimmer.

do not lie adjacent to each other and the tracks in between should be removed. The pulse transformer which divides the low and high tension is the only component which is mounted so as to bridge the gaps in the track. Care should be taken in the layout of the 40 kHz amplifier around the CA3035 as this has a high gain and can oscillate if the output is brought near the input.

Killing The Bugs

The only problem likely to be encountered with the receiver is oscillation. This shows itself as a continuous output and is most likely to be caused by bad layout. Keep the output away from the input i.e. cut any vero tracks that are not used. Adjustment of R10,12 in the decoder will ensure that the threshold level of the CMOS is crossed. A meter can be used to follow the action of this block. In the up/down voltage generator/memory, the differentiator into the latch formed by IC3b/c ensures that the input stays low longer than any glitch that might appear from Carry Out, so C10 can be made larger if trouble is encountered here. If the lamp will not dim from very nearly off to on then the tolerance C12 could be the snag. Adjusting R19, will help. Also, a meter on the function of R20,21 will show if the 4029 counter is going up and down properly. ▶

readers designs

PARTS LIST

RECEIVER/DIMMER UNIT

RESISTORS all ¼W 5%

R1	270k
R2	820k
R3	470k
R4, 23	22k
R5, 19	1M
R6, 8, 32	10k
R7, 10, 12, 22	47k
R9, 11, 17, 29	1k
R13, 14, 15, 33	100k
R16	220k
R18	2k2
R20	18k
R21, 28, 30, 31	8k2
R24	12k
R25	5k6
R26	1k5
R27	3k9

CAPACITORS

C1	4n7 polyester
C2	470u16V electrolytic
C3, 11	10n polyester
C4, 10	47n polyester
C5	2n2 polyester
C6	1n5 polyester
C7	1n
C8, 9, 12, 13	1u16V electrolytic
C14	10u 16V electrolytic
C15	470u 25V electrolytic
C16, 17, 18	100n polyester
C19	33n 600V

SEMICONDUCTORS

LED 1, 2	TL102, etc
D1-5	1N914
D6	1N4001
D7-11	1N914
Q1-4	BC184
IC1	CA3035
IC2, 3	4011
IC4	555
IC5	4029
IC6	7812 Reg. 100mA
IC7	741
SCR1	6A 400V
BR1	1A 100V

MISCELLANEOUS

L1	40 turns 26 swg on a 1in x ¼in ferrite core

Pulse Transformer primary and secondary 10 turns 26 swg on a 1in x ¼in ferrite core

T1	12V 100mA sec

2 Ultrasonic Transducers, switches, etc

PARTS LIST

TRANSMITTER

RESISTORS all ¼W 5%

R1	1M
R2	47k
R3	100k
R4	10k

POTENTIOMETER

RV1	4k7

CAPACITORS

C1, 2	100n
C3	1n1

SEMICONDUCTORS

IC1	4069
D1, 2, 3	1N914

MISCELLANEOUS

SW1, 2	Single pole, push to make

Ultrasonic Transducer
Case, Ever-Ready Trimlight 6060

ELECTRONIC WARFARE

ELECTRONIC WARFARE had its beginnings in the Second World War, with the development of radar, electronic navigation aids and early means of disrupting the enemy.

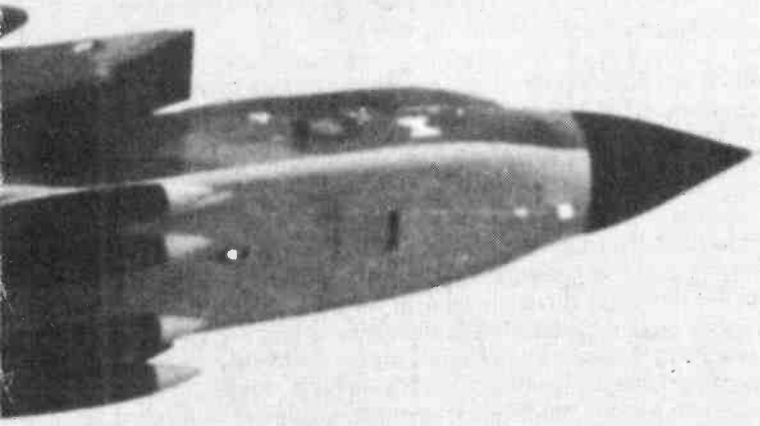
However, after the war, interest waned as Chiefs of Staff were more interested in hard weapons such as aircraft and tanks rather than somewhat 'ethereal' electronic weapons. In fact the importance of radar was not forgotten, and radar development continued apace, but the capability to deceive or deny the use of that radar was, in the West at least, given low priority.

This mode of thinking has been radically altered in the last 15 years and development of the military aspects of electronics is rapidly increasing, taking up a larger and larger proportion of military budgets each year.

The reason for this sudden surge in interest stems from experience; in peace time electronic aids and counter measures may seem a luxury, in any military action they have been shown to prove their worth. Three areas of conflict produced developments which finally shocked the West's military planners into action. The first was the U.S. experience in Vietnam, particularly with the B-52 raids on North Vietnam known as the 'Linebacker' raids. In the second series of raids, highly trained and experienced defensive forces fired over 800 surface-to-air missiles at 714 strike sorties, yet only 15 planes were lost, indicating that the electronic counter measures (ECM) were highly successful.

The next indication of the importance of an electronic capability was the Soviet invasion of Czechoslovakia, when NATO early warning devices were totally blinded by Soviet ECM. Czechoslovakia was already occupied by the time the West knew of the invasion.

The largest growth area in electronics is military hardware. Modern warfare is increasingly becoming a battle of software rather than armour. Any future combat force will have to include elements with ECM capability, as David Chivers explains . . .



The MRCA Tornado. As a low level strike aircraft it excels and is usually equipped with an external ECM pod in this role. Here the wings are swept back and the plane is carrying a full load of weaponry and stores.

ECM For Desert?

The Middle East War of 1973 provided more evidence. Before this it had been assumed that when it came to electronics the USSR would always be one step behind, but in fact the Arabs were armed with weapons to which Israel had no immediate answer: Surface-to-Air missiles and anti-aircraft guns guided by radar.

The type of radar employed 'Continuous Wave' or CW radar. This is a radar which instead of sending a series of pulses to be reflected from the target, illuminates constantly with a transmitted signal. The protection equipment carried by Israeli — and indeed all Western aircraft — was orientated to a Pulse-radar threat and was incapable of detecting — let alone jamming — the CW radar.

However, despite an initial high loss rate, Israeli losses fell rapidly with the introduction of new tactics and extensive use of ECM both in aircraft and 'dedicated' ECM helicopters.

EW is concerned with measures taken by either side to give them a combat effectiveness over their enemy by competitive use of the electromagnetic spectrum. There are three categories: Electronic Counter Measures (ECM); Electronic Warfare Support Measures (ESM); and Electronic Counter Counter Measures (ECCM); and we shall consider each in turn.

A Word About Air

To defend its airspace, a country must use radar first to detect an intruder and secondly to determine its position and course, guiding either an aircraft or missile to intercept. In either case at long range the only way to home in on an intruder is by radar. At close range low light television (LLTV) or heat seeking equipment (infra-red) guidance is used.

This 'radar threat' to an attacking aircraft is very real and tactics have naturally been devised to escape detection.

Due to the inability of land based radar to cover low altitudes at anything other than very short range, the accepted way for strike aircraft to penetrate enemy air space is by flying in at very low altitude. In this way an aircraft can fly undetected below the radar horizon, and this is the standard strike tactic of the Royal Air Force, and one at which the Tornado excels.

However, the introduction of airborne radars in AWACS (Airborne Warning And Control Systems) aircraft challenges aircraft to intrude unnoticed, since their 'lookdown' capability enables them to spot low flying aircraft and direct an attack on the intruder concerned. With the opportunity to make an undetected attack strongly diminished, it is increasingly important to be able to counter the enemy's radar.

Once a missile has been fired at an intruder, it must evade an enemy which is faster and at best only *slightly* less agile than itself; if the missile is heat-seeking or LLTV guided, then flares and manoeuvres may be effective.

Electronic Counter Measures

These seek to deny the enemy the use of the electromagnetic spectrum. This may take the form of 'jamming' enemy radar or communications by selective use of radiated energy, or by deceiving the radar operator — or computer — into believing that a number of targets are present when in fact only one exists, or that the target is in a different position.

ECM may be divided into two techniques: denial, where the enemy's electronic equipment is made ineffective by jamming communications or radar — and deception as described above. Both denial and deception may be either 'active' or 'passive'; that is, involve the use of radiated energy — or not. The simplest and most common form of active denial is that of noise-jamming.

Various techniques are used, but white noise, if transmitted at a high enough power, into the enemy's receiver will usually be effective in rendering it inoperative. If the jammer's noise energy is concentrated on a small bandwidth covering only the input frequency range of the enemy receiver then it is known as a 'spot jammer' while a jammer radiating noise over a much broader part of the frequency spectrum is a 'barrage jammer'. The former has the advantage of design simplicity, and greater effectiveness, while the latter can counter a number of receivers operating on different frequencies at the same time.

Active deception of radar can be accomplished by repeater jamming, i.e. creating a false echo of the radar signal by re-transmitting a noise signal at a set time after a receiver picks up an enemy radar pulse. An additional refinement is to use either a pre-recorded replica of the incoming signal or a transponded pulse to confuse the radar operator into believing that one or more false targets exist.

Tracking radar can be forced to 'lose track' by electronic means, and this is done by shifting the image of the target from its true position, so that the system follows the image.

In radars which have two modes — scan and track, once the tracking system has lost the target, the repeater may be silenced leaving the radar to return to its scan mode against which other jamming forms may now be used. However, new radars now employ 'track while scan' mode which is slightly more resistant to this kind of deception. Even so modern ECM equipment may deceive the radar in terms of range, altitude, position or speed and as such provides a very useful means of increasing the survivability of an aircraft in a hostile radar environment.

Passive resistance

Passive ECM is concerned with chaff, decoys and the radar 'cross section' of a potential target.

Chaff was the earliest countermeasure against radar and is still effective today, it consists of thin strips of aluminium foil, released in a cloud which is highly reflective to radar. Spot chaff dropped as an individual bundle may appear as another aircraft on a radar screen or its larger reflected signal may steal a tracking radar from the faster moving true target. Corridor chaff, released in a long cloud is a confusion measure which enables a series of aircraft to fly undetected behind a 'smoke screen.'

Chaff has proved particularly useful as a defence against radar-homing surface-to-air missiles, which, with their small radar window can be totally blinded at close range.

Plane to see

The cross section of a plane as it appears to radar may be reduced by careful design and the avoidance of sharp corners for example will help to keep the radar reflectivity low, as will the use of 'doubly' curved surfaces.

Flat, cylindrical, or conical surfaces not possessing double curvature are highly reflective if caught at right-angles to the incident wave. The US mothballed super-bomber the B1 is a good example of careful design, and despite its large size, it exhibits a far smaller radar cross section than many much smaller aircraft with the consequent result of increased survivability.

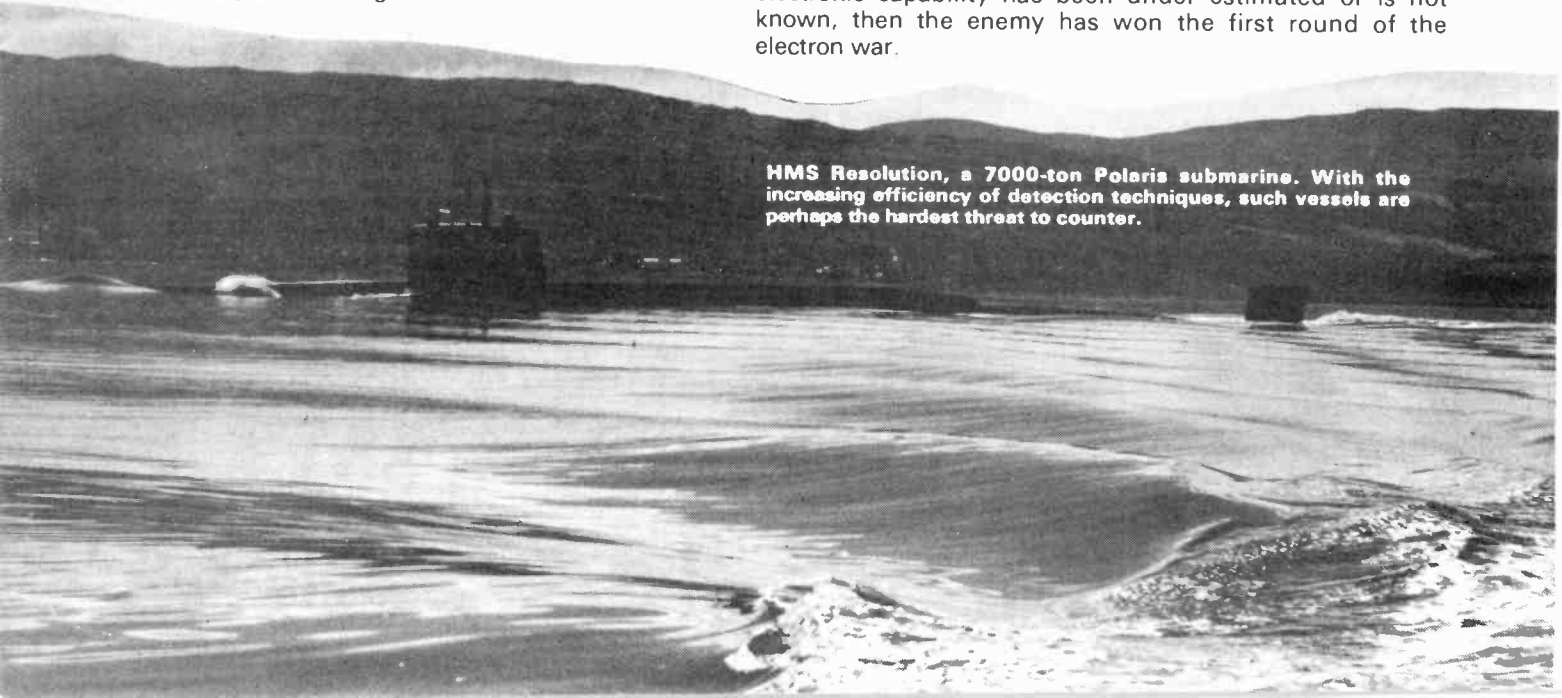
Radar absorbent materials may be used to reduce the reflectivity of the target, again reducing the ability of radar to detect the target, particularly at long range.

A decoy is a small aircraft-like device which can, by means of electronic and structural design, appear as a real aircraft to a radar set. Thus a number of attack aircraft, each carrying perhaps two decoys, could by tripling the number of targets present saturate the enemy defences. To add to the illusion of a full scale aircraft, the decoy may even carry a small jammer, to duplicate as accurately as possible the image of its mother aircraft.

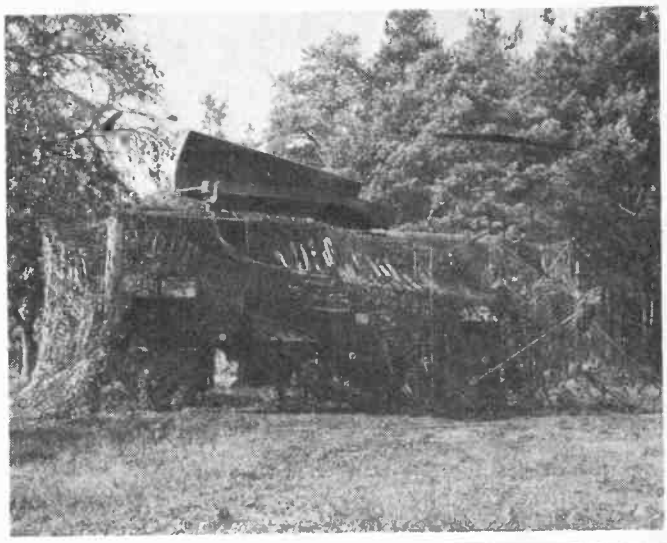
Support Measures

Warfare support concerns the collection of data from the reception of enemy radar, communications or counter measures. This data is then processed and may be used either immediately to warn of the nature of an impending threat or as ELINT (Electronically gathered INTelligence) from which a picture of enemy operations in the electromagnetic spectrum may be built up and equipment or tactics altered accordingly.

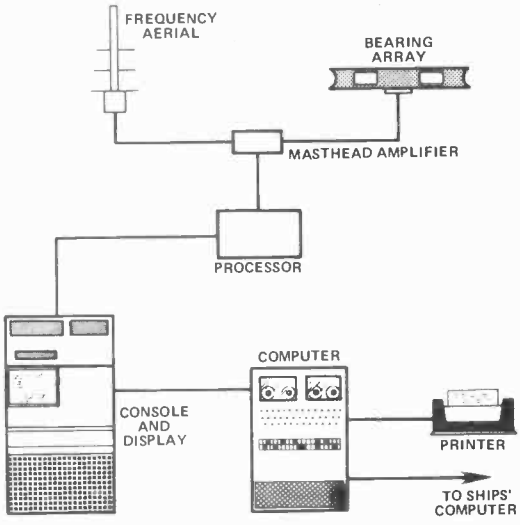
Whereas electronic warfare is for the most part actively deployed during time of war, ESM is at its height during peacetime. Indeed once hostilities have broken out, if enemy electronic capability has been under estimated or is not known, then the enemy has won the first round of the electron war.



HMS Resolution, a 7000-ton Polaris submarine. With the increasing efficiency of detection techniques, such vessels are perhaps the hardest threat to counter.



Above left: the ZB298 is a mobile ground surveillance radar for the detection and location of moving targets.
Above right: one of the early warning radars of the 16th Light Air Defence Regiment. Such units alert interceptor forces to tackle intruding strike aircraft.
Below left: representation of modular ESM equipment (shipboard). Such a system can be reduced according to vessel size down to simply console and bearing array.
Below right: EMI Searchwater. Probably the best airborne surveillance radar there is. Used from Nimrod aircraft it can identify ships and submarines by their radar profiles.



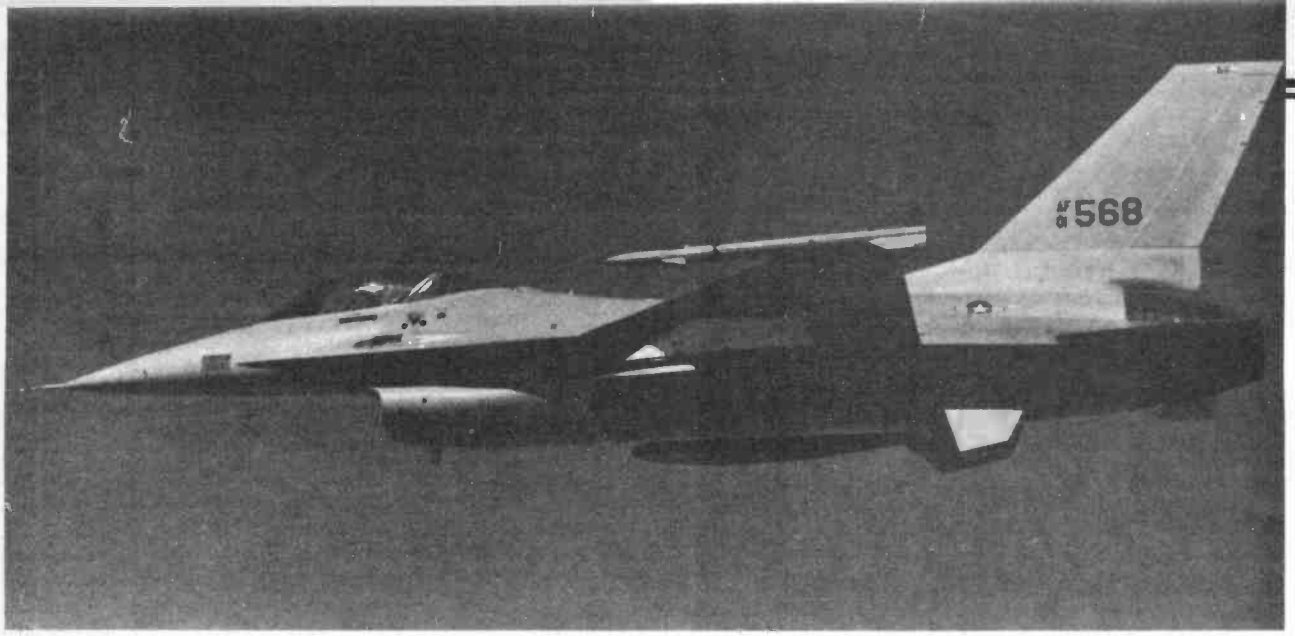
Both the Warsaw Pact and NATO indulge in ESM during detente especially during the other side's manoeuvers and exercises trying to gain information on the effectiveness of each other's EW capability. Soviet Spy trawlers have caught the news as they shadow NATO fleets, and Soviet Bear aircraft, studded with ELINT gathering devices, are regularly turned away from UK airspace as they probe the capabilities of the West's air defence. No doubt NATO aircraft are involved in similar activities in the opposite direction.

Staged System

The first stage of an ESM system is the receiver and processing stage and on its own this makes a useful instrument. This is known as a Radar Warning Receiver (RWR) and is a cheap but effective preliminary protection against radar threat. (Similar warning devices are available for other threats; including sonar warning on submarines, and new Laser warning receivers for protection against guided weapons).

For helicopters and smaller aircraft where space is at a premium and additional weight results in lower performance, simple devices may be used such as the US army's new series of RWRs. These weigh only 3.5kg yet indicate on a CRT the bearing and nature of any radar, while identifying any partricular threats associated with known anti-aircraft weapons systems.

Decca manufacture a similar unit which is hand held.



Identification of a radar is of particular importance especially in an environment where both sides are actively involved in EW and where there is such a diversity of radar types and threats. Friendly radar cannot be treated in the same way as hostile radar and must therefore be positively identified. Shipborne ESM systems are far more useful in this respect and can employ sizeable computers to aid identification and response. Such a system is made by Decca, whose Cutlass ESM system can hold a library of up to 2,000 radar signatures. The device can give radar type, frequency and bearing as well as all the relevant information available on that radar. MEL have a similar modular system — Susie — which can be tailored to suit the type of vessel it is to be employed upon from small Patrol Boats up to large Cruisers.

Such systems can be used in conjunction with jamming equipment to provide a very potent ECM capability. All the operator has to do is to decide whether or not to jam a particular threat radar. If he decides 'yes' the computer will decide on the most appropriate counter measures to take and then apply them.

Above, the F-16 fighter. The craft uses a computer stabilisation system to provide a stable weapons platform without the pilot having to worry about it. As a ground strike craft an external ECM pod can be fitted, as can 'chaff' missiles to help shield the craft from interrogating radar.

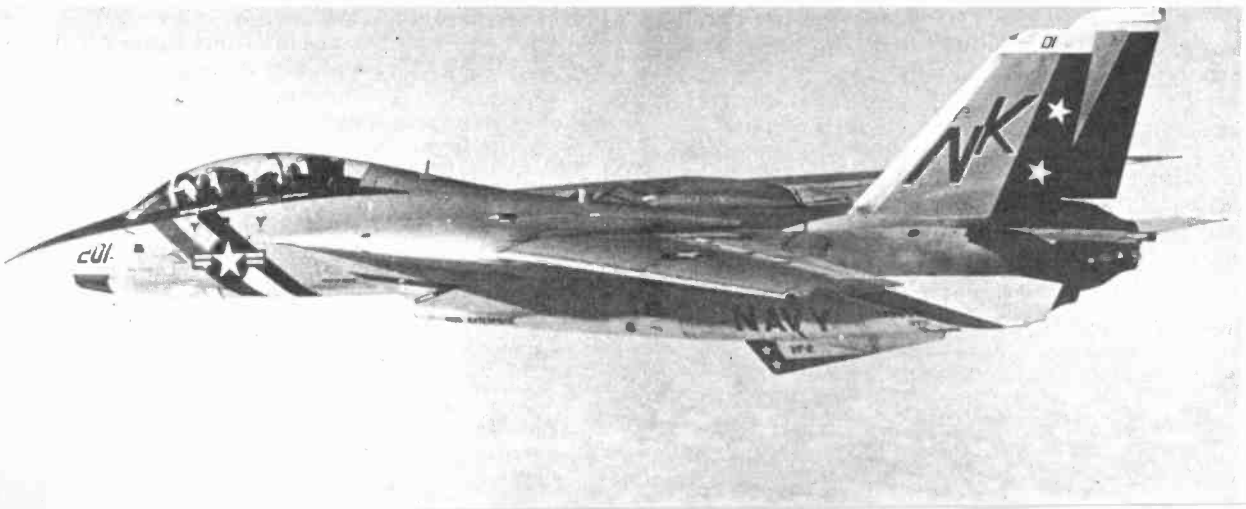
Opposite, a Polaris missile fired from HMS Resolution. The range of Polaris is about 2,500 nautical miles, and being fired from an undersea platform it makes them difficult to stop. Satellite mounted weapons will undoubtedly be a front line defence for both powers against ICBMs within a few years.

Information Received

In any case ESM carried out by a Radar Warning System is only secondary; the most important ESM being the incorporation of the 'potential threat' into the computer library, or in a RWR. This depends on good intelligence, anticipation of possible developments and the speed with which the system can be altered to meet any new threat.

Thus the effectiveness of any counter measure or counter counter measure depends on the accuracy of information received, the speed with which it is processed and the flexibility of the response. Current RWR trends are the use of broadband receivers — often with a crystal video front end — and detection circuits enabling a computer or microprocessor-based comparison with known parameters to be made. Also important is the incorporatrion of a simple

Below, the F-14 combat aircraft. It has a fire control system which can attack six targets simultaneously at 200km range, while tracking 18 others, deciding for itself which pose the greatest threats and facing them in that order! In addition the wings are automatically swept back to the optimum position by MPU control.



display, which enables the user to assess any threat at a glance essential to the pilot or helicopter crew in a combat situation where a few seconds may be the difference between survival or destruction. Hence the use of automatic response systems, which may for example dispense chaff as soon as a threat is identified.

Naturally the task of the RWR designer is made more difficult the more diverse the types and frequencies or radar employed. However, if designated for a particular use, the number of threats it is likely to encounter may be reduced. An air superiority fighter such as the USAF Eagle need only provide light ECM and ESM defence against ground based threats — its adversaries will be airborne weapons systems of which there are fewer types. The RAF's Tornado on the other hand is required to penetrate deep into enemy air space where the threat will be from both ground and air, hence its much more complex ECM and ESM equipment. The difficulty of designing equipment to face a varied assortment of threats must surely be seen as a very effective argument against too much standardisation of military electronics.

Counter Counter Measures

This will be more difficult from an aircraft or missile in which case the radar set as well as a target will be moving in relation to both the target and the chaff, where the chaff is very likely to have the higher relative speed.

To counter repeater tactics employed by the enemy as ECM, the waveforms of the transmitted pulses may become more complex, with subsequent recognition circuitry in the radar receiver. In addition, as a counter to various types of jamming and other ECM, radar should possess a good frequency range and if possible frequency agility — the ability to change frequencies from one pulse to the next.

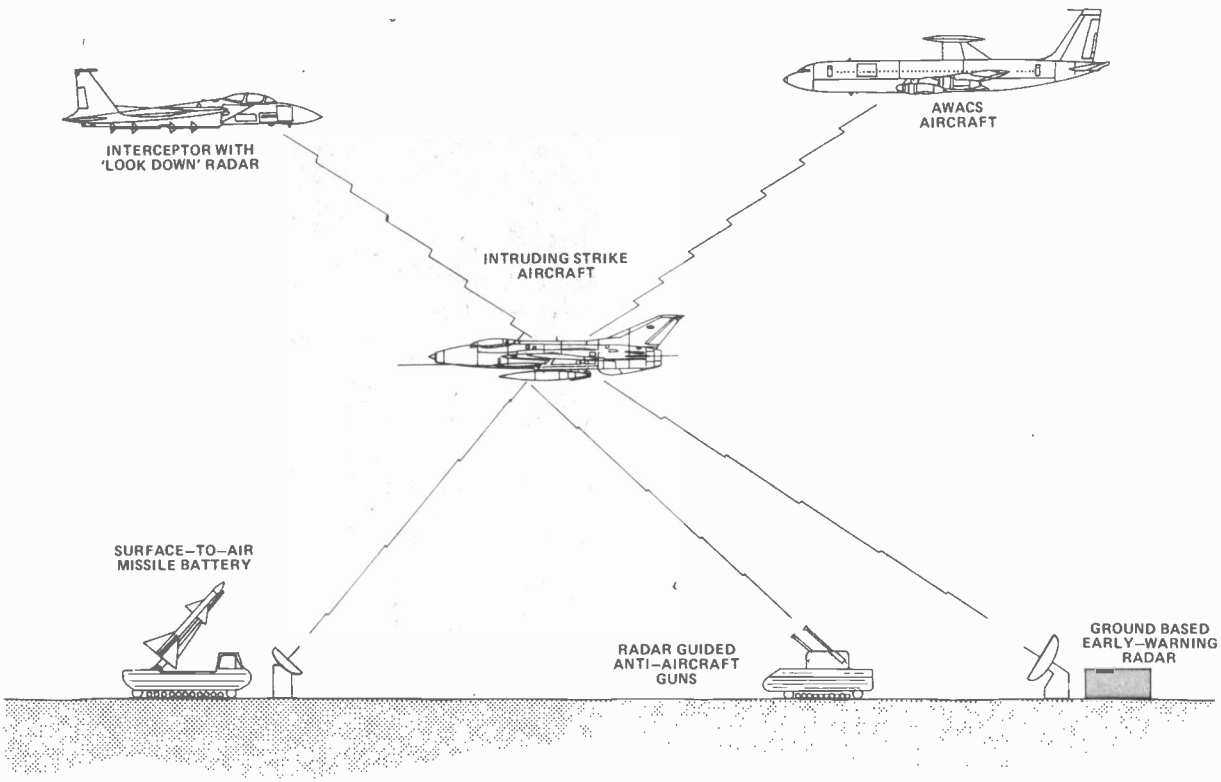
A useful ECCM is that of a Constant False Alarm Receiver (CFAR). This works by setting the receiver to 'expect' a certain number of false alarms, or rather spurious signals above a level which trips the receiver's processing circuitry and causes the radar to treat it as a target, giving a false signal on the radar screen. Assuming that such signals are caused by random noise in the atmosphere and receiver circuitry, then false alarms may be expected to occur in a poisson distribution from which a mean rate can be calculated and the receiver set accordingly. Noise jamming will therefore appear as noise above the expected rate, and the receiver will reduce its gain accordingly, though if the jamming is effective and persistent this may amount to shutting down the receiver.

Nevertheless CFAR technique is a valuable counter to noise jamming and is even more effective when used in conjunction with other ECCM.

Radiate Confidence

It should not discourage the aspiring ECCM designer to realise that all radiating electronics can be jammed. While the enemy might find this possible, there are two restrictions on his ECM activity, in particular on active ECM. The first is the cost of any jamming measures and especially the cost of providing comprehensive protection in a confined space and at limited weight. The second is the fact that the enemy needs to use the electromagnetic spectrum as well, and must ensure that at least his sections of the frequency spectrum are as clear as possible for his own use.

To ensure that one's own transmissions are not likely to be adversely affected by friendly jamming activity, Electro-Magnetic Compatability (EMC) is necessary. This may be



Above, intruding strike aircraft have to face a multitude of threats. Low flying is the usual way of avoiding being spotted. However 'look-down' capability is now fitted to most interceptors, and the AWACS system protects NATO airspace to some extent.

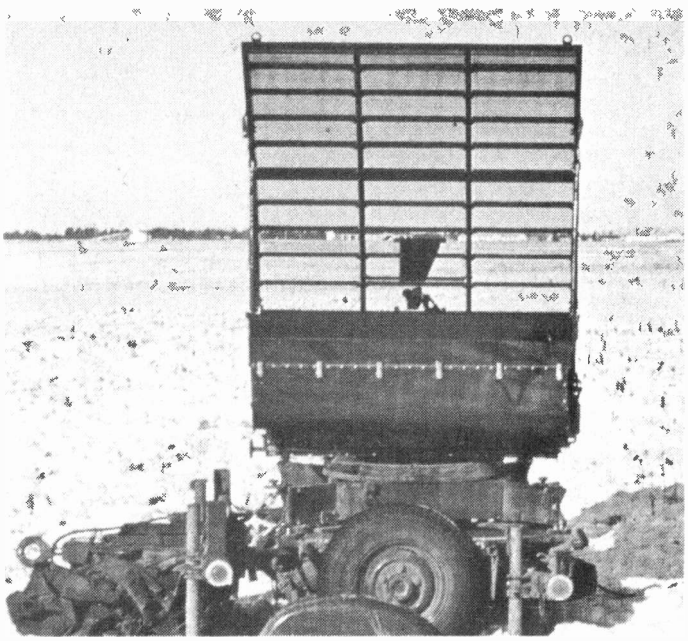
particularly difficult in a large defence force such as NATO where most member countries have their own electronics industries and where a subsequent diversity of standards and techniques are found in electronic equipment of all kinds. Thus compatability of equipment is a very important ECCM, though the versatility achieved through diversification is an obvious and useful ECCM in itself and should not be forgotten in the current race for standardisation.

Train Thoughts

An additional advantage of the increasing use of electronics in warfare is that is is increasingly simple and much cheaper to train personnel and simulate 'live' action. For example the British Army's 'Striker' anti-tank vehicle comes complete with a computer based simulation system as standard, for training soldiers in the use of its missiles. Since each anti-tank missile costs upwards of £5,000 it is extremely expensive to use live rounds for practice firings. However because the control systems for the missile firing are contained in digital logic, it is a simple matter to provide a simulation facility in which the operator experiences exactly the same situation as under real action.

In conjunction with laser gun sights and computer references, this makes the expensive business of 'war gaming' cheap yet more reliastic since combatants can actually 'fire' at each other much as in a TV 'tank battle' game. The use of simulators is also of great importance in training pilots, and though a simulator may cost more than a real aircraft, the fact that it requires no fuel, no expensive maintenance and cannot be grounded due to poor weather makes such equipment very worthwhile.

Below, EMI's Cymbaline mortar location system. It uses radar beams to reference a projectiles flightpath to a map to give accurate prediction of launch and impact points.



Summary

Whatever happens in the future, one thing is certain — without EW capability any armed force engaging in combat will be at a severe disability when faced by an EW equipped enemy. Its communications will be blinded, its radar jammed its planes downed and its hardware detected and neutralised. Not a comforting picture.

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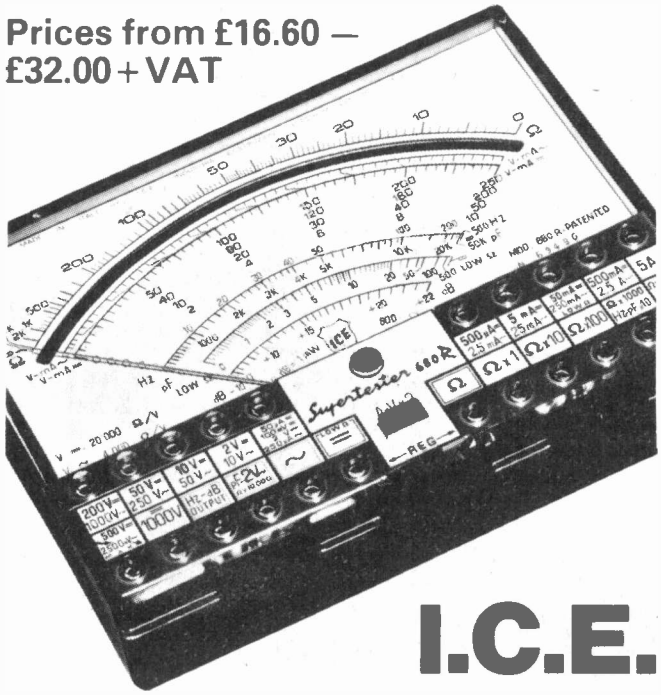

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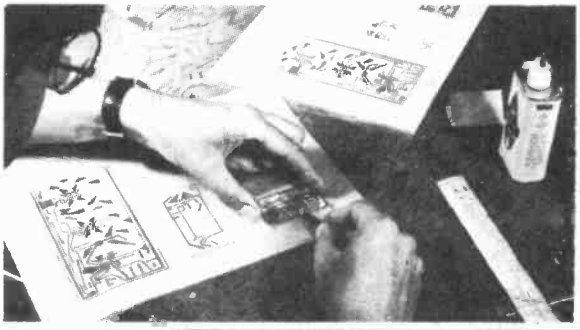

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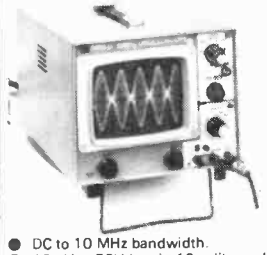
HORIZONTAL AXIS(X). Deflection Sensitivity — 0.400mV/division. Bandwidth (between 3 dB points — 1Hz-350KHz. Gain Control — Continuous when time bases in EXT position. Input Impedance — 1 Meg. Input Voltage — Max — 500V P.P.
TIME BASE. Sweep Range (calibrated) — 100msec/div to 1μ sec/div in 5 steps. FINE Control — Variable between steps — includes time-base calibration position. Blanking — Internal — on all ranges.
SYNCHRONISATION. Selection — Internal external. Synchronisation Level — Continues from positive to negative.
POWER SUPPLY. Input voltage — 115/200V AC± 10% at 50/60Hz Power Dissipation — 18W.
CRT DATA — 4in. — flat face, single beam. — Maximum high voltage — 1.5kV. — Fitted with Bx10 division blue filter graticule.
PHYSICAL DATA Dimensions — 15cm(h)x20.5cm(w)x28cm(d) Weight — 4.3Kg(approx.) Stand — 2 position flat and inclined Case — Steel, epoxy enamelled. Front panel — Aluminium enamelled epoxy printing.
(As recommended by ETI)
Cash with order £99 (+ £7.92 VAT + £1.50 Carriage
Test leads available £2.00
Barclay and Access

10MHz Scope with 5 x Magnifier for £147.95. (+£11.84 VAT + £2 carriage)



5" CRT

SAE for further details

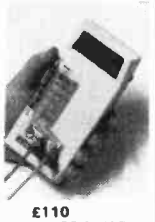
- DC to 10 MHz bandwidth.
- 10mV to 50V/cm in 12 calibrated steps.
- 0.5 μS to 0.1 Sec/cm sweep range in 6 calibrated steps plus 12.1 Vernier.
- Magnifier x5.
- Fully automatic trigger.
- DC to 1.5 MHz horizontal bandwidth.
- Fastest sweep 10ns/cm with Magnifier.

Sensitivity: <1 cm deflection 10 Hz to > 15MHz L.F. trigger extends below 5 Hz with 2 cm deflection. Trigger circuit locks to the mean value of the displayed waveform. It will lock to almost any waveshape including sine, square, triangle, pulse and TV video signals. When no signal is present to repetition rate is below 5Hz the trace free runs producing a bright base line. Company orders welcome by phone and Telex.

6MHz OSCILLOSCOPE 3106B

Similar in appearance to 10MHz scope. SAE for details.

FLUKE 8020A HANDYMETER



- Large, easy to read 3½ digit LCD display.
- 26 measurement ranges for AC/DC volts, amps, ohms and conductance.
- 0.25% VDC accuracy over one year.
- High power and low power capability.
- Measure to 10,000 MΩ using two conductance ranges.
- Fully protected to 250V on all ranges.
- Protected against transients up to 6KV for 10 μsecs.

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Inc. PP & VAT

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FEATURES include: Resolution to 0.1Hz and sensitivity to 10mV. 8-digit LED displaying frequency range of 20Hz to 200MHz. Xtal time base accurate to 0.3 ppm/°C and 10ppm/year and all this in a package weighing just 6oz. and 6.2" x 1.25". Adaptor **£3.20.** Padded case **£3.20.**

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Chess Challenger 7 **poa.**
Boris Microprocessor Chess Game **POA.**
PDM35 @ **£29.84.** UK Microvision @ **£90.26.**
DM350 @ **£96.76,** DM450 @ **£68.08.**

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TRITON 8K EPROM CARD

The Triton one board home computer has proved to be a very popular design. In this article Mike Hughes, the designer of Triton, describes how you can make an 8K EPROM card, the latest addition to the Triton hardware.

SINCE THE ORIGINAL launch of Triton in the November issue of ETI, many people have constructed the computer and are well under way with extensions to the system. We thought that, before we begin to describe the latest addition to the Triton hardware, this would be a good time to look back and review the current state of the project and try to put into perspective what has gone before and how planned expansion possiblities fit into the overall view of the Triton system.

The original article on Triton carried a brief outline of the basic design criteria. These were:

1 A single board design,
2 Easy to construct,
3 Programmable in machine code and BASIC,
4 Graphics and alphanumeric characters,
5 Cassette tape interface,
6 Full 56 key keyboard,
7 BASIC in EPROM,
8 Full power supply,
9 The whole kit to cost less than £300 and be housed in a suitable case for ease of transportation,
10 An interface to domestic TV set or video monitor.

Expansion

The original article carried detailed circuit and firmware descriptions, but at the time of publication only touched briefly on Triton's expansion possibilities.

The expansion of the basic machine falls into two distinct categories. The first is hardware extensions, such as memory expansion, etc. The second is firmware expansion such as extended monitors and extended BASICS.

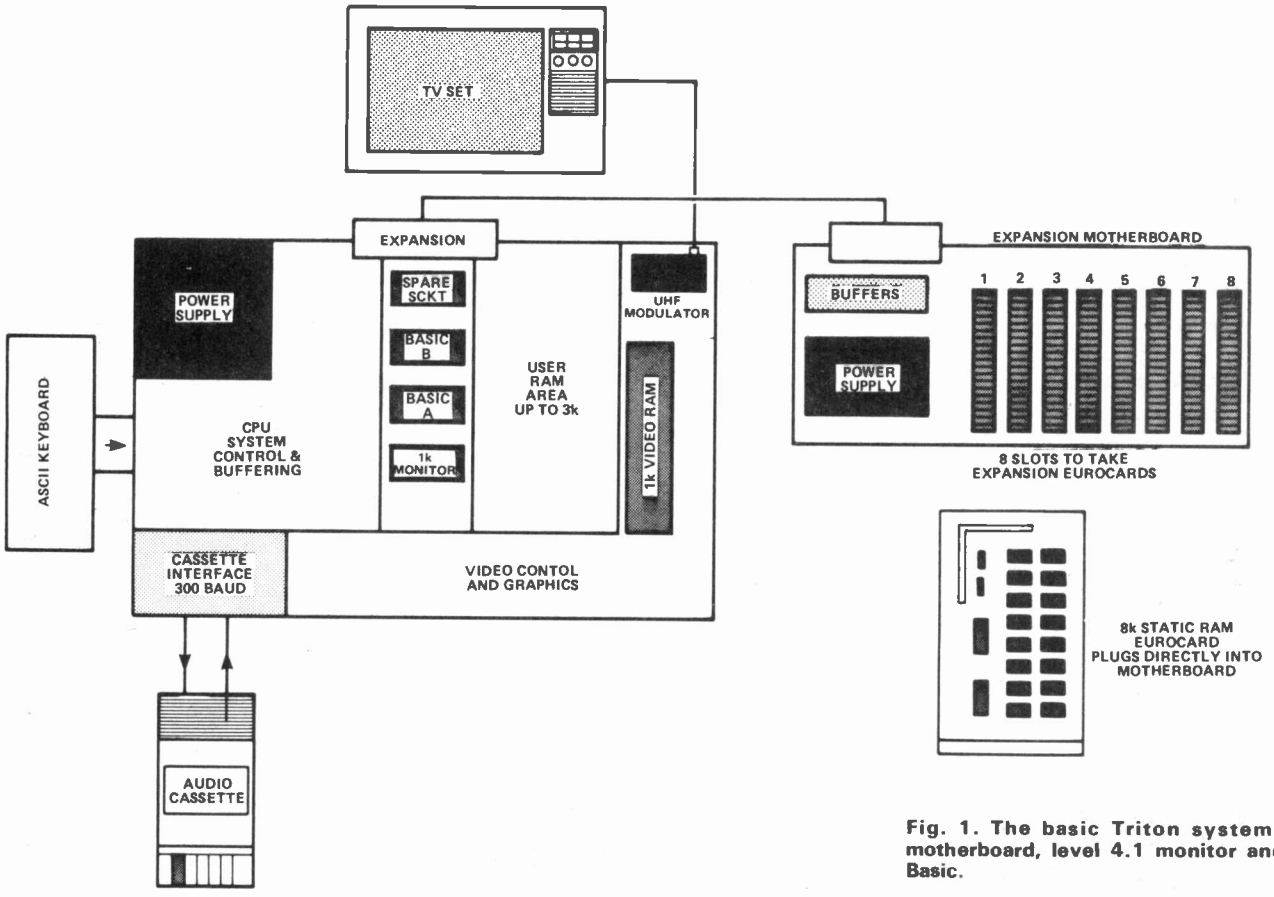


Fig. 1. The basic Triton system with motherboard, level 4.1 monitor and tiny Basic.

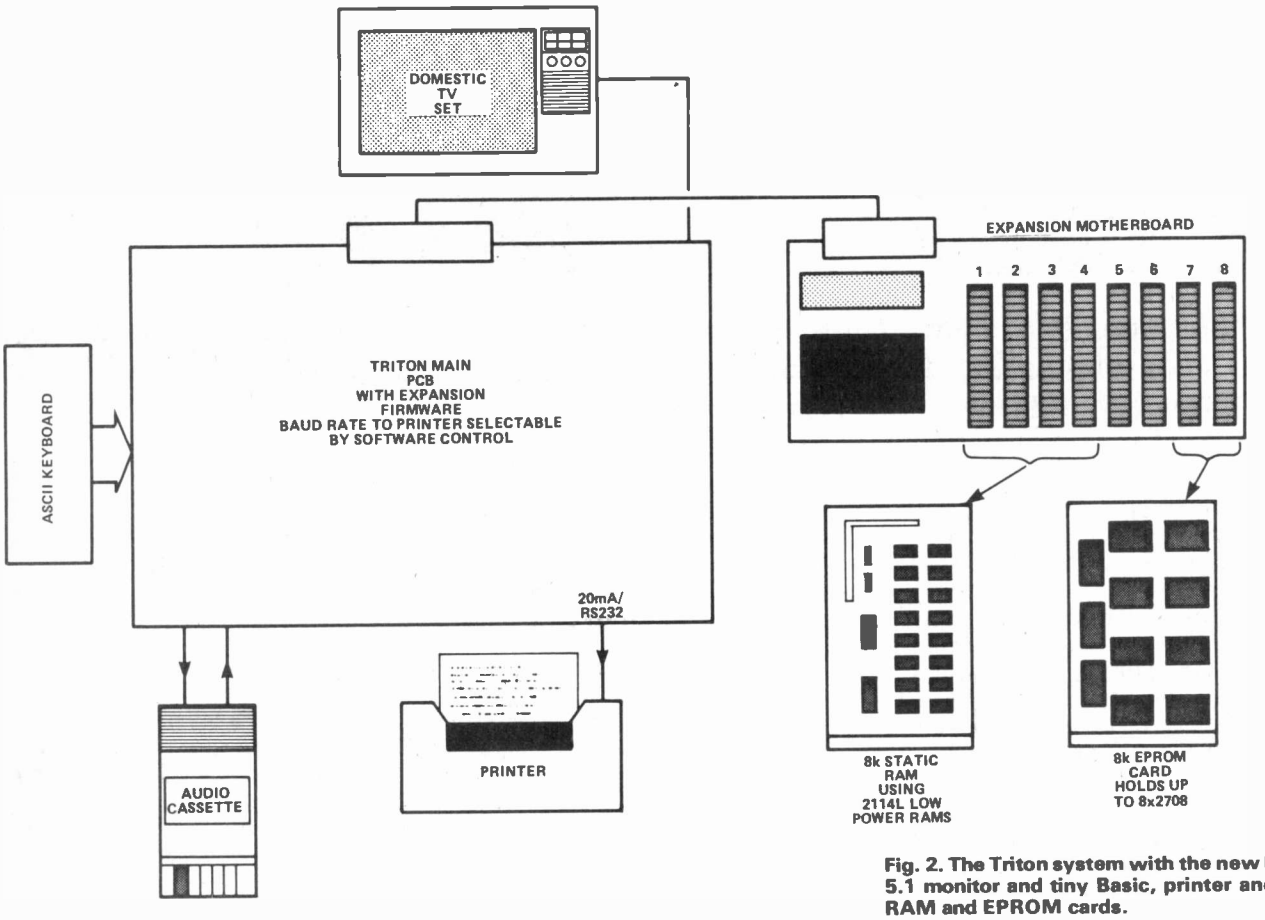


Fig. 2. The Triton system with the new level 5.1 monitor and tiny Basic, printer and 8K RAM and EPROM cards.

The Triton PCB, as originally designed, holds up to 8K of on board memory, up to 4K of EPROM and 4K of static RAM. 1K of RAM is, however, reserved for the VDU RAM and is not available for user programs.

Fig. 2 shows the Triton system overview, with the new 5.1 monitor and tiny BASIC, printer and 8K RAM and EPROM cards. Any firmware resident in EPROM can now be called by BASIC directly.

The top 8K of memory (56-64K), is reserved by Transam for their 8K Basic, so if you intend to take the system that far, use the 8K block below this for your own resident EPROM firmware.

Not Only, But Also

Most people will want more than just RAM and ROM for their system and as we have more sockets available on the motherboard we will be publishing other useful designs as they become available. We already have a number cruncher card in the pipeline which is a useful interface to the National Semiconductors MM57109 chip, one of their COPS series of calculator oriented microprocessors.

You will see from Fig. 1 that:

(a) No printer interface was originally provided.

(b) The monitor and tiny Basic only take up 3 out of the 4K EPROM. We could, therefore, put this spare EPROM socket to good use by developing a new resident firmware package to occupy the whole of the 4K memory space available on the original Triton board.

Transam Components Ltd, suppliers of Triton, have, in fact, developed this extension to the resident firmware and we shall be describing its advantages in a future article, but, briefly, it gives increased monitor functions over and above those present on the standard machine, including a 20 mA or RS232 printer interface, Hex dumps, register dumps, break points, ASCII string input and display, improved tape file search and an Extended Tiny BASIC.

Extra Commands

The BASIC has now been extended to include extra commands like READ, WRITE, PEEK, POKE, CALL and EDIT. Machine code subroutines can now be called from BASIC and data can be read in or written out to any port in real time. There is also a very useful extension to the BASIC look up table, out into RAM, so that the user can write his own extensions to BASIC. The new Level 5.1 monitor and BASIC will give the user that extra flexibility over the earlier version, but this will form the basis of a future article.

In order to expand resident firmware any further, it is necessary to have more ROM or EPROM space available. This is now possible using the new 8K EPROM card described in this issue. Designed to hold eight 2708 EPROMS, the card plugs directly into the Triton motherboard and, like the RAM card, its position in memory is selectable by means of a DIL switch or jumper lead. This means that a program can be run in RAM and then burnt into EPROM by selecting both boards to sit at the same address in memory, testing the program in RAM before you burn in your EPROMS and then replacing the RAM card by the EPROM card . . . . all very simple.

The long term plans for the 8K extra EPROM cards

include a full BASIC and also an assembler, which we understand Transam are working on as their next addition to the system.

RAMifications

Expansion of RAM soon became an important consideration as more and more people wanted to write larger and more complex programs. The Triton main PCB has an expansion connector and, as some of you will be aware, via this 64 way connector it is now possible to connect to the Triton motherboard. This board is a means to an end, and opens up a whole new area for Triton.

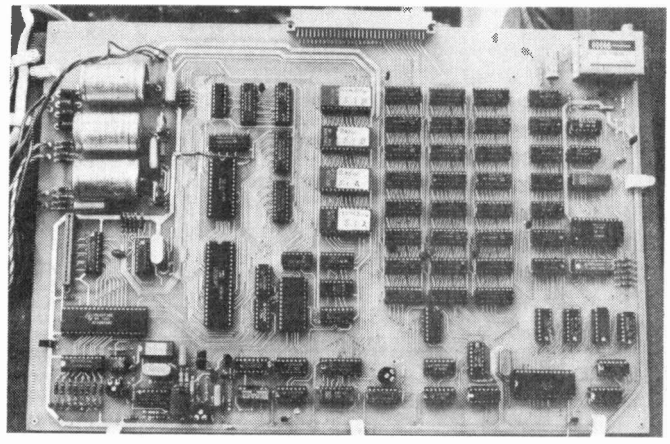
The design of the motherboard was published in our sister magazine "Computing Today" along with the first of the main expansion boards, the 8K RAM board. It is now possible to extend the user RAM area of Triton by simply plugging as much RAM as required into the motherboard, which is fully buffered for up to 64K.

However, the motherboard is not only designed to take RAM, it is capable of being used in many ways to interface between the main computer and any peripheral capable of being connected to a micro.

Fig. 1 shows an overview of the basic Triton with motherboard and level 4.1 monitor and tiny Basic. This is the original 1K monitor and 2K tiny BASIC resident in 3K of EPROM as described in the original article in November.

Floppy Facility

For those of you with mass storage in mind, work is just commencing on Floppy Disc Controller Card for Triton. This will enable those who so wish to add one of the most useful peripherals a home computer could have.

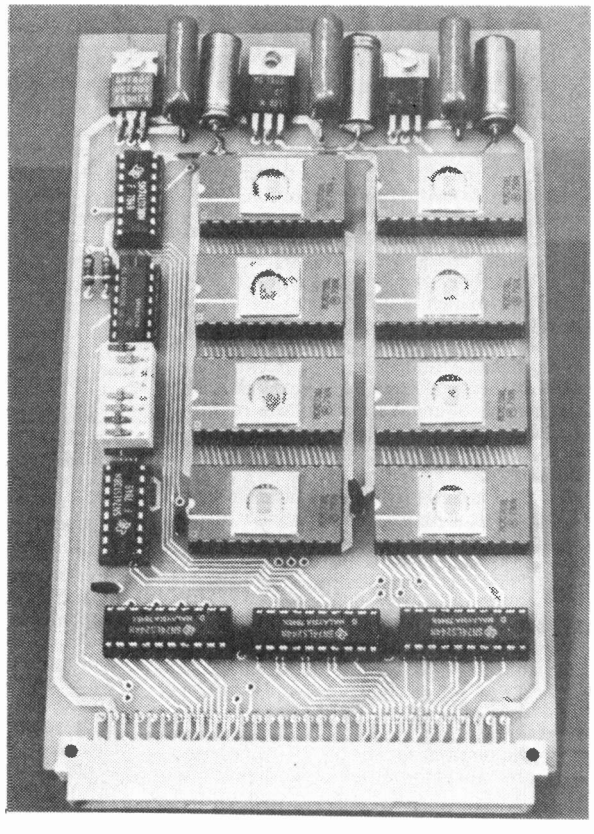


Above: the complete Triton PCB

The design is already underway to interface a Shugart SA400 mini disk drive unit to Triton using the 1771 floppy disk controller chip. The system will eventually be configured for CP/M, the standard Disk Operating System, which, if all goes well, will be available in the not too distant future. The use of CP/M will enable users to run CP/M compatible software on Triton and, hence, will greatly enhance the potential of the computer in applications which require a reliable means of mass data storage and transfer. The CP/M user group library of software is extensive and, as well as programs, other programing languages are also available on disk.

We will bring you more news of these and other developments for Triton as they become available, but first things first, the 8K EPROM card, as described in this issue, makes an interesting addition to the system. ▶

Below: the 8K extension card



8K EPROM CARD CONSTRUCTION

A prime design criterion for the whole of our TRITON project has been ease of construction. This EPROM extender card is no exception and needs very few words to help you on your way.

It is wise to start by soldering in all the integrated circuit sockets — ONE AT A TIME — checking all soldered connections as you go. Start, as usual, with the larger sockets and work downwards in size; this will prevent you putting a small socket in where it should have been a large one!

When soldering hold the iron in place slightly longer than for a single sided PCB. This will allow the solder to flow through the hole reinforcing the plating through. Do not, however, overdo this and certainly do not hold the iron in place for more than 3 seconds. Apply the minimum amount of solder that will make a clean wet joint. Remember to insert a sixteen pin DIL socket where the board select jumper is located. Go on to solder in the 64 pin Eurosocket which should be inserted from the component side of the board. Its fixing holes might need opening up with a suitable drill and then it should be firmly bolted to the board.

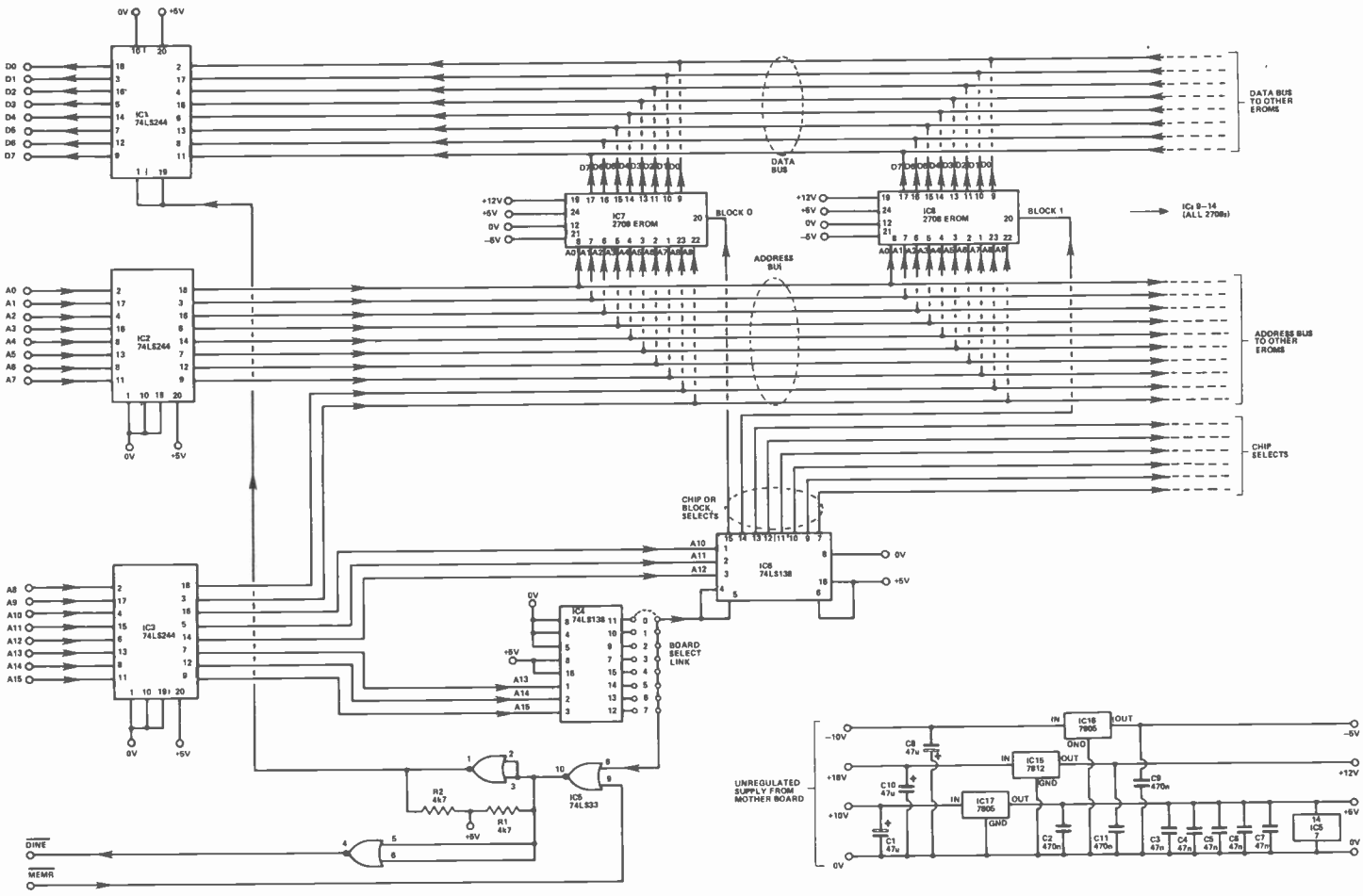


Fig. 3. Circuit diagram of the Triton 8K EPROM extension card.

HOW IT WORKS

The object of this board is to provide facility for the Triton to carry a much larger degree of resident firmware than is catered for on the main board. This extension card will provide space for a full 8K of ultra-violet erasable read only memory (using 2708 chips) which could be used to carry a much larger BASIC Interpreter or, maybe, an Assembler.

The board's position within the 64K memory map of Triton can be selected with a board select link to be any 8K region. Memory organisation on the board is in 1K blocks — each block contained in a single 2708 EROM.

It circuit is designed to interface directly with the Triton motherboard busbar from which it draws power to provide the three regulated voltage rails (+12V, +5V and —5V). The board also generates the correct DINE signal to control the enabling of the motherboard data bus buffer.

If you have already made the 8K RAM extension card you will notice a close similarity in this circuit. ICs 2 and 3 buffer the address bus on to the board and the address lines used exactly match the data sheet designations for the 2708 — there are, therefore, no ambiguities in address line nomenclature. IC1 is a similar 8 bit buffer which carries data coming from the EROMs and applies this to the motherboard busbar when it is enabled. As this card contains *only* ROM this latter buffer need only be unidirectional. Its output is enabled when the board select decoder recognises that its address is being interogated by the computer.

IC4 decodes the 8 memory regions of the 64K memory map and provides eight options for the board's starting address. These are user selectable by means of a jumper lead. When this board select signal is gated with MEMR it carries out three functions: (a) enables the output of the data bus buffer, (b) provides the DINE signal and (C) enables IC6 which decodes which block of 1K is being selected on the board.

Although the board will carry eight 2708 chips it is not necessary to have a full complement on board to start with. Care should be taken to ensure that the right EROM is plugged into its correct designation block number otherwise major computer brainstorms will ensue! IC7 corresponds to block "O" which is the lowest order address position on the board; IC8 is the next higher and so on.

Although you can position this board within any 8K region in Triton's memory architecture you must avoid region "O" which is completely spoken for by the main board. You must, also, make sure that you do not use a region that is already allocated to one or more RAM cards. We would suggest that any large scale firmware should occupy the top end of memory to prevent it interfering with the continuity of the RAM but this is for the individual user to choose.

BUYLINES

A complete kit of parts for this project is being offered by Transam Components Ltd of Church Road. See their advertisement on page 106 of this issue for details of prices etc.
Transam also market the whole Triton computer as a kit.

PARTS LIST

RESISTORS (all ¼W 5%)
R1, 2 4k7

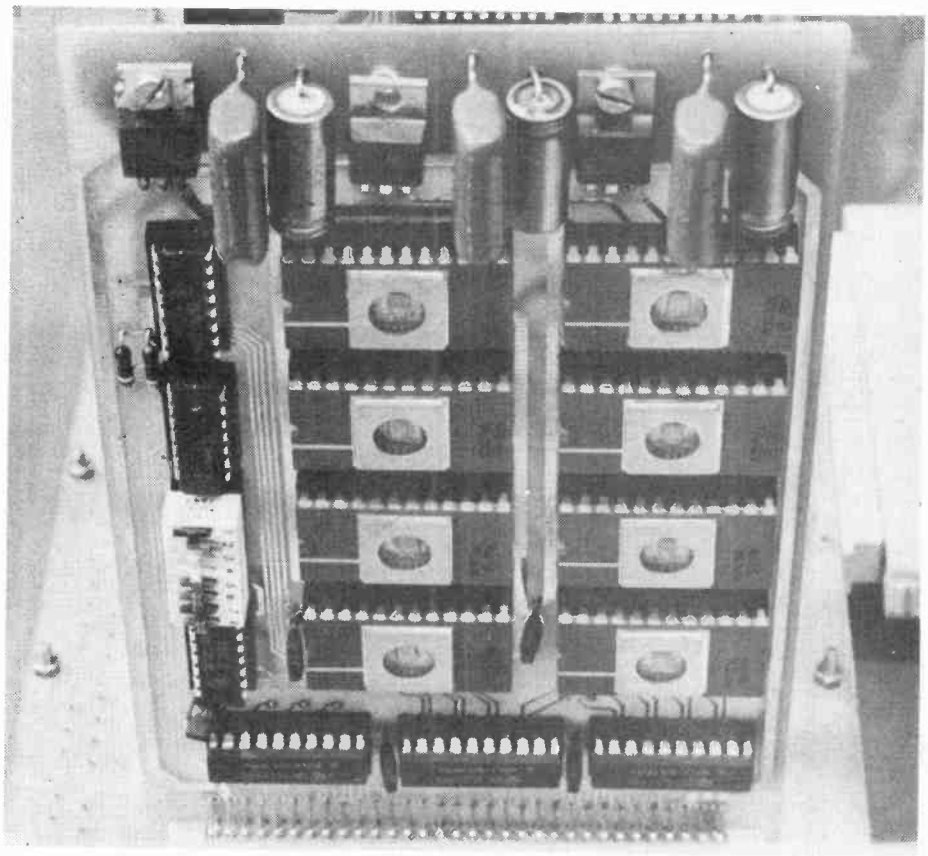
CAPACITORS
C1, 8, 10 47u 25V electrolytic
C2, 9, 11 470n polyester
C3-7 47n ceramic

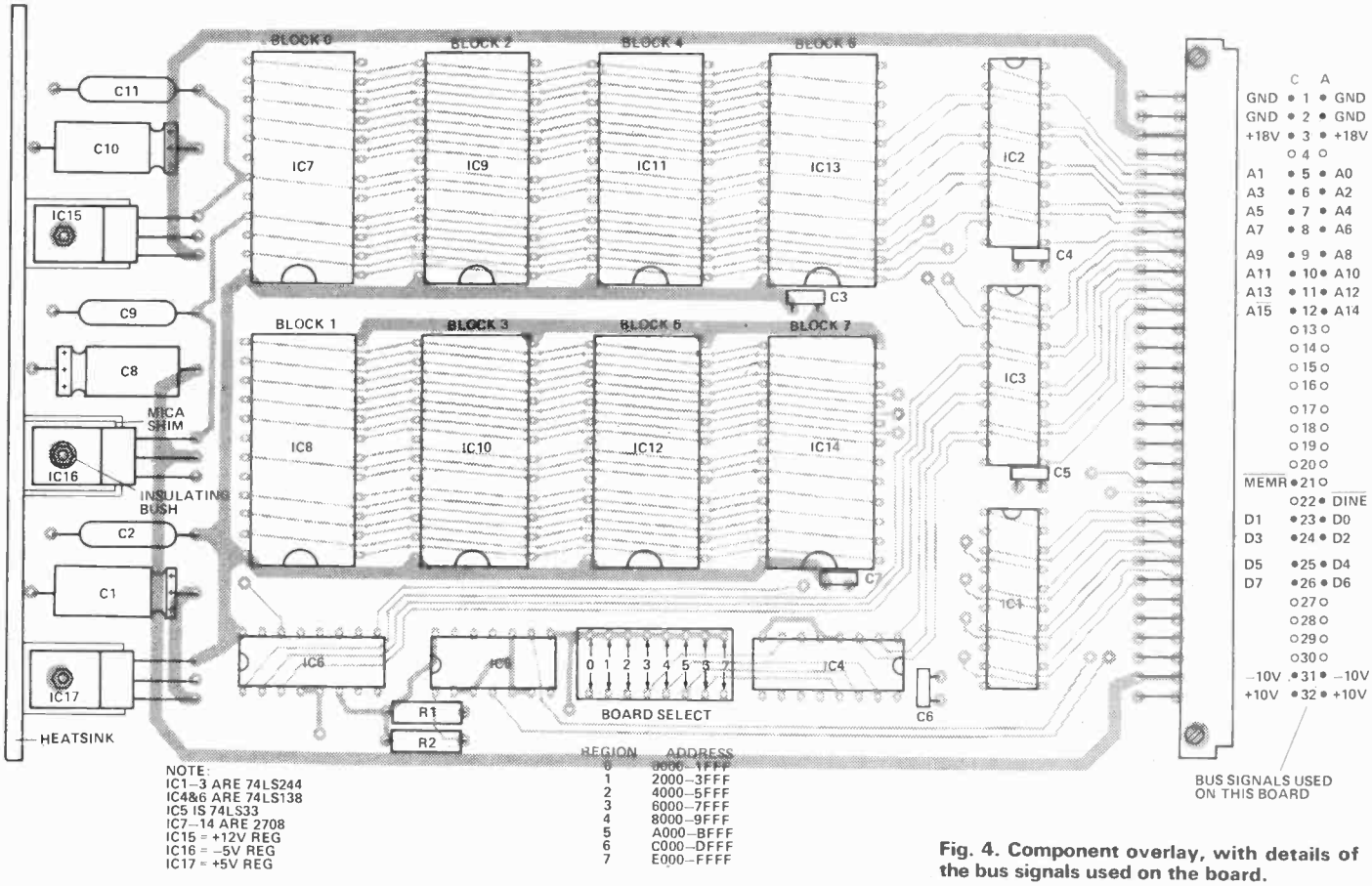
SEMICONDUCTORS
IC1, 2, 3 74LS244
IC4, 6 74LS138
IC5 74LS33

IC7-14 2708 EROMs suitably programmed
IC15 +12V 1A regulator
IC16 −5V 1A regulator
IC17 +5V 1A regulator

MISCELLANEOUS

PCB (Transam Components Ltd.)
64 pin Eurosocket (right angled pins)
heatsink
3 off 20 pin DIL sockets
3 off 16 pin DIL sockets
1 off 14 pin DIL sockets
8 off 24 pin DIL sockets
1 off 16 pin DIL header

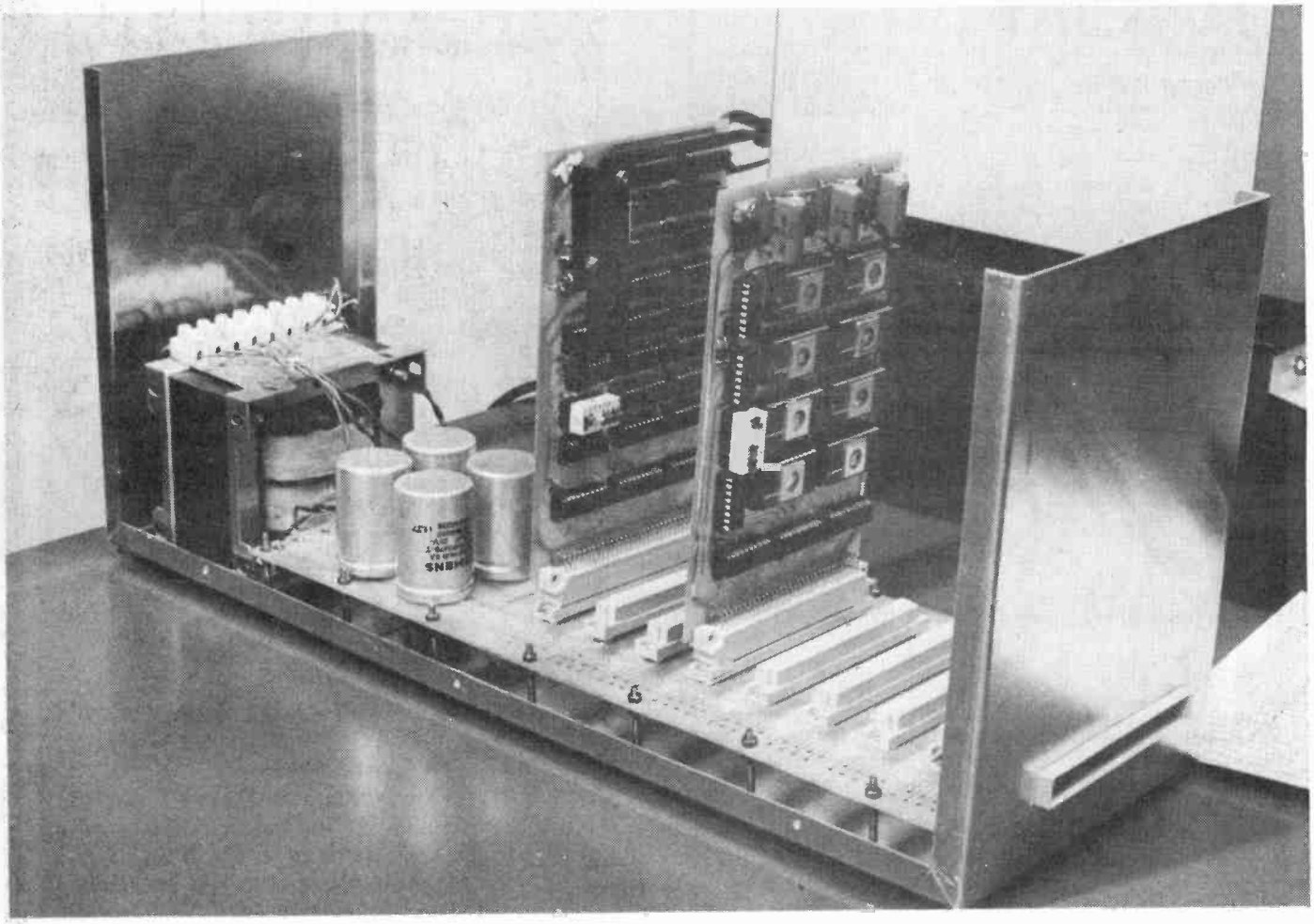




NOTE:
IC1–3 ARE 74LS244
IC4&6 ARE 74LS138
IC5 IS 74LS33
IC7–14 ARE 2708
IC15 = +12V REG
IC16 = –5V REG
IC17 = +5V REG

REGION	ADDRESS
0	0000–1FFF
1	2000–3FFF
2	4000–5FFF
3	6000–7FFF
4	8000–9FFF
5	A000–BFFF
6	C000–DFFF
7	E000–FFFF

Fig. 4. Component overlay, with details of the bus signals used on the board.



Insert all resistors and capacitors giving particular note to the orientation of C1, C8 and C10 — C8 is a different way round from the other two! Be careful, also, that you insert C7 into the correct pair of holes (the pair nearest the board's socket).

For obvious reasons do not mix up the three voltage regulators (ICs 15 to 17). Hold them so that their fixing holes line up with the large holie in the PCB and then put a right angled form on their leads so that they will neatly pass through their respective connection holes. Allow about $^{1}/_{16}$" gap between their backs and the PCB to allow space for the heat sink tabs to be sandwiched between them and the board. When soldering them into place make sure that the leads do not touch the power distribution tracks which they bridge over. Note that a mica shim and insulating bush is needed for IC16.

The heatsink should be cut and bent from 14 gauge aluminium. Before drilling holes in it slide it into place and mark drilling centres through the regulators' fixing tabs. Doing it this way will ensure a perfect matching.

Finally solder a link across the selected pair of contacts on a 16 pin DIL header and insert this into the board select socket and then insert all the integrated circuits taking note of the orientation of each one.

At the time of testing you might not have any firmware available to run on this board. None-the-less you can still test the board through Triton's Monitor. All you need is a 2708 EROM with some known program written into it. Every Triton user has such an EROM that can be used for this purpose in the shape of one of the BASIC chips on the main board. Firstly use the LIST function of the Monitor and write down the contents of the first dozen or so locations of BASIC "A" (to do this LIST from location 0400). Power the Triton off and remove the BASIC "A" EROM and insert it into the EROM extender card in the location for IC7 (that is Block 0).

With the EROM card plugged into the motherboard apply power to it and then switch Triton on. Press L for LIST and then enter the starting address of the Region that you have selected for the EROM card (e.g. for Region 2 you should enter 4000 and for Region 7 the start address would be E000). When you initiate LIST you should see the same data that you had originally noted. By carefully calculating the starting address of each block on the EROM card you can use BASIC "A" to test out each EROM socket in this manner.

When you have finished your tests do not forget to replace BASIC "A" back into its correct socket and give it a quick run to check that all is well.

At the time of writing we understand that Transam Components Ltd. will be offering a much larger and more versatile BASIC which could be housed on this board. This board, together with the 8K RAM card make Triton an extremely powerful machine and there is no reason (apart from financial!) why you should limit yourself to a single EROM card. Provided you use unallocated Regions you can add as many as you like.

ETI

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¼W 5% Carbon film 1R-10M E24 series. 1-99 **1½p**; 100-99 **1p**; 1000+ **0.7p.**
½W 2% Metal Oxide 10R-1M E24 series. 1-99 **6p**; 100+ **4p.** ¼W 1% Metal Glaze 1R-1M E24 series. 1-99 **10p**; 100+ **7½p.** (add 20% for values under 10R and over 510k). 1W 5% Carbon Film 4R7-10M E12 series. 1-99 **3p**; 100+ **2¼p.**

WIREWOUND

Watts	Range	1-99	100+
1	OR22-1k8	**7p**	**4½p**
2½	OR22-15k	**9p**	**6p**
5	OR47-33k	**12p**	**9p**
7/8	2R-22k	**14p**	**10½p**
9/10	OR4-60k	**16p**	**12½p**
15	1R-75k	**18p**	**14½p**

(Full list of values in cat)

POTENTIOMETERS

Lin or Log less switch 1k-2M2 **26p** each. Dual 1in or log less switch 4k7-2M2 **79p** each. Log + DPSW 4k7-2M2 **57p** each. Spkr Vol controls, 3W w/w, splined shaft: 20R 50R 100R or 200R **37p** each 100+ **26p.**

CAPACITORS

50V min ceramic, 5% up to 1000pF

Value	1-99	100+
1.5-1000pF	**3p**	**2.25p**
1500-.047	**4p**	**2.8p**

100V MYLAR, E12 series

Value	1-99	100+
.001-.0082µ	**4p**	**3p**
.01-.1µ	**5p**	**3.6p**
.15	**7p**	**4.8p**
.22µ	**9p**	**6.2p**
.33µ	**10p**	**7.4p**
.47µ	**14p**	**10.6p**

250V polyester

Value	1-99	100+
.01-.068	**4p**	**2.8p**
.1-.22	**5p**	**3.8p**
.33	**8p**	**5.6p**
.47	**12p**	**7.3p**
.68	**15p**	**9.6p**
1.0	**20p**	**13.4p**
1.5	**26p**	**18p**
2.2	**32p**	**22p**
3.3	**39p**	**26p**
4.7	**49p**	**32p**
6.8	**63p**	**39p**

ELECTROLYTICS

25V: 0.47 1 2.2, 3.3, 4 7, 10, 15, 22. 23, 47µ **7p**; 100µ **8p**; 150µ **10p**; 220µ **12p**; 330µ **15p**; 470µ **19p**; 1000µ **26p**; 1500µ **31p**; 2200µ: **38p**; 3300µ **51p**; 4700µ **60p**; 10000µ can **87p**; 40V: .47 1µ **7p**; 2.2, 4.7, 10, 15, 22µ **8p**; 47µ **9p**; 100µ **11p**; 150µ **13p**; 220µ **15p**; 330µ **20p**; 470µ **24p**; 1000µ **34p**; 1500µ **45p**; 2200µ **60p**; 4700µ **72p.** 63V: 1, 2.2µ **8p**; 4.7µ **9p**; 10µ **10p**; 22µ **11p**; 47µ **12p**; 100µ **13p**; 220µ **18p**; 470µ **26p**; 1000µ **51p**; 2200µ **78p**; 4700µ can **220p.**
100+ of any one type, less 25%

TANT BEAD CAPS

Value	volts	1-99	100+
0.1-1µ	35	**12p**	**7p**
1.5µ	35	**12p**	**7½p**
2.2µ	35	**12p**	**8p**
3.3µ	35	**12p**	**8½p**
4.7µ	35	**14p**	**9½p**
6.8µ	35	**14p**	**10½p**
10.0µ	35	**14p**	**11½p**
15µ	20	**14p**	**11½p**
22µ	16	**14p**	**11½p**
33µ	10	**14p**	**11½p**
47µ	6	**14p**	**11½p**
68µ	3	**14p**	**11½p**
100µ	3	**14p**	**11½p**

PRESETS

Min 0.1W vert or horiz mntg 100R-4M7. 1-99 **7p**; 100+ **4½p.** Std 0.3W vert or horiz mntg 100R-4M7, 1-99 **9p**; 100+ **6p.**

POPULAR SEMICONDUCTORS

Type	1.99	100+
741	**18p**	**14½p**
555	**25p**	**19½p**
556	**55p**	**49p**
BC107	**9p**	**7p**
BC108	**8p**	**6½p**
BC109	**9p**	**7p**
.125 Red LED	**11p**	**8½p**
.2 Red LED	**14p**	**10p**
76003N	**160p**	**100p**
76013N	**130p**	**85p**
76023N	**130p**	**85p**
76033N	**160p**	**100p**
1N4148	**2p**	**1.3p**
1N4003	**4p**	**2.9p**
1N4007	**7p**	**4.9p**

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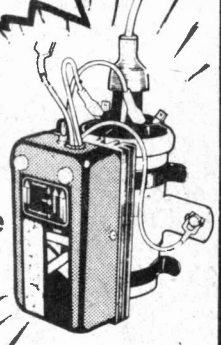
The kit includes components for a 4-minute timing circuit, miniature D.C motor and moulded parts in high impact styrene to provide an easily maintained, elegant appearance
Initial Gel Freshener provided FREE — further fresheners 48p each

The latest kit innovation!

from Sparkrite

Sparkrite — featured by Shaw Taylor in "DRIVE IN"



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electronic ignition
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- **Instant all-weather starting**
- **Continual peak performance**
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Sparkrite X4 is a high performance, high quality capacitive discharge, electronic ignition system in kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 1/3 mins.
Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). The circuit incorporates a voltage regulated output for greatly improved cold starting. The circuit includes built in static timing light, systems function light, and security changeover switch. All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED

Die pressed epoxy coated case. Ready drilled, aluminium extruded base and heat sink, coil mounting clips, and accessories. Top quality 5 year guaranteed transformer and components, cables, connectors, P.C.B., nuts, bolts and silicon grease. Full instructions to assemble kit neg. or pos. earth and fully illustrated installation instructions.

NOTE — Vehicles with current impulse tachometers (Smiths code on dial RV1) will require a tachometer pulse slave unit. Price £3.85 inc. VAT, post & packing.

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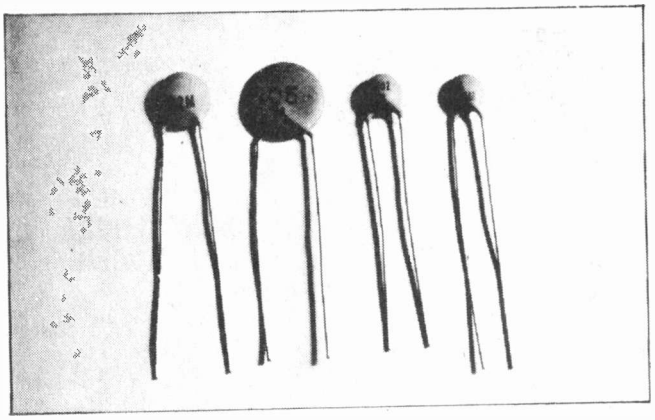
CAPACITORS

Ever wondered what's inside those small tubes with a wire at each end? Well if it's not a resistor or diode it's a fair bet it's a capacitor. Ian Sinclair leads the way into the jungle.

WHEN YOU THINK ABOUT IT (and who doesn't!) capacitors have quite a lot of uses in electronic circuits. They are used to store electric charge, when we use them as reservoirs in power supply units or as timing capacitors in multivibrator circuits. They are used to pass AC and block DC when we make use of them in coupling, decoupling and filtering circuits. Thirdly, of course, the capacitor connected to an inductor forms the familiar resonant circuit which tunes nearly every radio receiver or transmitter.

Now there's a bewildering variety of capacitor types, which is a bit confusing unless you know something about capacitors and how they are constructed. Let's start right at the beginning.



Four tiddlers — ceramic capacitors.

Capacitor Types

In a class by itself is the variable capacitor, using one set of fixed plates set in a frame and another set of moving vanes mounted on a shaft. Rotating the shaft meshes the moving vanes between the fixed vanes, and because all the moving vanes are connected together, the total area can be quite large, though the spacing between the fixed and the moving vanes can never be small because of the risk of shorting caused by vibration. The odd shapes of the plates, incidentally, are due to the desire to have a linear response — meaning that the amount of capacitance change for each degree of rotation should be pretty much the same for all the range of movement. At one time, radio tuning capacitors were always 500p, but 375p is more common now, and miniature versions use thin sheets of dielectric between the fixed and the moving vanes, a type of construction which also allows the sets of plates to be moved closer together. Radio tuning capacitors are seldom single units; ganged units of two or three capacitors are much more common. Ganging simply means that all the moving vanes move together, so that several lots of capacitors are varied in step.

Most of the capacitors that we use are fixed, however, and they can have capacitance values as low as a few picofarads or as high as several thousand microfarads. As you might expect, we don't use the same sort of construction for all of them.

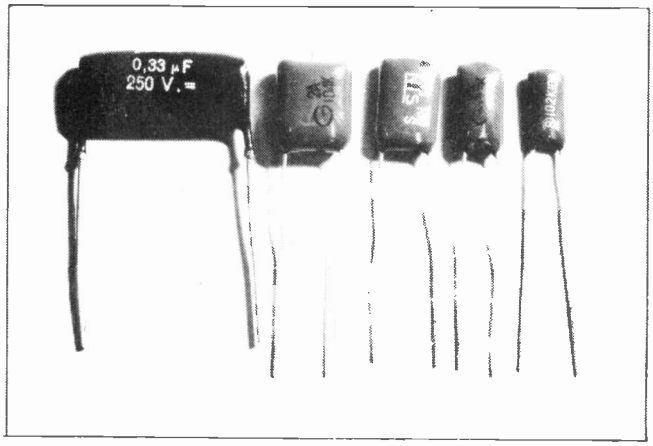
Tiddlers:

The smallest capacitor sizes are either flat parallel plates of mica or ceramic, or ceramic tubes which have been silvered inside and outside. Values range from 2p2 upwards, with mica capacitors of 10n (10,000 p) available. Silver mica capacitors, made by coating high-grade mica sheets with silver on each side, are greatly esteemed for use in tuned circuits because of their stability. They have surprisingly high working voltage ratings, and positive temperature coefficient of around 40 ppm/°C. The insulation resistance is very high, greater than 50,000 M. Ceramic plate types can also be obtained in the smaller sizes (2p2 to 220p, typically), and, except in the smallest sizes, have negative temperature coefficients. A combination of mica and ceramic plate capacitors can therefore be used in a tuned circuit to ensure that there is practically no change of total capacitance when the temperature is changed. The tubular ceramics are generally similar in characteristics, though of different construction.

Middle Sixes:

In this range, from a nanofarad up to a microfarad or so, there is a wide range of types. Ceramic disc capacitors appear in this group due to the use of 'high — K' ceramic material. This type of ceramic has a very large value of permittivity, often greater than 1000, so that small capacitors can have comparatively large capacitance values. There's one snag, though — 'high — K' ceramic capacitors must never be used for tuned circuits because these capacitors dissipate energy. An oscillator circuit with a 'high — K' capacitor in its tuned circuit won't oscillate, for example. Keep them for decoupling, and they'll serve you well. The other important type of construction which comes into its own in this range of values is the rolled type. A rolled capacitor consists of long ribbons of insulator coated with metal (usually aluminium) on each side, and rolled up with a

ribbon of plain insulator (to prevent shorting) so as to form a large total plate area in a small space. Insulators which can be used include paper (the original insulator used in this way) and several modern plastics such as polystyrene (no, not *her*), polyester (the stuff which is also called terylene and is made into clothes), polycarbonate, polypropylene, and mixtures of paper and plastics. In fact, paper is seldom used nowadays by itself. Polystyrene capacitors have very large insulation resistance (more than a million M) with fairly high negative temperature coefficients of around —150 ppm/°C. Values as low as 10 p can be made, with upper limits of around 10 n.



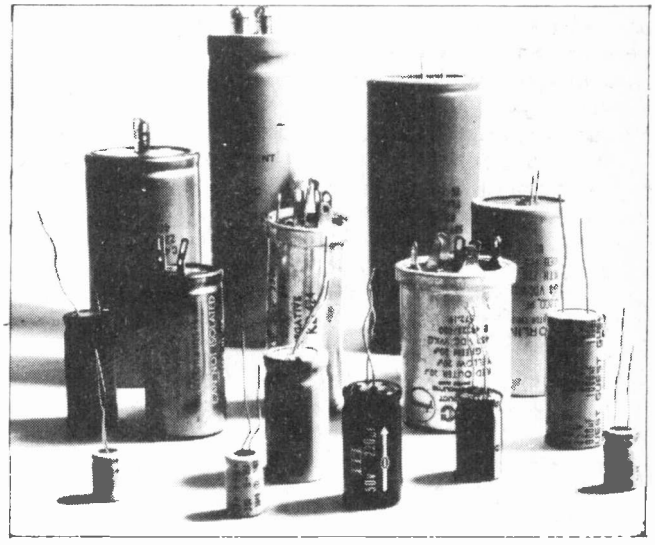
Polyester capacitors — high insulation resistance and large positive temperature coefficient.

Polyester capacitors are useful for the larger capacitance sizes, 1 n to 2u2, with high insulation resistance (100000M) and large positive temperature coefficients. A remarkable feature is that some varieties can recover from breakdown after having been overloaded or overheated. Polycarbonate,types have better insulation resistance in the larger capacitance sizes (1u upwards) and lower temperature coefficients (50 ppm/°C) — but at a price! Polypropylene capacitors are particularly suited for high voltage AC or pulse circuits; they have negative temperature coefficients of around —60ppm/°C. Mixed dielectric types are generally used for high voltage circuits, with ratings of 600-1000 V. They are physically larger than the single-plastic dielectric types and are used in mains voltage circuits and in timebase generators. All of these medium range capacitors can be used equally well for coupling, decoupling, change storage, or resonant circuits. The polyester type is the one which would normally be specified except for special purposes.

The Big, Big Ones:

Electrolytic capacitors are used wherever we need large capacitance values for power supply reservoirs and smoothing, for decoupling and coupling in low frequency circuits. The construction is very different from that of other types, consisting of one large aluminium foil 'plate', usually dimpled to provide extra area, in contact with a jelly which is slightly acid and conducting. The aluminium foil forms one plate, and the jelly in contact with it forms the other conducting plate. The insulator is a thin film of hydrogen gas which forms on the aluminium when the foil is connected to a negative supply and the case of the capacitor, in contact with the jelly, to a positive voltage.

During this initial 'forming' operation, the current flow through the capacitor has to be controlled, but it soon reduces to a very low leakage value. Reversing the voltage will cause the film to vanish, so that the leakage current increases enormously. This can cause rapid overheating, leading to the jelly boiling, the can bursting, and a nasty mess everywhere. The polarity of an electrolytic must always be observed, and two used back to back if there is any chance of reverse voltage in a circuit. Tantalum foil capacitors can be obtained which are unpolarised or which will withstand some reverse voltage. Since these also have much lower leakage currents, they are frequently used in high quality tape amplifiers for coupling the tape head to the replay amplifier. Electrolytics have wide tolerances (—25% to + 100%), a lot of leakage and the disadvantage of being polarised, but there is little choice when values of 10 u or more are needed. Even for the 1 u-10 u range, the small size of the electrolytic makes it the natural choice for many applications. Most suppliers now quote the maximum ripple current in mA which the capacitor can safely handle in power supply smoothing application. If an electrolytic which is correctly polarised is found to be running hot, a higher ripple current type should be substituted. Ripple currents of up to 15 A can be specified for the larger capacitance values (22000 u or so).



Electrolytic capacitors — getting the polarity wrong means a nasty mess on the carpet.

Electrolytics used for criticial decoupling or coupling applications should always be bypassed by rolled dielectric capacitors and also, if needed, by micas. This is because electrolytics have rather a high impedance to high frequency currents, and so need bypassing. This applies even at high audio frequencies incidentally, so that there is some advantage to be gained from wiring a 10 u polyester capacitor in parallel with the output capacitor of a hi-fi amplifier.

ETI

The Sinclair PFM200 digital frequency meter.

20 Hz-200 MHz...8 digits ..under £50.

The Sinclair PFM200 brings digital frequency measurement within the reach of every engineer. It has a performance comparable with the very best bench-top instruments, but it's packaged in a compact case which is rugged but light, ready for use anywhere.

The PFM200 out-performs many much more expensive instruments. Its 8-digit display and variable gate time give high-resolution coverage of frequencies from 20 Hz to over 200 MHz. It gives you exceptional sensitivity and simplicity, at a fraction of the price of meters with similar specifications!

The PFM200 is ideal for use with audio, video and radio systems, and all electronic and digital circuitry. Now every development engineer, service technician, student and hobbyist can afford to have a personal digital frequency meter.

The PFM200 embodies Sinclair Radionics' seven-year experience in digital test equipment design and production.

PFM200: features

20 Hz-200 MHz guaranteed range (typically better)
Frequency resolution down to 0.1 Hz
High sensitivity (10 mV typical)
High-accuracy crystal timebase
Full 8-digit capacity
Sharp, bright, easily-read LED display
Built-in attenuator
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Low-battery indication
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Where to use the new PFM200

The PFM200 is useful in every field of electronics, providing the ultra-precise frequency information that an oscilloscope can't give . . .

Transmitter checks: mobiles, ham, radio control – check frequency and stability on Low and High band VHF, etc, up to 200 MHz AM and FM. In most applications, the PFM200's optional telescopic aerial avoids the need for direct connections.

Audio testing and design: check oscillator frequencies, bandwidth limits, crossover frequencies, resonances, etc, with resolution down to 0.1 Hz.

Digital testing: check computer clock frequencies, divider ratios and other digital circuitry.

RF circuit checks: test local oscillators, BFOs, test IF and detector performance.

Video equipment: check syncronised circuits, scanning frequencies, video bandwidths, etc.

Technical specifications

Frequency range: 20 Hz.to 200 MHz
Display resolution: up to 8 digits
Lowest frequency resolution: 0.1 Hz
Gate time: decade adjustable from 0.01 secs to 10 secs
Sampling rate: varies with gate time up to 5 per second
Display format: 8 LEDs, direct reading in kHz.
Attenuator: –20 db
Input impedance: 1M in parallel with 50 pF
Timebase accuracy: 0.3 ppm/°C, 10 ppm/ year
Dimensions: 6.2 in x 3 in x 1.25 in
Weight: 6 oz
Power requirement: 9V DC or AC adaptor
Sockets: standard 4 mm for resilient plugs
Standard accessories: test leads and prods, carrying wallet, owner's instruction manual
Optional equipment: AC adaptor for 240 V 50 Hz power; deluxe padded carrying case; connector kit comprising BNC, co-ax, DIN and phono adaptors, plus telescopic aerial for off-air transmitter measurements

Built, tested, ready to go

The Sinclair PFM200 comes to you fully built, tested, calibrated and guaranteed. It comes complete with leads and test prods, operating instructions and a carrying wallet. And getting one couldn't be easier. Just fill in the order form below, enclose a cheque/PO for the right amount (usual 14-day money-back undertaking, of course), and send it to us.

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.....(qty) De-luxe carrying cases at £3.24 (inc 8% VAT) each £_____

.....(qty) AC adaptors for 240V power at £3.24 (inc 8% VAT) each £_____

.....(qty) connector kits at £10.58 (inc 8% VAT) each £_____

Post & packing (please add) £0.65

I enclose cheque/PO made payable to Sinclair Radionics Ltd for (indicate total amount) £_____

I understand that if I am not completely satisfied with my PFM200, I may return it within 14 days for a full cash refund.

Name.....

Address.....

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ETI/6

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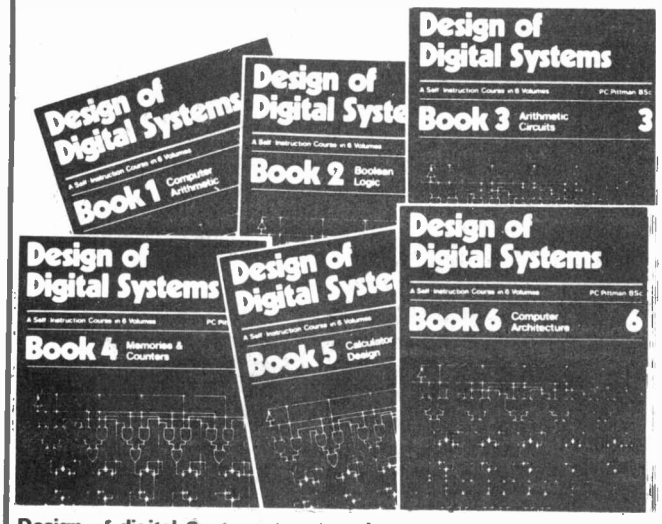

Design of digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes — each A4 size — are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.

The contents of Design of Digital Systems include:

Book 1 Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.
Book 2 OR and AND functions; logic gates. NOT, exlusive OR. NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.
Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
Book 6 Central processing unit (CPU); memory organisation; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.

Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though the student should have an aptitude for logical thought. It consists of four volumes — each A4 size — and serves as an introduction to the subject of digital electronics. Everyone can learn from it — designer, executive, scientist, student, engineer.

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In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your vehicle speed and petrol consumption; you could be calling people by entering their name into a telephone which would automatically look up their number and dial it for you.

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ETI 19

data sheet.....

The MCM6810A is a byte-organized memory designed for use in bus-organized systems. It is fabricated with N-channel silicon-gate technology. For ease of use, the device operates from a single power supply, has compatibility with TTL and DTL, and needs no clocks or refreshing because of static operation.

The memory is compatible with the M6800 Microcomputer Family, providing random storage in byte increments. Memory expansion is provided through multiple Chip Select inputs.

- Organized as 128 Bytes of 8 Bits
- Static Operation
- Bi-Directional Three-State Data Input/Output
- Six Chip Select Inputs (Four Active Low, Two Active High)
- Single 5-Volt Power Supply
- TTL Compatible
- Maximum Access Time = 350nS — MCM6810AL1
  450 nS — MCM6810AL

The MCM 6810A Static RAM is freely available at the moment. Maplin Electronics (PO Box 3, Rayleigh, Essex SS6 8LR) stock the device for £4.27 including VAT. Complete address decoding is performed on-chip and there are six chip-enable inputs (four are active-low and two are active-high) for absolute ease of memory expansion.

ABSOLUTE MAXIMUM RATINGS (See Note 1)

Rating	Symbol	Value	Unit
Supply Voltage	V_{CC}	-0.3 to +7.0	V DC
Input Voltage	V_{in}	-0.3 to +7.0	V DC
Operating Temperature Range	T_A	0 to +70	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

'NOTE 1: Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded. Functional operation should be restricted to RECOMENDED OPERATION CONDITIONS. Exposure to higher than recomended voltages for extended periods of time could affect device reliability.

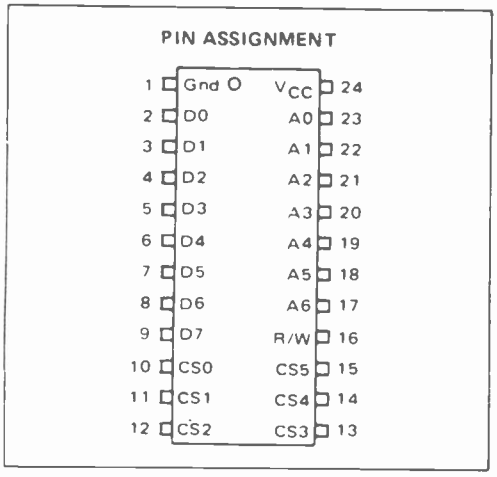
RECOMMENDED DC OPERATING CONDITIONS

Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V_{CC}	4.75	5.0	5.25	VDC
Input High Voltage	V_{IH}	2.0	–	5.25	VDC
Input Low Voltage	V_{IL}	-0.3	–	0.8	VDC

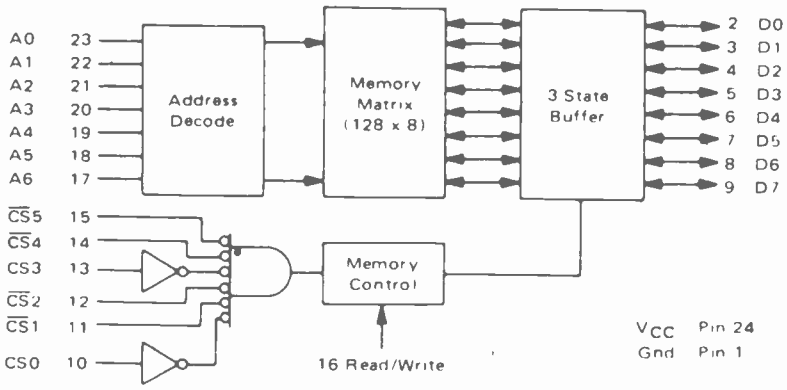
DC CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Input Current (A_n, R/W, CS_n, $\overline{CS_n}$) (V_{in} = 0 to 5.25 V)	I_{in}	–	–	2.5	uA DC
Output High Voltage (I_{OH} = –205 uA)	V_{OH}	2.4	–	–	V DC
Output Low Voltage (I_{OL} = 1.6 mA)	V_{OL}	–	–	0.4	V DC
Output Leakage Current (Three-State) (CS = 0.8 V or $\overline{CS}$ = 2.0 V, V_{out} = 0.4 V to 2.4 V)	I_{LO}	–	–	10	uA DC
Supply Current (V_{CC} = 5.25 V, all other pins grounded, T_A = 0°C) MCM6810AL MCM6810AL1	I_{CC}	– –	– –	70 80	mA DC

PIN ASSIGNMENT



BLOCK DIAGRAM



CAPACITANCE (f = 1.0 MHz, T_A = 25°C, periodically sampled rather than 100% tested.)

Characteristic	Symbol	Max	Unit
Input Capacitance	C_{in}	7.5	pF
Output Capacitance	C_{out}	12.5	pF

This device contains circuitry to protect the inputs against damage due to static voltages or electric fields; however, it is advisable that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.

READ CYCLE

Characteristic	Symbol	MCM6810AL		MCM6810AL1		Unit
		Min	Max	Min	Max	
Read Cycle Time	$t_{cyc(R)}$	450	–	350	–	nS
Access Time	t_{acc}	–	450	–	350	nS
Address Setup Time	t_{AS}	20	–	20	–	nS
Address Hold Time	t_{AH}	0	–	0	–	nS
Data Delay Time (Read)	t_{DDR}	–	230	–	180	nS
Read to Select Delay Time	t_{RCS}	0	–	0	–	nS
Data Hold from Address	t_{DHA}	10	–	10	–	nS
Output Hold Time	t_H	10	–	10	–	nS
Data Hold from Write	t_{DHW}	10	80	10	60	nS

WRITE CYCLE

Characteristic	Symbol	MCM6810AL		MCM6810AL1		Unit
		Min	Max	Min	Max	
Write Cycle Time	$t_{cyc(W)}$	450	–	350	–	nS
Address Setup Time	t_{AS}	20	–	20	–	nS
Address Hold Time	t_{AH}	0	–	0	–	nS
Chip Select Pulse Width	t_{CS}	300	–	250	–	nS
Write to Chip Select Delay Time	t_{WCS}	0	–	0	–	Ns
Data Setup Time (Write)	t_{DSW}	190	–	150	–	nS
Input Hold Time	t_H	10	–	10	–	nS

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Tunable over whole range uses Dual gate Mosfets. Covers European/American CB frequencies and Amateur 10 metre band can be used as a tuneable IF for many 2 metre convertors. Low noise, high performance. Especially designed to go with IF15 and IF20 but compatible with any receiver covering 10.7MHz. **£13.25**

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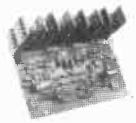
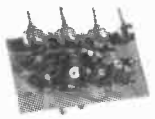
Tunable 2 metre front end converter. Covers 144-146MHz. Three stage tuning uses bipolar devices for low current consumption can be battered powered for 2 metre direction finding or portable use. Ideal basis for 2 metre monitor. Receiver can be uses with IF 15, IF20 or comm. rx. Output 10.7MHz. **£9.95.**

8 VT01
108-150MHz MOSFET front end 26dB gain 10.7MHz 1F output. Covers 2 metres. Varicap tuned. Amateurs. Aircraft, etc. **£11.99.**

9 AMP 020
Stereo power amp 30W RMS per channel. Class ABI TIP34AxTIP33A. 16 Transistor circuit Fre resp 15Hz-18kHz — 1dB. **£7.99**



10 Matching HiFi Preamplifier
Four rotary controls — Vol, Bal, Treb, Bass, Treble± —14B. Bass+ ±14B facility for loudness control. **£6.99**



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8 pin 10p
14 pin 12p
16 pin 13p
18 pin 18p
24 pin 24p
28 pin 28p
40 pin 40p

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2N5777 50p
OCP71 70p
ORP12 70p
DL704 100p
DL707 100p

.125"/.2" LEDs
Red 9p
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1A/50V 22p
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1A/200V 27p
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2A/50V 34p
2A/100V 38p
2A/200V 44p
2A/400V 48p

DIODES
BY127 10p
OA47 8p
OA91 8p
OA200 6p
OA202 9p
1N4148 4p
1N916 5p
1N4001 4p
1N4002 4p
1N4003 5p
1N4004 6p
1N4005 7p
1N4006 8p
1N4007 9p
1N5400 13p
1N5401 14p
1N5402 15p
1N5404 20p

VOLTAGE REGULATORS
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320H-24 40p
7805 60p
7812 60p
7815 60p
7818 60p
7824 60p
7905 80p
7912 80p
7915 80p
7918 80p
7924 80p

LINEARS
710CN 30p
741-8 22p
747C-14 45p
748C-8 30p
CA3011 80p
CA3018 80p
CA3028A 85p
CA3036 120p
CA3046 75p
CA3054 110p
CA3080 70p
CA3140E 51p
LM301AN 28p
LM308N 64p
LM380N 61p
LM381N 120p
NE555 25p
NE556 60p
T8A641-B11 200p
TBA800 70p
TBA810 100p

TTL
7400 10p
7401 10p
7402 10p
7403 10p
7404 12p
7405 12p
7406 24p
7407 24p
7408 12p
7409 12p
7410 12p
7411 15p
7412 15p
7413 25p
7414 45p
7416 24p
7417 24p
7420 12p
7421 20p
7422 15p
7427 18p
7428 25p
7430 12p
7432 20p
7433 24p
7437 20p
7438 17p
7440 12p
7441 46p
7442 40p
7443 40p
7444 60p
7445 64p
7446 50p
7447 50p
7448 50p
7450 12p
7451 12p
7453 12p
7454 12p
7460 14p
7470 24p
7472 24p
7473 25p
7474 22p
7475 25p
7476 25p
7480 35p
7485 60p
7486 24p
7490 25p
7491 40p
7492 26p
7493 25p
7494 45p
7495 44p
7496 40p
7497 120p
74100 80p
74105 40p
74107 25p
74109 30p
74110 46p
74118 75p
74121 25p
74122 33p
74123 40p
74125 35p
74126 35p
74132 45p
74141 50p
74142 180p
74145 45p
74150 65p
74151 45p
74153 45p
74154 50p
74155 45p
74156 40p
74157 45p
74160 55p
74161 40p
74162 55p
74163 55p
74164 60p
74165 60p
74166 75p
74173 80p
74174 60p
74175 50p
74176 50p
74177 50p
74180 40p
74181 100p
74182 45p
74190 70p
74191 70p
74192 45p
74193 60p
74194 55p
74195 50p
74196 50p
74197 50p
74198 100p
74199 90p

CMOS
4000 12p
4001 12p
4002 12p
4006 68p
4007 14p
4008 64p
4009 25p
4010 35p
4011 12p
4012 12p
4013 30p
4014 60p
4015 50p
4016 30p
4017 50p
4018 55p
4019 40p
4020 50p
4021 60p
4022 50p
4023 12p
4024 45p
4025 12p
4027 30p
4028 45p
4029 50p
4030 30p
4035 60p
4041 57p
4042 54p
4043 54p
4044 50p
4047 80p
4048 50p
4049 25p
4050 25p
4066 35p
4069 12p
4070 12p
4071 12p
4072 12p
4073 16p
4081 14p
4082 14p
4086 60p
4510 60p
4511 70p
4516 64p
4518 65p
4520 65p
4528 55p

TRANSISTORS
AC126 17p
AC127 17p
AC128 17p
128/176 MP 42p
AC141 24p
AC142 18p
AC151 22p
AC153 22p
AC176 16p
AC187 23p
AC188 20p
A0149 65p
A0161 35p
A0162 35p
AF114 23p
AF118 30p
AF125 22p
AF126 22p
AF127 22p
AF139 32p
AF186 54p
AF239 40p
ASY53 33p
ASY54 33p
ASY55 33p
BC107 8p
BC108 8p
BC109 8p
BC113 10p
BC117 12p
BC119 25p
BC140 27p
BC142 20p
BC143 20p
BC147 8p
BC149 8p
BC157 8p
BC158 8p
BC159 8p
BC168 8p
BC170 8p
BC171 8p
BC172 8p
BC173 8p
BC182 8p
BC183 8p
BC184 9p
BC186 19p
BC187 19p
BC207 8p
BC212 10p
BC213 10p
BC214 10p
BC237 15p
BC238 15p
BC301 25p
BC303 25p
BC328 16p
BC338 16p
BC547 11p
BC548 11p
BC549 11p
BC557 11p
BCY30 60p
BCY34 66p
BCY59 16p
BCY70 14p
BCY71 14p
B0115 30p
B0121 70p
B0123 60p
B0124 77p
B0131 35p
B0132 35p
B0135 30p
B0136 30p
B0137 30p
B0138 30p
B0139 30p
B0140 30p
BF115 35p
BF167 25p
BF173 20p
BF178 27p
BF179 25p
BF180 20p
BF181 16p
BF182 20p
BF183 20p
BF184 20p
BF185 20p
BF194 8p
BF196 8p
BF197 8p
BF198 8p
BF200 33p
BF224 18p
BF257 14p
BF258 28p
BF259 22p
BFR39 18p
BFR40 18p
BFR79 18p
BFR80 22p
BFX29 20p
BFX30 32p
BFX85 20p
BFX86 27p
BFX87 20p
BFY50 15p
BFY51 15p
BFY53 17p
BSX19 20p
BSX20 18p
BU205 130p
BU208 150p
OC25 76p
OC28 86p
OC35 86p
OC71 16p
OC72 32p
OC84 42p
TIP29 40p
TIP30 35p
TIP31 45p
TIP32 45p
TIP33 60p
TIP34A 80p
TIP35A 230p
TIP36A 290p
TIP41A 60p
TIP42A 60p
TIP2955 65p
TIP3055 55p
ZTX108 12p
ZTX109 12p
ZTX300 14p
ZTX500 16p
2N706 10p
2N1131 23p
2N1132 24p
2N1302 38p
2N1304 50p
2N1305 40p
2N1306 38p
2N1308 50p
2N1613 18p
2N1711 20p
2N1893 25p
2N2217 24p
2N2219 21p
2N2369 15p
2N2484 18p
2N2905 22p
2N2906 19p
2N2907 20p
2N2926 10p
2N3053 15p
2N3054 50p
2N3055 50p
2N3702 8p
2N3703 8p
2N3704 8p
2N3706 8p
2N3707 8p
2N3710 8p
2N3711 8p
2N3772 172p
2N3773 280p
2N3866 54p
2N3904 8p
2N4061 12p

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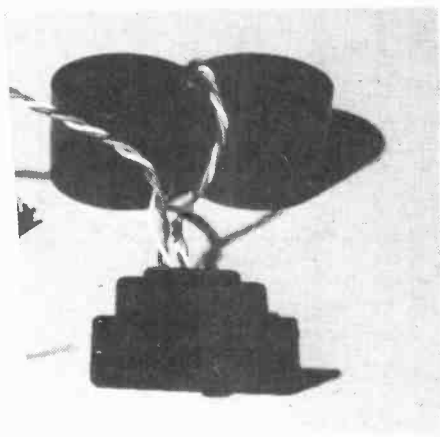
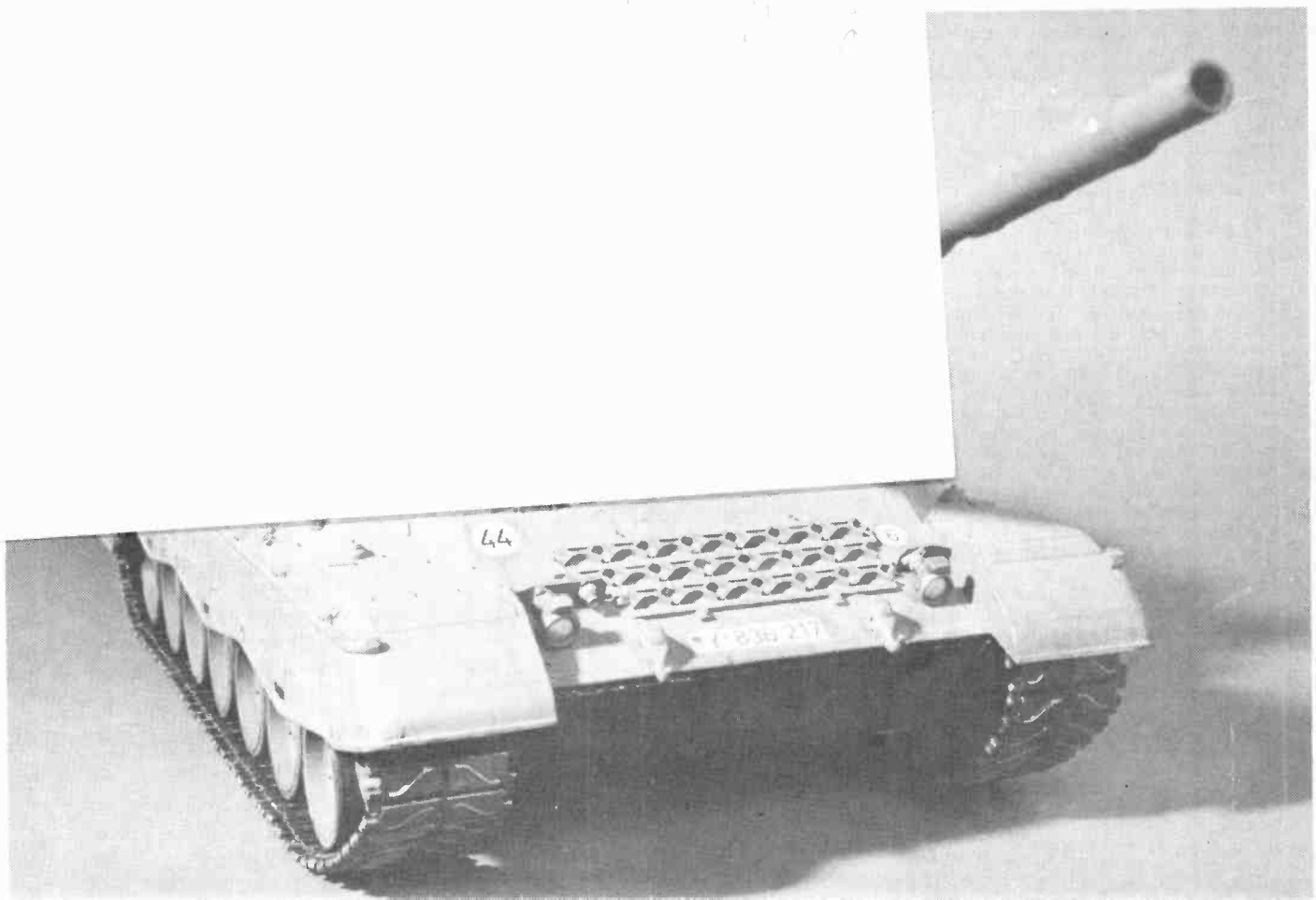
RADIO CONTROL SYSTEM

PART TWO: RECEIVER. In this concluding part of the article, we cover the receiver and its associated circuitry and give some ideas on installing the system into the model





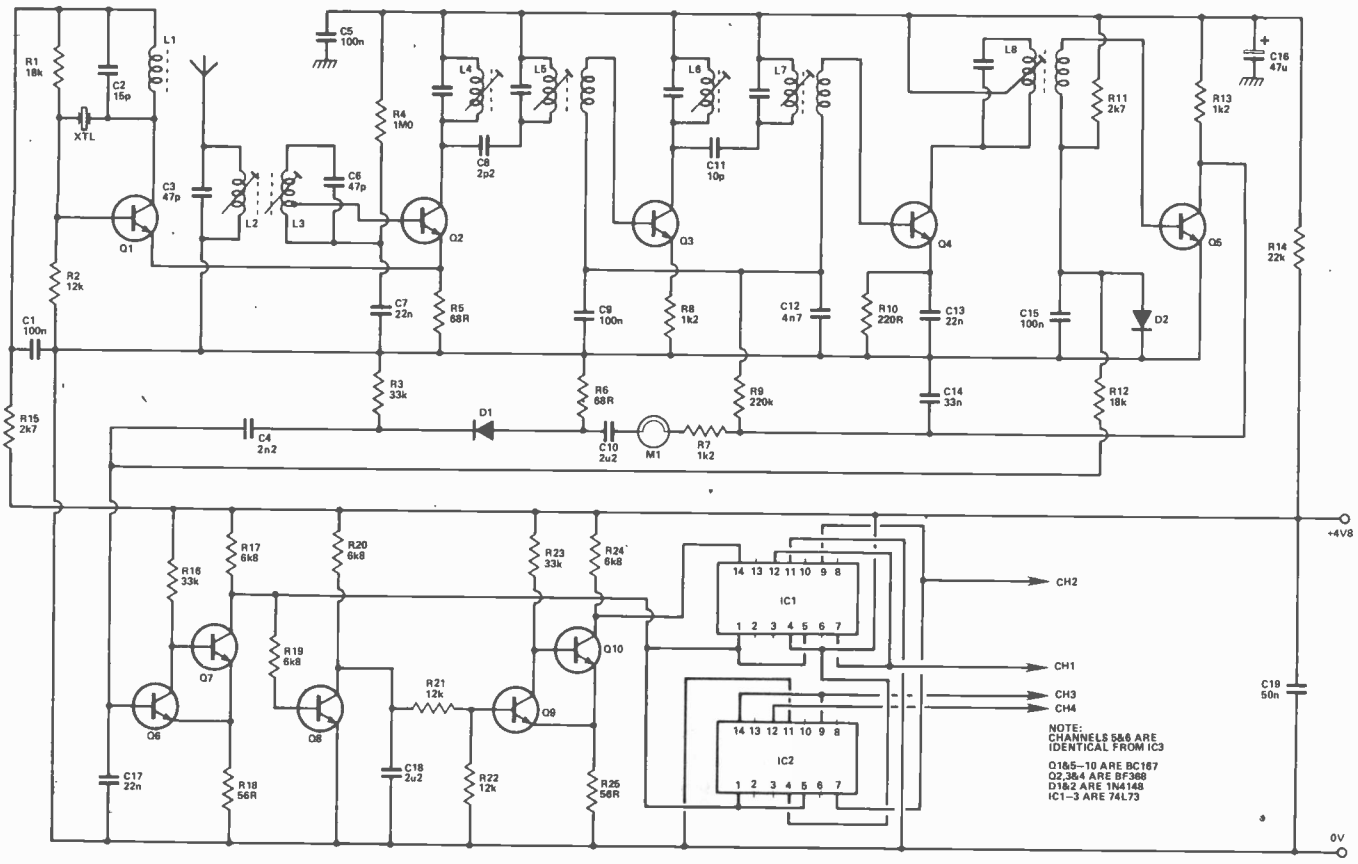


Fig 1 (Above) The full circuit diagram of the receiver unit. Note that power is best obtained from a rechargable cell. MI is a normally bridged test point.

HOW IT WORKS

The RF section is of single conversion superhet design, Q1 is a crystal controlled local oscillator, using a third overtone circuit, it has emitter injection to the mixer Q2. The aerial circuit has L2, C3 as a preselector which is inductively loose coupled to L3, C6 and provides a useful amount of image rejection. The base of Q2 is apped in near the earth end of L3 to provide impedence mathing.

A similar arrangement is used for the first LF stage, Q3. The second IF stage, Q4, uses a conventional single tuned transformer to couple it to the detector D2 and AGC amplifier Q5. D2 and R11 provide temperature compensated bias for the working point of Q5 and Q6. Amplified AGC is taken to the two IF stages from Q5 collector, via R9. The somewhat unusual IF amplifier, detector and AGC arrangement provides better than average selectivity at 455 kHz, together with a good AGC dynamic range. In addition to an AGC amplifier, Q5 has another role to play. It is also a pulse amplifier for the demodulated pulse train. After passing the test point m, the DC component of the pulse train is lost in C10, R6. The forward drop of D1 allows only signals in excess of about 0.6V to be passed to Schmitt trigger Q6, 7 and in so doing improve the receiver's noise rejection capabilities. Q6 is turned on by the incoming +ve going pulses, and the regenerative action of Q7 ensures that clean rectangular pulses appear at the junction of R17 and R19. The nicely reconstituted pulse train is now fed to a shift register comprising IC1, 2 (and 3 if fitted). The channel outputs of the latter sequentially go from logic 0 to 1 in response to the clocking action of the incoming pulses. Now the pulse train from the collector Q7 is passed via R19 to the base of Q8, the pulse omission detector. With no input pulses, this stage is cut off, allowing C18 to charge positively through R20. Under this condition Q9 conducts, cutting off Q10. When the pulse train is present at Q7 collector, C18 is discharged repetitively, maintaining a voltage across it which is lower than the threshold level for Q9. Then the collector of Q10 remains at logic 0. However, after the last pulse in the train there is a minimum pause of 8mS the reset time. This is long enough for C18 to charge to a potential which triggers Q9, Q10, causing a logic 1 to be produced at the collector of Q10. This effectively resets the shift register, ready for the next frame of data. Individual pulse outputs to the servos are taken from the shift register.

get. The Strato system is primarily a utility system, and as such must be suited to both vehicles and aero-models.

A Case For It

If you're building up the system using the kit, your coils have arrived ready wound on the PCB. For you more fortunate souls the next few paragraphs hold no interest. Pass on quickly, despairing of those who must tread the path of weird windings.

L2 and L3 are wound on 6mm x 15mm formers using 0.4mm wire. Wind L3 first, and mount the former on the PCB before you start. Insert one end of the wire into the pad at the junction of C7 and R4 and solder it there. The other end goes around the core approx. 2½ turns and is soldered to the pad at the base of Q2. The second winding on this core

consists of approx. 6½ turns between the base of Q2 and the connection at C6.

Next to L2. Glue on the former, and start with one end of the wire soldered to the connection at C3. Add on about 8½ turns which should take you to the other end of C3 and solder off there. Insert the slugs in both L2 and L3 and screw in until they just enter the windings.

Refer to the overlay throughout these machinations.

IF You Can

The IF transformers are colour coded, L4 is yellow (so is L6), L5 is white (so is L7) and L8 is black. Fit these to the PCB, but do not solder the centre pin of the group of three you will find on one side of the base. Make sure also that this rouge pin does not make contact with the board. If thine pin offends thee, cut it off.

L8, the black coil, is to be treated normally and all pins soldered.

The rest of the board should be assembled normally, but take the usual care with IC orientation and polarised components. Putting on the plugs and sockets should be easy — remember that the only plug fits at the bottom LH corner of the PCB, and the rest are sockets.

From this sole line of pins comes the aerial and goes the receiver power.

Xtal Clear

Changing the crystal changes the frequency of operation of the receiver, and so having the Xtal mounted in a socket makes for easy switching around. These sockets are, however, expensive, but worth it for their usefulness. Pin money well spent.

It is probably worth noting that most components fit the board vertically and that at this frequency there is no room for overlong leads. Keep them as short as possible and watch the soldering iron does not burn its bridges!

Fit all the resistors and capacitors, leaving L1 until all are nestled nicely with solder around their ends. The semiconductors too should be sat sitting there looking at you before L1 joins them. As sockets are not to be used watch the orientation of the semiconductors.

Play A Tune

Once you've checked the PCB and are satisfied it is correct, check that it fits the case and that no solder clogs up the runners. Now the receiver needs tuning. Make up a power lead, connecting the battery and (39") aerial to the only socket on the board.

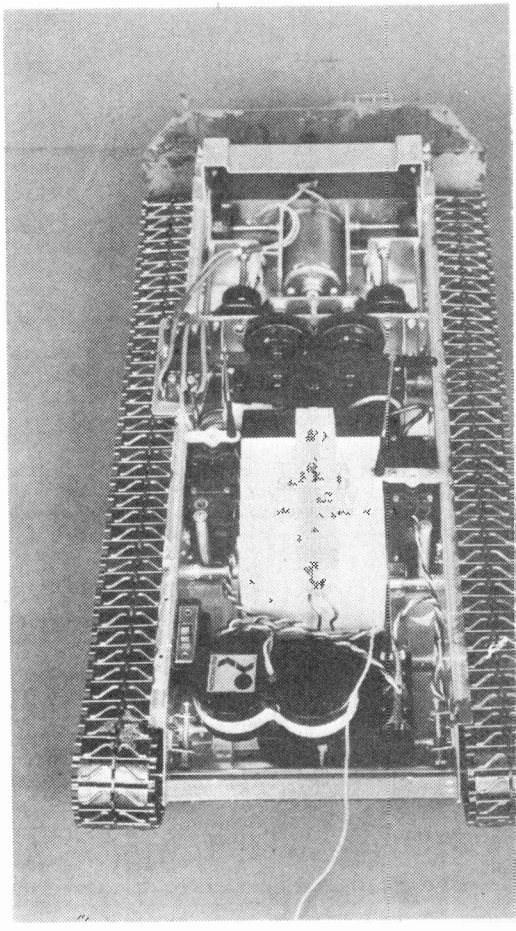
Connect a voltmeter with FSD around 5V between negative rail and the positive side of R7. The reading should be around 3V. Place the transmitter next to the receiver and switch it on. The meter should go down to about 1V. Remove the Tx aerial, and move it away until you get a reading of between 2V-2V5.

Core Wot A Job

Using a non-metallic tuning tool — even a piece of wood will do — screw in the core of L2 until you get a minimum reading on the meter. Go to L3—do not pass go or collect 200V — and tune that in to a minimum too. Work your way along all seven coils in this manner, tuning each in turn to get that minimum reading.

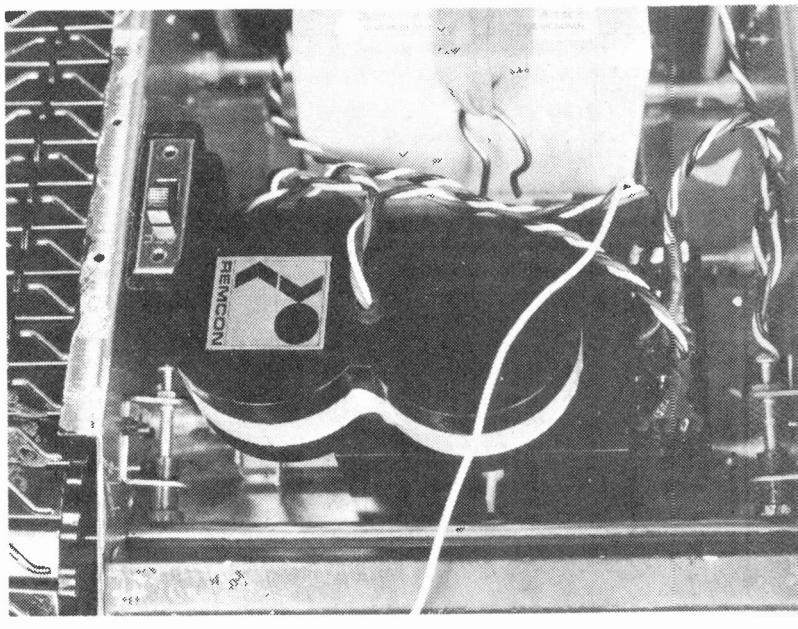
There may be some interaction so it is probably worth going through the whole thing a couple of times to make sure you've got it right. Once you're satisfied — that's it.

All this takes longer to read than it does to do, and the whole operation shouldn't take more than ten minutes. ▶



Above: The Tamiya Leopard laid bare to the world. The receiver is mounted right at the front and sits beneath the DEAC. Note the clutch steering mechanism about 2/3 down the chassis. The servo to operate this is on the right of the battery.

Below: The receiver mounting in more detail.



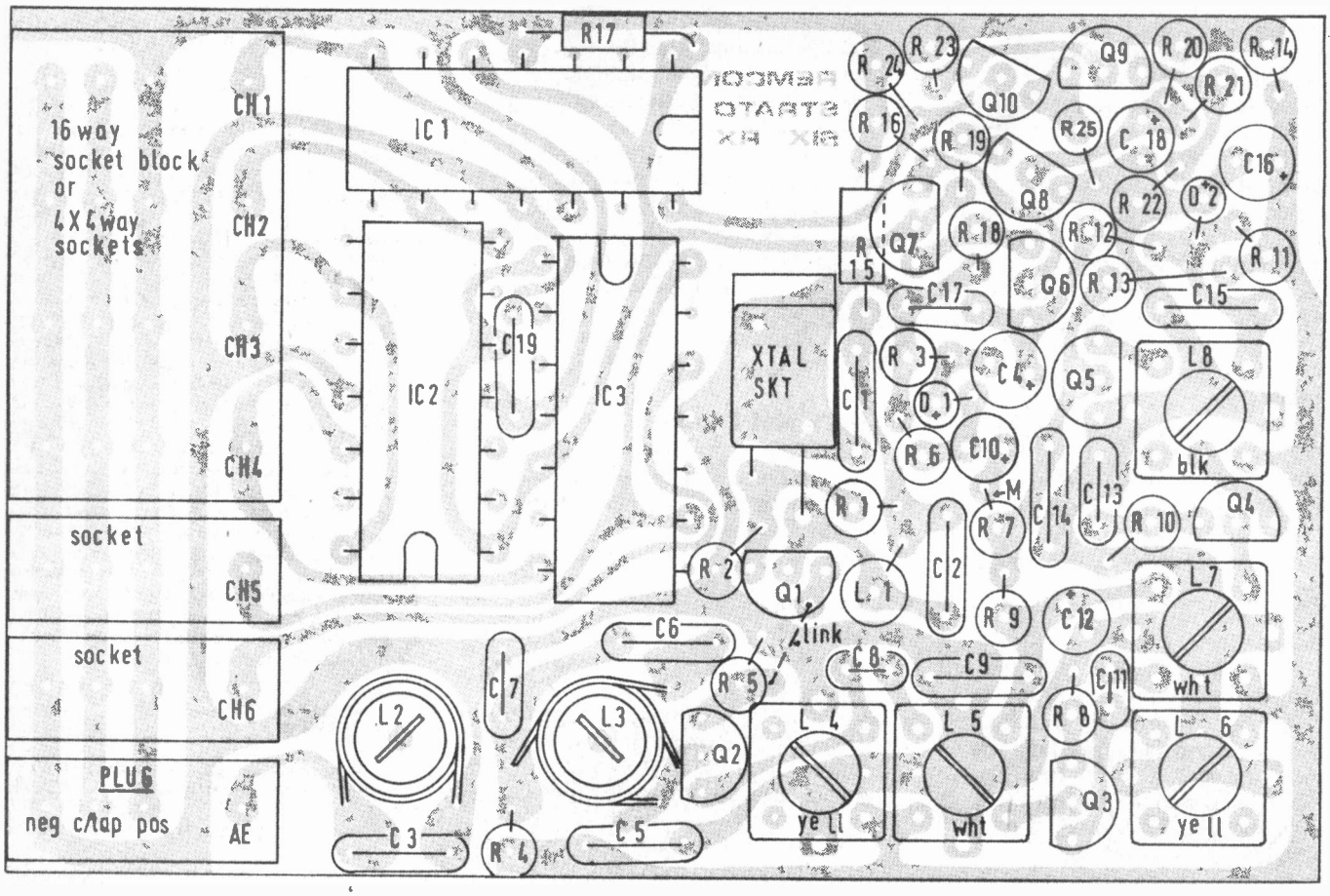


Fig 2. (Above) Component overlay for the radio control receiver board. In contrast to our usual style this is shown twice size to make construction easier. Since no sockets are employed take care with the ICs.

Fit the board into its case and the receiver is now completed. However it's not all over yet. You still need to make up a charging lead to run from the Tx, if you're using the internal charger, or whatever source of power takes supplies the electrons. Last month's article gives the plug configurations to enable you to avoid two dimensional batteries.

Your Servo

We have not given details of home build servos because the commercial market makes the exercise a singularly uneconomic and unattractive one. There are a very large number of servos available, both kit and complete, IC and discrete, and most of these will work with our system perfectly well.

The words which, upon incantation inside a shrine of servo supply, will conjure forth a compatible unit are: 4V8 supply, positive going signal, pulse width swing 1-2mS (1.5mS centre) and commutation rate 50 Hz.

With our system a tolerance of 20% surrounds the ideal. In order to set up the drive accurately, it is best to buy at least one ready built (and set up to 1.5 mS centre) servo. This

PARTS LIST

RESISTORS ALL 5%

R1, R12	18k
R2, R21, R22	12k
R3, R16, R23	33k
R4	1M0
R5, R6	68R
R7, R8, R13	1k2
Rg	220k
R10	220R
R11, R15	2k7
R14	22k
R17, R19, R20, R24	6k8
R18, R25	56R

CAPACITORS

C1, C5, C9, C15	100n polyester
C2	15p ceramic
C3, C6	47p ceramic
C4	2n2 polyester
C7, C13, C17	22n polyester
C8	2p2 ceramic
C10, C18	2u2 polyester
C11	10p ceramic
C12	4n7 polyester
C14	33n polyester
C16	47u electrolytic

INDUCTORS

L1-8 IF coils (see text)

SEMICONDICTORS

Q1, 5-10	BC167
Q2-4	BF368
D1, D2	IN4148
ICl-3	74L73

MISCELLANEOUS

4 V 8 battery, case, PCB.
Servos to suit application
Switch to fit model

can then be plugged in and used to set the output pulse widths of the transmitter, using the on board presets, to align with servo centre.

Having A Fit

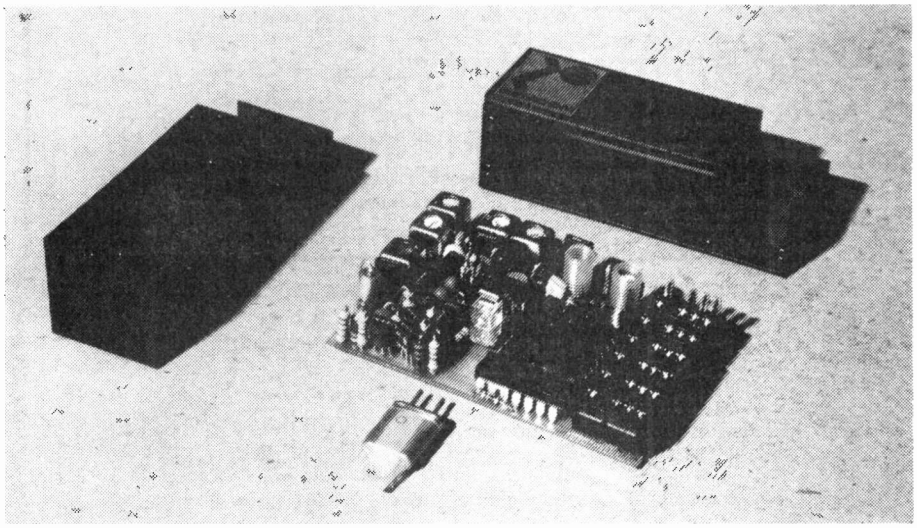
Installation of the system is totally dependent on where you intend to put it! If the unit is to spend its days running down pigeons in the smog above this green and pleasant land of ours, then your servos need to be smaller than average, and will generally cost more the smaller you want them.

For several reasons — probably all to do with delusions of being Gueridan reincarnate — our prototype went into a tank model— Tamiyas Leopard A4. Such a siting is probably atypical, but as you can see from the photographs it allows more flexibility of illustration. One thing did become clear after only a couple of runs though, the need for some kind of speed control.

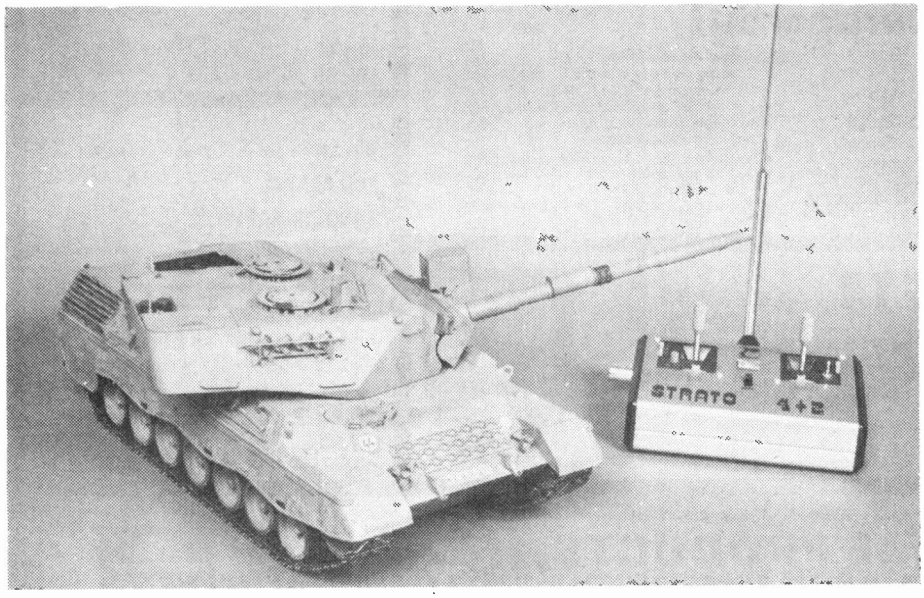
This kit is capable of about 3 MPH absolute (about 50 MPH scale) and just try driving a very heavy, metal-tracked stubborn mass around at flat-out walking speed sometime, when the only speeds available are fatal and off.

Our illustrious Project Editor has developed a 'pulse stretcher' electronic speed control which would seem to be applicable to any sort of Radio control vehicle and we'll be publishing this as a separate project next month as it is not part of the basic system presented here. ETI

Below: the receiver removed from its case. Note the crystal.



Below: all you gotta do now is find something to shoot at.



BUYLINES

With a project of this type the metalwork is more important than for our usual endeavours. For the transmitter in particular, with the joysticks and aerial to be mounted, we cannot imagine anybody enjoying filing away for hours. In consequence we strongly recommend use of the hardware packs offered by the designers, Remcon. Our photographs and text employ these.

Ambit are marketing the components for this project, so between the two a complete kit is to be had. We estimate that, including four servos, the project will cost about £130 in total, which is approximately £60 less than a commercial set-up of approximately equal performance would cost.

The model we decided to base our installation on is the Tamiya Leopard A4 in 1/16th scale, which is designed for radio control. The kit is superb in all respects, both as a model and as a vehicle for radio control, and cannot be recommended highly enough. Beatties chain of stores stock the kit and it will cost around £90 including the gearbox/clutch/motor assembly for direction control.

Component details:
From Remcon.

Manual for system (worthwhile step-by-step constructional details) £2.75

£1.00 refundable against purchase of packs over £25

Transmitter hardware pack (everything except components and batteries):
4 channel £39.95
6 channel £45.00

All components available separately. SAE to Remcon for details.

Receiver hardware pack complete (six channels) £18.50

All components available separately.

From Ambit —

Transmitter components £10.95
Two PCB DIN plugs and charging resistors £1.60
Matched crystals (2) and DIN plug £4.00
Five-pin plug DIN (options) £0.75
Receiver components (complete) £8.95

All components available separately. Rechargeable batteries also available. SAE for details.

After considering the market availability of servos, we found that World Engines of 97 Tudor Avenue, Watford, Herts, have at least a dozen types to offer in both kit and assembled form — mostly American.

Fleet Electronics of 47 Fleet Road, Fleet, Hants can offer a design perfectly suited to our system in both kit and built form. There are undoubtedly many many more. Prices run from about £10 to about £15-£20 depending upon whether you intend to assemble it yourself.

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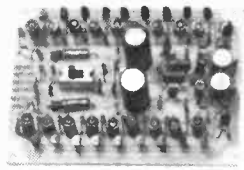
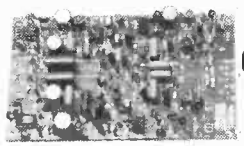
STEREO PRE-AMPLIFIERS

MC 1





CPR 1

CPR 1—THE ADVANCED PRE-AMPLIFIER

The best pre-amplifier in the U.K. The superiority of the CPR 1 is probably in the disc stage. The overload margin is a superb 40dB, this together with the high slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design. R.I.A.A. is accurate to 1dB; signal to noise ratio is 70dB relative to 3.5mV; distortion <.005% at 30dB overload 20kHz. Following this stage is the flat gain/balance stage to bring tape, tuner, etc., up to power amp. signal levels. Signal to noise ratio 86dB; slew-rate 3V/uS; T.H.D. 20Hz — 20kHz<.008% at any level. F.E.T. muting. No controls are fitted. There is no provision for tone controls. CPR 1 size is 138 x 80 x 20mm. Supply to be ±15 volts.

MC 1 PRE-PRE-AMPLIFIER

Suitable for nearly all moving-coil cartridges. Sensitivity 70/170uV switchable on the p.c.b. This module brings signals from the now popular low output moving-coil cartridges up to 3.5mV (typical signal required by most pre-amp disc inputs). Can be powered from a 9V battery or from our REG 1 regulator board.

XO2 : XO3 — ACTIVE CROSSOVERS

XO2 — two way XO3 — three way Slope 24dB/octave Crossover points set to order within 10%

REG 1 — POWER SUPPLY

The regulator module, REG 1 provides 15-0-15v to power the CPR 1 and MC 1. It can be used with any of our power amp supplies or our small transformer TR 6. The power amp kit will accommodate it.

POWER AMPLIFIERS

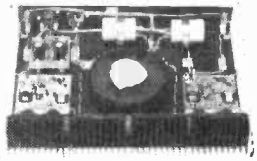
It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc., who have been using CRIMSON amps satisfactorily for quite some time. We have a reputation for the highest quality at the lowest prices. The power amp is available in five types, they all have the same specification: T.H.D. typically .01% any power 1kHz 8 ohms; T.I.D. insignificant; slew rate limit 25V/uS; signal to noise ratio 110dB; frequency response 10Hz-35kHz, —3dB; stability unconditional; protection drives any load safely; sensitivity 775mV (250mV or 100mV on request); size 120 x 80 x 25mm.

POWER SUPPLIES

We produce suitable power supplies which use our superb TOROIDAL transformers only 50mm high with a 120-240 primary and single bolt fixing (includes capacitors/bridge rectifier).

POWER AMPLIFIER KIT

The kit includes all metalwork, heatsinks and hardware to house any two of our power amp modules plus a power supply. It is contemporarily styled and its quality is consistent with that of our other products. Comprehensive instructions and full back-up service enables a novice to build it with confidence in a few hours.



POWER AMPLIFIER MODULES

CE 608 60W/8 ohms 35-0-35v	£16.30
CE 1004 100W/4 ohms 35-0-35v	£19.22
CE 1008 100W/8 ohms 45-0-45v	£23.22
CE 1704 170W/4 ohms 45-0-45v	£29.12
CE 1708 170W/8 ohms 60-0-60v	£31.90

TOROIDAL POWER SUPPLIES

CPS1 for 2 x CE 608 or 1 x CE 1004	£14.47
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CPS5 for 1 x CE 1708	£22.88
CPS6 for 2 x CE 1704 or 2 x CE 1708	£23.98

HEATSINKS

Light duty, 50mm, 2 C/W	£1.30
Medium power, 100mm, 1.4 C/W	£2.20
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Fan, 80mm, state 120 or 240v	£18.50
Fan mounted on two drilled 100mm heatsinks, 2 x 4 C/W, 65 C max. with two 170W modules	£29.16
THERMAL CUT-OUT, 70 C	£1.38

POWER AMP KIT £32.40

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.

CPRI	£29.49	CPRIS	£39.98
MCI	£18.50	MCIS	£29.49

ACTIVE CROSSOVERS

XO2	£14.83	XO3	£23.06

POWER SUPPLY:

REGI	£5.75	TR6	£1.75

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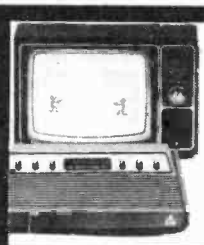

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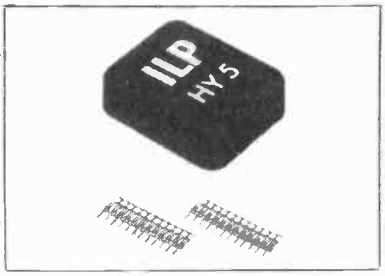
FEATURES: Complete pre-amplifier in single pack — Multi-function equalization — Low noise — Low distortion — High overload — two simply combined for stereo.

APPLICATIONS: Hi-Fi — Mixers — Disco — Guitar and Organ — Public address.

SPECIFICATIONS:

INPUTS: Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; input impedance 47kΩ at 1kHz.
OUTPUTS: Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS: Treble ± 12dB at 10kHz; Bass ± at 100Hz
DISTORTION: 0.1% at 1kHz; Signal/Noise Ratio 68dB.
OVERLOAD: 38dB on Magnetic Pick-up; SUPPLY VOLTAGE ± 16.5DV

Price £6.27 + 78p VAT. P&P free.
HY5 mounting board B1 48p + 6p VAT P&P free.



HY30
15 Watts into 8Ω

The HY30 is an exciting New kit from I.L.P. it features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available

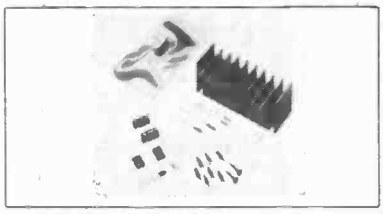
FEATURES: Complete kit — Low Distortion — Short, Open and Thermal Protection — Easy to Build.

APPLICATIONS: Updating audio equipment — Guitar practice amplifier — Test amplifier — Audio oscillator.

SPECIFICATIONS:

OUTPUT POWER 15W R.M.S. into 8Ω. DISTORTION 0.1% at 15W
INPUT SENSITIVITY 500mV FREQUENCY RESPONSE 10Hz-16kHz — 3dB
SUPPLY VOLTAGE ± 18V.

Price £6.27 + 78p VAT. P&P free.



HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components.

APPLICATIONS: Medium Power Hi-Fi systems — Low power disco — Guitar amplifier.

SPECIFICATIONS: INPUT SENSITIVITY 500mV.
OUTPUT POWER 25W RMS in 8Ω LOAD IMPEDANCE 4-16Ω. DISTORTION 0.04% at 25W at 1kHz.
SIGNAL/NOISE RATIO 75dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB
SUPPLY VOLTAGE ± 25V. SIZE 105.50.25mm.

Price £8.18 + £1.02 VAT. P&P free.

HY120
60 Watts into 8Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection, this amplifier sets a new standard in modular design.

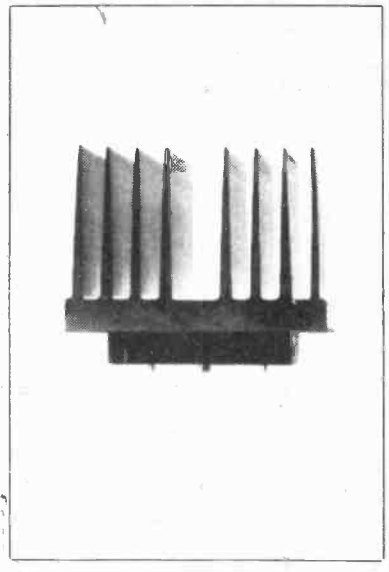
FEATURES: Very low distortion — Integral Heatsink — Load line protection — Thermal protection — Five connections — No external components.

APPLICATIONS: Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ.

SPECIFICATIONS:

INPUT SENSITIVITY 500mV
OUTPUT POWER 60W RMS into 8Ω LOAD IMPEDANCE 4-16Ω. DISTORTION 0.04% at 60W at 1 kHz
SIGNAL/NOISE RATIO 90dB. FREQUENCY RESPONSE 10Hz-45kHz —3dB. SUPPLY VOLTAGE ±35V.
Size 114 x 50 x 85mm.

Price £19.01 + £1.52 VAT. P&P free.



HY200
120 Watts into 8Ω

The HY200, now improved to give an output of 120 Watts, has been designed to stand the most rugged conditions, such as disco or group while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown — Very low distortion — Load line protection — Integral Heatsink — No external components.

APPLICATIONS: Hi-Fi — Disco — Monitor — Power Slave — Industrial — Public address.

SPECIFICATIONS:

INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.05% at 100W at 1kHz.
SIGNAL/NOISE RATIO 96dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB. SUPPLY VOLTAGE ±45V.
SIZE 114 x 50 x 85mm.

Price £27.99 + £2.24 VAT. P&P free.

HY400
240 Watts into 4Ω

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

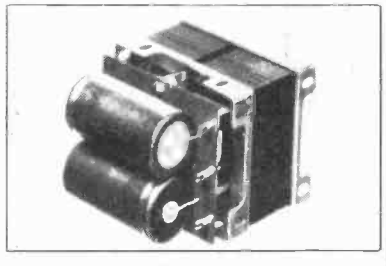
FEATURES: Thermal shutdown — Very low distortion — Load line protection — No external components.

APPLICATIONS: Public address — Disco — Power slave — Industrial.

SPECIFICATIONS:

OUTPUT POWER 240W RMS into 4Ω. LOAD IMPEDANCE 4-16Ω. DISTORTION 0.1% at 240W at 1 kHz.
SIGNAL/NOISE RATIO 94dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB. SUPPLY VOLTAGE ±45V
INPUT SENSITIVITY 500mV. SIZE 114 x 100 x 85mm.

Price £38.61 + £3.09 VAT. P&P free.



POWER SUPPLIES

PSU36 suitable for two HY30's **£6.44** + 81p VAT
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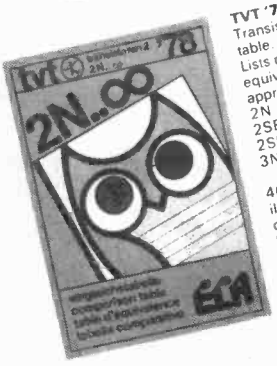

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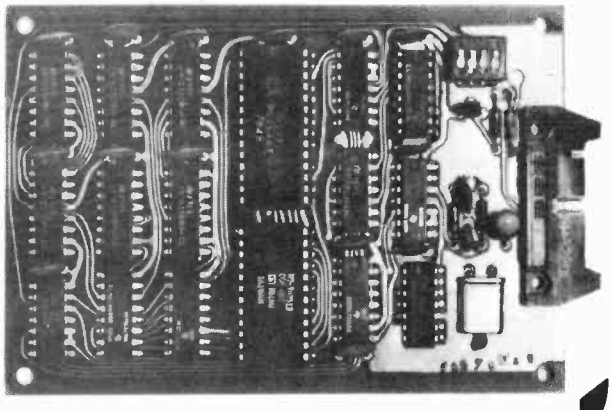

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microfile.....

After a month off from the mortifying task of writing Microfile, Gary Evans returns to talk over two stories — one straight applications tale, and a little oddity to astound and amuse!

WHILE I'd like to think that the hundreds of PETS, TRS-80s et al being sold each month are going into the homes of the likes of us to bring a bit more joy into our lives by thrusting us into the world of intergalactic warfare it's an educated guess that this is not so. Most small computers will be expected to work rather than play for their living.

Special Breed

Now most magazines that carry stories about "computing" things, ourselves included, have described that special breed of man — is it a bird? Is it a plane — no it's a small businessman (whatever happened to the tall businessman?) who realises the potential of a computer in his activities AND has the programming skills to write his own software or to modify a standard package to meet his exact specification.

If he is unable to do much because until now there has not been much activity in the area of software houses to provide a comprehensive, and cost effective package, it would be difficult to convince our man that after paying £700 for a computer he should pay £5000 to get it to do anything.

Do Anthing

You may have gathered that I'm about to brighten up the gloomy picture painted above. I happened to be at the premises of a component supplier well known to readers of ETI when poking my head around a door (nosey if you like but I prefer to call it a strong journalistic instinct) what greeted my eyes was a system that would be most people's dream.

Now I can never figure out my bank statement and am continually running out of sugar — what I'm trying to say is that my knowledge of financial control systems and stock control techniques, is nil.

To my uneducated eye the package (PET based incidently) was a very impressive beast. As goods were dispatched, invoices would be prepared and stock levels adjusted — that seems good to me. Also provided was a word processor package which many people are starting to see as an essential part of an organisation with a large outgoing mail of primarily standard letters.

The guy responsible for this feast was a Mr Grant. I went to see Mr Grant as soon as I could.

The thing that struck me during the conversation; apart from a tail — Mr Grant has a dog, was that Mr Grant is a very skillful business man. He built up a photographic processing house from nothing to a very sizeable company when he went into the laundrette line. Photography to washing.

Well our Mr Grant likes a challenge and he saw that after a boom in the 60's laundrettes were a declining business. A challenge.

He took over shops in the red and tried to put them in the black. In nearly all cases he was successful.

He also has a knowledge of programming, machine/assembly language on an old singer.

He first came across personal computer last November at a show. He thought not much more of it until over dinner one night a friend in market research described an agency system he used to process his data — do you like coffee A etc.

The cost and the frequent delays were lamented by the friend. A challenge. Mr Grant calmly offered to devise a package for a total capital outlay of less than about £3000.

He did, his friend is happy and Mr Grant has decided to offer his services to others.

He is opening a shop which will provide an initial feasibility study and estimate. Then, if all parties agree, installation, software modifications and continued support. If you employ more than about ten and don't like spending most nights "doing the books" see Mr Grant.

To end this tale on a cautionary note I have been told of one MD who was keen on installing a computer and doing it himself. He was so taken up with programming that he neglected other affairs. When he had a system he had no company.

The Odd One

I'd like estimates as to when you the readers think Texas are to launch their long-awaited small system. No sign of it at the WES in America this year. Send me, please, a date and the odds you feel should be offered. I'll report on your concensus and if anybody gets it right — you'll be really chuffed.

Four In A Row

Oxford won the boat race this year — not much to do with MPUs this — and the newscaster giving the result, with a totally straight face, said this is Oxford's fourth win in a row — well I suppose they play football against each other.

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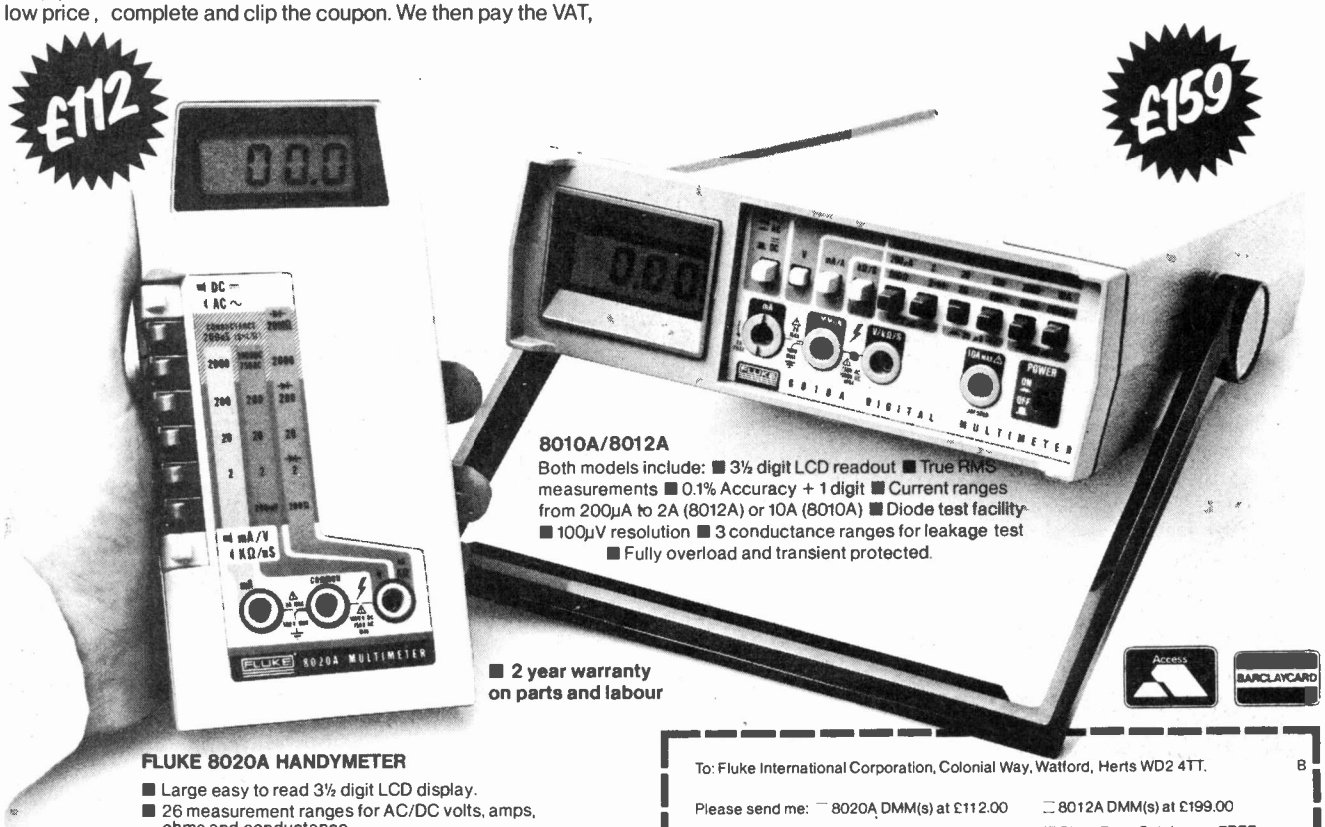

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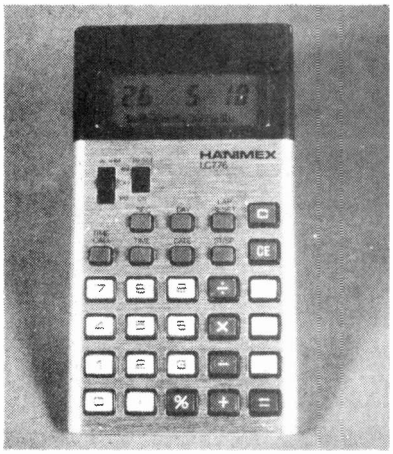

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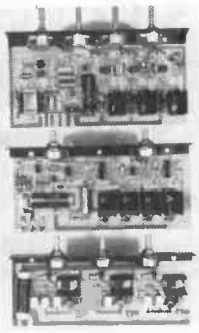

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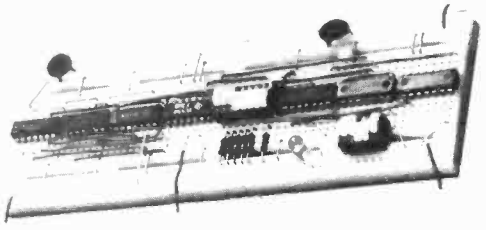

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BC153	0.085	0.070	0.055	0.045
BC172	0.075	0.060	0.050	0.040
BC173	0.075	0.060	0.050	0.040
BC205	0.070	0.055	0.040	0.035
BF181	0.240	0.200	0.185	0.160
BFY50	0.180	0.160	0.140	0.125
BFY51	0.180	0.160	0.140	0.125
BFY64	0.220	0.195	0.175	0.150
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BU205	1.000	0.900	0.800	0.750
BU208	1.250	1.100	1.000	0.950
LM311H	0.700	0.600	0.550	0.500
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BARCLAYCARD

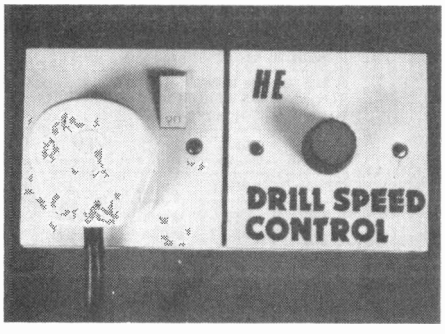
Hobby Electronics

Next Month

CB

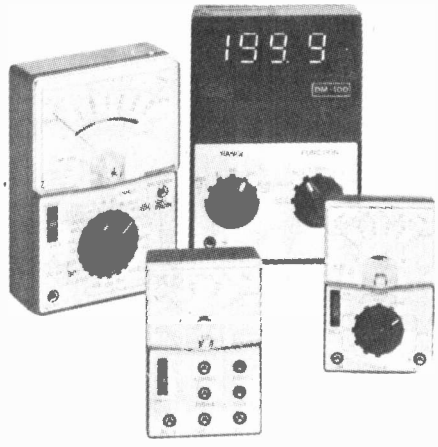
Open almost any American magazine and you'll see adverts for Citizen's Band (CB) transceivers. Although we don't have CB in Britain (yet) we though you'd like to know more about it. In the States it has a language all its own, but if you want it in plain English, look out for CB next month.

Drill Speed Controller



This unit regulates the speed of your trusty single-speed machine for those jobs, like masonry, when it's simply too fast.

Meters and Multimeters

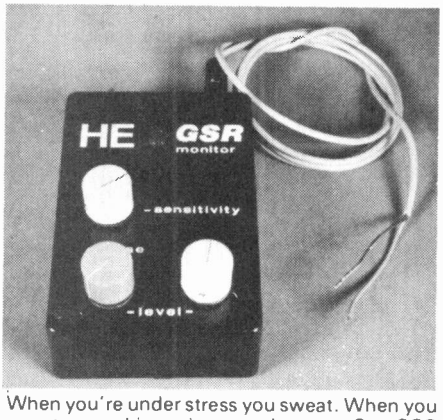


We published an introduction to test gear in the March issue. Next month Ray Marston explores the subject of meters and multimeters. He explains what is important in the spec., how they work and looks at the circuit of a current (no pun intended) design.

Into Electronics

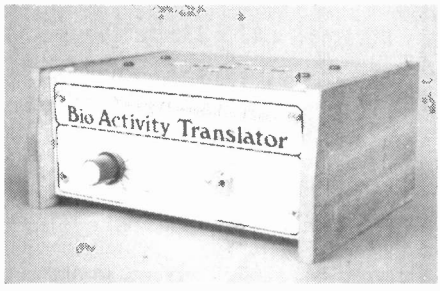
We conclude this very popular series with goggle boxes, fighter finders and number crunchers. Ian Sinclair goes into TV, radar and computers.

GSR Monitor



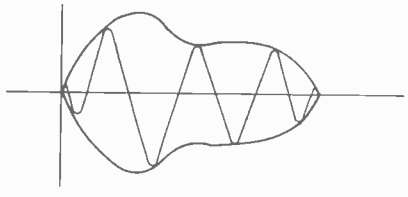
When you're under stress you sweat. When you sweat your skin resistance changes. Our GSR Monitor shows you (and everyone else) how you're feeling. Build it for fun or for more serious biofeedback experiments.

Kit Review



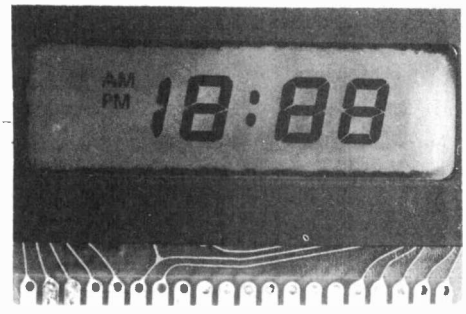
Would you like to hear your plants sing? Yes, sing. This kit combines a biological amplifier, to give more oomph to natural potentials produced by the plant, and a music synthesizer, controlled by the boosted plant power.

Envelope Generator



Built around the Motorola MC3340P attenuator chip, this unit gives you full Attack. Decay, Sustain and Release (ADSR) control.

Display Techniques



In this article Tim Orr looks at a variety of displays, including the familiar LED and LCD types. He explains how they work and what they're used for.

The June issue will be on sale on May 11th

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

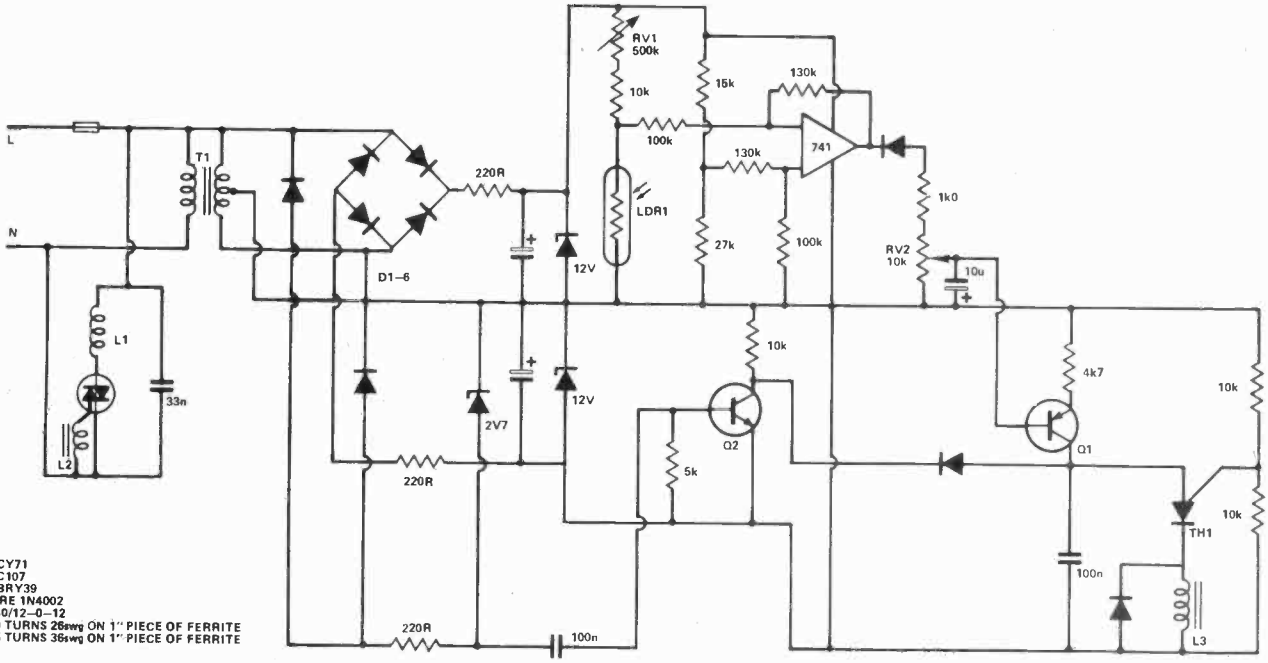
Porch Light Controller

R. Johnson

This circuit controls a light bulb, so that its brightness is approximately inversely proportional to the surrounding lighting conditions. This may be useful for a porch light, which would begin to switch on at dusk, reaching full brightness late in the evening. In the morning it would switch off again.

The dimmer consists of Q1, TH1 and their associated components. Q2 provides synchronisation pulses. RV1 effectively alters the time of day at which the light switches on and RV2 alters the maximum brightness of the bulb.

The LDR is connected to a differential amplifier whose output voltage rises when the resistance of the LDR is above about 600 kilohms (corresponding to dusk) and reaches a maximum when the resistance is about six megohms (corresponding to complete darkness).



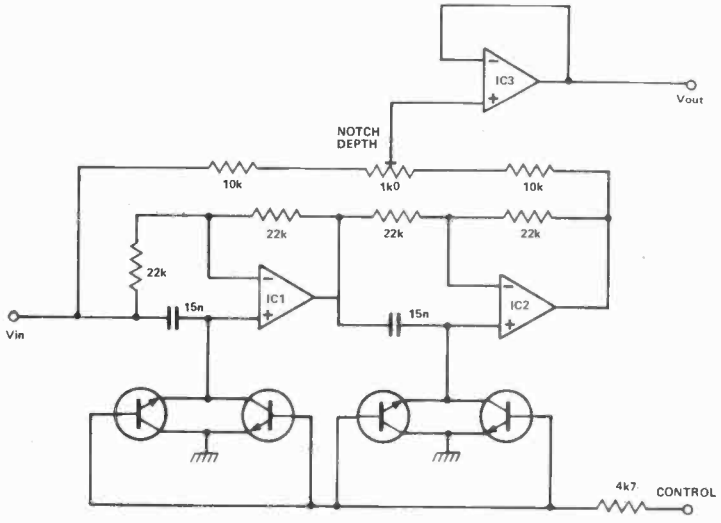
NOTE:
Q1 IS BCY71
Q2 IS BC107
TH1 IS BRY39
D1–6 ARE 1N4002
T1 IS 240/12–0–12
L1 IS 30 TURNS 26swg ON 1" PIECE OF FERRITE
L2 IS 15 TURNS 36swg ON 1" PIECE OF FERRITE

Variable Notch Filter

P. McChesney

In electronic music circuits there is need for an all-pass notch filter possessing a movable notch frequency. The circuit shown is capable of moving the reject frequency over a 10 kHz range throughout the full range of audio frequencies, the position of the notch being dependent on the voltage applied to the control input.

IC1 and IC2 are both all-pass filters possessing a flat frequency response well beyond the audio range, but having a phase difference between input and output signals of 0.5/CR. This phase difference becomes 180 degrees, so that if the output and input are mixed, signal cancellation occurs i.e. the circuit is now working as an all-pass notch filter, letting through all frequencies except at 0.5/CR.



The two transistor networks Q1, 2 and Q3, 4 act as voltage controlled resistors which allow the notch frequency to be moved when the control voltage is changed.

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, 25-27 Oxford St., London W1R 1RF.

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.022	0.10
.033	0.10
.047	0.10
.068	0.10
.1	0.12

250V — 7mm	
Value	Price
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.0015	0.08
.0022	0.08
.0033	0.08
.033	0.10
.047	0.10
.068	0.11
.1	0.14
.15	0.16
.22	0.18

100V — 7mm		100V — 100mm	
.18	0.18	.22	0.16
.22	0.18	.33	0.22
.27	0.23	.68	0.31
.33	0.23	1.00	0.41
.39	0.30		
.47	0.30	400V — 7mm	
.56	0.36	.001	0.07
.68	0.36	.0015	0.07
		.0022	0.07
		.0033	0.07
		.0047	0.07
		.0068	0.07

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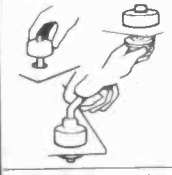

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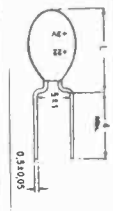
1.5						
2.2				£0.17		£0.17
3.3					£0.25	£0.21
4.7				£0.17		£0.21
6.8					£0.21	£0.23
10		£0.17		£0.21		£0.23
15		£0.21	£0.21	£0.23	£0.23	£0.35
22		£0.21		£0.23		£0.35
33			£0.23			£0.75
47	£0.21	£0.23			£0.75	
68				£0.65		
100	£0.23			£0.91		
150				£1.18		
220			£1.10			
330						
470		£1.10				



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TIC, TAC & TROM are NMOS — VIP is linear bipolar.
We recommend using DIL Sockets with these chips.

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10 MHz	HC25/µ	£2.95
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1A	T0220	£0.88	1A	T03	£1.56
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CA3000	£3.30	CA3054	£1.10	TBA530	£2.45	TDA1005	£3.50
CA3001	£4.25	CA3059	£2.10	TBA540	£2.00	TDA1022	£7.50
CA3002	£3.30	CA3060	£2.50	TBA5400	£2.70	TDA1024	£1.24
CA3006	£4.60	CA3062	£3.75	TBA550	£3.00	TDA1034	£4.75
CA3007	£4.15	CA3064	£1.10	TBA5500	£3.00	TDA2020A0	£4.50
CA3008	£2.55	CA3065	£1.10	TBA5600	£2.95	TDA2522	£3.50
CA3012	£1.85	CA3068	£3.00	TBA5600	£3.00	TDA2530	£2.90
CA3013	£1.85	CA3070	£1.90	TBA570	£2.10	TDA2540	£3.84
CA3014	£2.20	CA3071	£1.90	TBA5700	£2.20	TDA2541	£3.30
CA3018	£0.75	CA3072	£1.90	TBA6410	£3.00	TDA2560	£3.40
CA3018A	£1.10	CA3075	£1.70	TBA651	£2.50	TDA2571	£3.45
CA3020	£2.20	CA3076	£2.12	TBA673	£3.20	TDA2581	£2.85
CA3020A	£2.50	CA3080	£0.85	TBA700	£2.20	TDA2590	£3.70
CA3021	£2.40	CA3080A	£2.10	TBA750	£2.35	TDA2600	£4.10
CA3022	£2.20	CA3086	£0.50	TBA7500	£2.45	TDA2610	£3.10
CA3023	£2.20	CA3088E	£1.87	TBA790A	£1.75	TDA2611A	£1.98
CA3026	£0.70	CA3089E	£2.90	TBA800	£1.30	TDA2640	£2.70
CA3028A	£0.90	CA30900	£4.40	TBA810S	£1.30	TL080CP	£0.85
CA3028B	£1.25	CA3130	£1.06	TBA820	£0.80	TL081CP	£0.42
CA3029	£0.75	CA3140	£1.04	TBA920	£2.90	TL082CP	£0.80
CA3029A	£0.90	TAA263	£1.35	TBA9200	£3.00	TL083CN	£1.16
CA3030	£1.50	TAA300	£3.70	TBA980	£2.75	TL084CN	£1.45
CA3030A	£2.20	TAA521	£1.10	TBA9900	£3.00	SN76001N	£1.30
CA3033	£3.70	TAA522	£1.65	TCA105	£1.40	SN76003N	£3.00
CA3034	£2.75	TAA550	£0.48	TCA150	£1.80	SN76008KE	£1.95
CA3035	£1.95	TAA611B	£2.30	TCA180C	£2.66	SN76013N	£2.04
CA3036	£1.21	TAA621	£2.50	TCA2200	£2.10	SN76013ND	£1.72
CA3038	£2.90	TAA661A	£1.65	TCA270S	£2.90	SN76018KE	£1.90
CA3038A	£4.10	TAA661B	£1.45	TCA440	£1.65	SN76023N	£2.05
CA3039	£0.77	TAA790	£1.65	TCA640	£3.45	SN76023ND	£1.72
CA3040	£3.75	TAA700	£3.30	TCA650	£3.45	SN76033N	£3.00
CA3041	£1.65	TAA930A	£1.45	TCA660B	£3.45	SN76110N	£1.30
CA3042	£1.85	TAA930B	£1.45	TCA730	£3.00	SN76115N	£1.65
CA3043	£2.20	TBA120	£0.80	TCA740	£3.00	SN76116N	£1.80
CA3045	£1.55	TBA331	£0.90	TCA740	£2.60	SN76131N	£1.30
CA3046	£0.77	TBA341	£0.95	TCA800	£3.75	SN76226N	£2.56
CA3047	£2.20	TBA395	£1.80	TCA800Q	£3.05	SN76227N	£1.80
CA3047A	£3.78	TBA396	£1.20	TCA830S	£1.80	SN76228N	£1.85
CA3048	£2.45	TBA400	£2.20	TCA900	£1.85	SN76477N	£2.30
CA3049	£1.98	TBA440	£1.80	TCA910	£1.20	SN76530N	£1.50
CA3050	£2.66	TBA510	£1.76	TCA940	£1.90	SN76532N	£2.28
CA3051	£1.83	TBA520	£2.60	TCA980	£3.19	SN76533N	£2.17
CA3052	£1.78	TBA5200	£2.70	TDA1002	£2.10	SN76544N	£1.88
CA3053	£0.77	TBA530	£2.35	TDA1004A	£3.33	SN76545N	£1.80

TTL (see catalogue for full range)

SN74H05N	0.80	74LS75N	0.58	74LS195N	0.70	SN74S00N	0.77
SN74H10N	0.55	74LS76N	0.42	74LS196N	0.80	SN74S03N	0.77
SN74H11N	0.55	74LS78N	0.42	74LS197N	0.80	SN74S04N	0.94
SN74H20N	0.55	74LS83ANN	0.90	74LS221N	0.80	SN74S10N	0.77
SN74H21N	0.55	74LS85N	0.95	74LS240N	1.50	SN74S20N	0.77
SN74H30N	0.55	74LS86N	0.44	74LS241N	1.50	SN74S40N	0.77
SN75H40N	0.55	74LS90N	0.84	74LS242N	1.25	SN74S64N	0.77
SN74H51N	0.55	74LS91N	1.20	74LS243N	1.25	SN74S65N	0.77
SN74H53N	0.55	74LS92N	0.70	74LS244N	1.50	SN74S112N	1.70
SN74H54N	0.55	74LS93N	0.84	74LS245N	1.65	SN74S114N	1.70
SN74H55N	0.55	74LS95AN	0.90	74LS247N	1.09	SN74S140N	0.77
SN74H60N	0.55	74LS96N	1.35	74LS248N	1.09	SN74S157N	2.95
SN74H62N	0.55	74LS107N	0.42	74LS249N	1.08	SN74S186N	2.70
SN74L00N	0.55	74LS109N	0.42	74LS251N	1.00	SN74S188N	1.81
SN74L02N	0.55	74LS112N	0.42	74LS253N	1.00	SN74S200N	3.50
SN74L04N	0.60	74LS113N	0.42	74LS257N	1.00	SN74S201N	3.71
SN74L47N	3.19	74LS114N	0.42	74LS258N	1.00	SN74S262N	12.50
SN74L74N	0.90	74LS122N	0.62	74LS259N	1.55	SN74S287N	2.95
SN74L85N	2.62	74LS123N	0.83	74LS261N	3.25	SN74S288N	2.70
SN74L93N	2.38	74LS124N	1.70	74LS266N	0.44	SN74S289N	1.81
SN74LS00N	0.26	74LS125N	0.50	74LS273N	1.30	SN74S300N	5.06
SN74LS01N	0.26	74LS126N	0.50	74LS275N	3.20	SN74S301N	3.71
SN74LS02N	0.26	74LS132N	0.85	74LS279N	0.58	SN74S387N	3.05
SN74LS03N	0.26	74LS136N	0.42	74LS290N	1.65	SN74S470N	5.06
SN74LS04N	0.29	74LS138N	0.85	74LS293N	1.20	SN74S471N	£5.06
SN74LS05N	0.29	74LS139N	0.65	74LS295N	3.74	SN74S472N	13.48
SN74LS08N	0.26	74LS145N	1.30	74LS298N	1.00	SN74S473N	13.48
SN74LS09N	0.26	74LS147N	1.65	74LS299N	1.00	SN74S474N	13.48
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SN74LS14N	0.75	74LS156N	0.80	74LS328N	2.40	SN74S494N	0.90
SN74LS15N	0.26	74LS157N	0.60	74LS348N	1.10	SN74S495N	0.76
SN74LS20N	0.26	74LS158N	0.65	74LS352N	1.07	SN74S496N	0.54
SN74LS21N	0.26	74LS160N	0.80	74LS353N	1.07	SN74S497N	1.95
SN74LS22N	0.26	74LS161N	0.85	74LS365N	0.55	SN74100N	1.40
SN74LS25N	0.32	74LS162N	0.80	74LS366N	0.55	SN74107N	0.24
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SN74LS32N	0.27	74LS166N	1.65	74LS374N	0.85	SN74122N	0.55
SN74LS33N	0.29	74LS168N	1.45	74LS375N	0.88	SN74123N	0.55
SN74LS37N	0.32	74LS169N	1.45	74LS377N	1.30	SN74141N	0.56
SN74LS38N	0.32	74LS170N	1.90	74LS378N	1.00	SN74145N	0.85
SN74LS40N	0.26	74LS173N	1.10	74LS379N	1.25	SN74148N	1.35
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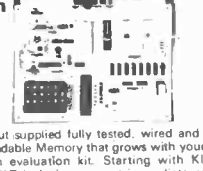
SN74LS47N	1.09	74LS175N	0.75	74LS390N	0.90	SN74151N	0.76
SN74LS48N	1.00	74LS181N	2.75	74LS393N	0.90	SN74153N	0.65
SN74LS49N	1.09	74LS183N	2.70	74LS395N	1.50	SN74154N	1.20
SN74LS51N	0.26	74LS189N	3.74	74LS398N	1.90	SN74156N	0.70
SN74LS54N	0.26	74LS190N	1.00	74LS399N	1.45	SN74157N	0.78
SN74LS56N	0.26	74LS191N	1.00	74LS490N	0.90	SN74160AN	0.90
SN74LS63N	1.26	74LS192N	0.95	74LS670N	1.98	SN74161AN	0.90
SN74LS73N	0.42	74LS193N	0.95				
SN74LS74N	0.42	74LS194N	0.70				

TRANSISTORS (See catalogue for full range)

2N3738	1.35	2N3900	.28	2N4222	.78	2N4347	2.20	40251	1.15	40407	.57	AF115	.70	BC138	.44	BF159	.37	TIP33A	.80	TIS50	.59
2N3740	2.10	2N3901	.30	2N4223	.78	2N4348	2.65	40254	.56	40408	.82	AF116	.70	BC140	.30	BF160	.33	TIP33C	1.18	TIS52	.82
2N3741	2.20	2N3902	7.00	2N4224	.78	2N4360	.36	40264	.86	40409	.82	AF117	.70	BC141	.32	BF161	.65	TIP34A	.97	TIS53	1.55
2N3766	1.50	2N3903	.20	2N4234	1.35	2N4390	.45	40280	3.70	40410	.82	AF118	.70	BC142	.32	BF166	.44	TIP34C	1.31	TIS54	.88
2N3771	2.15	2N3904	.10	2N4235	1.85	2N4400	.18	40309	.80	40411	3.10	AF124	.70	BC143	.32	BF167	.37	TIP35A	2.20	TIS58	.88
2N3772	2.20	2N3905	.18	2N4236	1.65	2N4401	.20	40310	.85	40412	.68	AF125	.70	BC147/A/B/C	.13	BF170	.76	TIP36A	3.00	TIS60	.20
2N3773	3.15	2N3906	.18	2N4237	.90	2N4402	.20	40311	.55	40414	4.99	AF126	.70	BC148A/B/C		BF173	.37	TIP41A	.78	TIS61	.25
2N3789	1.95	2N3945	.60	2N4238	1.28	2N4403	.20	40312	.99	40422	2.20	AF139	.75		.13	BF177	.27	TIP41C	.97	TIS62	.50
2N3790	2.05	2N3962	.95	2N4239	1.55	2N4409	.20	40313	1.38	40440	.78	AF172	.70	BC149/B/C		BF178	.27	TIP42A	.86	TIS64	.50
2N3791	2.25	2N3993	3.85	2N4240	1.70	2N4410	.20	40315	.80	4067A	1.05	AF178	1.30		.15	BF179	.33	TIP42C	1.08	TIS88A	.44
2N3792	2.40	2N4030	.53	2N4248	.22	2N4416	.88	40316	.95	40468A	.70	AF186	.55	BC152	.36	BF180	.37	TIP50	.82	TIS90	.22
2N3794	.21	2N4031	.55	2N4249	.20	2N4440	8.50	40317	.80	40513	1.89	AF200	1.30	BC153	.30	BF181	.37	TIP54	1.83	TIS91	.27
2N3819	.36	2N4032	.65	2N4250	.26	3N81	3.50	40324	.95	40514	1.60	BC107/A/B		BC154	.30	BF182	.37	TIP110	.77	TIS92	.33
2N3820	.39	2N4033	.65	2N4254	.83	3N83	2.25	40325	1.35	AC128	.48		.16	BC157/A/B		BF184	.41	TIP112	.93	TIS93	.36
2N3821	.95	2N4036	.72	2N4258	.50	3N128	1.35	40326	.90	AC151	.43	BC108/A/B/C			.15	BF185	.37	TIP115	.83	TL170	.45
2N3822	.85	2N4037	.60	2N4266	.22	3N139	1.60	40327	.73	AC152	.54		.16	BC158/A/B		BF194	.16	TIP117	.98	ZTX107	.17
2N3823	.95	2N4058	.22	2N4254	.27	3N140	1.10	40348	1.10	AC153	.59	BC109/B/C			.15	BF195	.16	TIP120	.87	ZTX108	.17
2N3824	.80	2N4059	.17	2N4275	.33	3N141	.95	40349	1.45	AC153K	.59		.16	BC159/A/B/C		BF196	.16	TIP122	1.04	ZTX109	.17
2N3826	1.70	2N4060	.22	2N4284	.38	3N142	.70	40360	.55	AC176K	.70	BC113	.22		.17	BF197	.18	TIP125	.93	ZTX300	.17
2N3827	.27	2N4061	.18	2N4286	.22	3N143	.80	40361	.55	AC176	.54	BC114	.22	BC160	.38	BF198	.19	TIP127	1.11	ZTX301	.17
2N3831	2.30	2N4062	.20	2N4287	.22	3N152	1.10	40362	.55	AC187	.59	BC115	.22	BC161	.38	BF199	.19	TIP130	1.16	ZTX302	.27
2N3854A	.30	2N4064	1.35	2N4288	.22	3N153	1.80	40363	1.45	AC187K	.65	BC116	.21	BC167/A/B		BF200	.38	TIP132	1.33	ZTX303	.27
2N3855	.30	2N4074	2.85	2N4289	.22	3N154	.99	40364	1.45	AC188	.54	BC116A	.22		.13	BF224J	.22	TIP135	1.26	ZTX304	.27
2N3855A	.30	2N4091	1.35	2N4290	.22	3N159	1.35	40372	1.15	AC188K	.65	BC117	.22	BF115	.39	BF225J	.27	TIP137	1.45	ZTX310	.17
2N3856A	.30	2N4092	.82	2N4291	.22	3N187	1.80	40373	1.65	AD136	2.75	BC118	.22	BF119	1.10	RF238	.55	TIP140	2.23	ZTX311	.18
2N3858	.22	2N4093	1.10	2N4292	.27	3N200	2.85	40374	1.65	AD142	1.45	BC119	.33	BF121	.60	TIP29A	.49	TIP142	2.57	ZTX312	.19
2N3858A	.22	2N4121	.27	2N4294	.22	3N201	1.35	40389	.78	AD143	1.45	BC122	.61	BF123	.60	TIP29C	.65	TIP145	2.47	ZTX313	.21
2N3859	.22	2N4122	.27	2N4297	.33	40050	1.70	40390	1.05	AD149	2.85	BC123	.65	BF134	.60	TIP30A	.54	TIP147	2.84	ZTX314	.27
2N3859A	.22	2N4123	.19	2N4302	.31	40081	1.20	40391	.80	AD150	3.10	BC125	.22	BF137	.60	TIP30C	.70	TIS34	1.05	ZTX320	.33
2N3860	.20	2N4124	.19	2N4303	.33	40232	.60	40392	.70	AD161	1.00	BC132	.33	BF139	.60	TIP31A	.54	TIS42	.50	ZTX330	.22
2N3866	1.98	2N4125	.19	2N4304	.28	40233	.70	40394	.80	AD162	1.00	BC134	.22	BF152	.27	TIP31C	.72	TIS43	.47		
2N3877	.28	2N4126	.19	2N4313	.60	40235	.65	40395	1.45	AF106	.60	BC136	.22	BF153	.27	TIP32A	.59	TIS45	.76		
2N3877A	.30	2N4220	.87	2N4342	.50	40237	.45	40396	1.45	AF109	.82	BC136	.21	BF154	.27	TIP32C	.82	TIS46	.55		
2N3879	2.20	2N4221	.80	2N4343	.77	40242	.86	40406	.73	AF114	.70	BC137	.22	BF157	.48			TIS49	.55		

NEW LOW PRICE "KIM" The Ready to Use Microprocessor System



Not a kit but supplied fully tested, wired and guaranteed. Expandable Memory that grows with your system not just an evaluation kit. Starting with KIM 1 at £107.95 VAT inclusive you get immediate capability which can be expanded to a complete system capable of addressing up to 65K BYTES of Memory.

KIM IS EXPANDABLE. Expand as you learn up to 65K.

KIM 1 — Basic board with above features assembled £107.95

KIM 3 — 8K static RAM card plugs into motherboard £140.35

KIM 4 — Motherboard (takes 8xKIM 3) + power supply £75.55

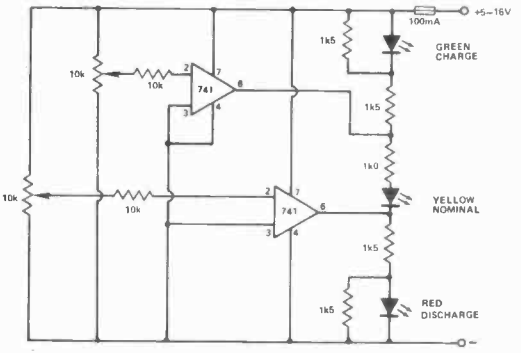
Battery Charge/Discharge Indicator

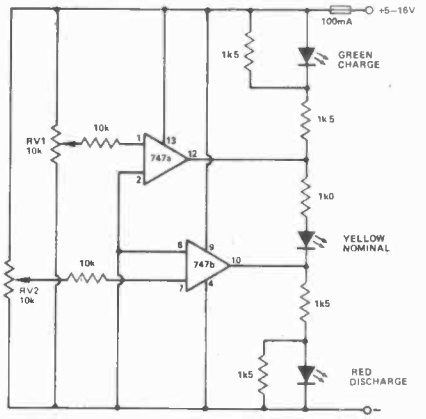
A. A. C. McInnes

This circuit is intended to monitor car battery voltage. It differs from other circuits in that it provides indication of the nominal supply voltage as well as low or high voltage. This makes it particularly useful for indicating deviation of the supply voltage from the nominal.

Three LEDs are used — red, yellow and green. Yellow indicates the nominal voltage and red and green indicate low and high values respectively. RV1 and RV2 adjust the point at which the red/yellow and yellow/green LEDs are on or off. Therefore, a wide supply voltage may be monitored.

The prototype has been installed in a car and set so that the red LED comes on at 11V.7 and the green LED at 12V.8. The yellow LED is on between these values.





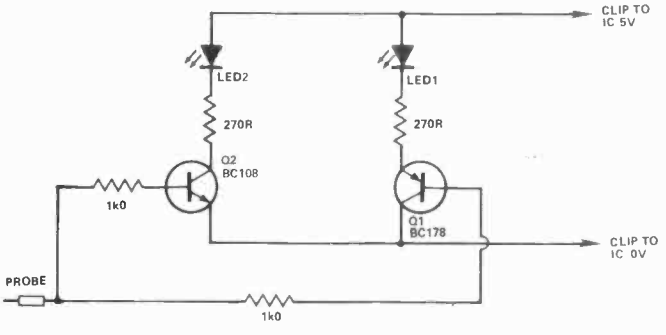
Crosshatch Generator Update

D. M. Lauder B.Sc.

Re the ETI Crosshatch Generator — it is rather difficult to make a 555 timer work at 249.6 kHz. The author tried three different devices, but none could quite manage it, even with the timing capacitor reduced to 100 p. Reducing R1 to 220 ohms helped, but greatly increased the power consumption. The final solution was to connect a 1N4148 diode between pins 3 and 7, with the cathode connected to pin 7. This turns the discharge transistor off more quickly by pulling it up with the output. It is then necessary to increase the timing capacitor to 270 p, as the internal propagation delays of the 555 have been reduced.

Simple Logic Probe

David Boreham



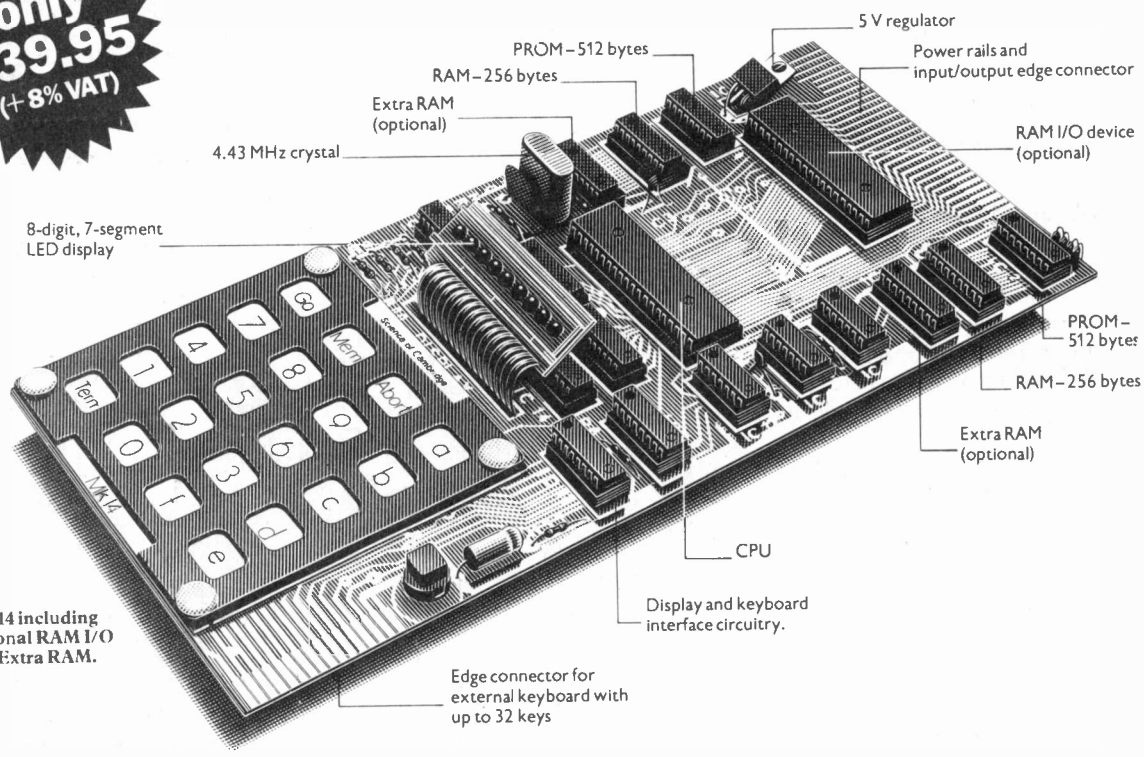
This simple piece of test equipment can be built using widely available components for little more than £1.

If the probe is connected to an IC pin which is at logic 0, Q1 will be turned on, lighting D1. If, however, the pin is at logic 1, Q2 will be turned on, lighting D2. In the case of a damaged IC there may be no connection to the pin. If this is so, both D1 and D2 will light together.

The author used a BC178 and BC108 for Q1 and Q2 respectively, but any NPN or PNP transistors will do. Similarly, D1, 2 can be any LEDs.

From Science of Cambridge: the new MK 14. Simplest, most advanced, most flexible microcomputer – in kit form.

only £39.95 (+8% VAT)



MK 14 including optional RAM I/O and Extra RAM.

The MK 14 is a complete microcomputer with a keyboard, a display, 8 x 512-byte pre-programmed PROMs, and a 256-byte RAM programmable through the keyboard.

As such the MK 14 can handle dozens of user-written programs through the hexadecimal keyboard.

Yet in kit form, the MK 14 costs only £39.95 (+£3.20 VAT, and p&p).

More memory – and peripherals!

Optional extras include:

1. Extra RAM – 256 bytes.
2. 16-line RAM I/O device (allowed for on the PCB giving further 128 bytes of RAM.
3. Low-cost cassette interface module – which means you can use ordinary tape cassettes/recorder for storage of data and programs.
4. Revised monitor, to get the most from the cassette interface module. It consists of 2 replacement PROMs, pre-programmed with sub-routines for the interface, offset calculations and single step, and single-operation data entry.
5. PROM programmer and blank PROMs to set up your own pre-programmed dedicated applications.

All are available now to owners of MK 14.

A valuable tool – and a training aid

As a computer, it handles operations of all types – from complex games to digital alarm clock functioning, from basic maths to a pulse delay chain. Programs are in the Manual, together with instructions for creating your own genuinely valuable programs. And, of course, it's a superb education and training aid – providing an ideal introduction to computer technology.

SPECIFICATIONS

●Hexadecimal keyboard ● 8-digit, 7-segment LED display ● 8 x 512 PROM, containing monitor program and interface instructions ●256 bytes of RAM ● 4 MHz crystal ● 5 V regulator ● Single 8 V power supply ● Space available for extra 256-byte RAM and 16 port I/O ● Edge connector access to all data lines and I/O ports

Free Manual

Every MK 14 kit includes a Manual which deals with procedures from soldering techniques to interfacing with complex external equipment. It includes 20 sample programs including math routines (square root, etc), digital alarm clock, single-step, music box, mastermind and moon landing games, self-replication, general purpose sequencing, etc.

Designed for fast, easy assembly

The MK 14 can be assembled by anyone with a fine-tip soldering iron and a few hours' spare time, using the illustrated step-by-step instructions provided.

How to get your MK 14

Getting your MK 14 kit is easy. Just fill in the coupon below, and post it to us today, with a cheque or PO made payable to Science of Cambridge. And, of course, it comes to you with a comprehensive guarantee. If for any reason, you're not completely satisfied with your MK 14, return it to us within 14 days for a full cash refund.

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Telephone: Cambridge (0223) 311488

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.
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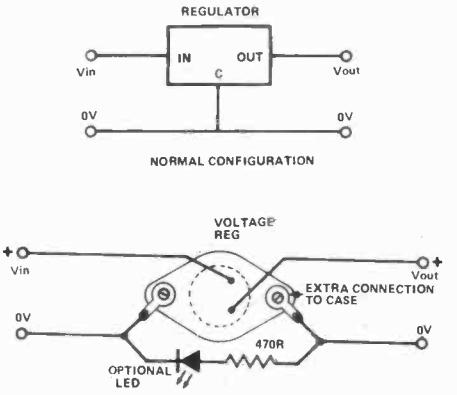
Fail-safe For IC Voltage Regulators

Andrew Bain

One of the problems with using power supplies based on IC voltage regulators is the chance that the common (case) connection could come off, allowing the output to rise to the full input voltage. If the regulator was driving TTL there could be disastrous consequences.

By using the regulator as shown and taking the output from another connection to the metal case, the output will drop to zero if a lead becomes disconnected.

An LED can be connected as shown, if required, to provide an indication of a fault.



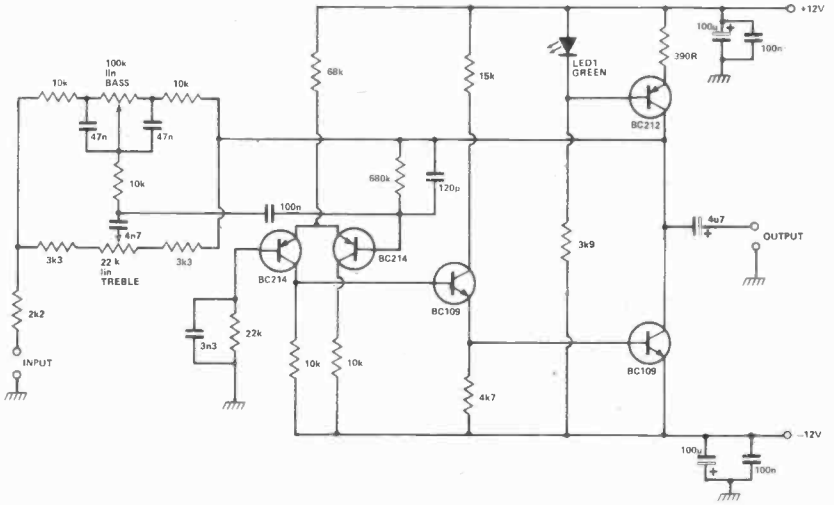
High Quality Tone Control

P. Mills

When designing a high quality preamp, the author was faced with the problem of designing a suitable tone control stage. Op amps such as the 741 are commonly used, but in general have a poor slew rate, fairly high distortion and high noise when used in this application.

The circuit shown is based on an inverting op amp using discrete transistors to overcome the above problems. The output stage is driven by a constant current source, biased by a green LED to provide temperature compensation.

With the controls flat the unit provides unity gain, so the stage can be switched in or out.



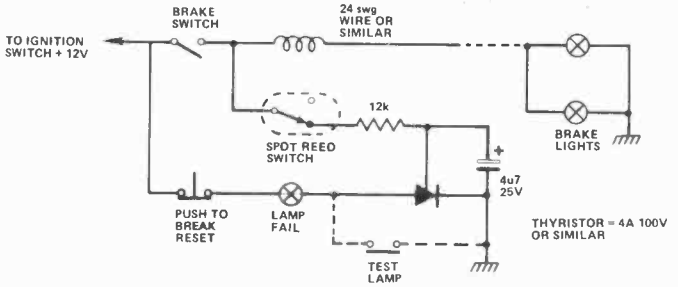
The design is suitable for inputs between 100 mV and 1V0. and provides a good overload margin at low distortion for the accurate reproduction of transients. The usual screening precautions against hum should be carried out.

Car Lamp Failure Warning

A. Taylor

Many lamp failure warning circuits indicate only when both bulbs are working or only when the lamps are on. The circuit shown solves this and has the added effect of not dimming the lamps as some failure circuits do.

A suitable gauge enamelled copper wire is wound around an SPDT reed switch until a certain number of turns is found that will only open the contacts when both lamps are working. If either or both of the lamps should fail, the contacts remain closed and the thyristor is triggered, illuminating the lamp failure indicator until the ignition switch is turned off or the circuit is reset.



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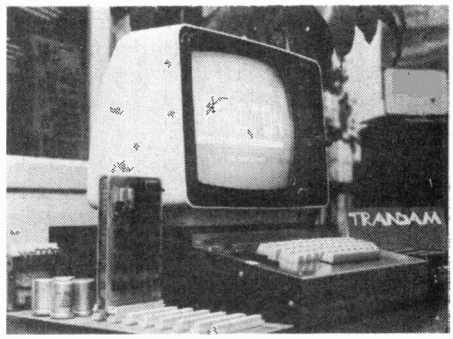

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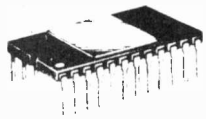

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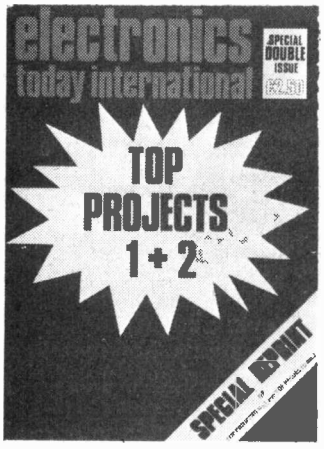

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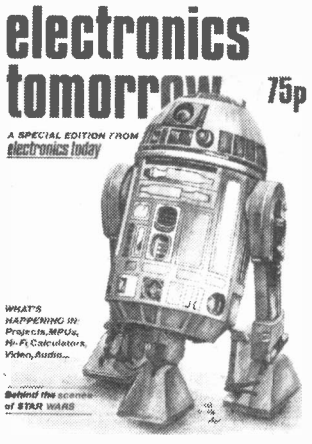

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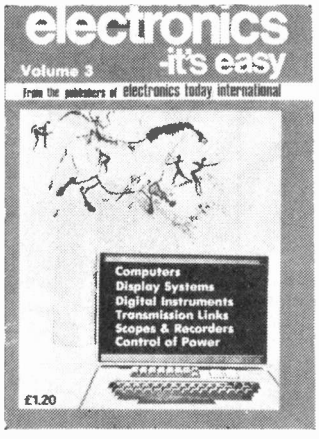

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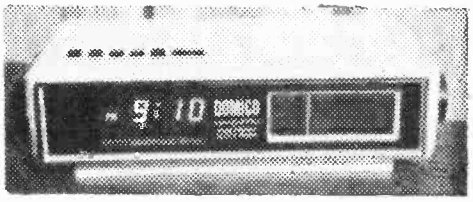

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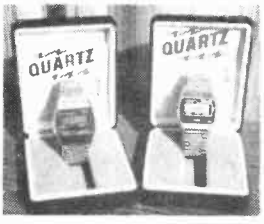

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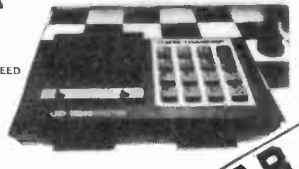

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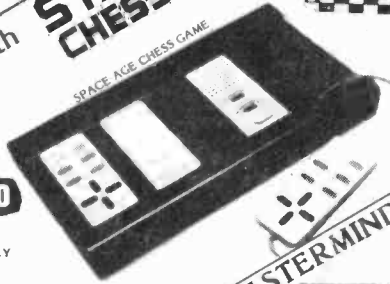

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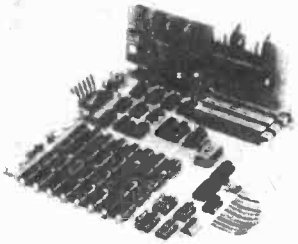

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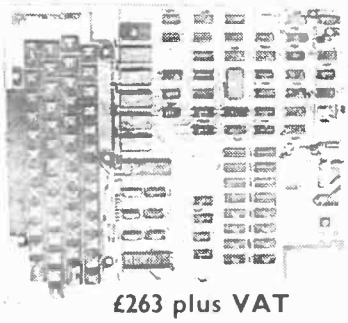

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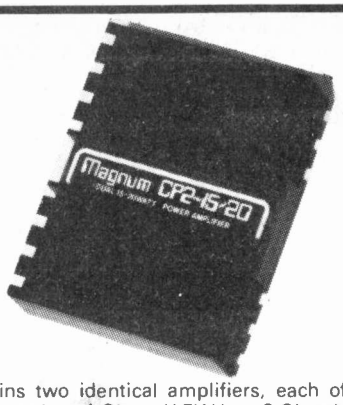

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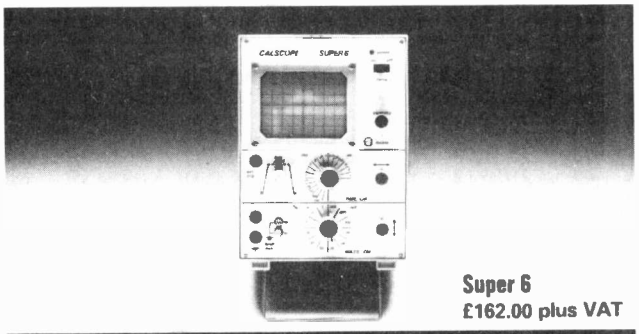

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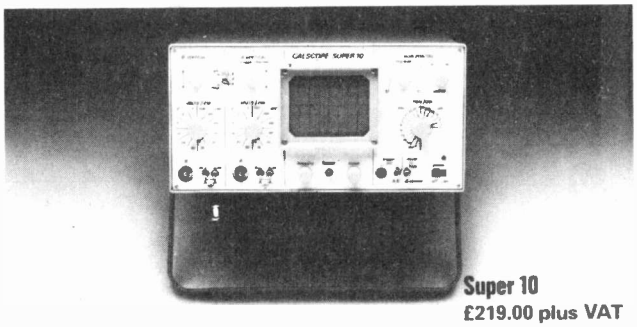

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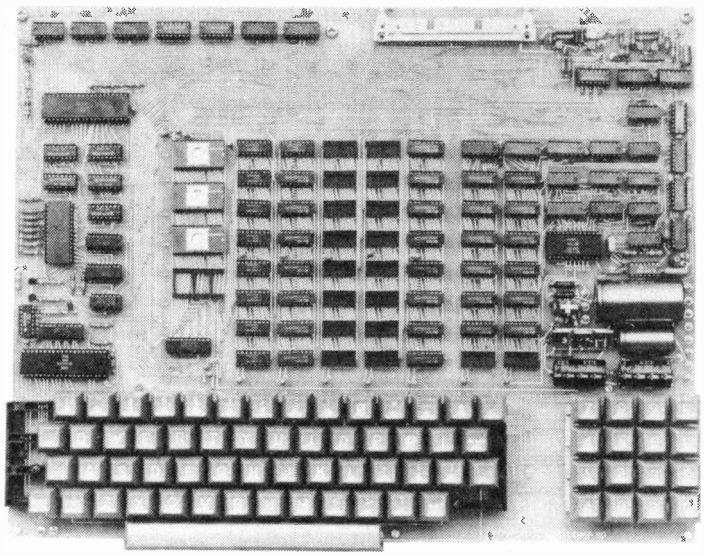

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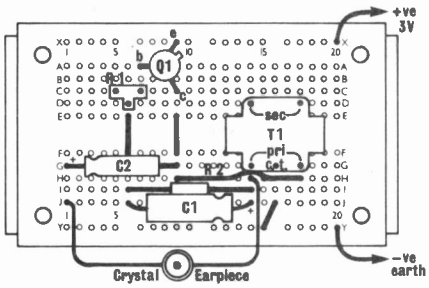

YOU WILL NEED

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C1, C2 – 50 uF, 12-VDC electrolytic capacitor
E1 – Crystal earphone
Q1 – Motorola HEP-230 pnp transistor
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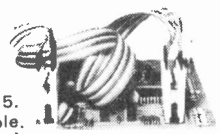

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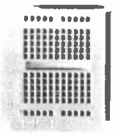

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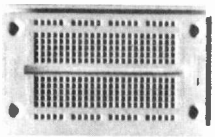

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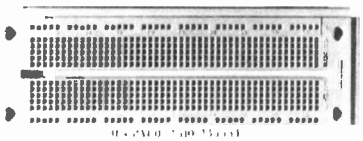

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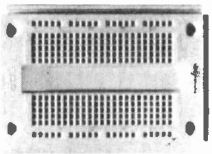

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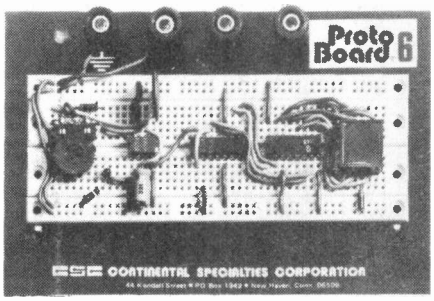

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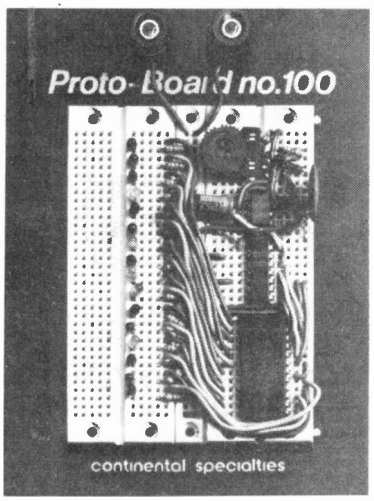

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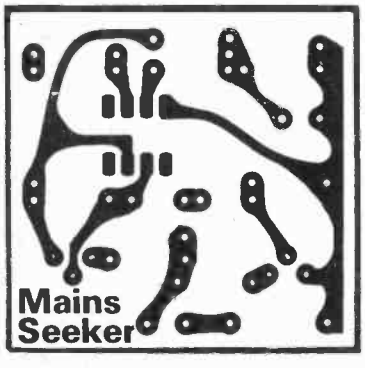
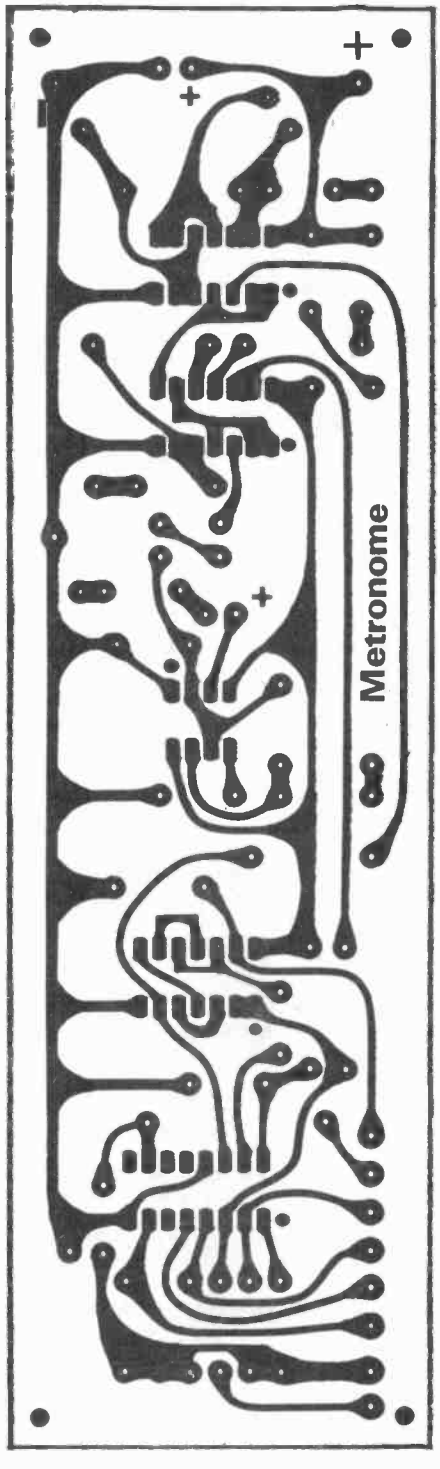
PCB FOIL PATTERNS

GATHERED HERE are all the PCBs for this month's projects. From now on the boards will be grouped together like this in order to facilitate their use by those readers wishing to produce their own PCBs from these patterns.

All are shown foil side up, and full size. Companies wishing to produce these for sale as ready made PCBs should note that where the board carries a copyright symbol, the designer retains that copyright to himself, so his company, and that particular board may not be produced on a commercial basis.

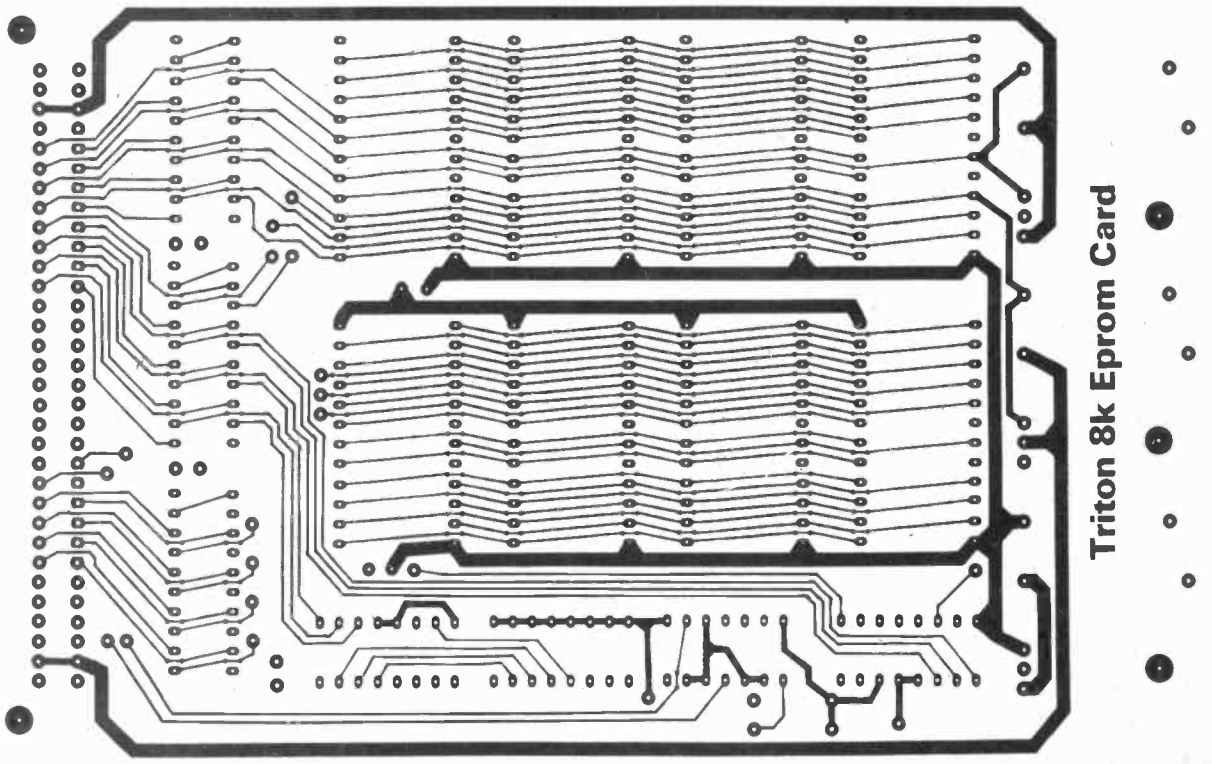
These pages form the basis of our ETIPRINT sheets, which are etch resistant transfers of the foil patterns, designed to simplify one-off PCB production. See the ad on page 71 for further details.





Left: the Mains Seeker foil pattern.

Right: the accentuated beat metronome board



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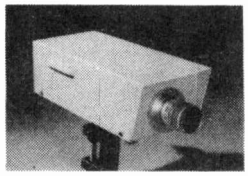

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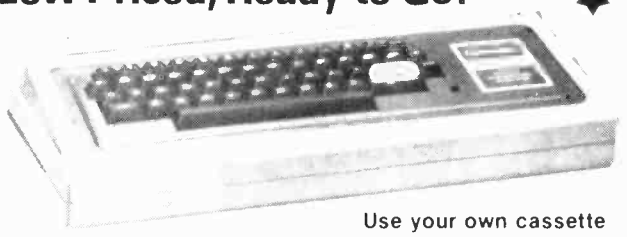

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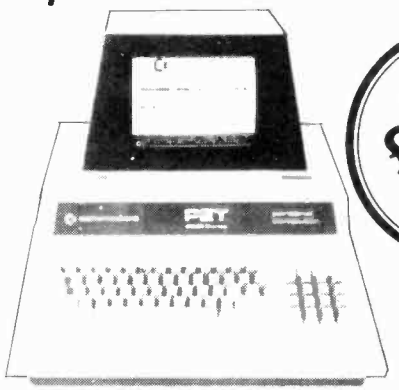

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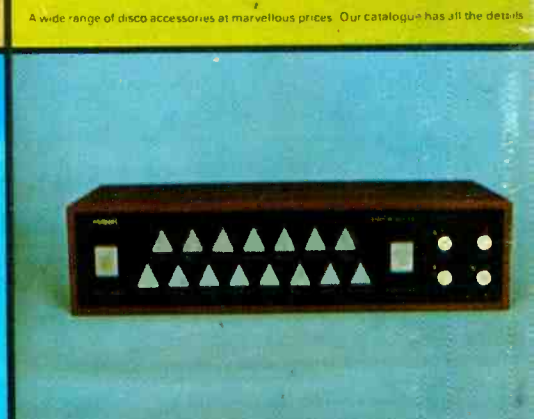

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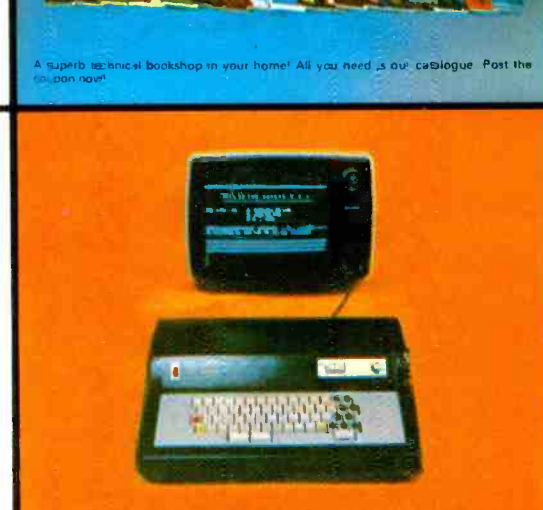

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