electronics today INTERNATIONAL

JUNE 1979

50p

HI-FI RECEIVER
70W HIGH QUALITY DESIGN

ELECTRONIC WARFARE
Mains Seeker
Accentuated Metronome
Triton 8K Extension

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

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

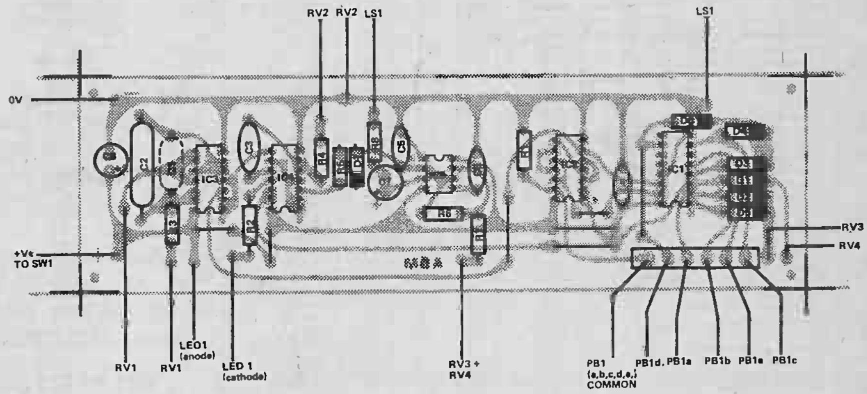
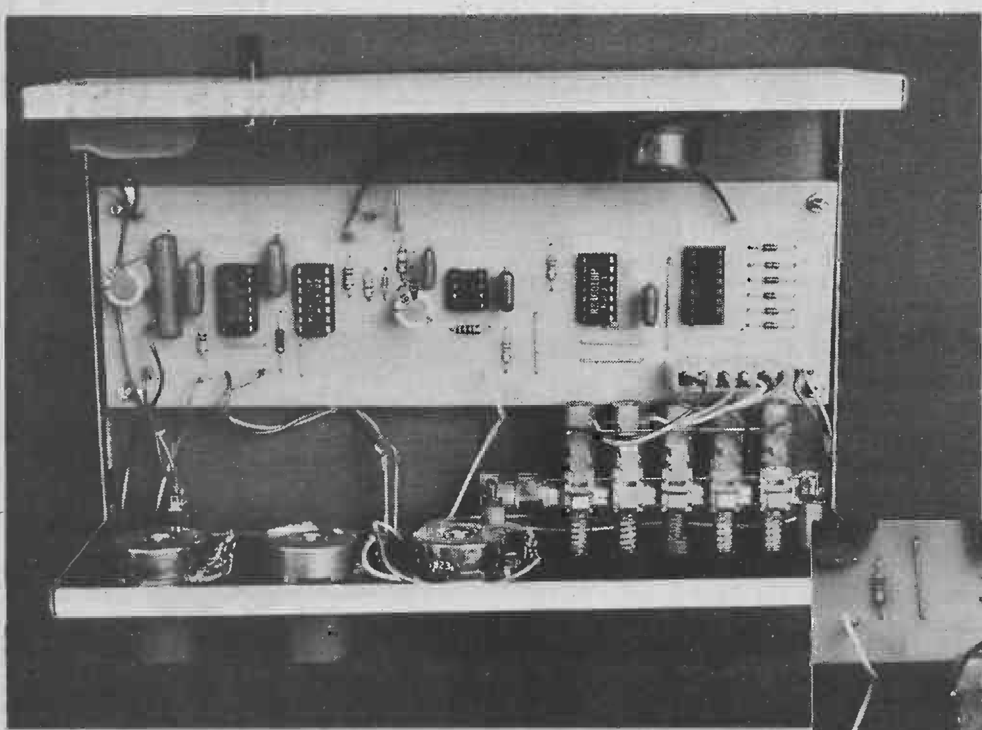
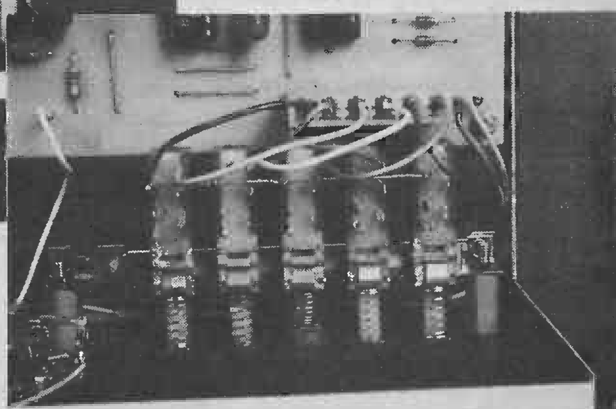


Fig. 3. Component overlay.



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.

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.

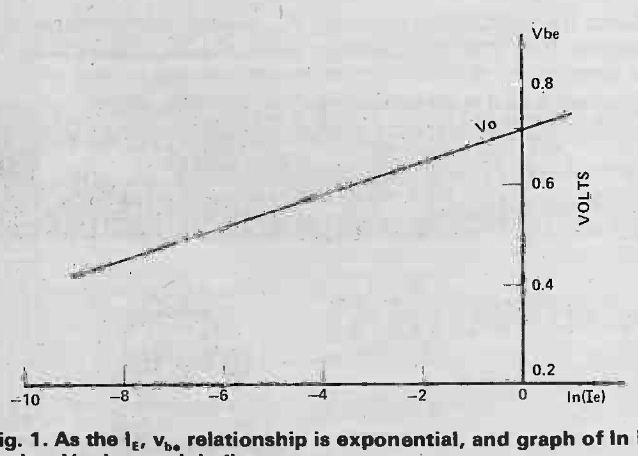


Fig. 1. As the I_E, v_{be} relationship is exponential, and graph of ln I_E against V_{BE} is a straight line.

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:

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

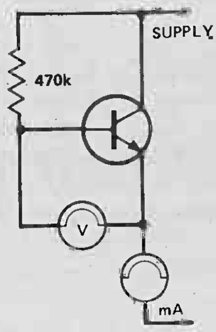


Fig. 2. The circuit used to verify the relationship between I_E and V_{BE}.

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

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

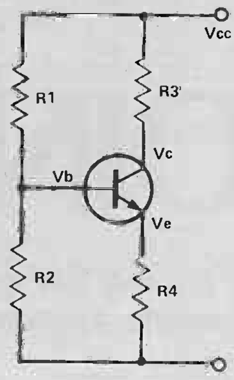
This turns out to be of the order of 30×10^{-3} when V_{BE} is in volts and I_E is in mA.

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:

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

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:

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

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

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

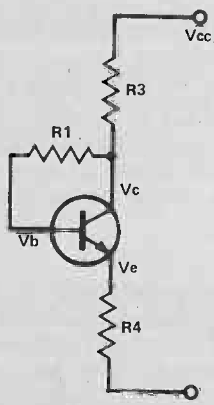
$$V_{BE} = m(\ln I_E) + V_0 \quad (7)$$

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

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

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:

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

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

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

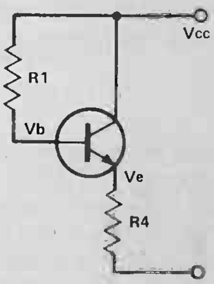
$$V_{BE} = m(\ln I_E) + V_o \quad (13)$$

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

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

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:

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

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

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

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

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

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.

ETI

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.

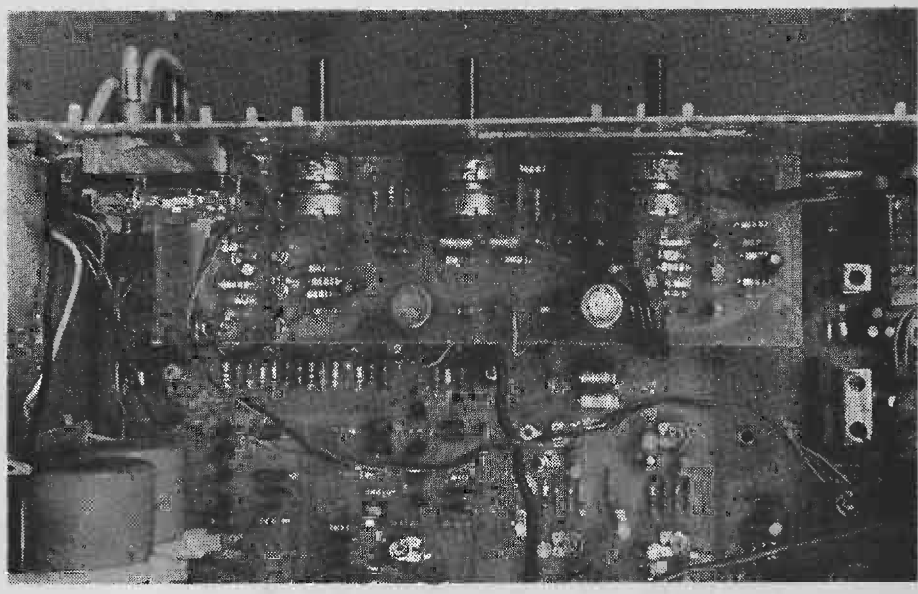
Head Start

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

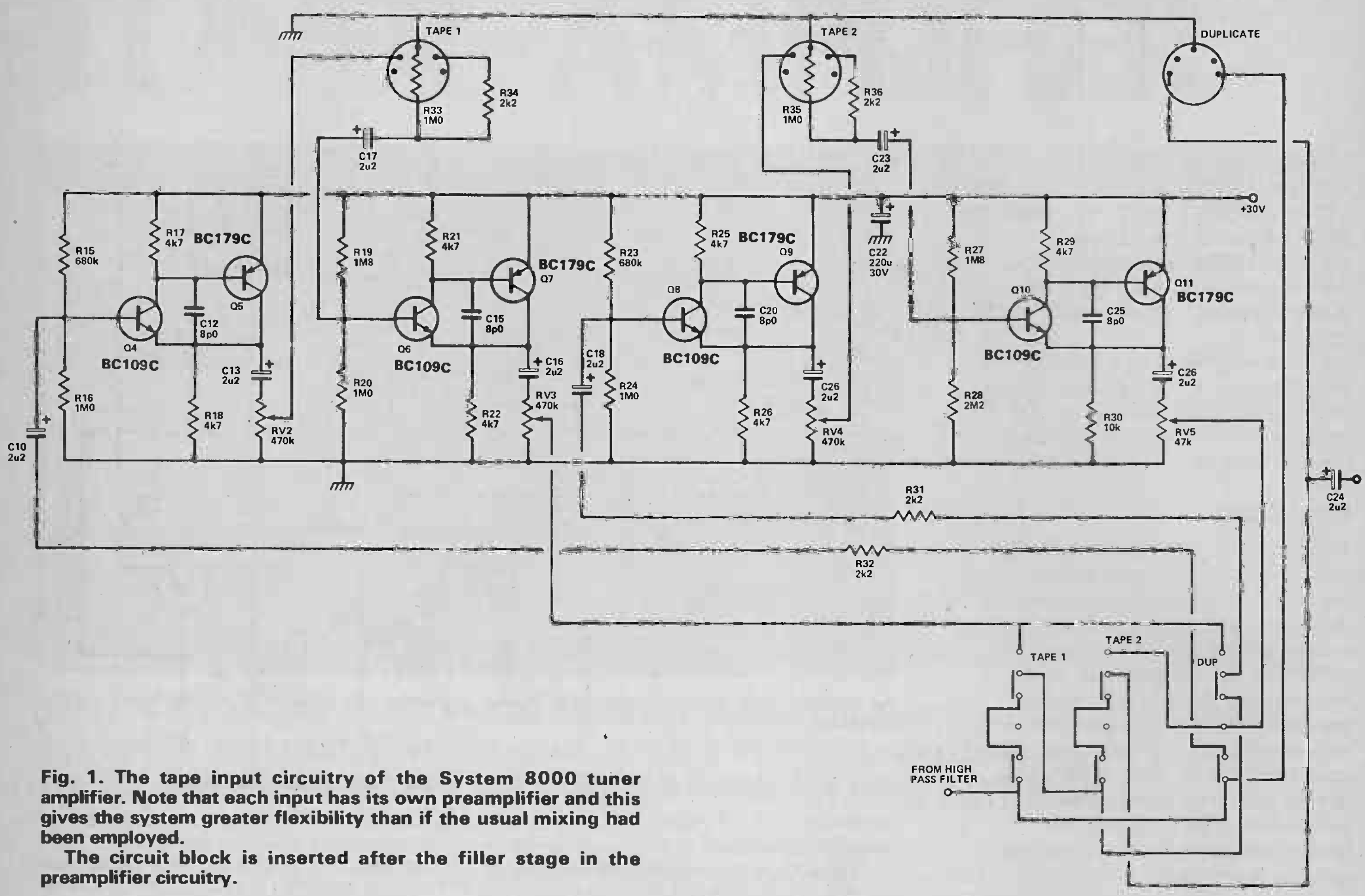
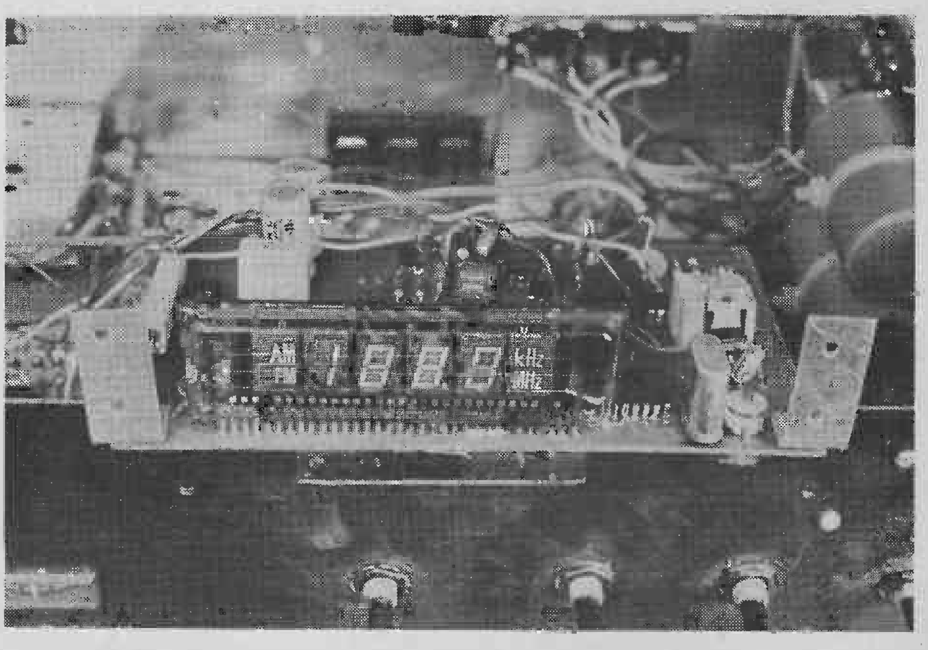


Fig. 1. The tape input circuitry of the System 8000 tuner amplifier. Note that each input has its own preamplifier and this gives the system greater flexibility than if the usual mixing had been employed.

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.

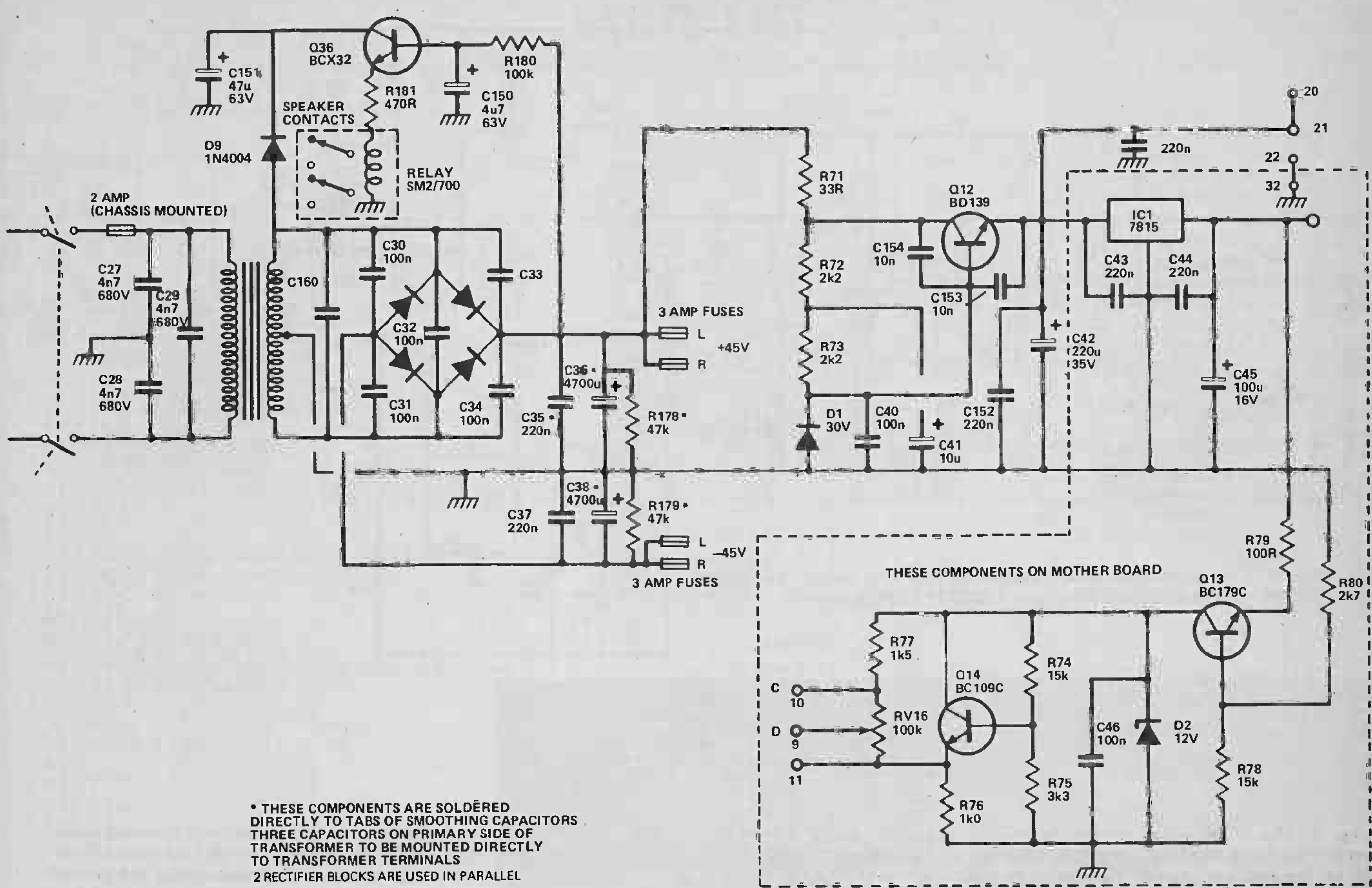
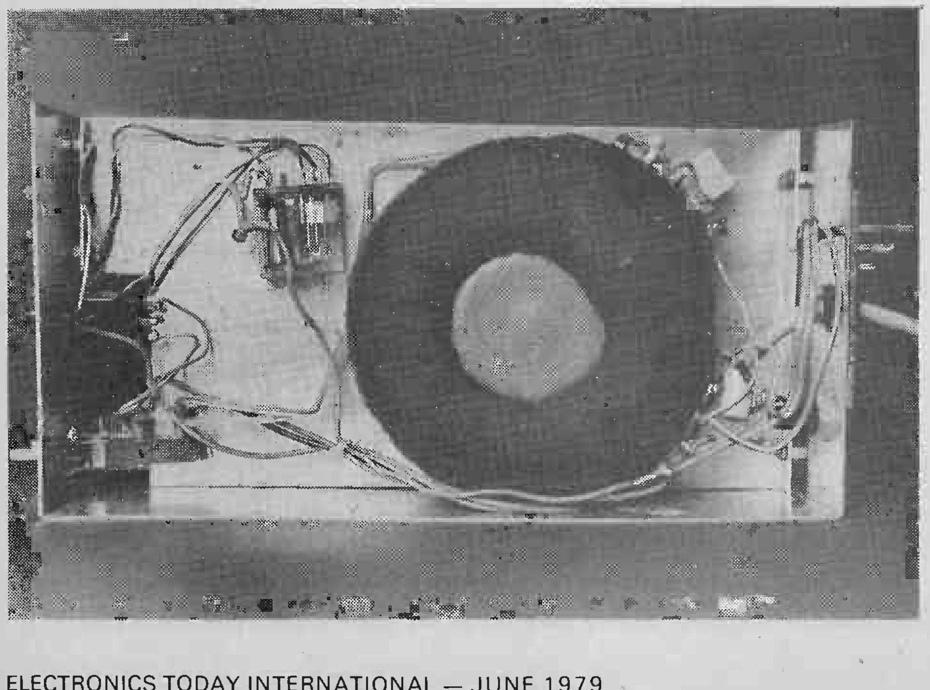


Fig 2. (Above) the power supply and speaker protection components and associated circuitry. Note that some components mount directly onto the main PCB and not onto the separate PSU board.

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 ▶

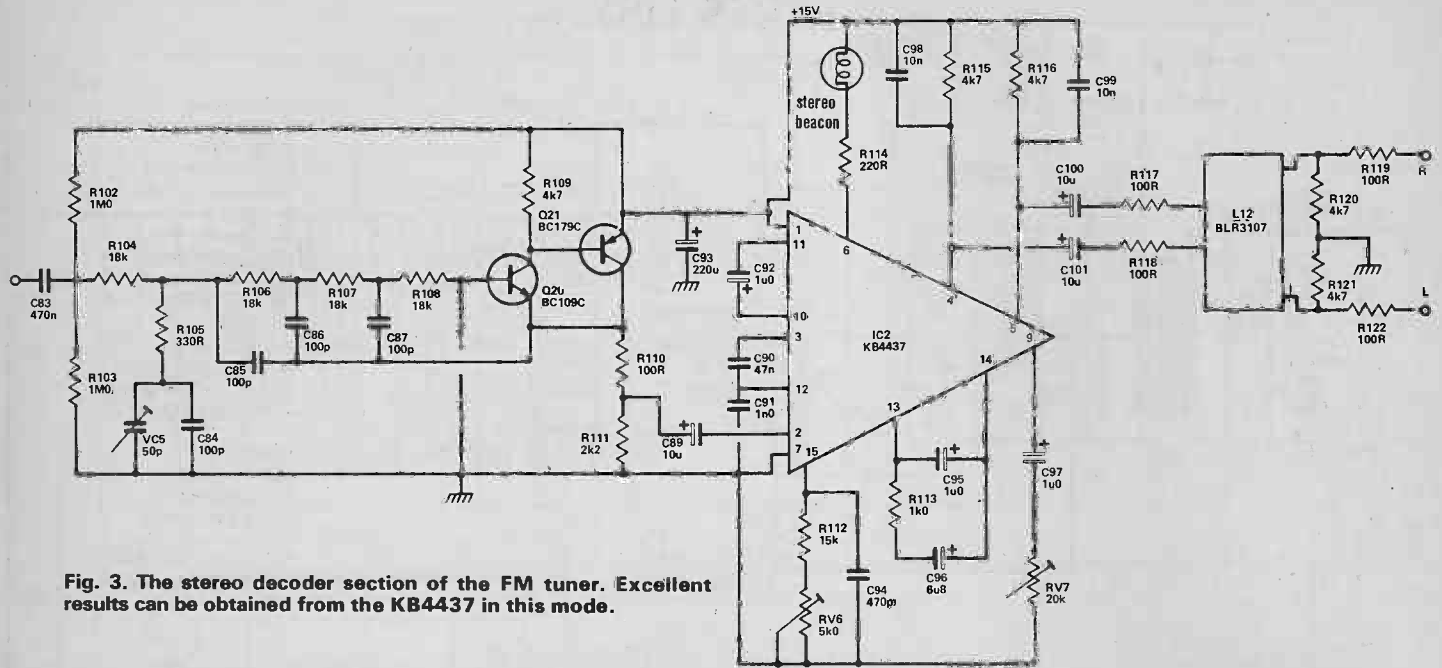
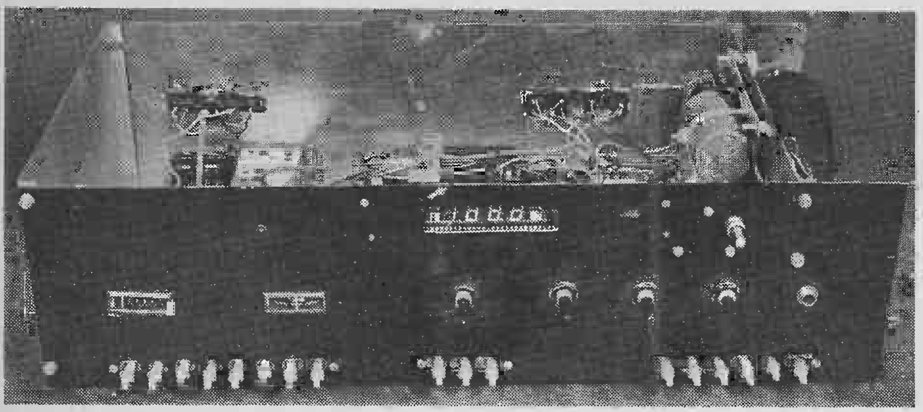


Fig. 3. The stereo decoder section of the FM tuner. Excellent results can be obtained from the KB4437 in this mode.


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

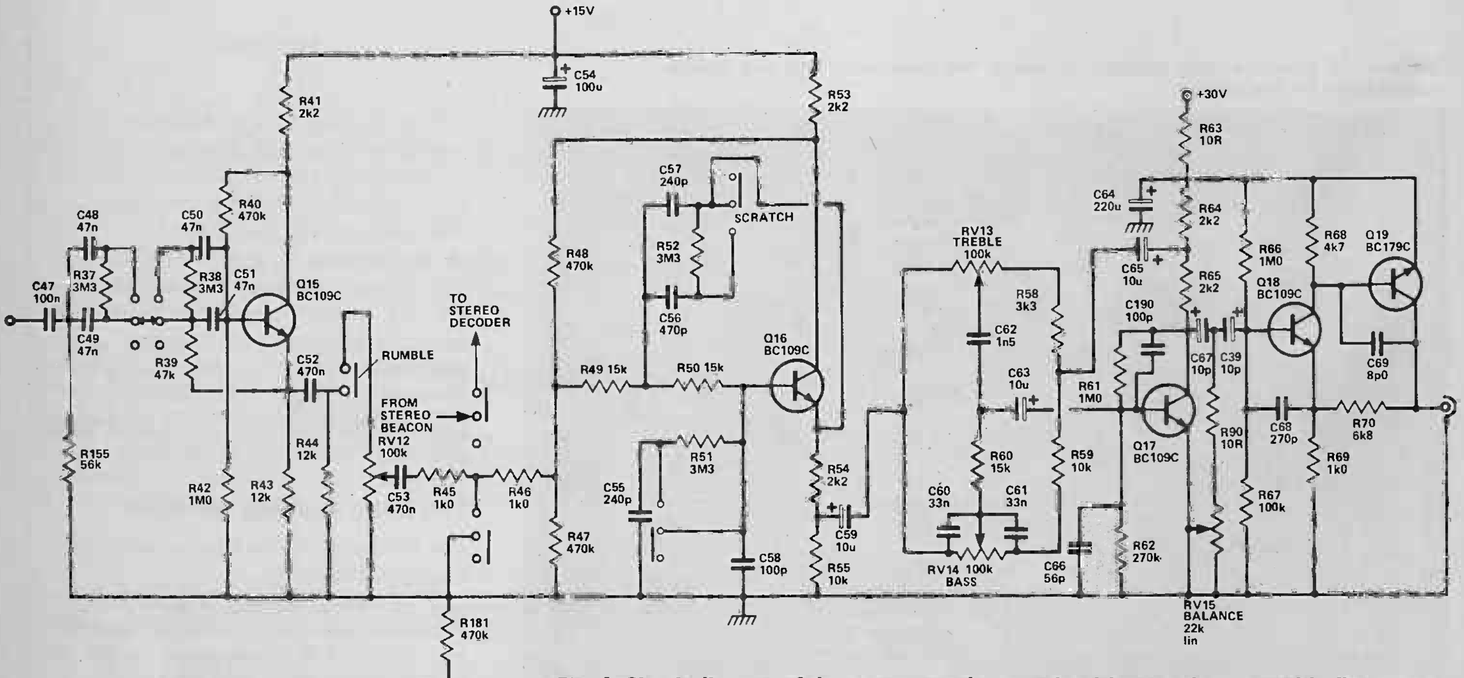


Fig. 4. Circuit diagram of the tone control network with scratch and rumble filters and mono/stereo switch.

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 ( ).

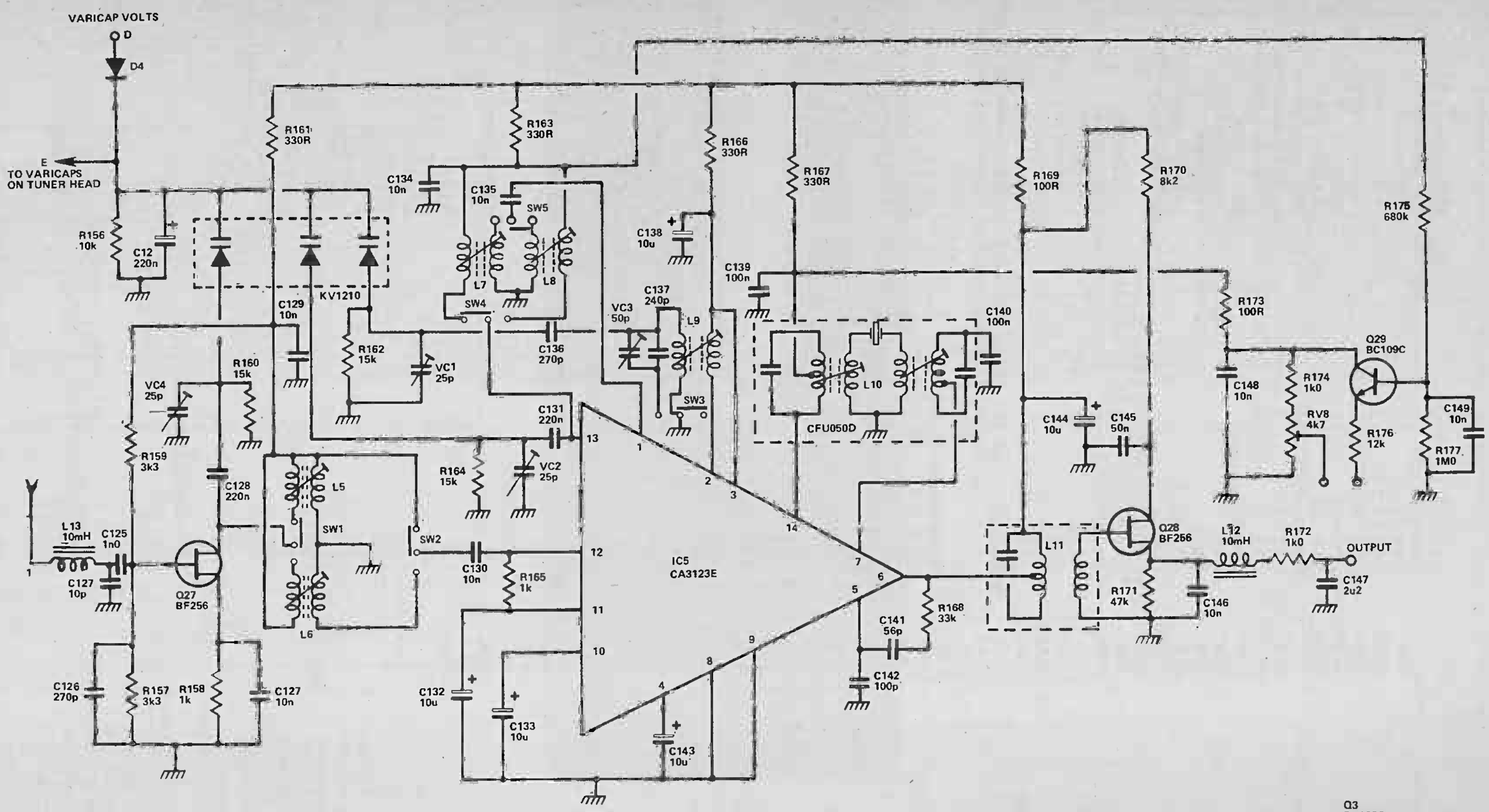


Fig. 5. (above) circuit diagram of the AM tuner, based on the CA3123 chip with its own internal RF amplifier.

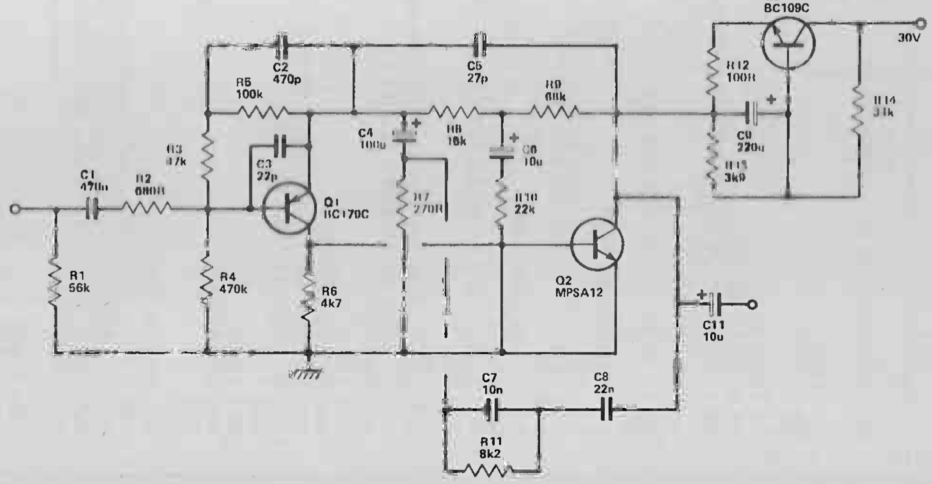


Fig. 6 (right). Circuit diagram of the preamp section for the magnetic cartridge input used in this design. The use of discrete components gives better quality here than a corresponding IC circuit.

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

electronics today INTERNATIONAL

JUNE 1979 VOL 8 NO 6

FEATURES

PROJECTS

INFORMATION

INTERNATIONAL EDITIONS

AUSTRALIA Collyn Rivers Publisher
Les Bell Acting Editor

HOLLAND Anton Kriegsman Editor-in-Chief

CANADA Steve Braidwood Editor
Graham Wideman Assistant Editor

GERMANY Udo Wittig Editor

ABC

EDITORIAL AND ADVERTISEMENT OFFICE
25-27 Oxford Street, London W1R 1RF. Telephone 01-434 1781/2. Telex 8811896

Ron Harris, B.Sc	Editor
Ian Graham B.Sc.	Editorial Assistant
Diego M. Rincon	Art Director
Pete Howells	Production Editor
Paul Edwards, Tony Strakas	Technical Illustrators
Ray Marston	Project Editor
John Fitzgerald	Project Engineer
Steve Ramsahadeo	Project Development
Margaret Hewitt	Administration
Alan Carlton (Manager), Kim Hamlin, Neville MacDonald	Reader Services
Halina Di-Lallo, Bren Goodwin, Tim Salmon Christopher Surgenor (Manager), David Sinfield, Joy Cheshire, Sandie Neville	Advertising
Halvor Moorshead	Editorial Director

PUBLISHED BY Modmags Ltd., 25-27 Oxford Street,
DISTRIBUTED BY Argus Distribution Ltd. (British Isles)
Gordon & Gotch Ltd. (Overseas)
PRINTED BY QB Limited, Colchester

Electronics Today International is normally published on the first Friday of the month prior to the cover date

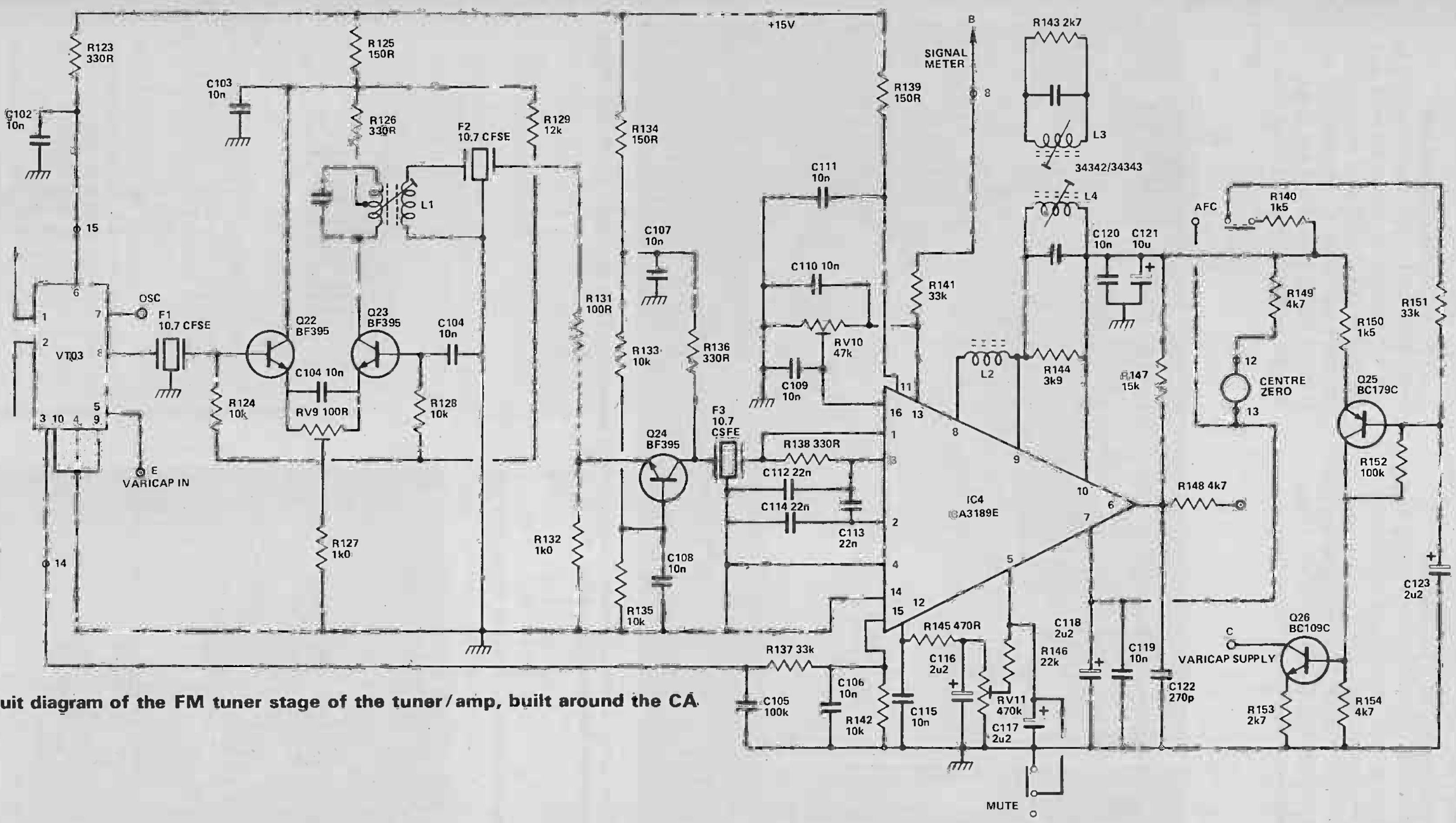
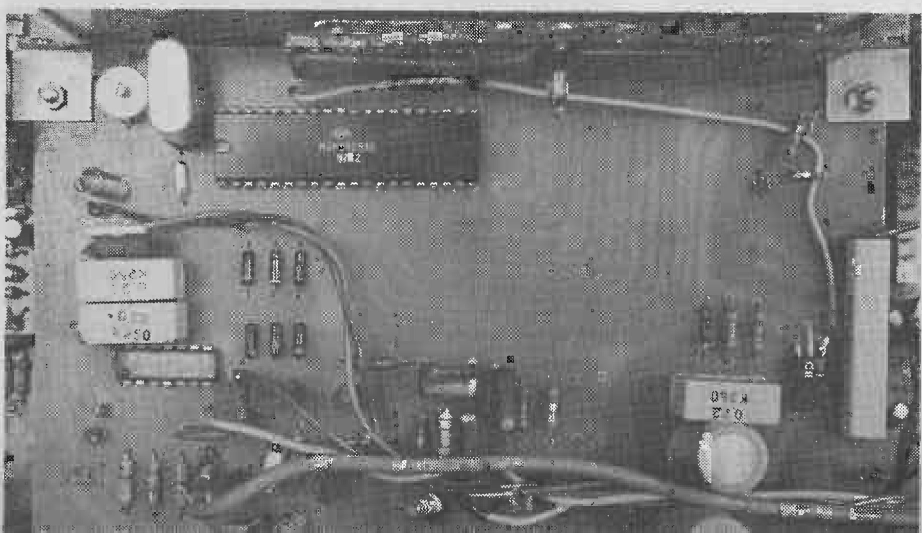


Fig. 7. Circuit diagram of the FM tuner stage of the tuner/amp, built around the CA 3189E IC.

(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

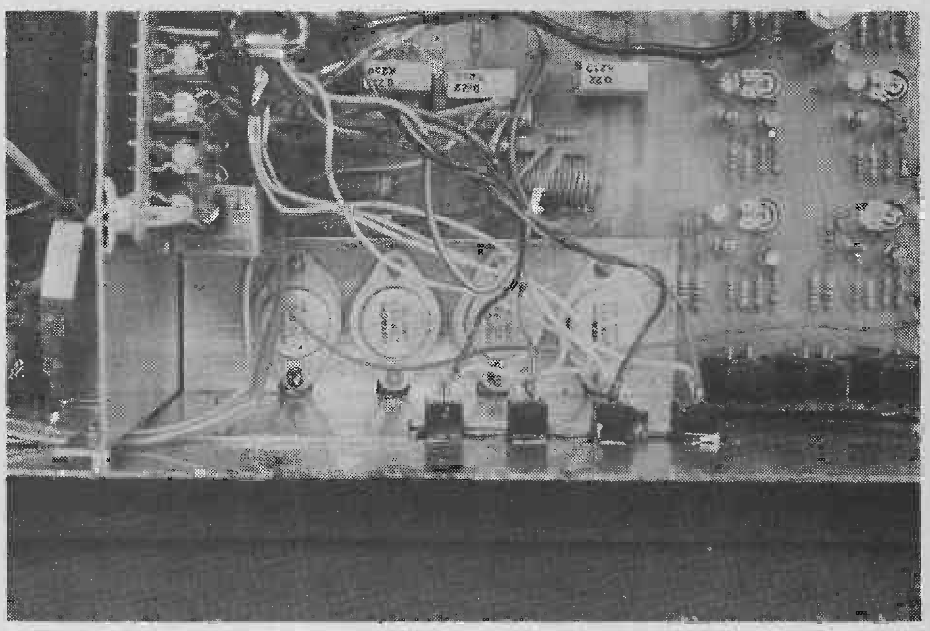
All input switches takes unused signals to earth, avoiding stray pickup. The whole system is largely built on one PCB to avoid the bulk of wiring normally associated with this kind of project. However, for cosmetic reasons, and anticipating remote control, the tone controls, volume and balance are an 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.

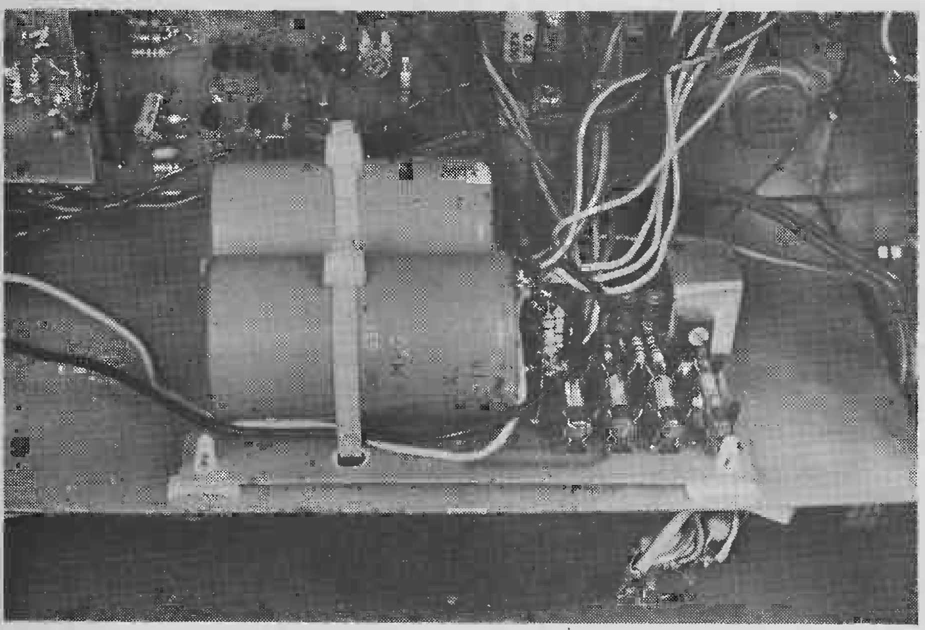
The circuit details here are complete, and if you don't intend to use our boards you may as well get started — good luck and don't call us, we'll call you! A complete kit of parts is being marketed for this design — see Buylines for details.

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.

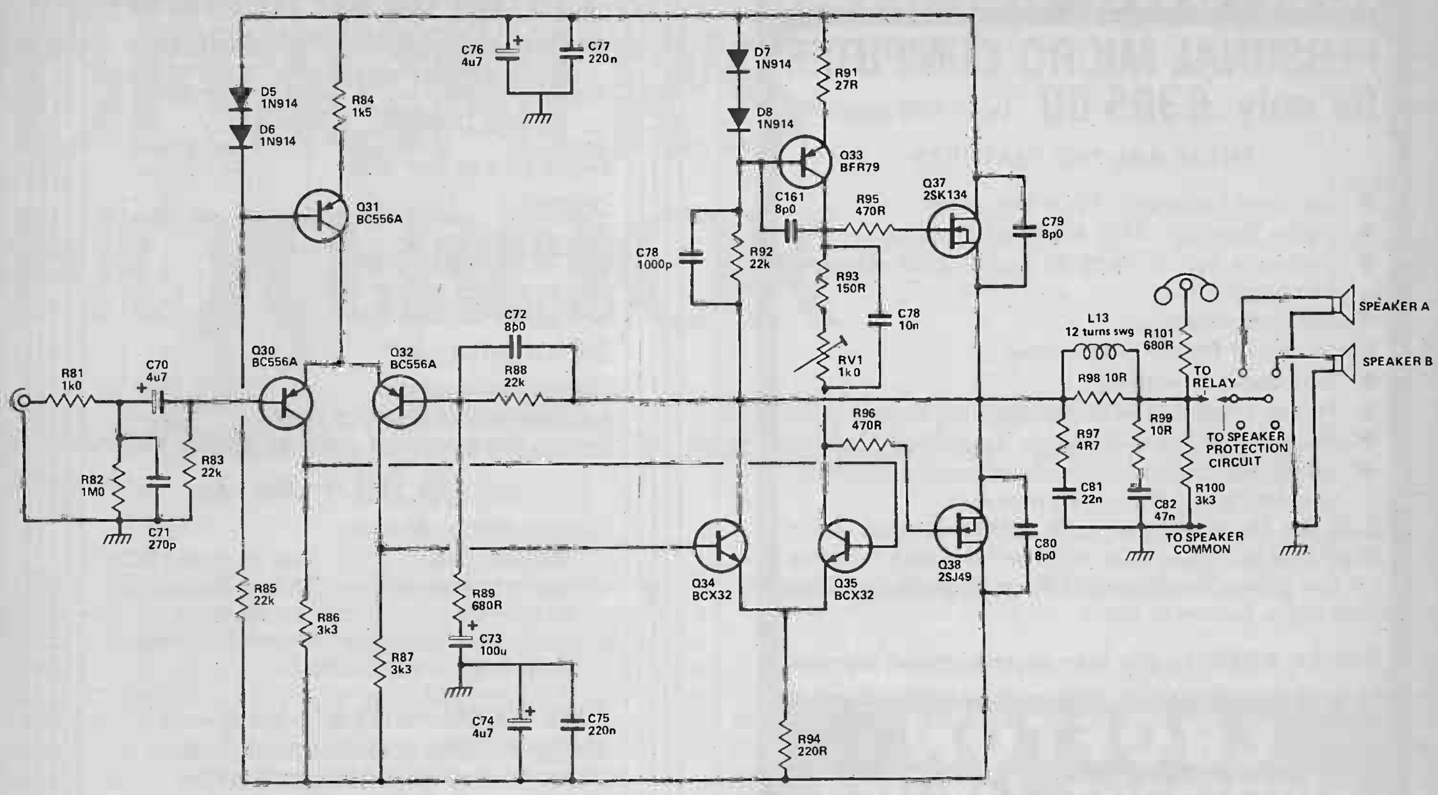


Fig. 8. The power amplifier stages of the system 8000 receiver. That strange little symbol in the output stages is a power FET!

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.

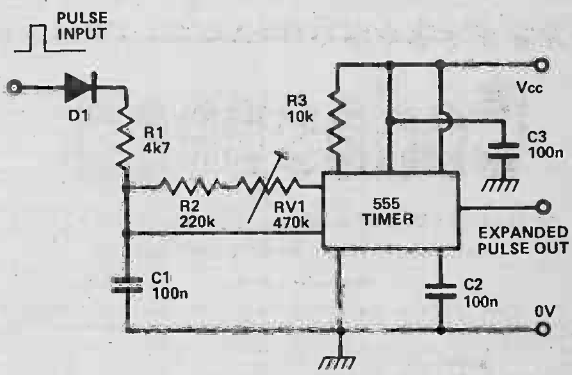


Fig. 1. Using a 555 chip as a tone generator. The control signal is applied directly to the 555's timing capacitor.

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

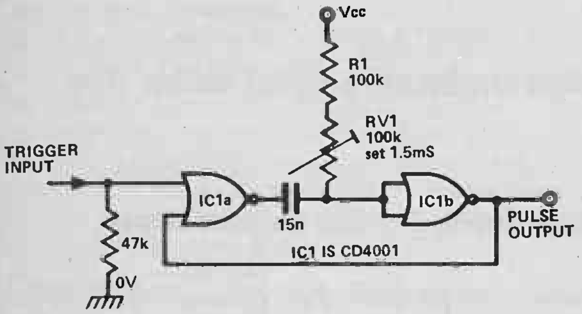


Fig. 2. A CMOS pulse expander circuit — not suitable for this application.

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.

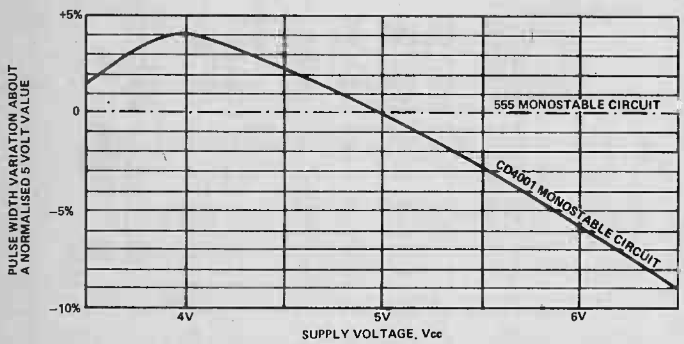


Fig. 3. Variation in pulse width against supply voltage for the CMOS pulse expander.

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

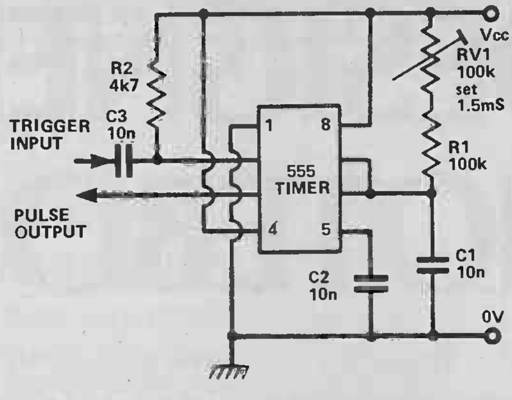


Fig. 4. A 555 monostable circuit — constant pulse width over supplies of 4V to 6V.

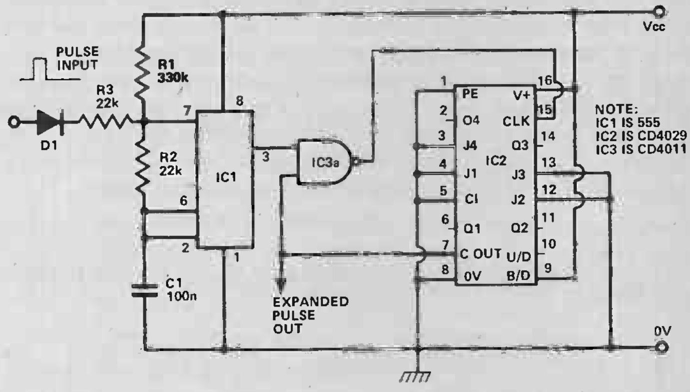


Fig. 5. A digital version of the pulse expander circuit.

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.

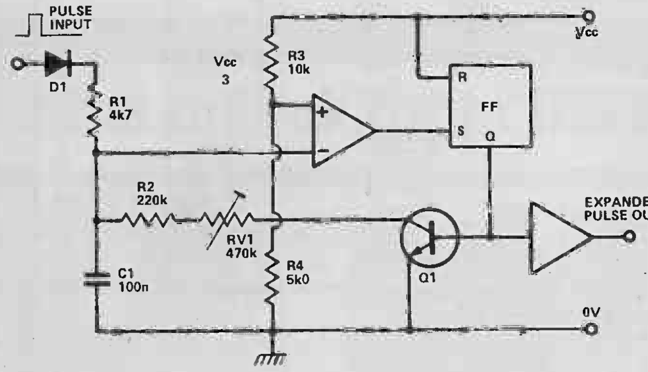


Fig. 6. An analogue version of the pulse expander circuit.

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. ETI

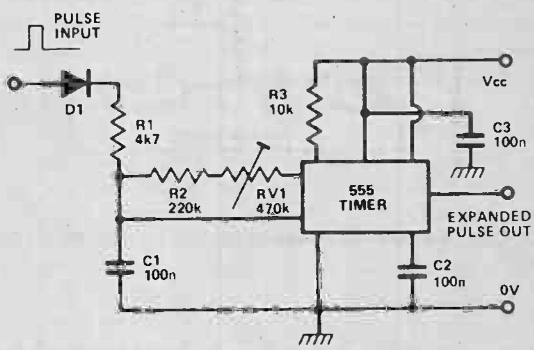


Fig. 7. The circuit finally chosen for use in the radio control motor speed controller.

MAINS SEEKER

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

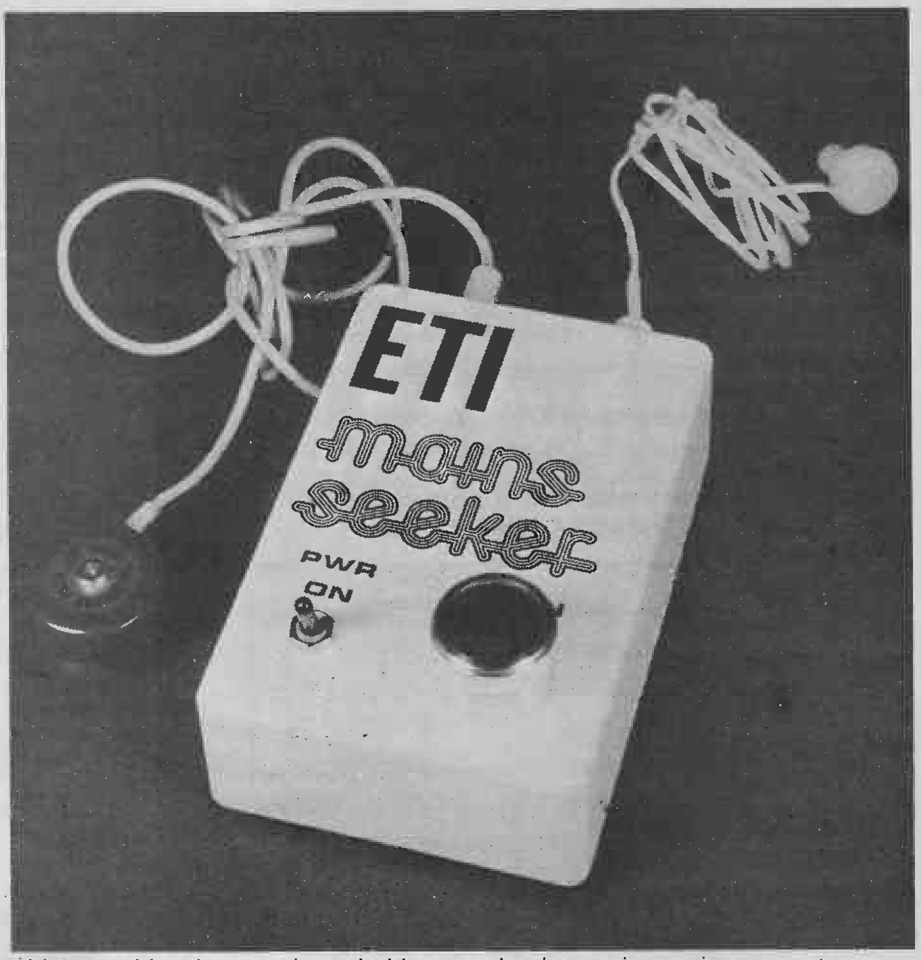
IF YOU HAVE EVER done a complete or partial rewire of a house, or have found yourself lumbered with jobs like drilling holes or knocking masonry nails into interior walls, you'll appreciate just how useful and reassuring it can be to know exactly where live mains wiring is hidden beneath the wall plaster. 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 ▶

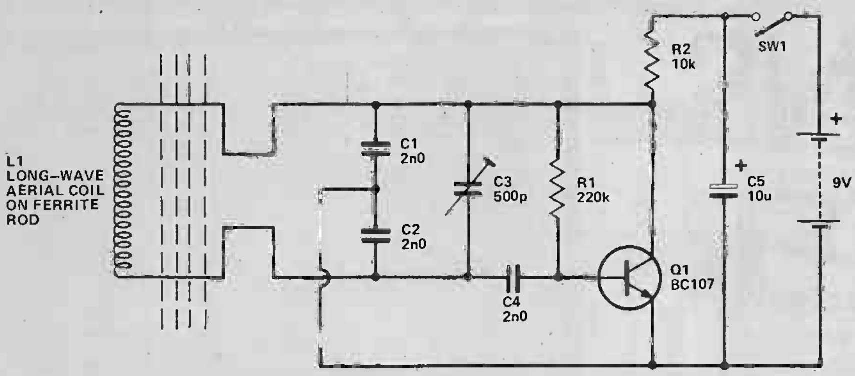


Fig. 1. Circuit diagram of one simple version of a BFO metal detector.

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.

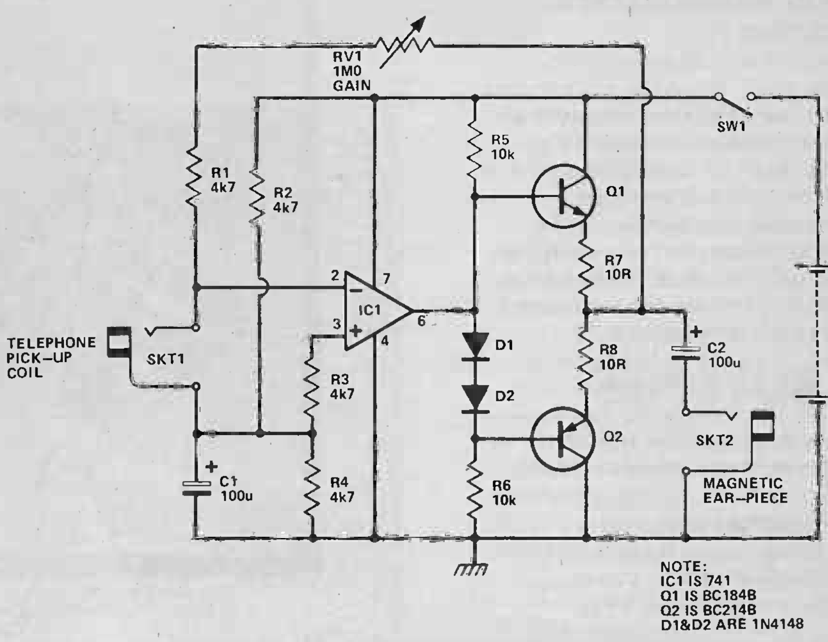
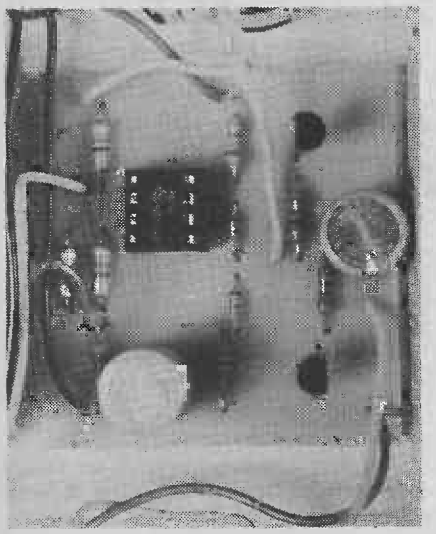


Fig. 2. Circuit diagram of the ETI Mains Seeker.



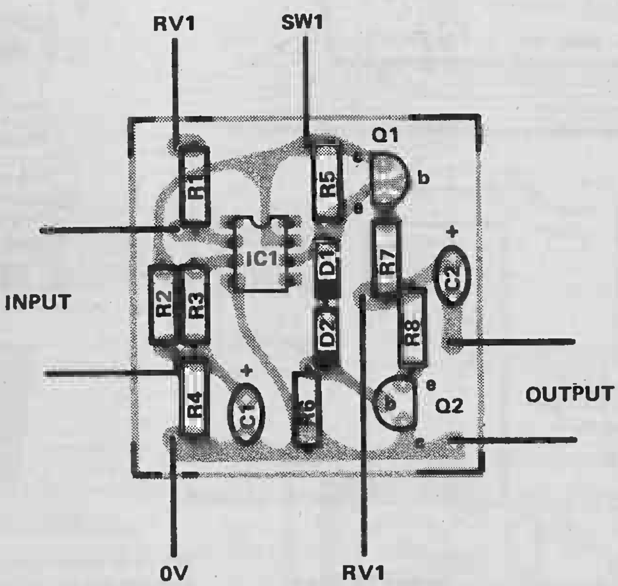


Fig. 3. Component overlay.

PARTS LIST

RESISTORS	
R1, 2, 3, 4	4k7
R5, 6	10k
R7, 8	10R
CAPACITORS	
C1, 2	100p
POTENTIOMETERS	
RV1	1M0 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	

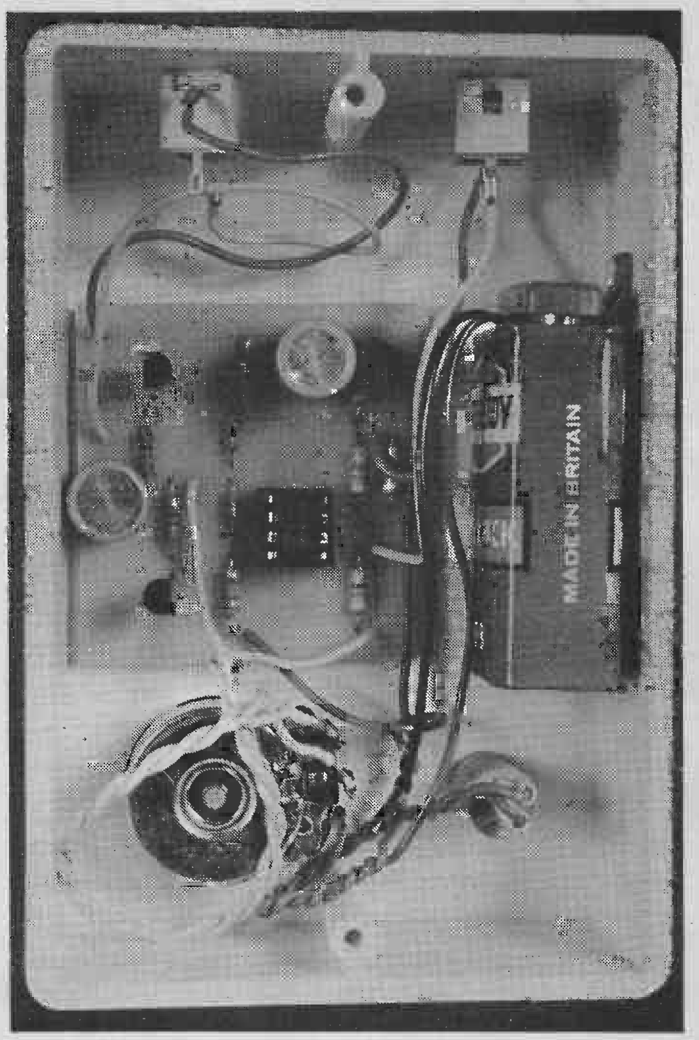
wiring route.

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

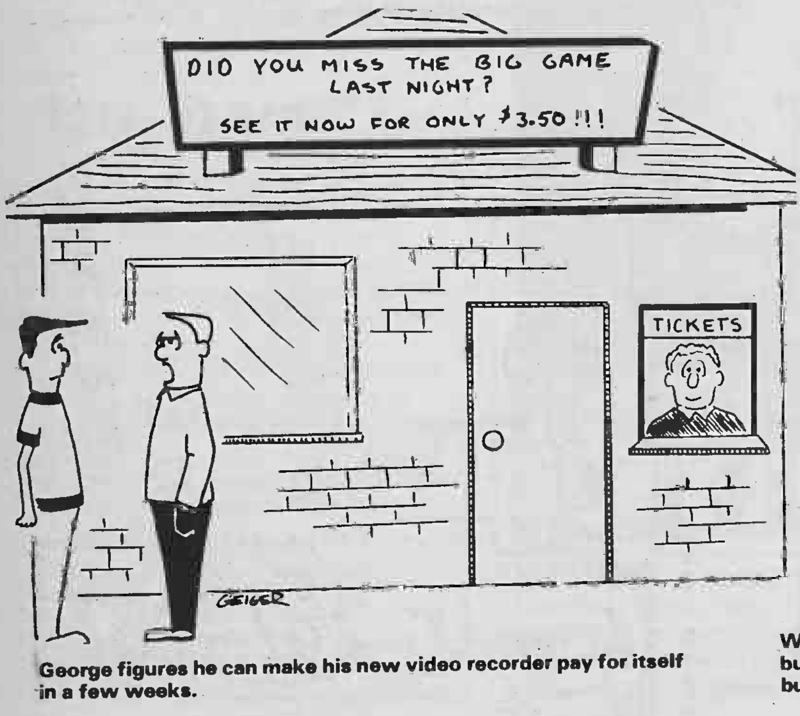
Construction should present no problems at all, since the circuit uses relatively few components, most of which are mounted on the PCB.

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.

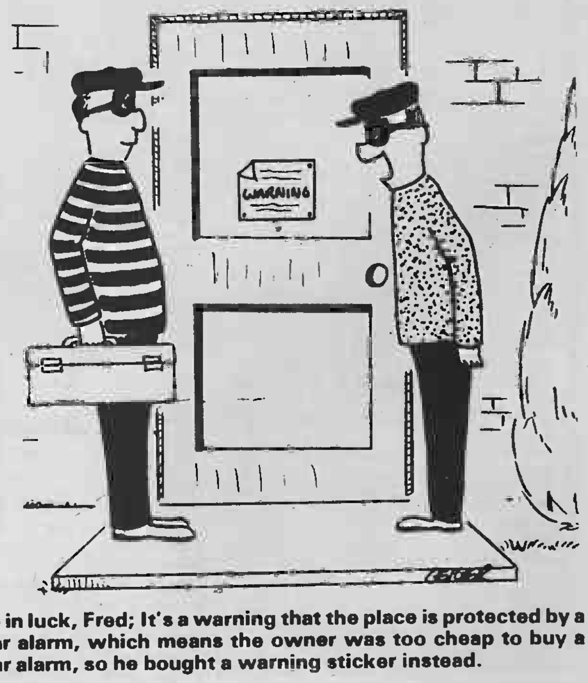


BUYLINES

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.

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.

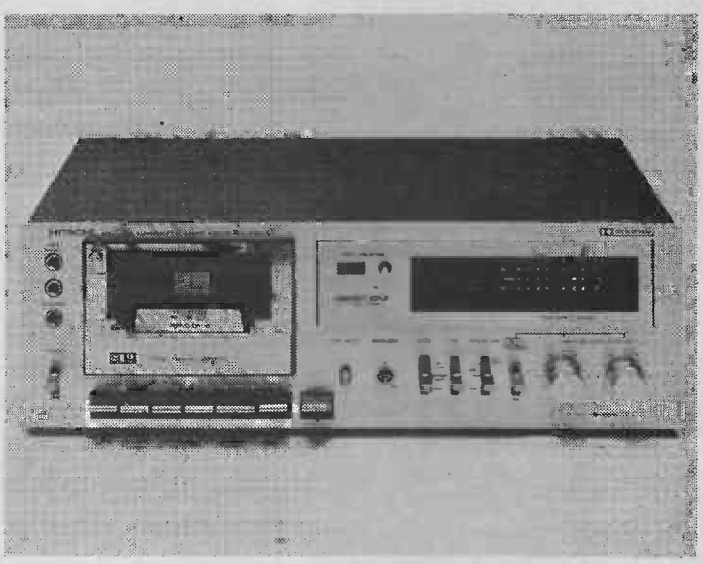
Apparently there is a new restaurant, at Hanover Square London, which has fitted itself out with a high hi-fi system as a reaction to musak. They have employed large numbers of Wharfedale E50s, eighteen in fact, and five bass bins — operable below 150 Hz — to set up areas of stereo sound no larger than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



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

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 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.

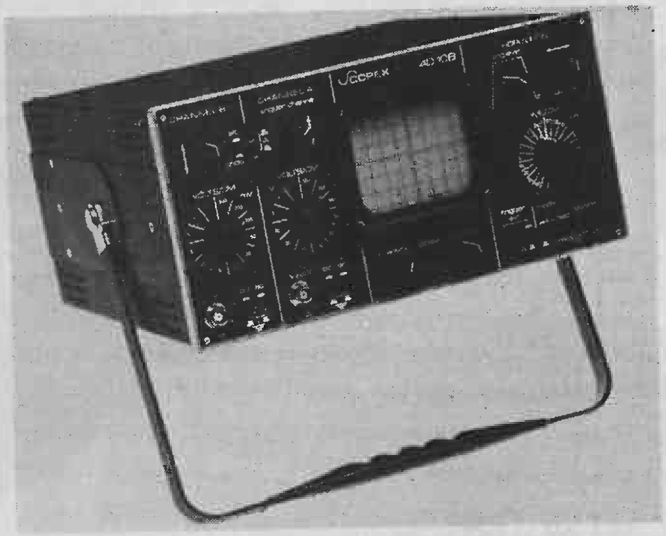
news digest..................

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.



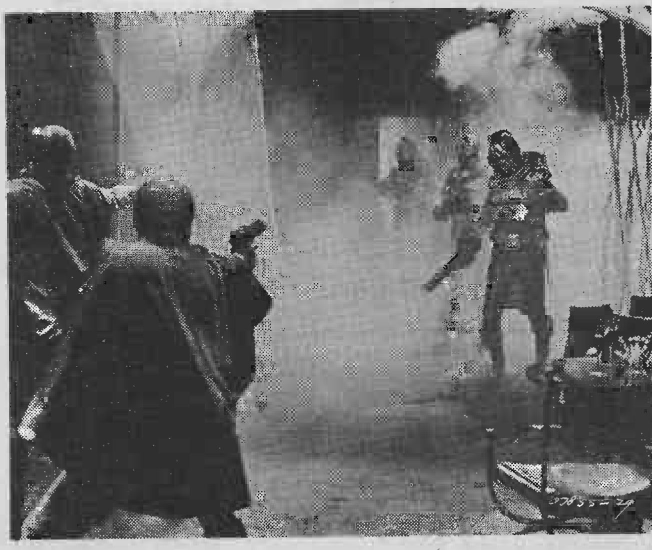
The Scopex single trigger control is retained. The XY mode is easily selected on just one position of the timebase switch.

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.

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

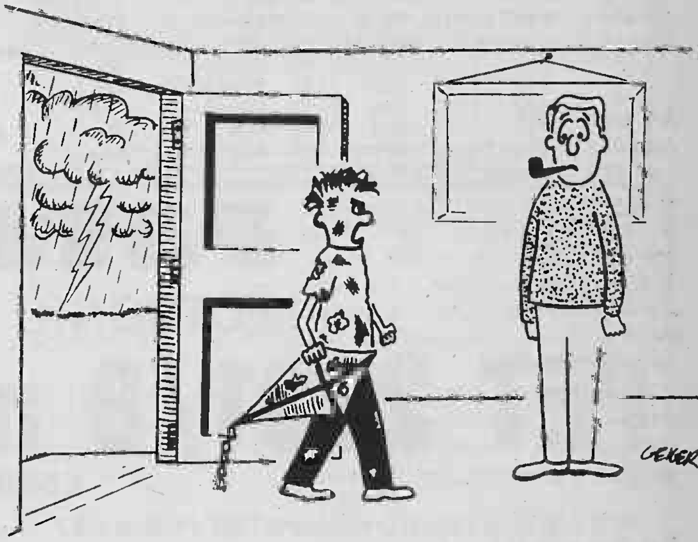
Since then I have repeated the, initially unintended, deception on every member of that panel. Moreover, upon direct comparison — individually — the identification of tape against source went down to barely 60%.

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%.

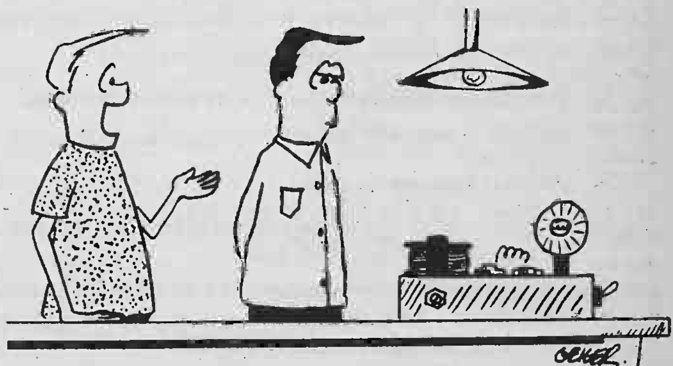
Small variations in audio signals would seem to be detected somewhat unreliably on the whole. If a panel of 'experts' can come up between them with one set of results, and individually with a totally *different* set — what price the conclusions?

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.

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.

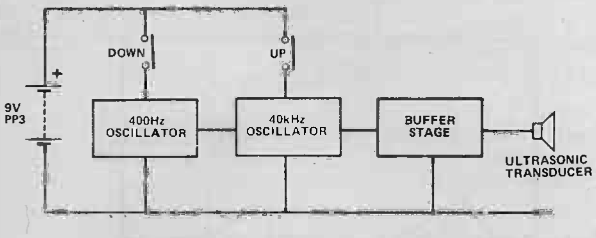


Fig. 1a Block diagram of the transmitter.

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.

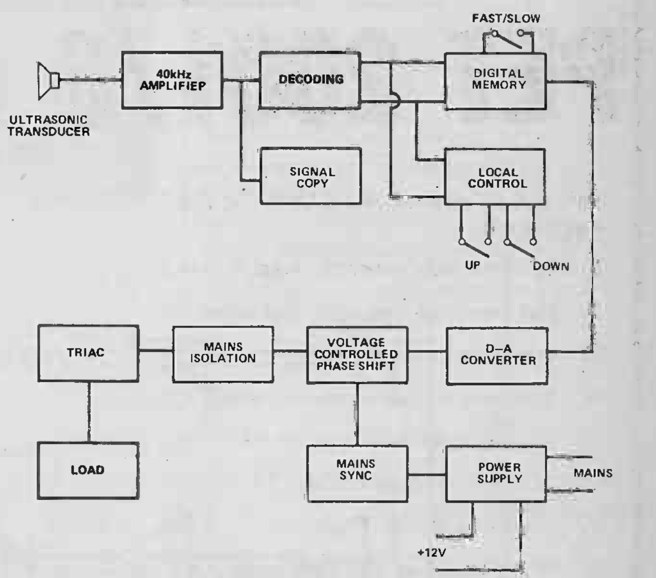


Fig. 1b Block diagram of the receiver/control circuit.

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.

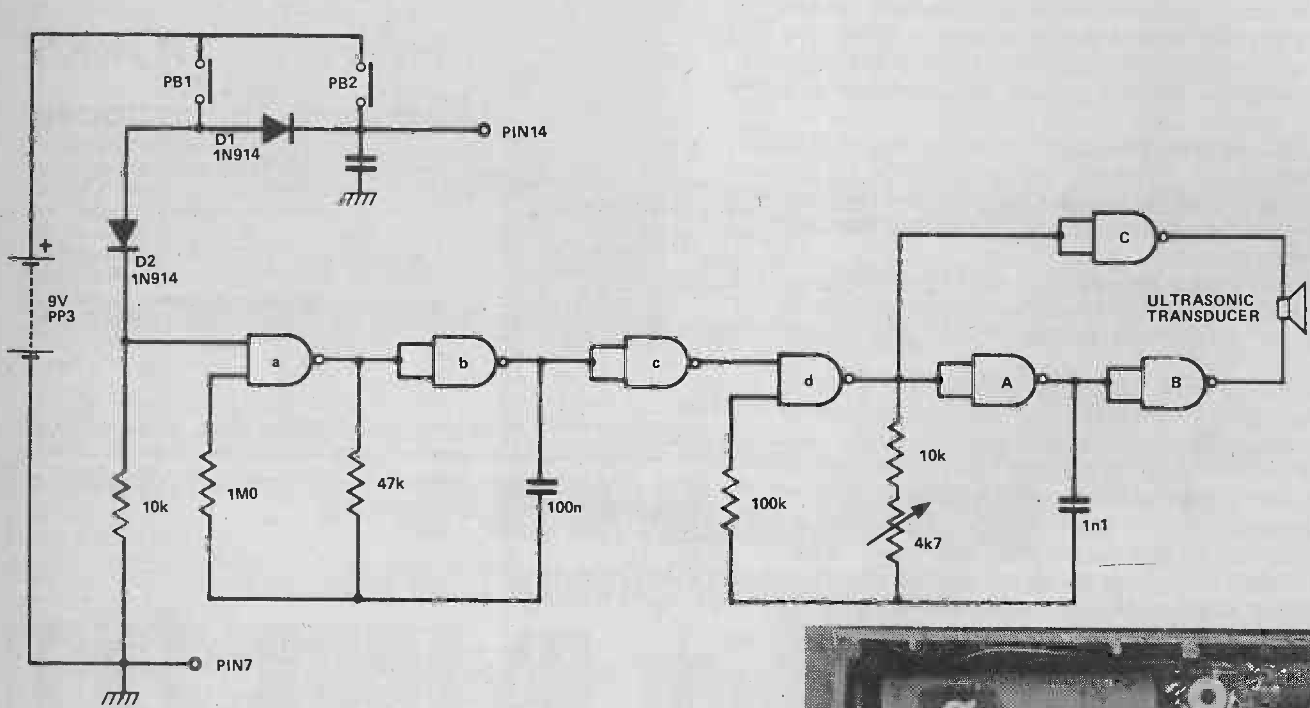
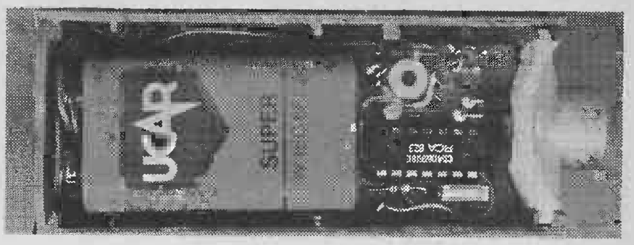
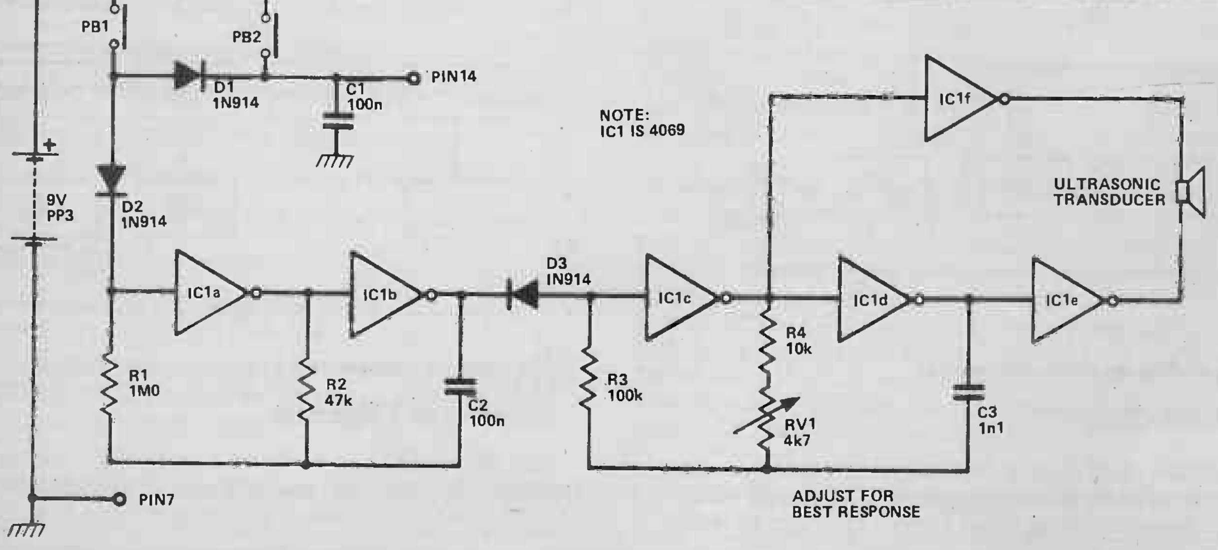


Fig. 2a Circuit diagram of the transmitter.





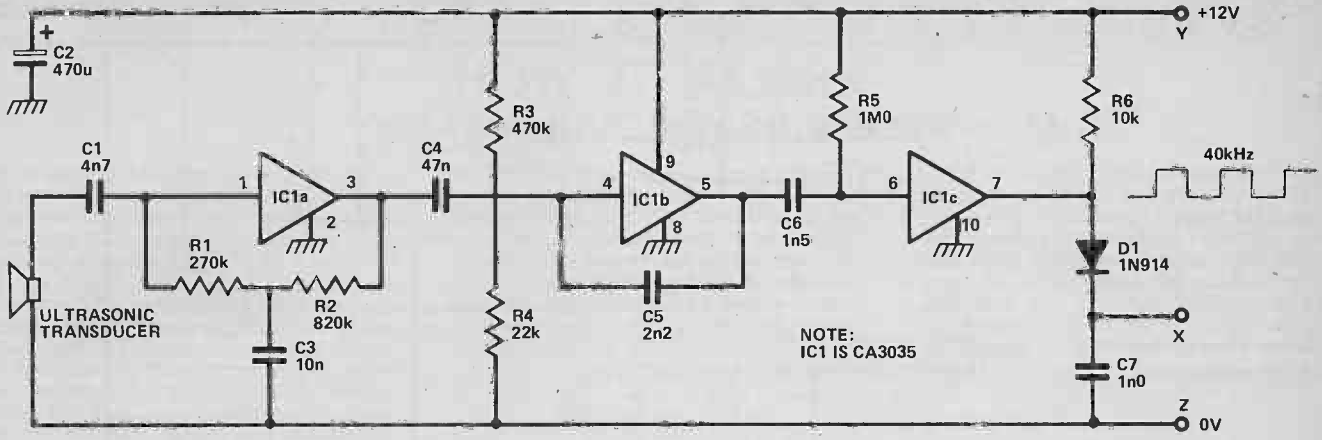
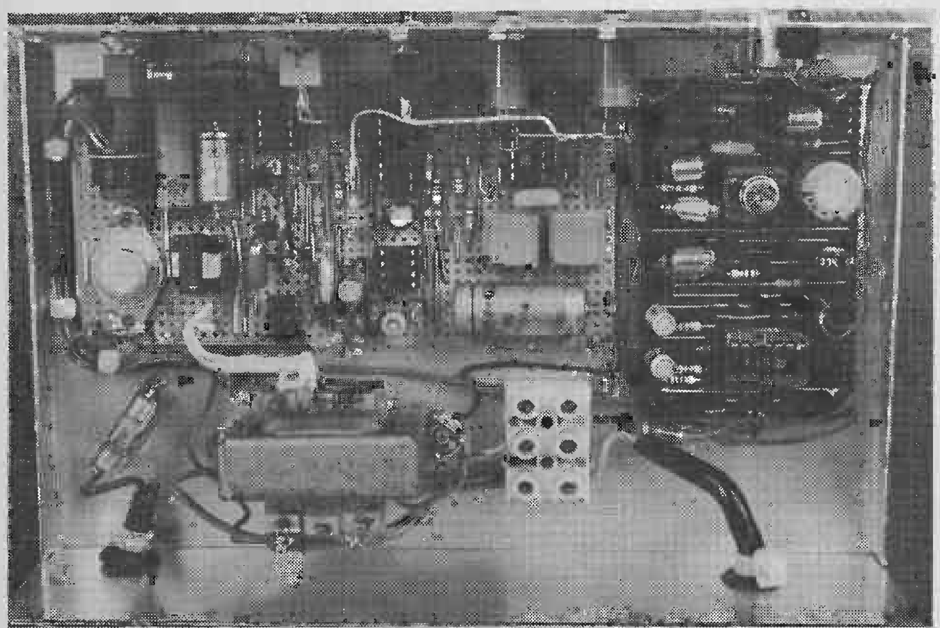


Fig. 3 Circuit diagram of the receiver.

Below: internal view of the prototype



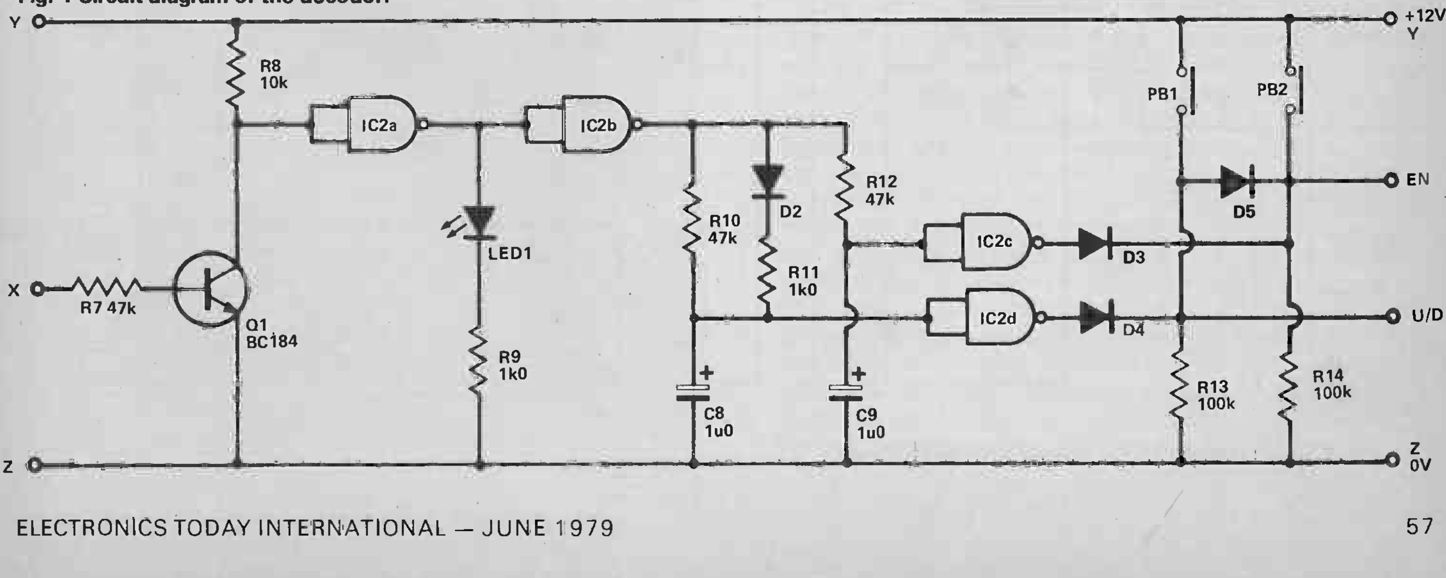
Left: the hand hold transmitter exposed!

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.



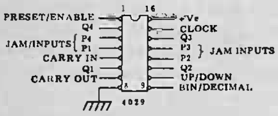


Fig. 5b Top view of the 4029 pin out arrangement.

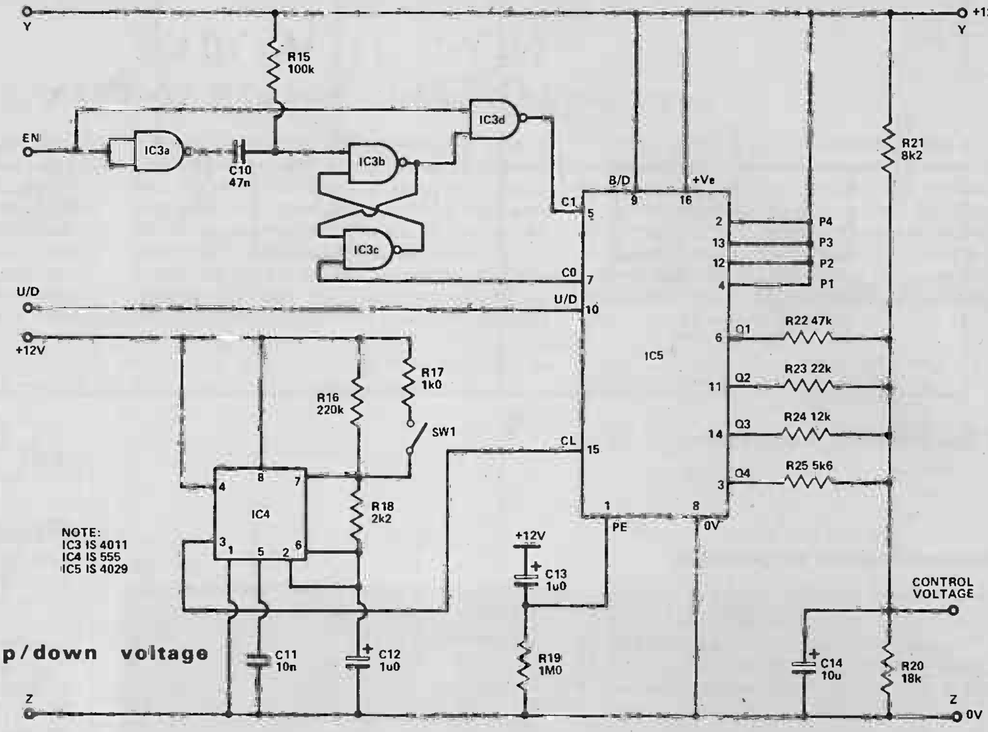


Fig. 5a Circuit diagram of the up/down voltage generator/memory.

HOW IT WORKS

THE UP/DOWN VOLTAGE GENERATOR/MEMORY

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

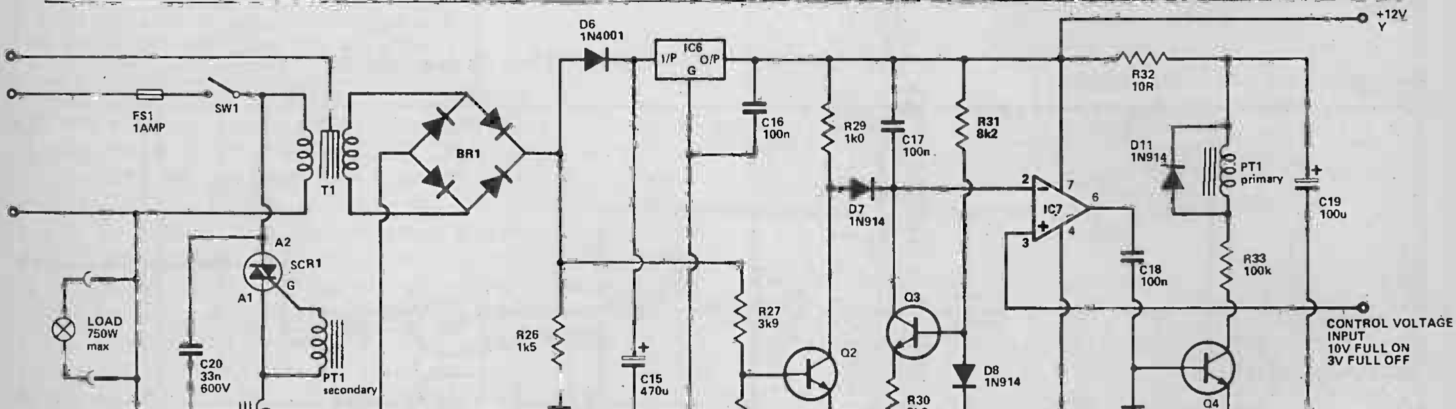
FUNCTION	EN	U/D
Do nothing	0	0
Go down	1	0
Go up	1	1

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.

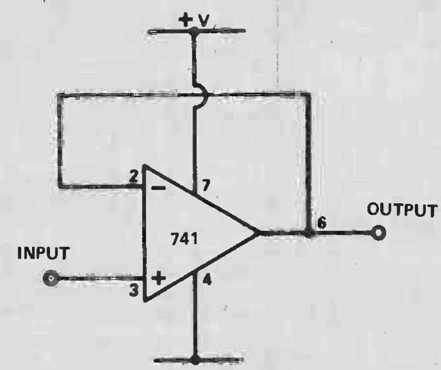
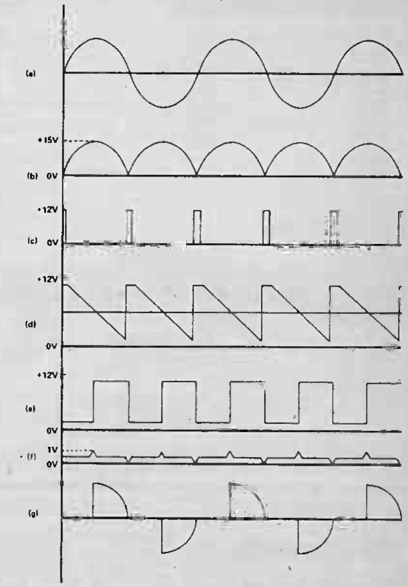
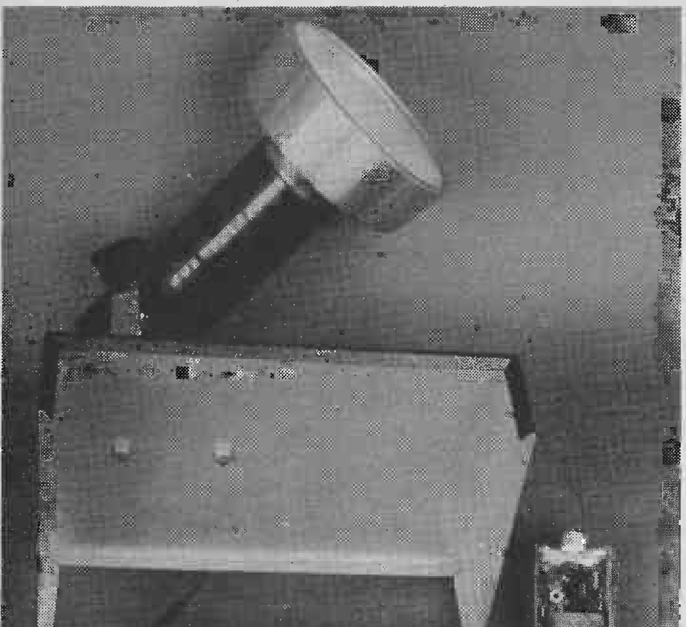


Fig. 8 The output buffer for the ramp waveform.



(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. ▶

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.

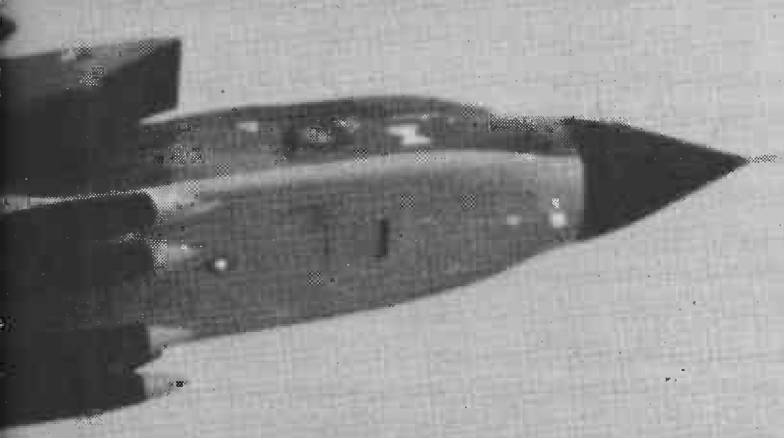
However, after the war, interest waned as Chiefs of Staff were more interested in hard weapons such as aircraft and tanks rather than somewhat 'ethereal' electronic weapons. In fact the importance of radar was not forgotten, and radar development continued apace, but the capability to deceive or deny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

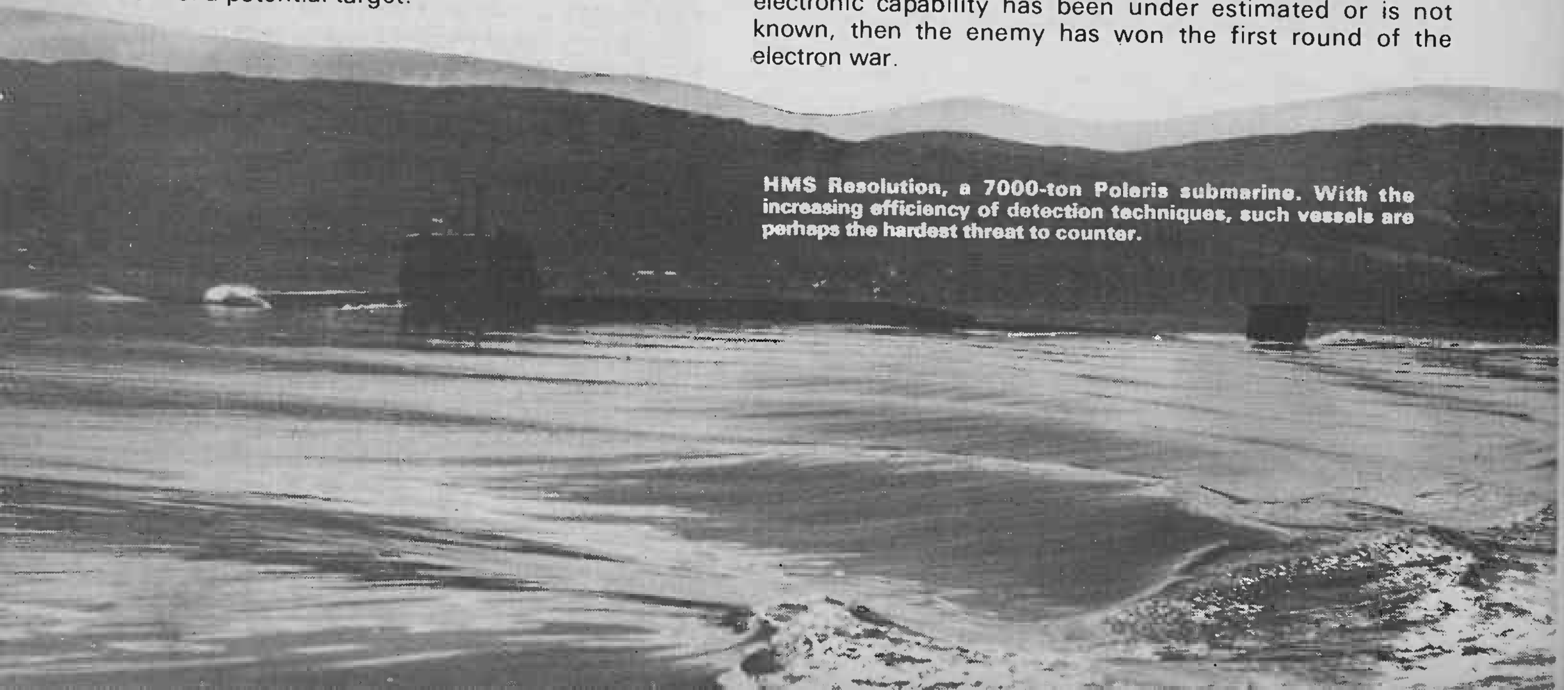
Radar absorbent materials may be used to reduce the reflectivity of the target, again reducing the ability of radar to detect the target, particularly at long range.

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

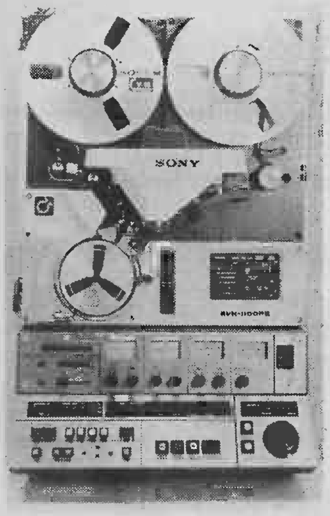
Warfare support concerns the collection of data from the reception of enemy radar, communications or counter measures. This data is then processed and may be used either immediately to warn of the nature of an impending threat or as ELINT (Electronically gathered INTelligence) from which a picture of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

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.

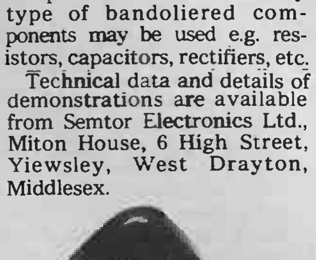
COUNTED OUT

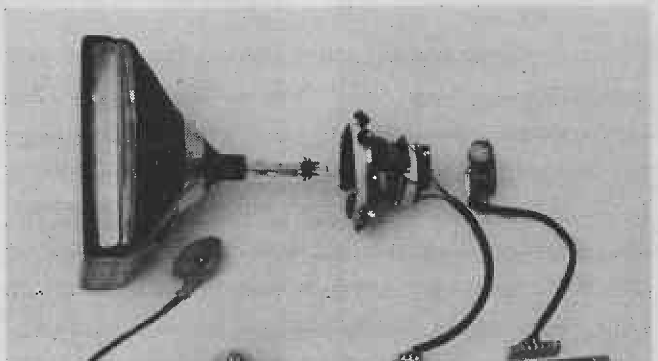
Semtor Electronics are introducing a new counter for bandoliered components.

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 à 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

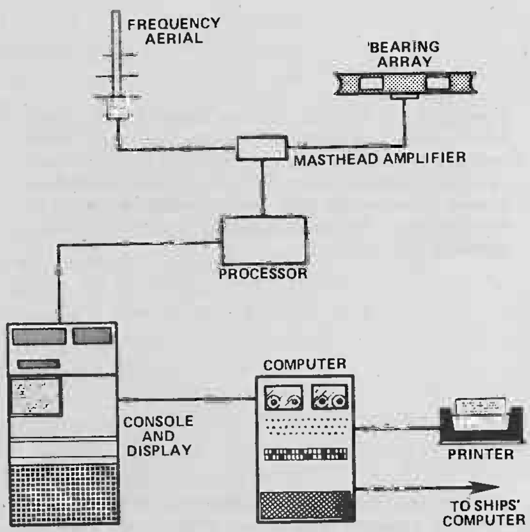
Is the seat in your motor a bit lumpy, or a bit too high. Maybe the seat back isn't quite right. Your troubles could be over, with the new experimental, computerised, push-button seat adjustment system from National Semiconductors and RECARO, the custom seat specialists.

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.

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.



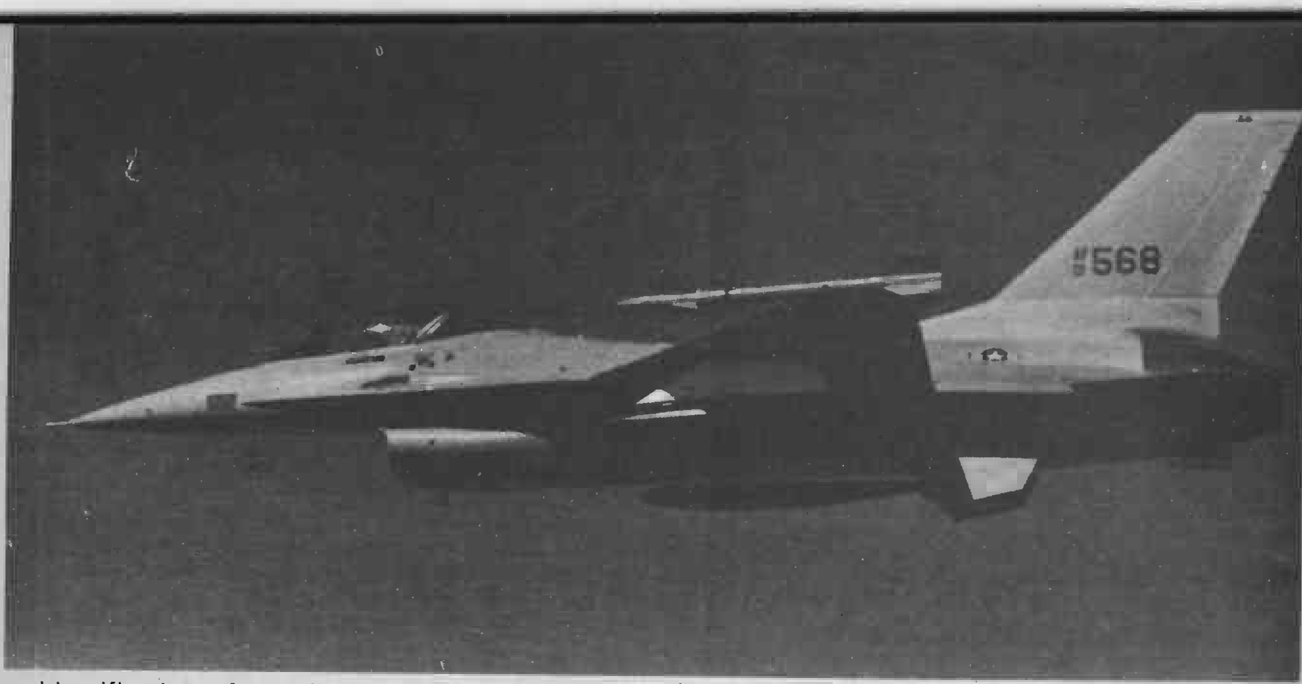
Both the Warsaw Pact and NATO indulge in ESM during detente especially during the other side's manoeuvers and exercises trying to gain information on the effectiveness of each other's EW capability. Soviet Spy trawlers have caught the news as they shadow NATO fleets, and Soviet Bear aircraft, studded 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.

Information Received

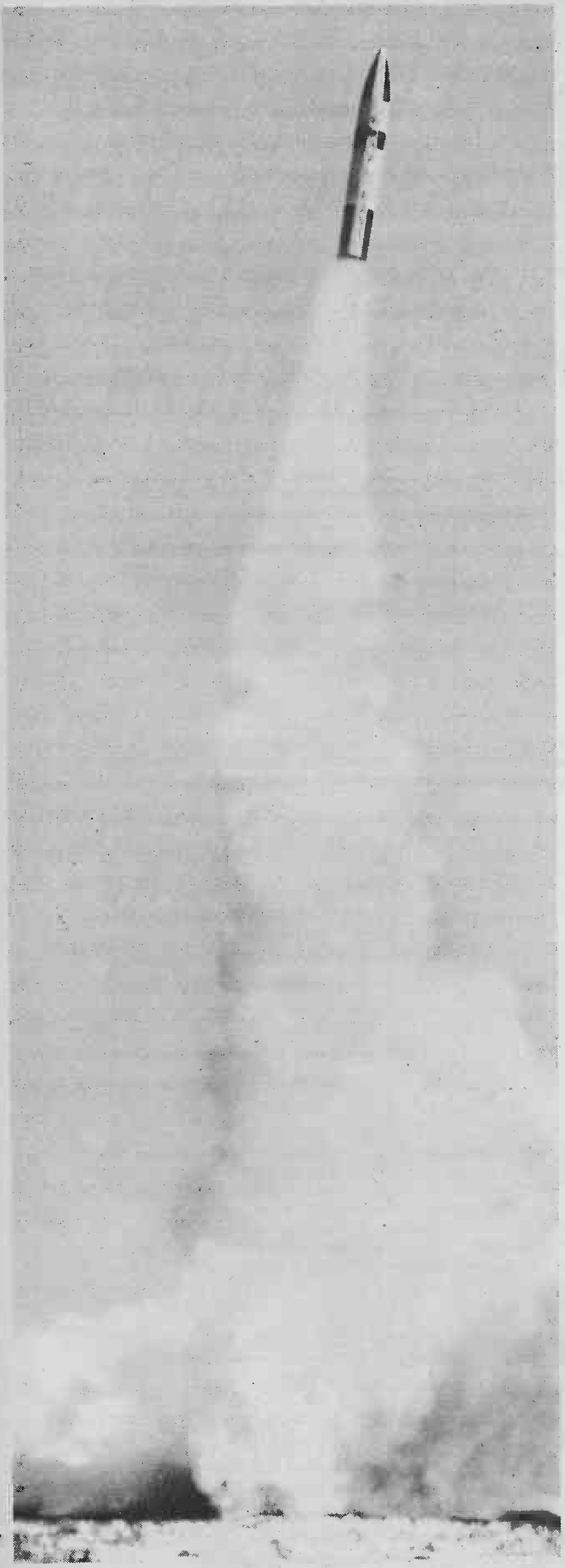
In any case ESM carried out by a Radar Warning System is only secondary; the most important ESM being the incorporation of the 'potential threat' into the computer library, or in a RWR. This depends on good intelligence, anticipation of possible developments and the speed with which the system can be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

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.

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.

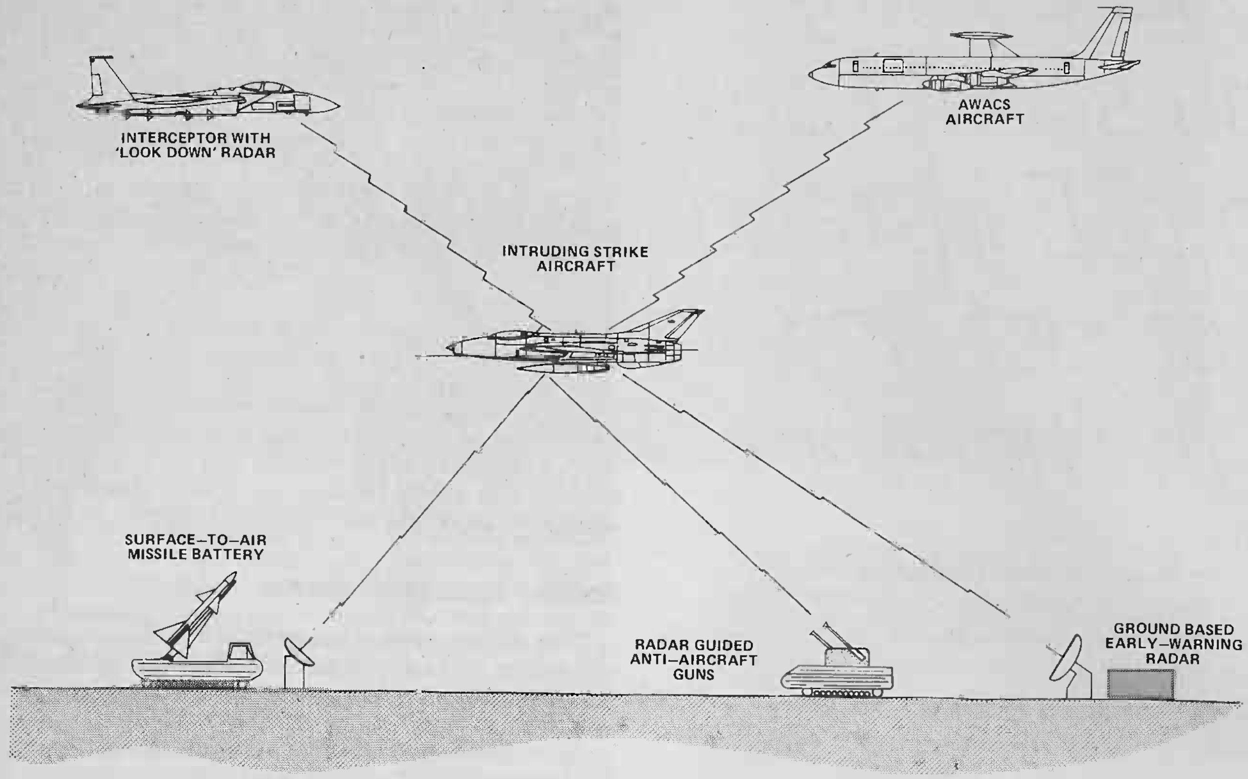
A useful ECCM is that of a Constant False Alarm Receiver (CFAR). This works by setting the receiver to 'expect' a certain number of false alarms, or rather spurious signals above a level which trips the receiver's processing circuitry and causes the radar to treat it as a target, giving a false signal 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.

Let us hope it doesn't happen to us. ETI

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.

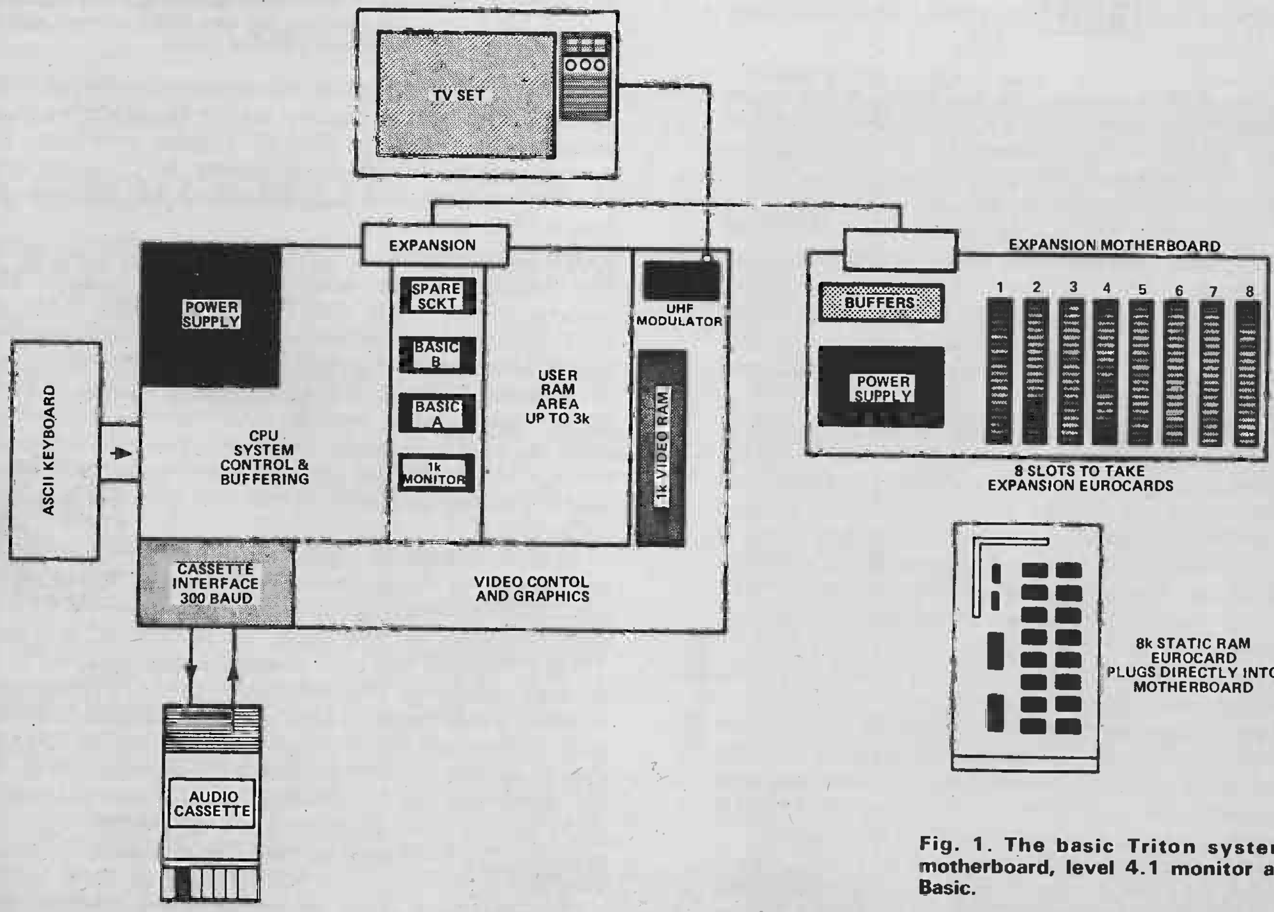


Fig. 1. The basic Triton system with motherboard, level 4.1 monitor and tiny Basic.

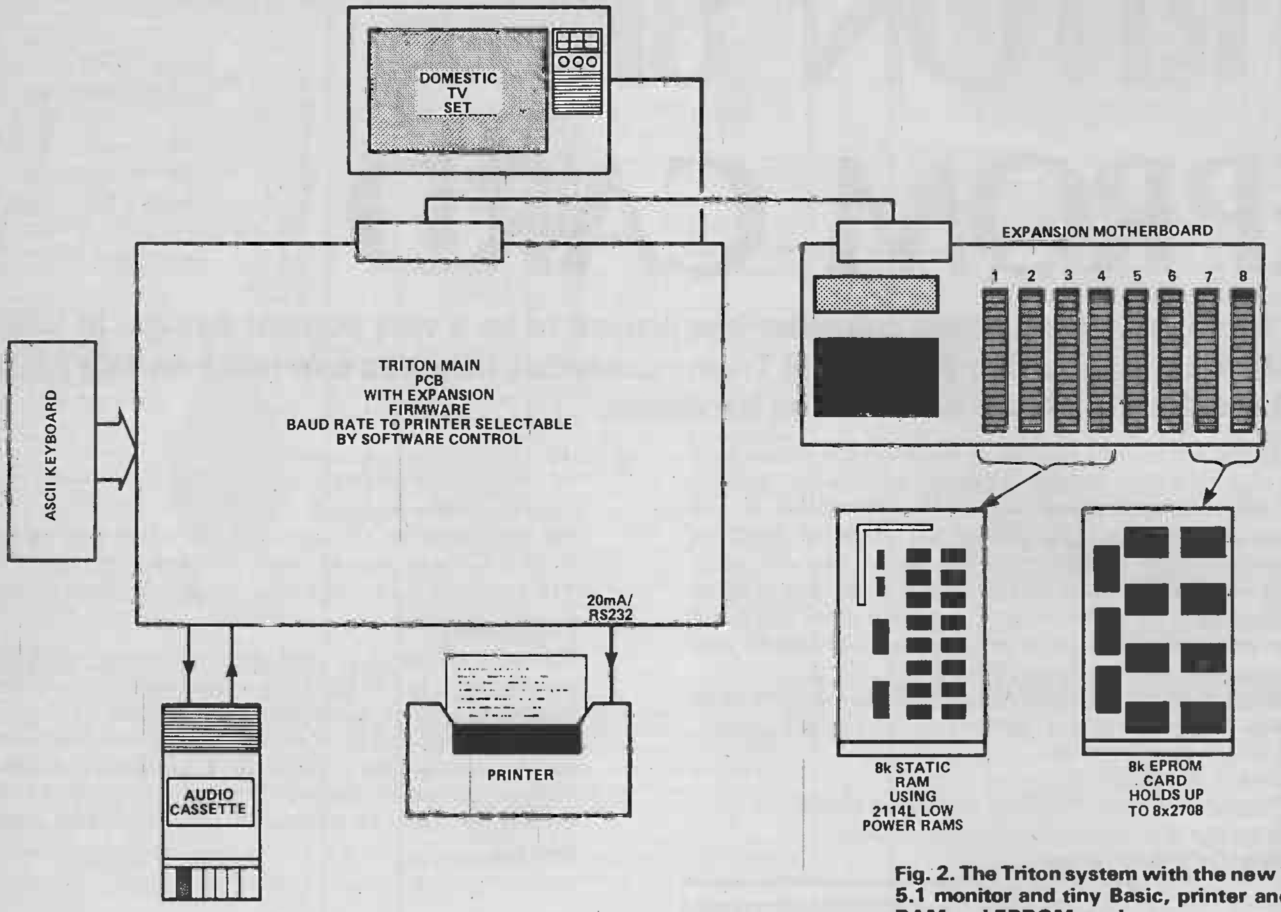


Fig. 2. The Triton system with the new level 5.1 monitor and tiny Basic, printer and 8K RAM and EPROM cards.

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.

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!

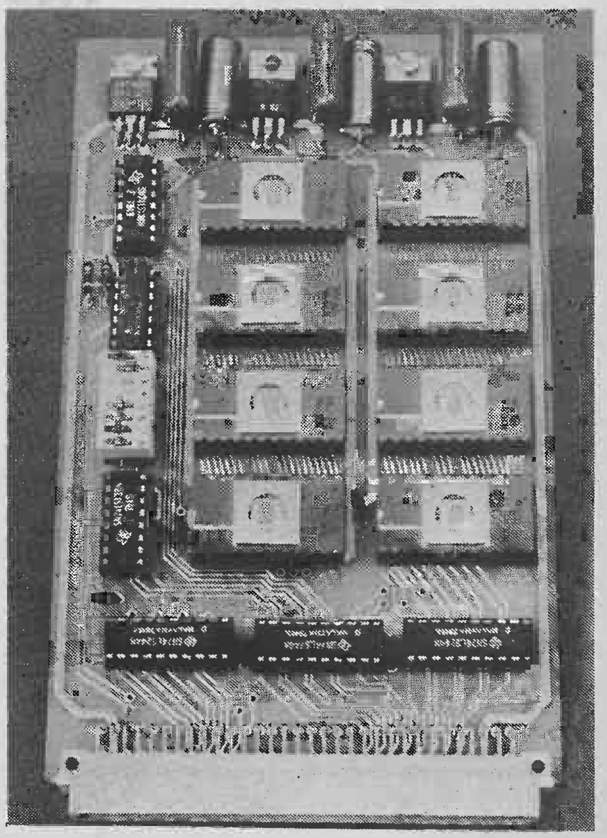
When soldering hold the iron in place slightly longer than for a single sided PCB. This will allow the solder to flow through the hole reinforcing the plating through. Do not, however, overdo this and certainly do not hold the iron in place for more than 3 seconds. Apply the minimum amount of solder 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.

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



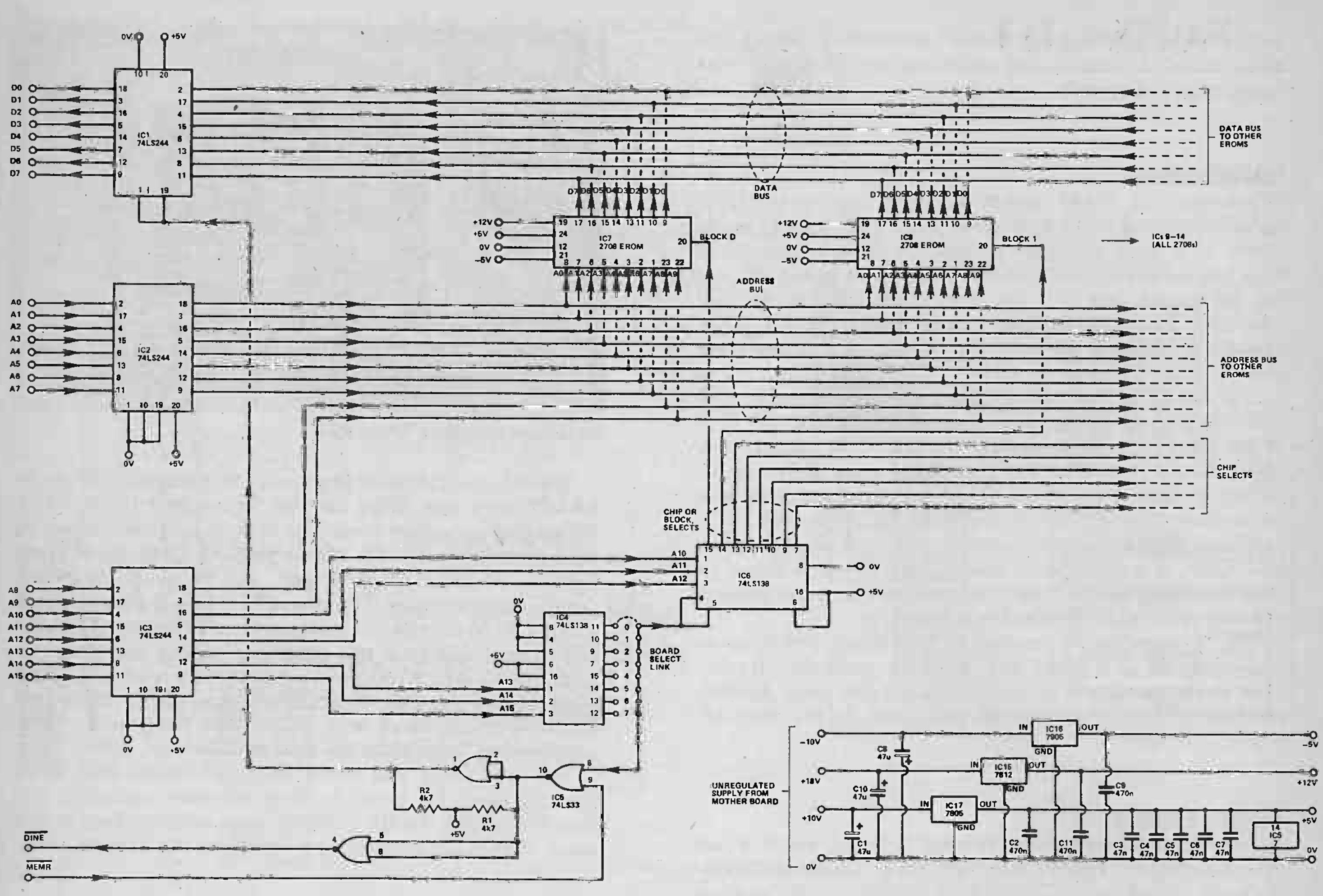


Fig. 3. Circuit diagram of the Triton 8K EPROM extension card.

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

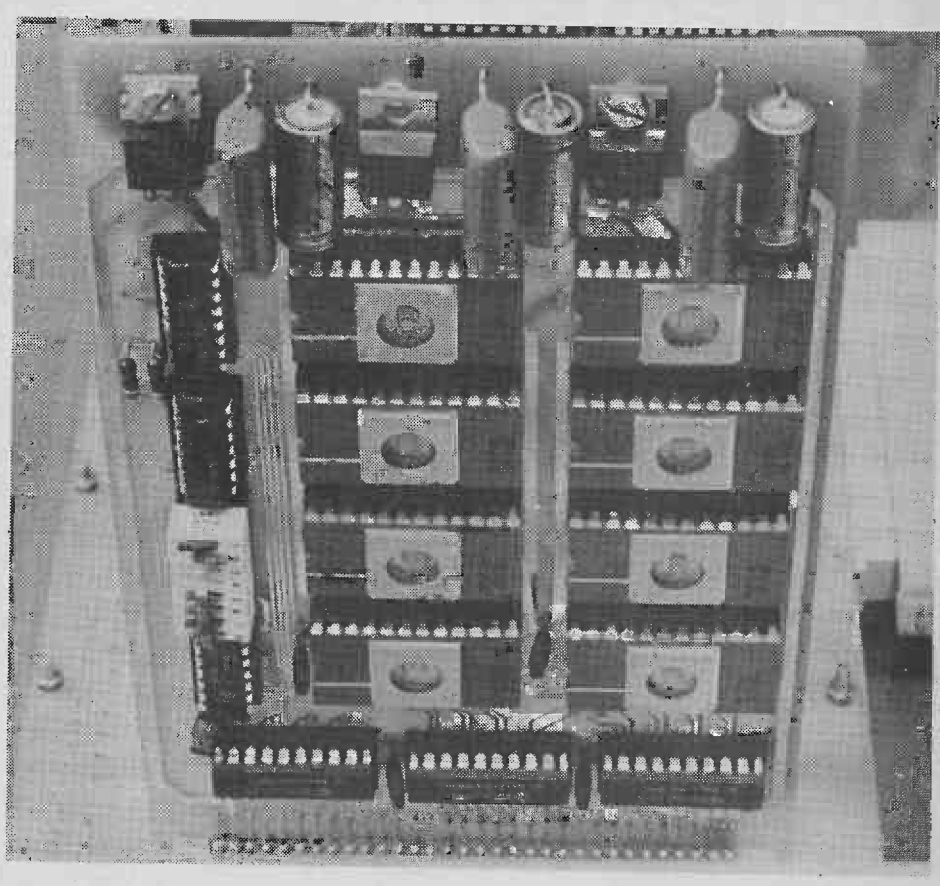
CAPACITORS
C1, 8, 10 — 47u 25V electrolytic
C2, 9, 11 — 470n polyester
C3-7 — 47n ceramic

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



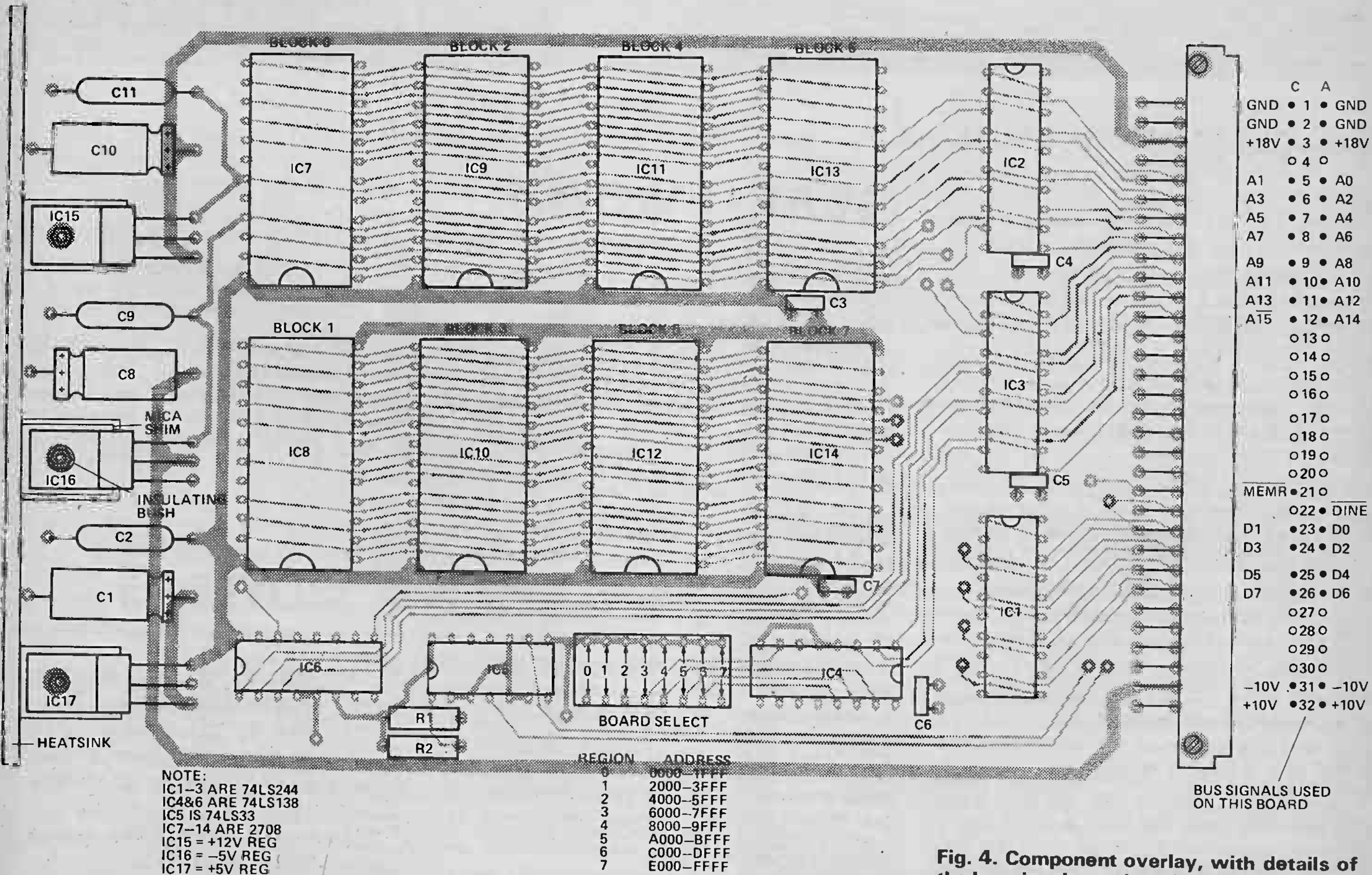
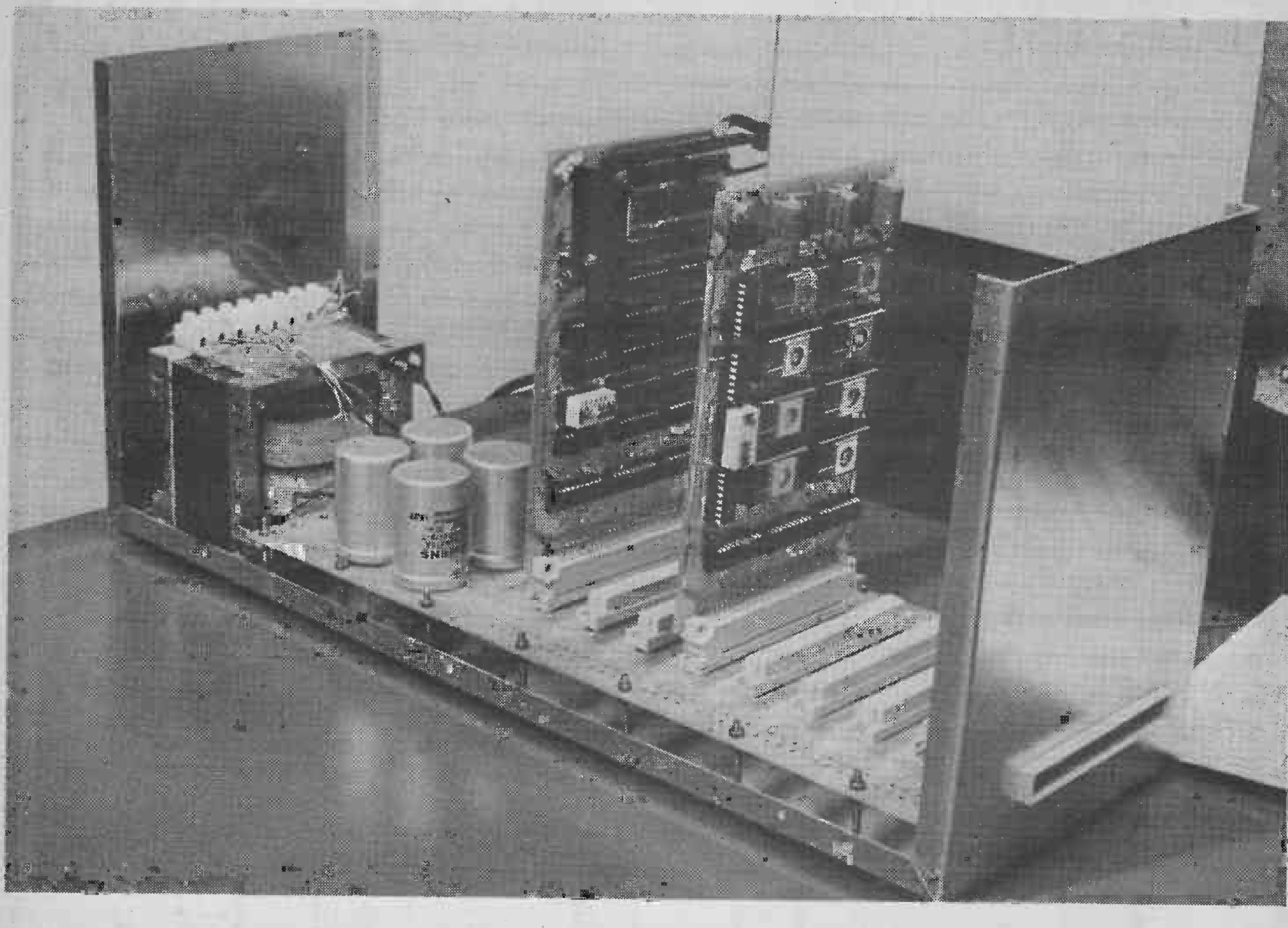


Fig. 4. Component overlay, with details of the bus signals used on the board.



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 O).

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.

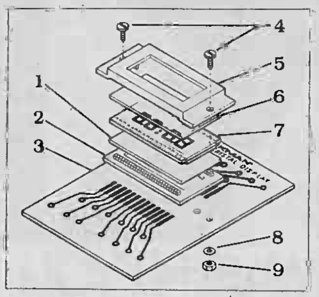
ETI

........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.

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.

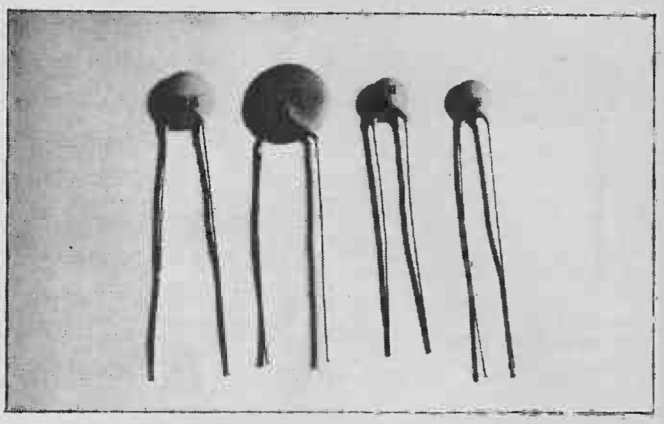
Capacitor Types

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-

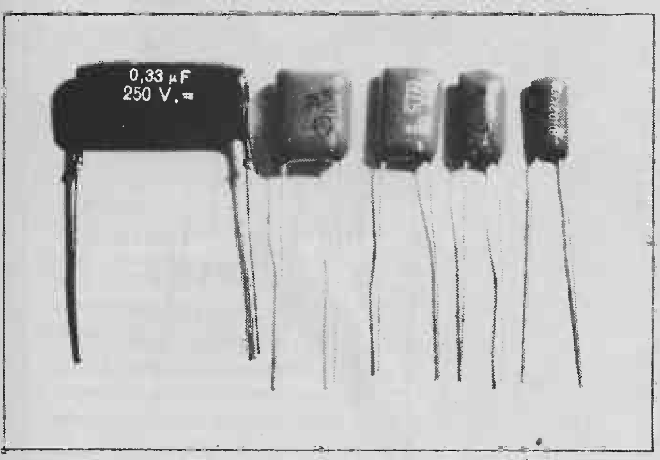


Four tiddlers — ceramic capacitors.

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.



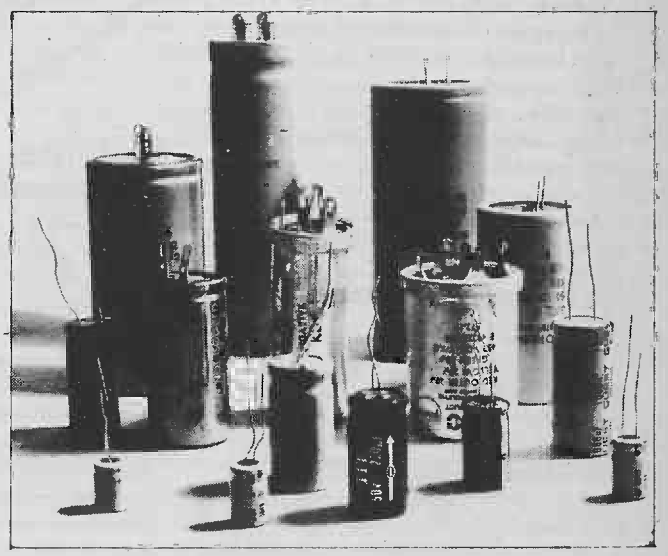
Polyester capacitors — high insulation resistance and large positive temperature coefficient.

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

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 = 350 nS — 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

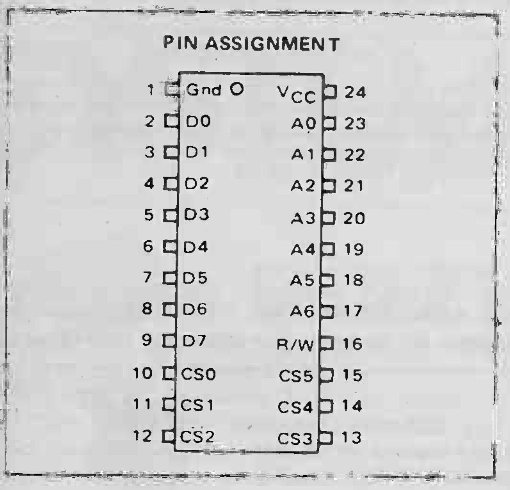
Parameter	Symbol	Min	Nom	Max	Unit
Supply Voltage	V_{CC}	4.75	5.0	5.25	VDC
Input High Voltage	V_{IH}	2.0	–	5.25	VDC
Input Low Voltage	V_{IL}	-0.3	–	0.8	VDC

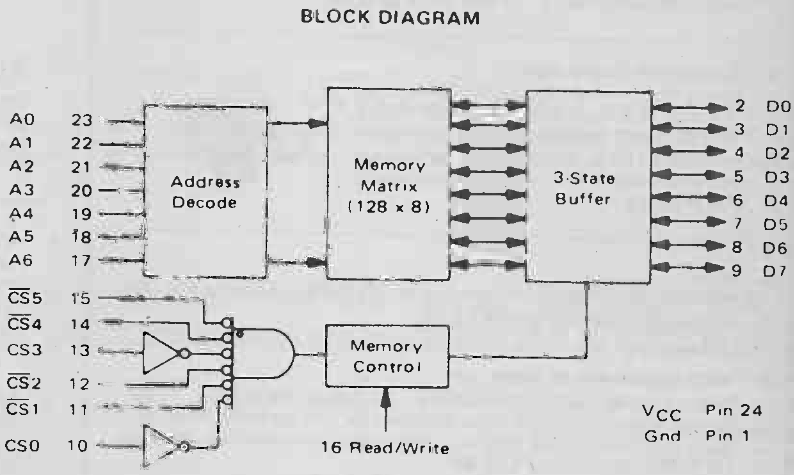
DC CHARACTERISTICS

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)	I_{CC}				mA DC
MCM6810AL		–	–	70	
MCM6810AL1		–	–	80	

MCM 6810A 128 x 8 RAM

MOTOROLA





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

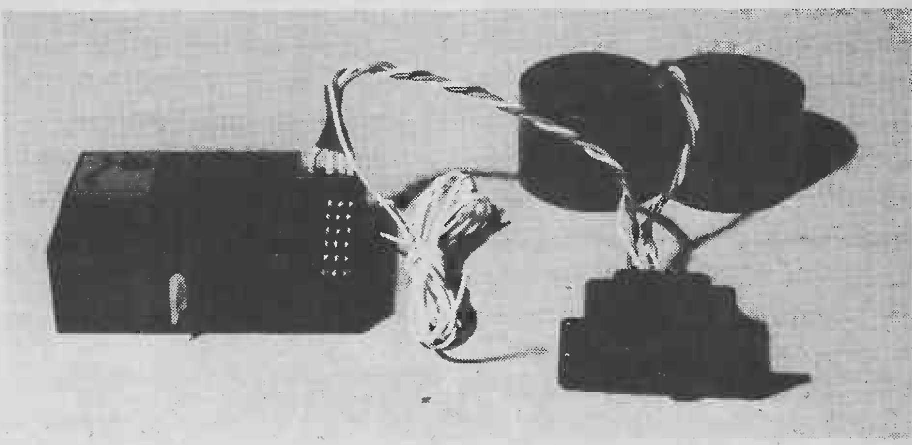
Characteristic	Symbol	MCM6810AL		MCM6810AL1		Unit
		Min	Max	Min	Max	
Write Cycle Time	$t_{cyc(W)}$	450	–	350	–	nS
Address Setup Time	t_{AS}	20	–	20	–	nS
Address Hold Time	t_{AH}	0	–	0	–	nS
Chip Select Pulse Width	t_{CS}	300	–	250	–	nS
Write to Chip Select Delay Time	t_{WCS}	0	–	0	–	Ns
Data Setup Time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

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.

CONSTRUCTION OF THE receiver unit for our radio control system should pose most hobbyists no real problems, although the physical size is somewhat less than the average constructor might expect. The PCB itself is quite well packed, and for once IC sockets are a disadvantage as they both increase the weight and make casing tighter and more difficult to fit.

The reason for this drive to miniaturisation will be well understood by regular followers of the disciplines of radio control — aircraft need all the help they can ▶



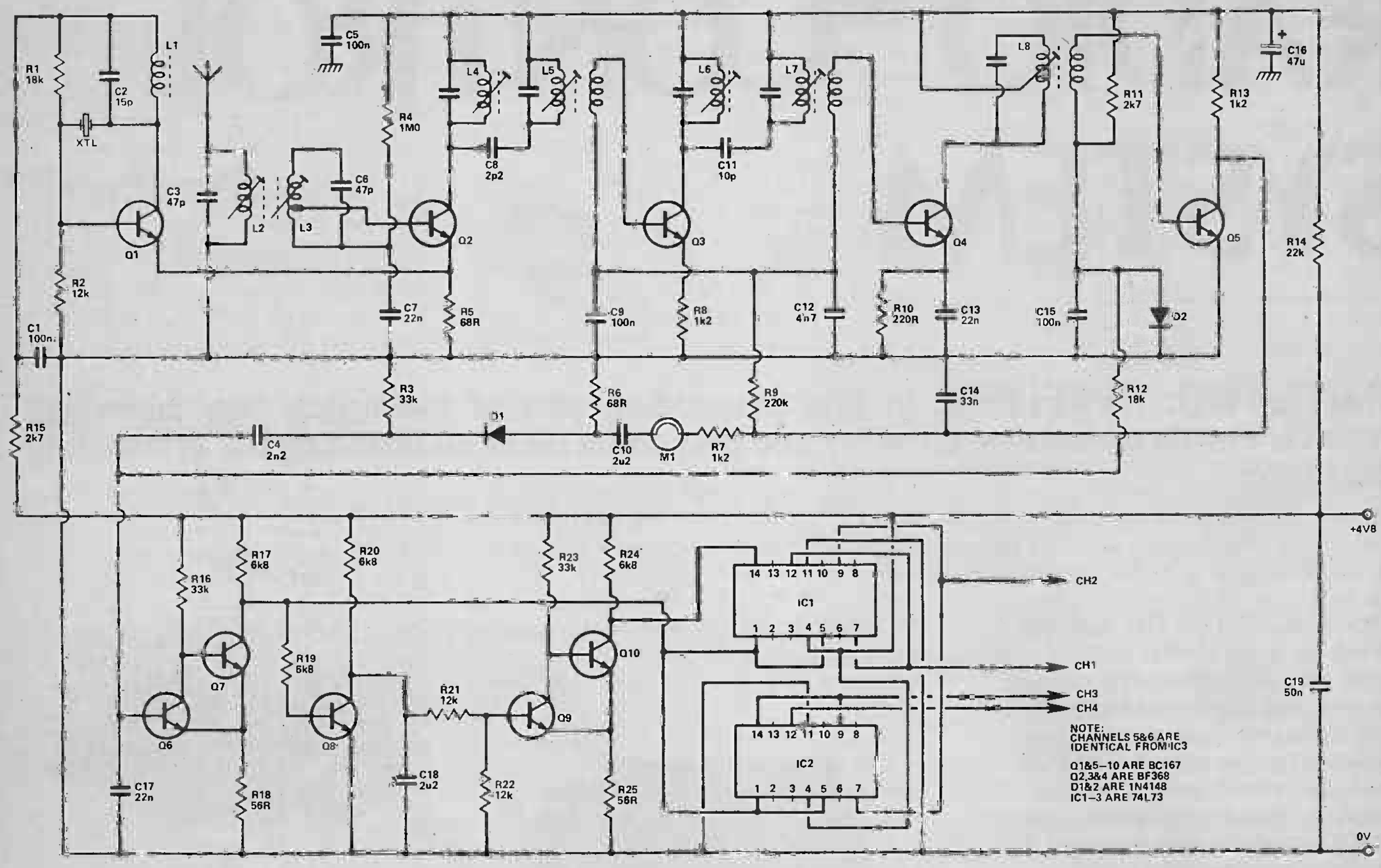


Fig 1 (Above) The full circuit diagram of the receiver unit. Note that power is best obtained from a rechargable cell. MI is a normally bridged test point.

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.

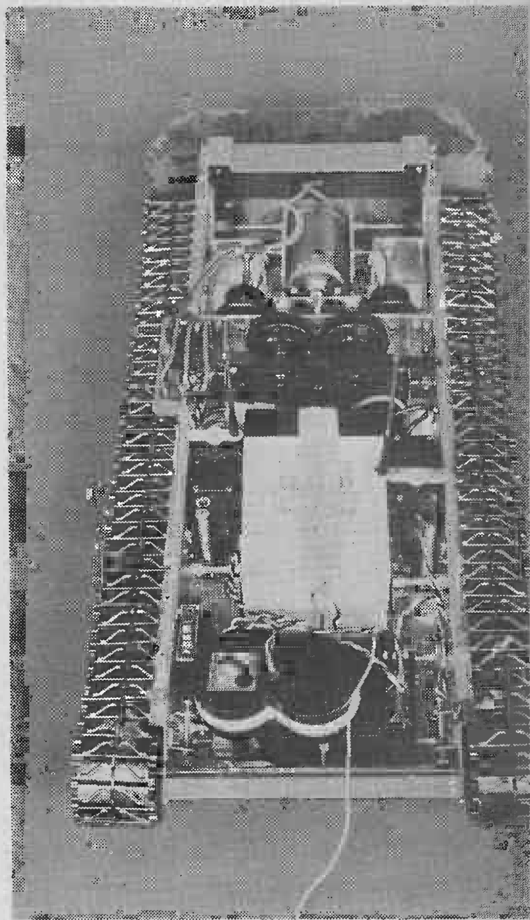
Connect a voltmeter with FSD around 5V between negative rail and the positive side of R7. The reading should be around 3V. Place the transmitter next to the receiver and switch it on. The meter should go down to about 1V. Remove the Tx aerial, and move it away until you get a reading of between 2V-2V5.

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.

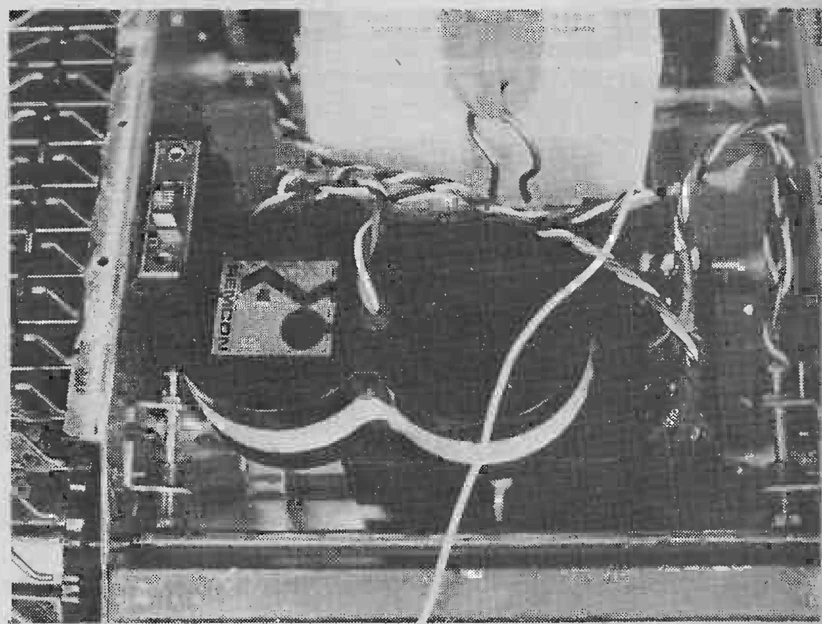
There may be some interaction so it is probably worth going through the whole thing a couple of times to make sure you've got it right. Once you're satisfied — that's it.

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.



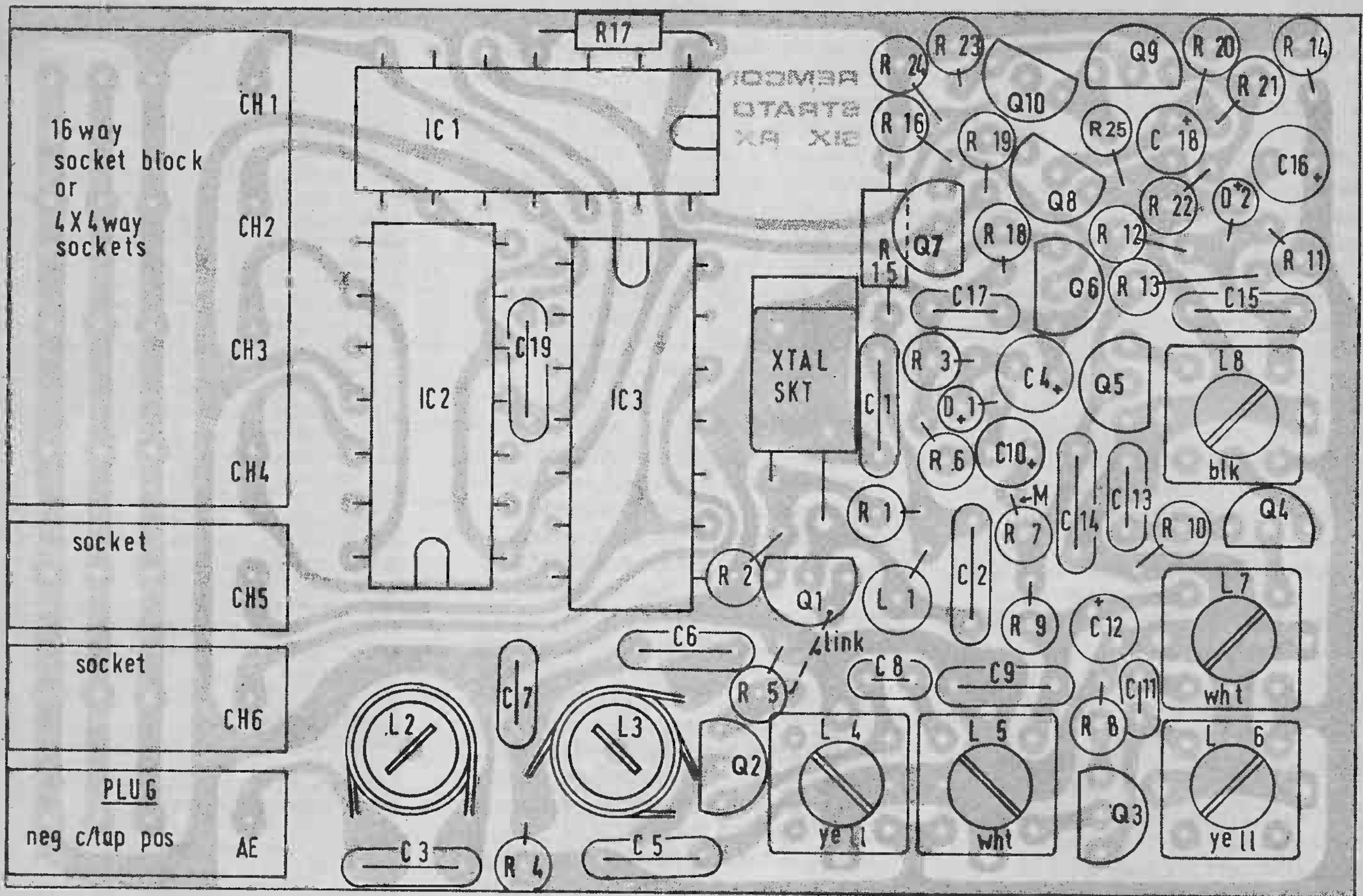


Fig 2. (Above) Component overlay for the radio control receiver board. In contrast to our usual style this is shown twice size to make construction easier. Since no sockets are employed take care with the ICs.

PARTS LIST

RESISTORS ALL 5%		C10, C18	2u2 polyester
R1, R12	18k	C11	10p ceramic
R2, R21, R22	12k	C12	4n7 polyester
R3, R16, R23	33k	C14	33n polyester
R4	1M0	C16	47u electrolytic
R5, R6	68R		
R7, R8, R13	1k2	INDUCTORS	
Rg	220k	L1-8 IF coils (see text)	
R10	220R		
R11, R15	2k7		
R14	22k	SEMICONDUCTORS	
R17, R19, R20, R24	6k8	Q1, 5-10	BC167
R18, R25	56R	Q2-4	BF368
		D1, D2	IN4148
CAPACITORS		ICI-3	74L73
C1, C5, C9, C15	100n polyester		
C2	15p ceramic	MISCELLANEOUS	
C3, C6	47p ceramic	4 V 8 battery, case, PCB.	
C4	2n2 polyester	Servos to suit application	
C7, C13, C17	22n polyester	Switch to fit model	
C8	2p2 ceramic		

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 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

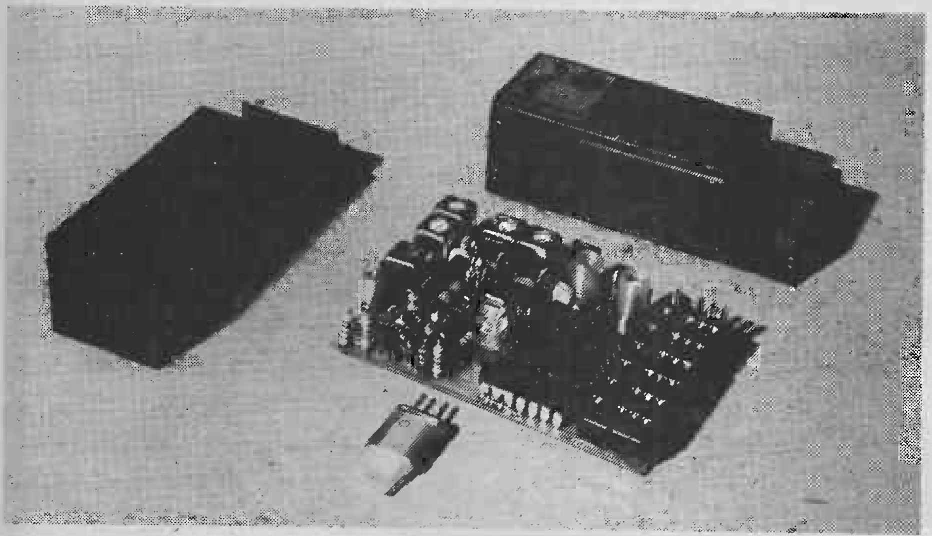
Installation of the system is totally dependent on where you intend to put it! If the unit is to spend its days running down pigeons in the smog above this green and pleasant land of ours, then your servos need to be smaller than average, and will generally cost more the smaller you want them.

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.

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.

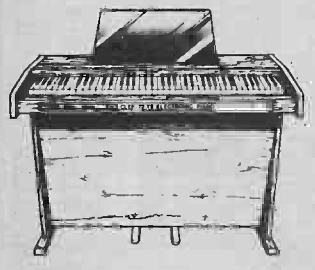
The Odd One

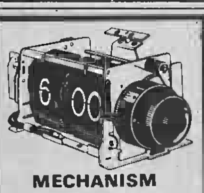
I'd like estimates as to when you the readers think Texas are to launch their long-awaited small system. No sign of it at the WES in America this year. Send me, please, a date and the odds you feel should be offered. I'll report on your concensus and if anybody gets it right — you'll be really chuffed.

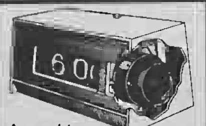
Four In A Row

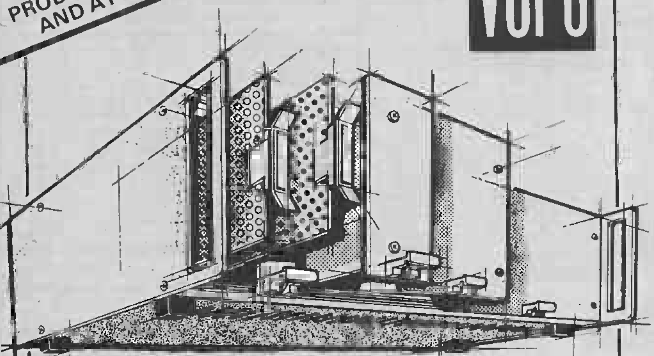
Oxford won the boat race this year — not much to do with MPUs this — and the newscaster giving the result, with a totally straight face, said this is Oxford's fourth win in a row — well I suppose they play football against each other.

ETI









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

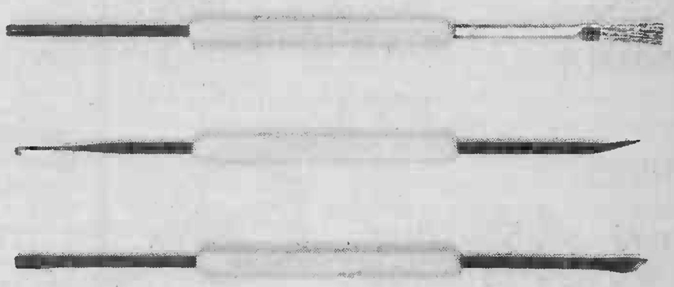
SOLDER TOOLS

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

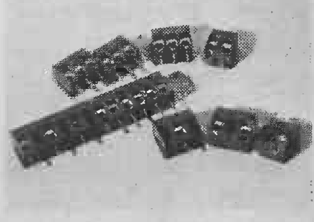
The Lake Placid Olympic Organizing Committee have chosen two new versions of the Heuer Microsplit LCD stopwatch as the official stopwatches of the 1980 Olympic Winter Games.

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.



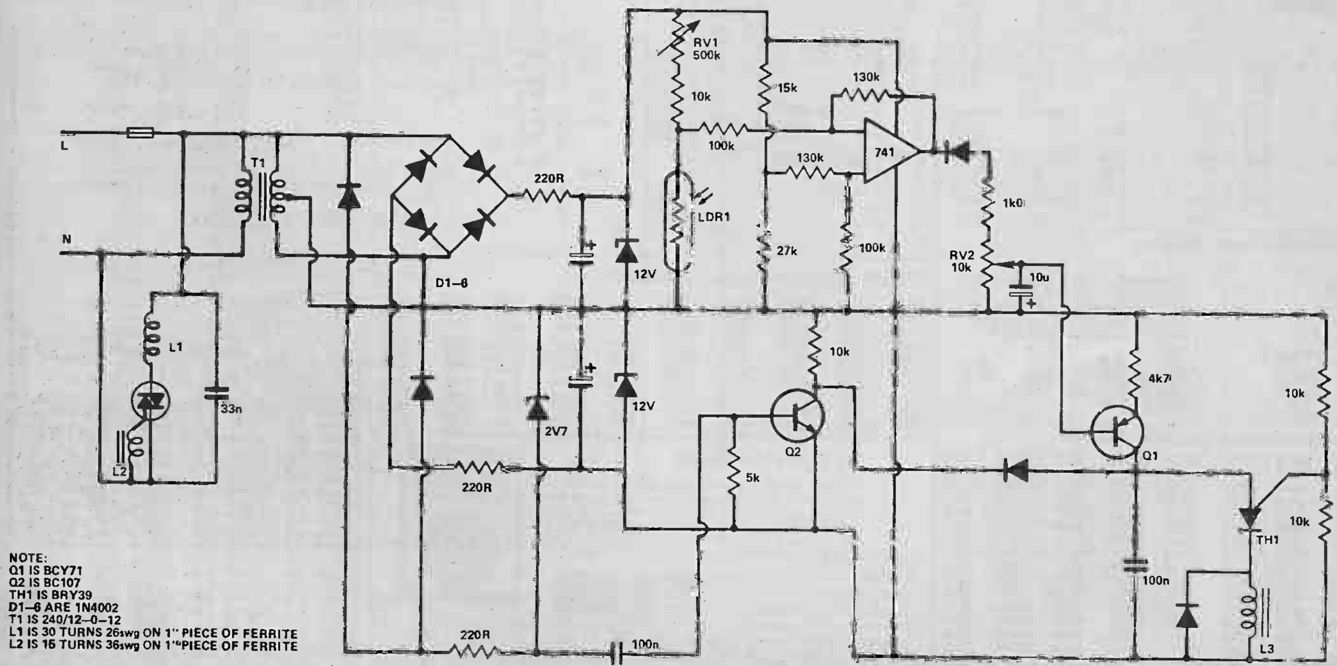
Porch Light Controller

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).



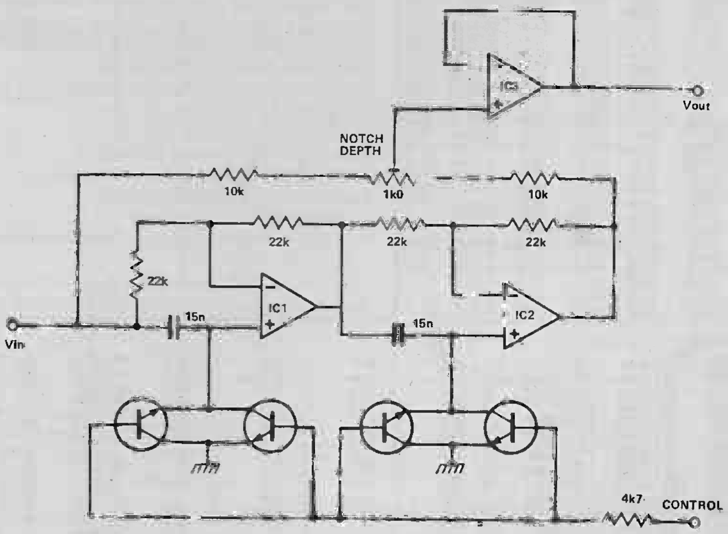
Variable Notch Filter

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.

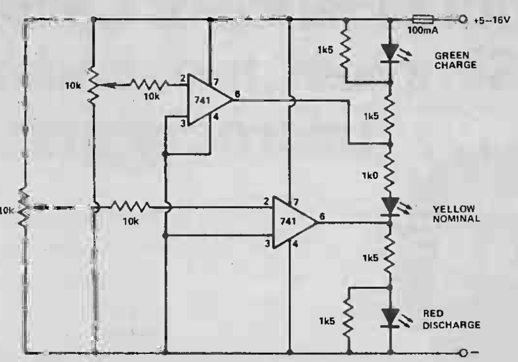
Battery Charge/Discharge Indicator

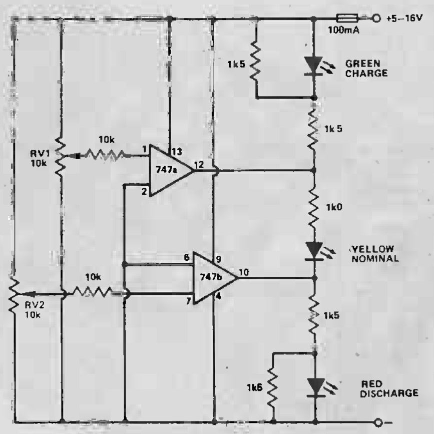
A. A. C. McInnes

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.





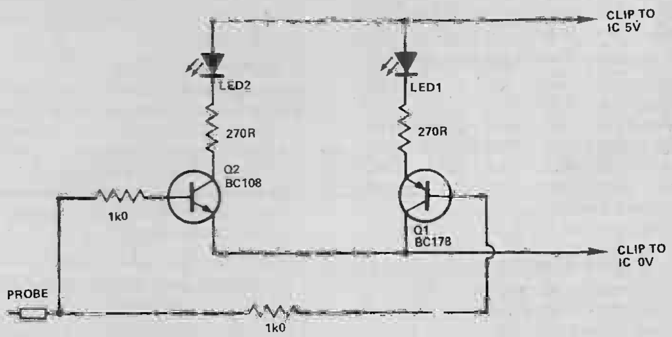
Crosshatch Generator Update

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



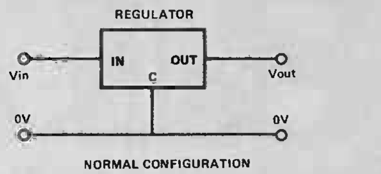
This simple piece of test equipment can be built using widely available components for little more than £1.

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.

Fail-safe For IC Voltage Regulators

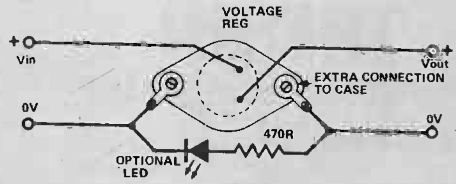
Andrew Bain



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.



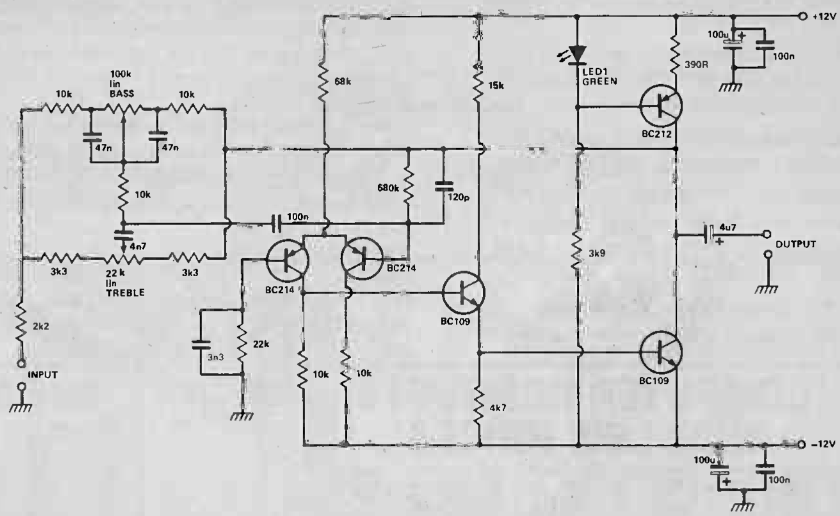
High Quality Tone Control

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.



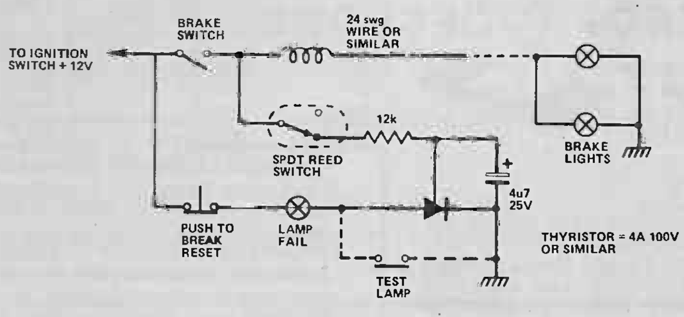
The design is suitable for inputs between 100 mV and 1V0. and provides a good overload margin at low distortion for the accurate reproduction of transients. The usual screening precautions against hum should be carried out.

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.

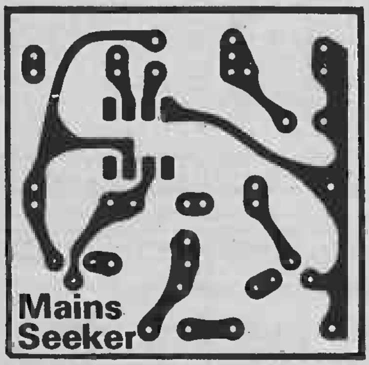


PCB FOIL PATTERNS

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.

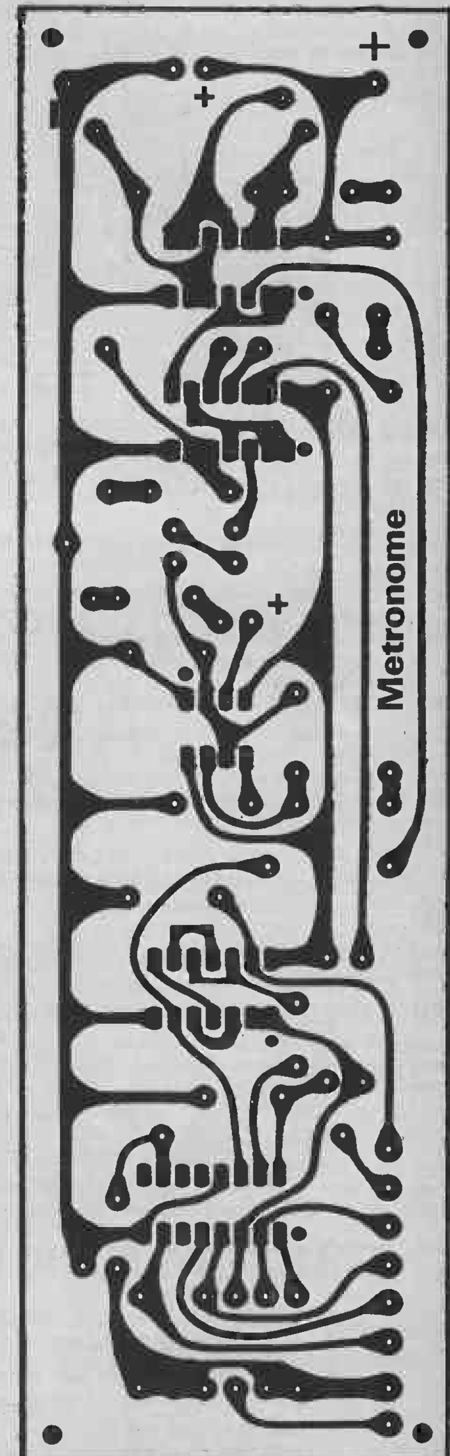
All are shown foil side up, and full size. Companies wishing to produce these for sale as ready made PCBs should note that where the board carries a copyright symbol, the designer retains that copyright to himself, so his company, and that particular board may not be produced on a commercial basis.

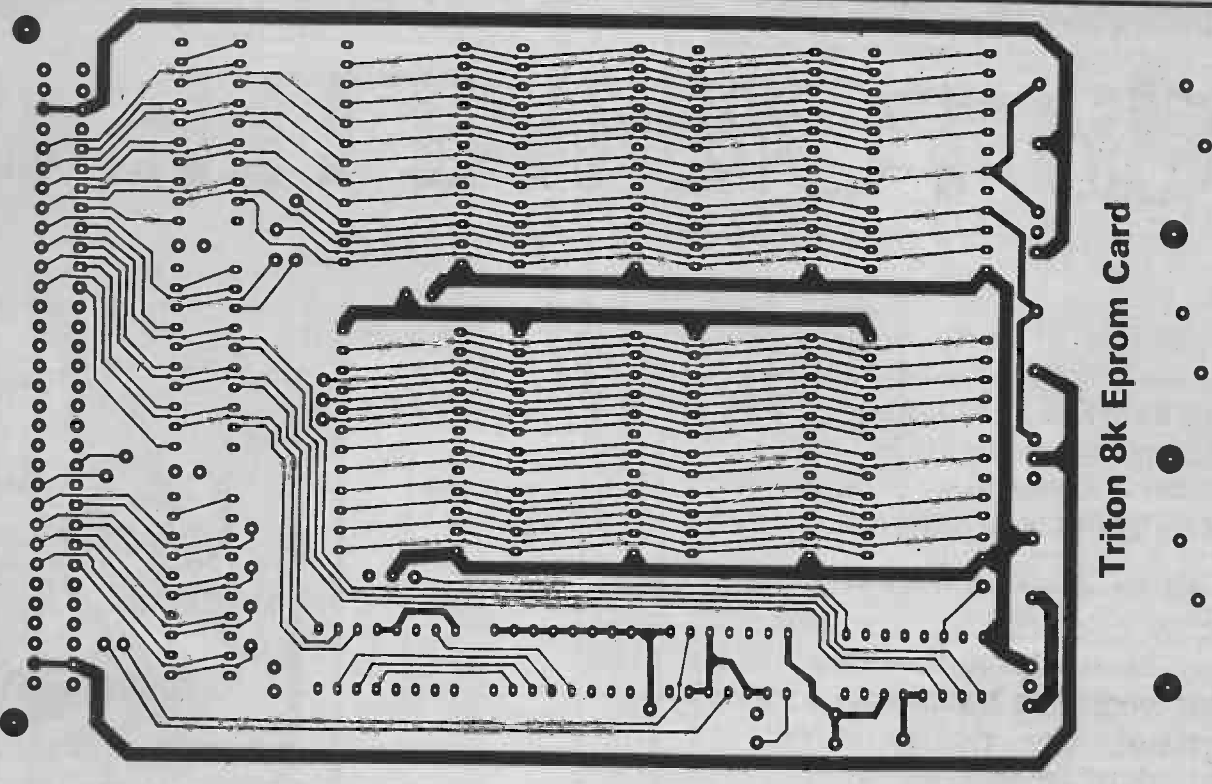
These pages form the basis of our ETIPRINT sheets, which are etch resistant transfers of the foil patterns, designed to simplify one-off PCB production. See the ad on page 71 for further details.



Left: the Mains Seeker foil pattern.

Right: the accentuated beat metronome board





Triton 8k Eprom Card

.... 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.

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.

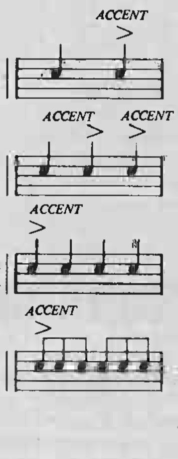


Fig. 1. The accented beat of the bar.

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 ▶

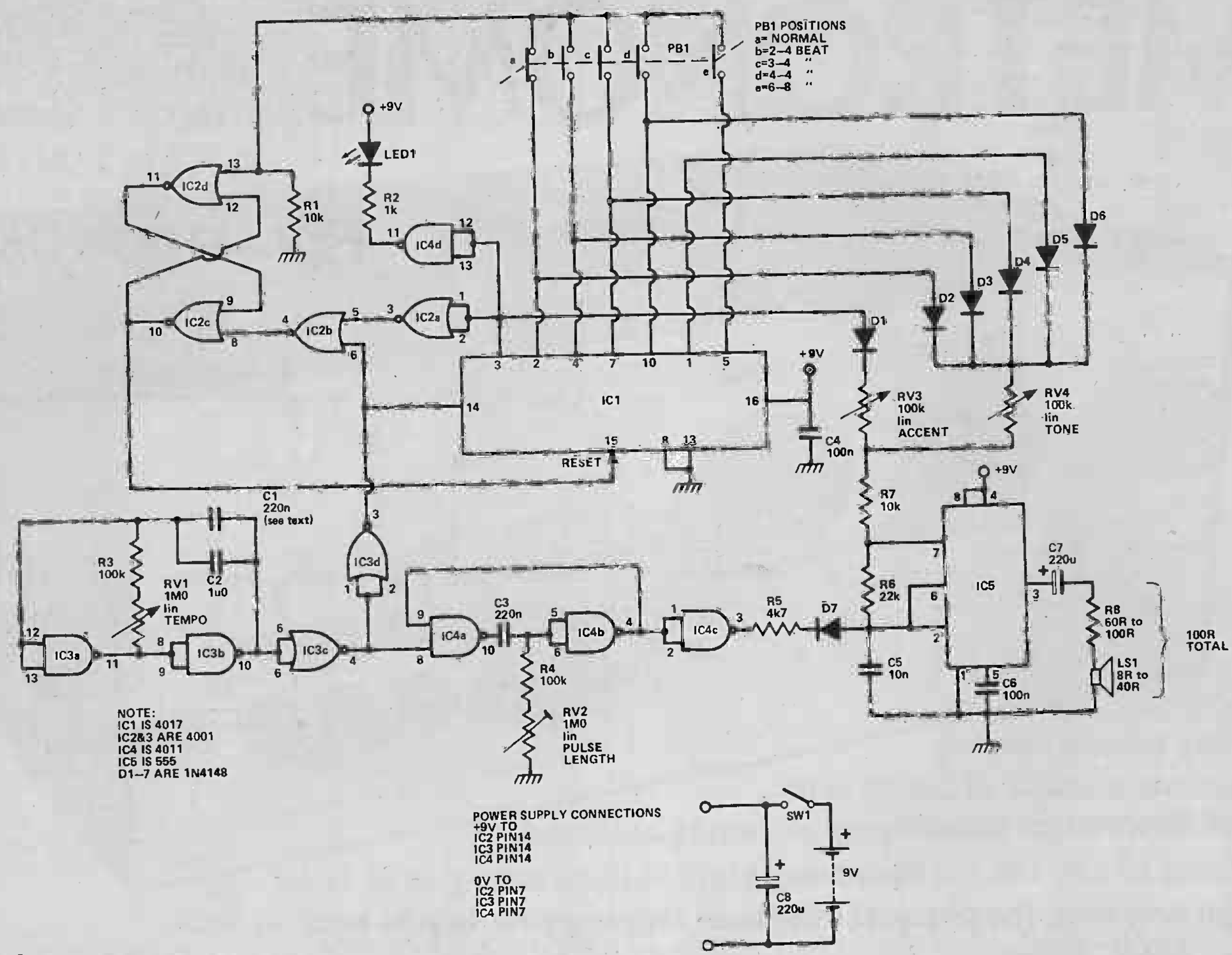


Fig. 2. Circuit diagram of the metronome.

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	1M0 Lin
RV2	1M0 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.