Hobby Electronics

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SPACELAB

TV on TV
Minature TV Survey

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Constructional Projects

Crosshatch Generator
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Hobby Electronics

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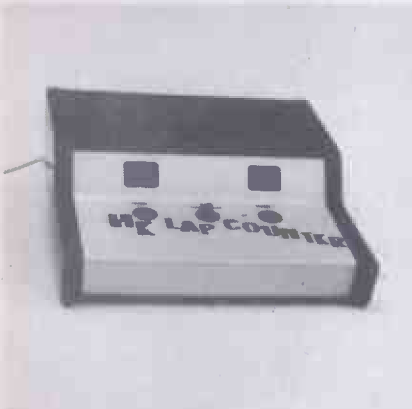
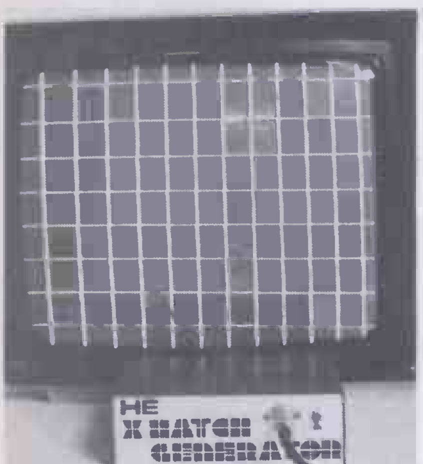
PROJECTS





FEATURES

NEWS AND INFORMATION

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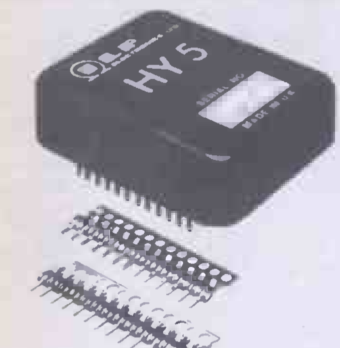
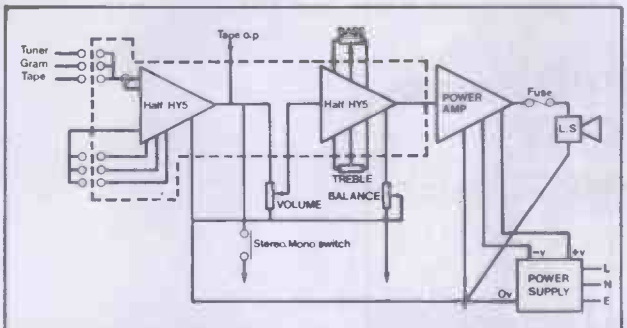
ILP
HY50

and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER



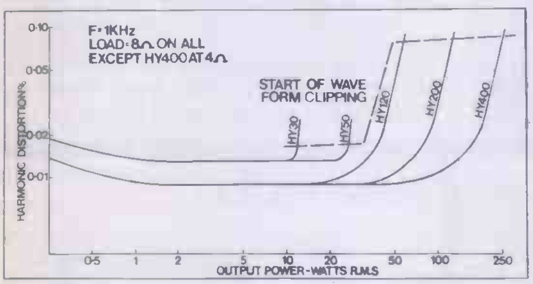


VALUES OF COMPONENTS FOR CONNECTING TO HY5
Volume — 10K Ω log.
Bass/Treble — 100K Ω linear. Balance — 5K Ω linear.

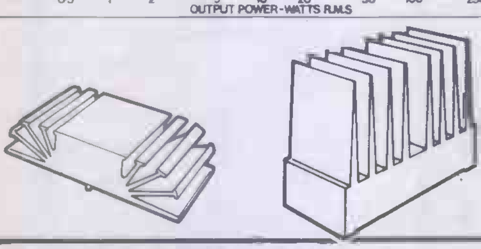
The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion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

£4.64 + 74p VAT

THE POWER AMPLIFIERS

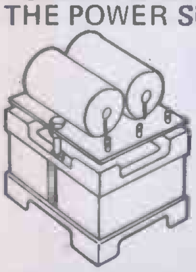


Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	£6.34 + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0 +25	105x50x25	155	£7.24 + £1.09
HY120	60 W into 8 Ω	0.01%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



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

THE POWER SUPPLY UNITS



I.L.P. Power Supply Units are designed specifically for use with our power amplifiers and are in two basic forms — one with circuit panel mounted on conventionally styled transformer, the other with toroidal transformer, having half the weight and height of conventional laminated types.

PSU 30	±15V at 100ma to drive up to five HY5 pre-amps	£4.50 + £0.68 VAT
PSU 36	for 1 or 2 HY30's	£8.10 + £1.22 VAT
PSU 50	for 1 or 2 HY50's	£8.10 + £1.22 VAT
PSU 70	with toroidal transformer for 1 or 2 HY120's	£13.61 + £2.04 VAT
PSU 90	with toroidal transformer for 1 HY200	£13.61 + £2.04 VAT
PSU180	with toroidal transformer for 1 HY400 or 2 x HY200	£23.02 + £3.45 VAT

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. . . .
NAME . . . .
ADDRESS . . . .
. . . .
Signature . . . .

Monitor

CHEAP GAME

Latest programmable TV game to hit the streets comes from ACE. Most of the games are fairly standard (Atari, Grandstand etc) but one or two really stand out. We particularly liked the Boxing and Shooting Gallery games. The Boxing game has two very colourful gentlemen 'slugging' it out in the ring, the object being to knock your opponent out. The Shooting Gallery has a collection of wildlife flying, swimming and running across the screen. Two vicious hunters have the job of trying to shoot as many animals as possible in the time allowed (or alternatively with a limited stock of ammunition). Not in very good taste considering the current interest in Anti Bloodsports, great fun though. All games are in colour with sound effects coming from the 'sets' speaker.

What really sets this apart from the other 'programmables' is the astoundingly low price, just £89.95 plus £14.95 each for the 14 cartridges available at the moment. ACE tell us that chess and Space War cartridges will be available early in the new year.

If this machine sounds like it is for you then your local games shop should have it in stock about now, if for any reason you can't find one then ACE at Unit 3, Fulton Road, Wembley, Middlesex are waiting for a call from you.

CUT ABOVE THE REST

It's a fact of life, whenever you get hold of a new knife one of the first things you will cut with it will be yourself. There is a saying that it is better to be cut with a sharp knife as it doesn't hurt so much.

What has all of this got to do with the folding knife shown here? The answer is simple, because it folds up the chances of cutting yourself are minimised but should you be unfortunate/careless/stupid enough to cut yourself you can comfort yourself that because it is so sharp it won't hurt as much as a blunt blade.

The sharpness is assured by the Vanadium Stainless-Steel blade measuring just over three inches long. When not in use the blade folds in the amber coloured handle. To become the proud owner of one of these cutting tools then Telepro Ltd of Stiron House, Electric Avenue, Westcliff-on-Sea, Essex, would like to hear from you.

MINI-MULTI

This interesting looking little multi-meter comes from Alcon instruments and is called the Mini 20. As you can see from the picture it has a pretty comprehensive set of ranges. The meter features an anti-parallex mirror on the clearly calibrated scale. Sensitivity is 20 k per volt and accuracy in the order of 2% on the DC ranges and 3% on the AC. Price for the meter is a respectable £27.37 inc VAT. Contact Alcon Instruments at 19 Mulberry Walk, London SW3 for further details.

SHURLOKS GOOD

Ultrasonic alarms come and go but this one designed specifically for automotive applications, looks very interesting.

It's called the Shurlok Detector and is only slighly bigger than a packet of 20 cigarettes. The small size and minimum external wiring make it ideal for siting under dashboards or other equally 'discrete' places. The alarm operates by sending out a continuous stream of ultrasonics. Should any movement be detected within the 'field' it will trigger the alarm for 12 seconds. The alarm has a further capability for monitoring the car's battery voltage. Should the battery voltage drop for any reason the alarm will also be triggered.

The Shurlok comes with a very comprehensive installation kit and is being offered mail-order only at the moment for just £44.95 plus £1.50 P & P. For more information contact Linkdell Ltd, 7 Eastside Road, London, NW11 OAY.

JUST IN TIME

Just a quick reminder to say that our technical enquiry service will be on holiday from Dec 14th to January 5th.

News from the Electronics World

AIR TODAY . . .

Have you ever wondered why nearly all radio sets tune over virtually the same set of frequencies? Could it be that these 'lost or missing' bands are completely dead or is it more subtle?

The fact is there are plenty of transmissions that for one reason or another are avoided by the radio manufacturers, these include 'sensitive' frequencies used by armed forces and police etc which, though, undoubtedly fascinating to listen to is deemed illegal by the powers that be. One group of frequencies however, the so-called Air Band is not restricted so we were intrigued to hear of this rather unusual receiver that along with the normal broadcast bands has the provision for monitoring these transmissions.

The receiver in question comes from Ingersol Electronics and is given the inspiring title of the XK 725 (whatever happened to the 724?). A close look at the tuning dial reveals that the FM/VHF band extends from 88 MHz to 130 MHz (most radios give up at 108 MHz).

The set measuring 150 mm×70 mm×35 mm runs from three HP7 type batteries has a built-in telescopic aerial and an LED tuning indicator. Interested? Then if you cannot find it at your local radio emporium contact Ingersol at: 202 North Road, London N1 7BL.

PIECE TOGETHER PROBE

Logic circuits are notoriously difficult to troubleshoot. Many fruitless hours can be wasted changing 'suspect' ICs when the fault is (Murphy's Law) usually a poor solder connection or open circuit PCB track. The value of an oscilloscope (if you're rich) or Logic probe in these situations cannot be overemphasised.

Like most types of test equipment, logic probes are essentially easy to build but are rarely constructed until it is too late.

Now there is no excuse, Continental Specialties Corporation (CSC) have got together an inexpensive logic probe kit that will hold its head (or pointed probe) up amongst the best of them. The probe (christened LPK-1) is powered from the circuit under test and shows conventional logic states via two LEDs marked 'HI' and 'LO'.

Assembly should prove no obstacle to even the most 'ham fisted' and should make a worthwhile addition to any workshop. CSC can be found at: Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

SAVE OUR BREN

The lovely Bren Hunter, the lady who looks after all of our Readers Offers has been complaining. It's her feet, she keeps getting orders for backnumbers and subscriptions in letters containing orders for Readers Offers. She has to trek across the office to deliver these rogue orders to the various departments. So, please, if you have any sympathy at all for Bren's feet keep your orders for the three departments separate or Bren will come round your house and beat you up, (she would too).

NEW CATALOGUES

Catalogue time again. Two interesting ones this month for your perusal.

A rather festive looking catalogue from Heathkit has just arrived. It contains all of their current range of very high quality kits at prices which may look rather excessive at first but then they are the best.

Second offering comes from Hamlin Electronics Ltd. They are probably the foremost supplier of LCD devices and displays. Call them at Diss, Norfolk, IP22 3AY.

WE'VE GOT IT TAPED

The small picture on our cover shows our feature on miniature Tellys being filmed for a short feature that we hope to show at BREADBOARD. The equipment used comes courtesy of JVC and includes one of the latest home video colour cameras and video tape recorders. We were so impressed with the quality of this equipment it is doubtful whether JVC will ever get their gear back. We would like to thank JVC for the loan and Barbara Riddell and David Watson of Prestige PR Ltd for their invaluable assistance in getting it all together.

SCALEXTRIC CONTROLLER

Due to lack of space last month we had to commit the cardinal sin of reducing the PCB foil pattern for the speed controller. If anyone would like a full-size copy of our original artwork then send an SAE to: Controller Foil Pattern, Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE.

RADIO CONTROL

Sorry about the lack of Radio Control project this month but the suppliers of the 'dedicated' ICs used in the design have told us there may be some supply problems. So rather than leave you hanging around with half finished projects we decided to postpone if t for a few months until the problems are all sorted out.

BREADBOARD 79

This issue should be out in time for the BREADBOARD electronics show at the Royal Horticultural Hall Westminster (Dec 4th to 8th). If you are in the area why not drop in and say hello. HE, along with our sister magazines ETI and CT have secured the largest stand at the show and all of our major projects along with back issues, readers offers etc will be on show. Look out for the HEBOT display, it promises to be very interesting.

CHANGE OF ADDRESS

NIC Models run by that gentleman Nick Nicholls has just opened up a retail shop at 61 Broad Lane Tottenham London N15. He assures us that he would be delighted to see you and take your money for any of his rather impressive range of goods. How about some more goodies for us to play with Nick?

CHRISTMAS LIGHTS

By now you will probably have heard that despite everything Christmas will again be appearing on December 25th. In view of this, we have taken the liberty of including two festive circuits. Both are Christmas tree light flashers but rely on different methods to achieve their effects. We at HE would like to take this opportunity of wishing everybody a very happy Christmas and a prosperous New Year. HAPPY CHRISTMAS . . .

Scalextric Lap Counter

An ideal companion to last month's Speed Controller. Our 2-track lap counter features infra-red slot-car detection, presettable race laps, count-down lap indication, plus 'lap completed' and 'race won' sound effects.

THE HE DESIGN TEAM recently acquired a large Scalextric slot-car racing outfit. We were very impressed with the outfit in general, but thought that the mechanical lap counter supplied with the system was absolutely awful. It was so inefficient that it often stopped or derailed the slot-cars and tended to distract the driver's visual attention from the race. So we decided to design a really first class 2-track electronic lap counter to replace it. The results of our efforts are presented here.

Our lap counter incorporates a number of unique features. It uses an infra-red source and detector, built into the actual slot of each track, to frictionlessly detect the passage of each slot-car as its' slot horn breaks the infra-red beam. The detectors are positioned behind the starting grid. Before the start of each race the proposed number of race laps (up to a maximum of 99) are dialled up on a pair of thumbwheel switches. This number is then loaded into the lap counters via a press-button switch and is displayed on the 7-segment LED readouts of each counter. This number can be re-entered at any time by simply re-pressing the 'set' button.

Once the race has started the appropriate counter decrements by one each time it's slot-car completes a lap and passes the appropriate infra-red detector. A brief (100mS) audio tone is generated each time the counter decrements. Each counter produces it's own distinctive tone, so the drivers can aurally judge the state of the race without taking their eyes from the track. Eventually, as the winning car completes the last of the pre-set number of laps, the appropriate counter indication decrements to zero and at this point another distinctive tone, of roughly 5-seconds duration, is generated, indicating that the race has been won. The counter action is then complete.

The lap counter incorporates a mains-driven power supply. The counter unit is designed specifically for use with a Scalextric slot-car outfit, but can probably be used with most other makes of slot-car system (the critical factor being the fitting of the infra-red detectors into the slots). The system can be used with any standard, unmodified, slot-car.

CONSTRUCTION: THE TRACK DETECTORS

The first step in the construction of the unit concerns the fitting of the infra-red source and detector units to the track. The idea here is to drill a ⅛ inch hole right through each slot rail on a short section of track, as close as possible to the top surface of the slot, as shown in Fig 2. An infra-red light-emitting diode is then fitted in the hole on one side of the slot and an infra-red detector is fitted in the hole on the other side, so that the guide horn of a slot-car breaks the resulting infra-red beam when it passes over the detector assembly.

The finished unit in its attractive case.

The most critical factor in this 'fitting' operation, which only takes a few minutes to complete, is to get the drill holes as close as possible to the top of the track. The procedure is as follows.

Take a short secton of track. Using a ⅛ inch drill, angled at about 15 deg, drill through the soft plastic and into the metal rail on one side of the slot, as shown in Fig 2a, so that the drill breaks through the slot rail as close as possible to it's top surface, as shown in Fig 2b. Repeat the operation on the other side of the slot, taking care to align the second hole with the first, as shown in Fig 2c. Now arch the top surface of the flexible track upwards from the slot and push the drill right through the slot so that the two opposing holes align perfectly. Remove the drill and use a fine file to clean up any burrs on the inside of the slot rails.

Now push an infra-red light-emitting diode (with gold leads) firmly into the hole on one side of the slot, so that it butts firmly into the slot-rail hole, and push a detector diode (with tinned leads) firmly into the opposing hole, as shown in Fig 2d.

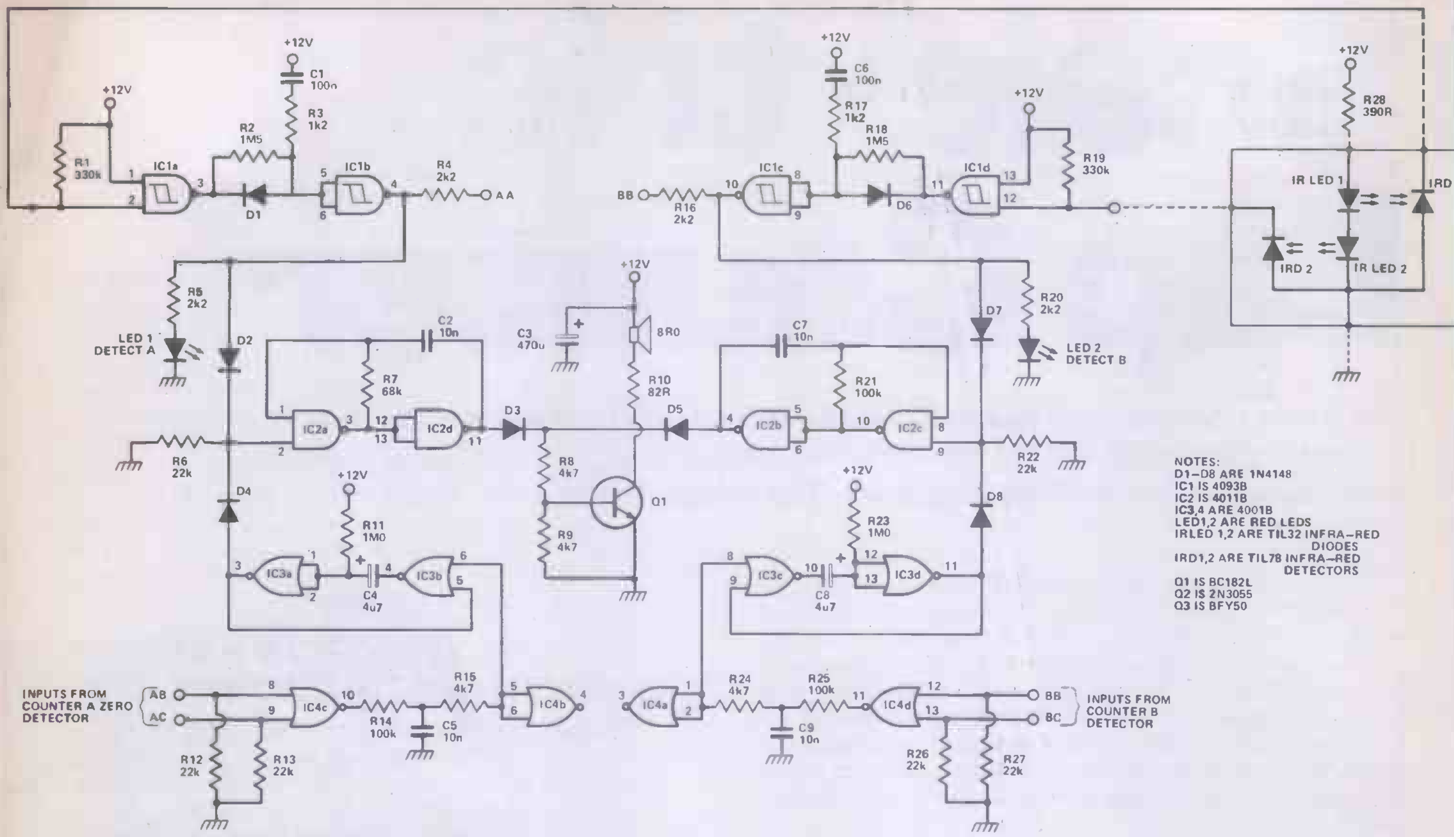
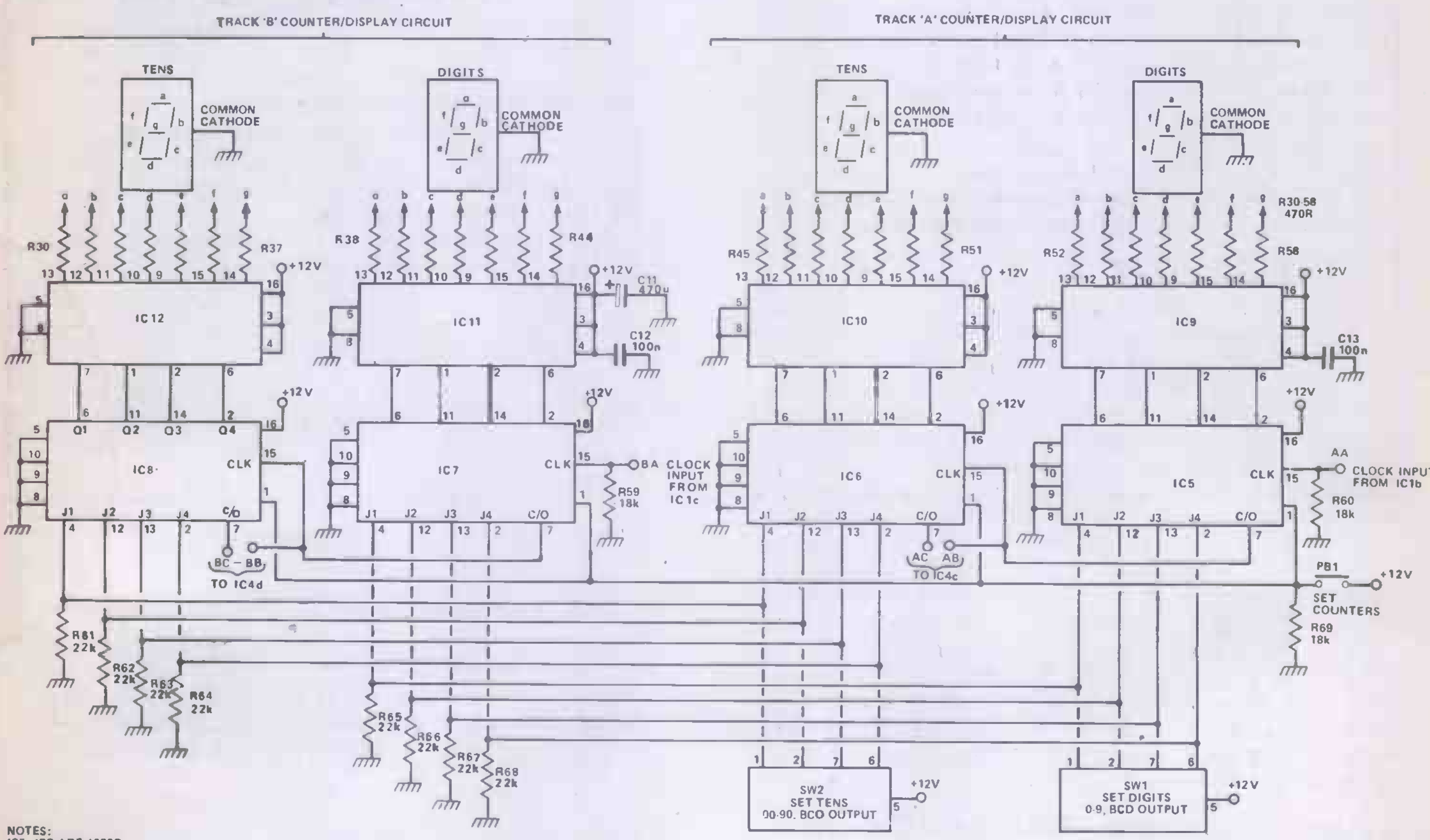


Fig. 1. The detector and sound generation logic.



NOTES:
IC5–IC8 ARE 4029B
IC9–IC12 ARE 4511B
7 SEGMENT DISPLAYS ARE COMMON CATHODE (MAPLIN TYPE FR38R)
SW1–SW2 ARE BCD THUMBWHEEL SWITCHES
(MAPLIN FF84F, PLUS MOUNTING KIT – FF86T)

Fig. 2. The counter-display circuitry.

How it Works

LAP COUNTER AND 'GAME WON' CIRCUITRY

Each lap counter contains a series-connected pair of presettable binary-coded-decimal 'down' counters (IC5 and IC6), each with its outputs fed to a 7-segment LED display via a BCD — to — 7-segment decoder/driver (IC9 and IC10). At the start of each race the intended number of laps are dialled up on thumbwheel switches SW1 and SW2 (which have BCD outputs). This number is then loaded into the counters by pressing push button switch PB1. The displays thus indicate the proposed number of laps at the start of each race.

Once the race has started, a 100 mS pulse is generated each time a slot car passes the appropriate track detector. This pulse is fed to the clock input terminal (pin 15) of IC5 and causes the counter display to decrement by one.

The carry-out (pin 7) terminal of each counter IC goes low whenever the counter reading reaches zero. When the pre-set number of laps are completed both counters give a low carry-out signal and this condition is detected by IC4c, which produces a 'high' output. This output is used to trigger monostable multivibrator IC3a-IC3b, which produces a 5-second output pulse which in turn gates on astable multivibrator IC2a- IC2d to produce a 'win' tone in the speaker via D3 and Q1. Note that the gated astable used in each of the two lap counters produces its own distinctive tone, so the players can tell which car has won the race or completed the lap by the sound of the generator.

The two lap counter circuits are powered from the mains via step-down transformer T1 and the Q2-Q3 12 volt regulator circuitry.

THE SYSTEM

THE UNIT CONTAINS two identical lap-counter circuits (see the block diagram and the circuit diagrams), each containing a pair of pre-settable down counters with appropriate 'clocking' and 'count zero detection' circuitry. Each circuit also incorporates a gated oscillator, which produces a brief pulse tone each time a lap is completed and produces a five second tone when the pre-set number of laps are completed. Each lap counter is 'clocked' via an infra-red detector circuit that is wired unobtrusively into the track slot to produce a pulse each time that it is passed by a slot car.

The two counters are powered from a common mains-derived 12 volt supply and have their audio outputs fed to a common mixer/amplifier and speaker. Before the start of each race, the intended number of laps (up to 99 maximum) are dialled up on a pair of thumbwheel switches (which are also common to both counter circuits) and the number is then 'loaded' into the counters by operating a press-button 'load' switch.

Since two lap-counter circuits are identical, only the component numbers applying to the track-A circuit will be listed in the following detailed description of the circuit operation.

THE LAP-DETECTION AND INDICATION CIRCUITRRY

The lap-detection circuitry is rather cunning. A small section of each race track is modified by drilling a hole completely through the track slot, as close as possible to the top surface of the track. An infra-red light-emitting diode (IR LED 1) is then wired into the hole on one side of the slot and an infra-red detector (IRD 1) is wired into the hole on the other side of the slot. Normally, the detector is flooded with infra-red and produces a low voltage at the R1-IRD 1 junction. Each time a slot car passes the detector circuitry, however, it's slot horn breaks the infra-red beam and causes the voltage at the R1-IRD 1 junction to go high.

A positive-going pulse is thus produced at the R1-IRD 1 junction each time a slot car passes the detector. This pulse is amplified and expanded by the IC1-a IC1b circuitry, to produce a positive-going 100 mS (approximately) pulse at the output of IC1b. This pulse causes LED 1 to flash and also briefly gates on a stable multivator IC1a-IC2d, to produce a brief tone in the speaker via D3 and Q1. The detector pulse is also fed to the lap counter circuitry via point AA.

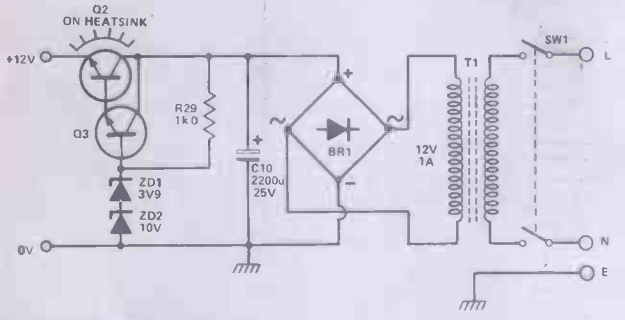


Fig. 3. The regulated power supply.

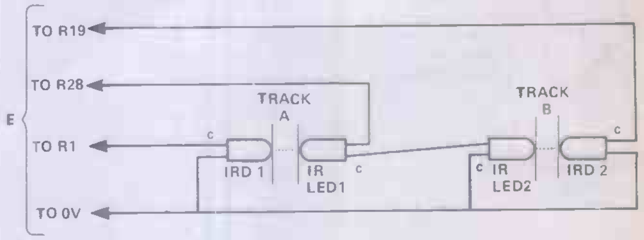
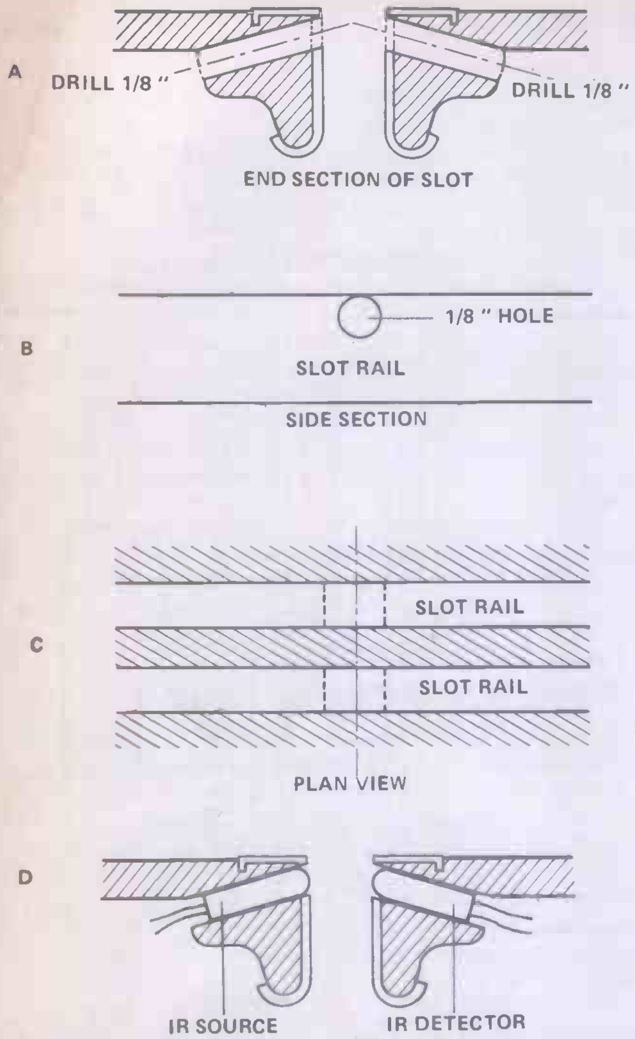


Fig. 4. The track detector interconnections.



Repeat the above process on the second track slot and then wire up the two IR LEDS and two IR detectors as shown in Fig 2e, using suitably long lengths of flexible wire to make the connections back to the lap counter unit.

CONSTRUCTION: THE LAP COUNTERS

The unit is wired up on two PCBs, one small board being used for the power supply circuit and a large PCB being used for most of the remaining components.

Wire up the power supply board first, noting that transformer T1 is a special PCB-mounting unit (see Buylines). Power transistor Q2 must be mounted on a large heat sink and connected to the PCB via suitable leads (this transistor is mounted on the rear panel of the case in our prototype unit.

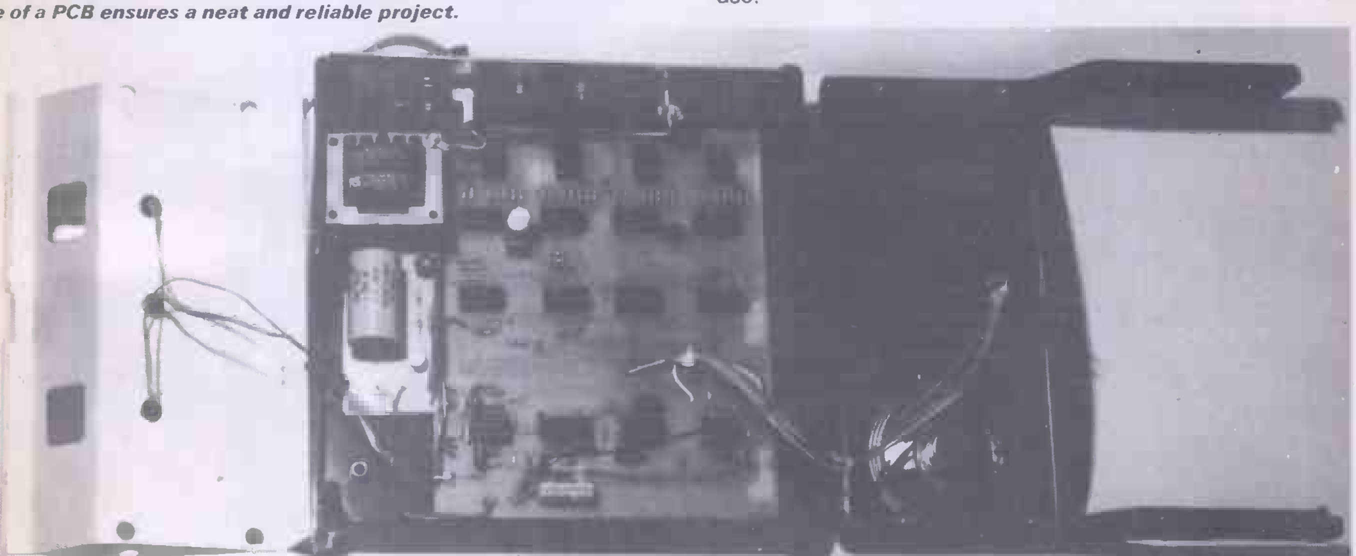
Construction of the main PCB should present few problems. We recommend that all ICs be fitted to the board via suitable sockets. Start construction by soldering the 40 links to the PCB and then fit the 16 IC sockets in place. Now fit the remaining components to the board, taking special care to note the polarities of all electrolytic capacitors and semiconductor devices. Do not fit the ICs at this stage.

Sockets are provided on the PCB for the four 7-segment LED displays. The displays can either be fitted directly into these sockets or can, as in our prototype, be mounted on the case front panel and connected to the sockets via dual-in-line (DIL) insulation displacement connectors, e.g. 'speedblock' type.

When construction is complete, fit the PCBs in a suitable case, connect up the two BCD thumbwheel switches (use the Maplin units recommended in Buylines) and the speaker and complete the interwiring. Finally, fit all ICs into place, taking special care to observe the polarity.

Connect the finished unit up to the two sets of track sensors and switch on. A five second (approx) tone should be generated at switch on. Dial up a number on the thumbweel switches and check that the number loads into the counter displays when PB1 is pressed. Move a slot car across a track detector and check that the appropriate indicator LED flashes and a brief tone is generated in the speaker: if this action is not obtained, suspect faulty construction in the track detector. Check that the appropriate counter decrements by one each time a slot car is detected. Finally, check that the win sound (a five second tone) is generated when the counters decrement to zero. The unit is then ready for use. **HE**

Use of a PCB ensures a neat and reliable project.



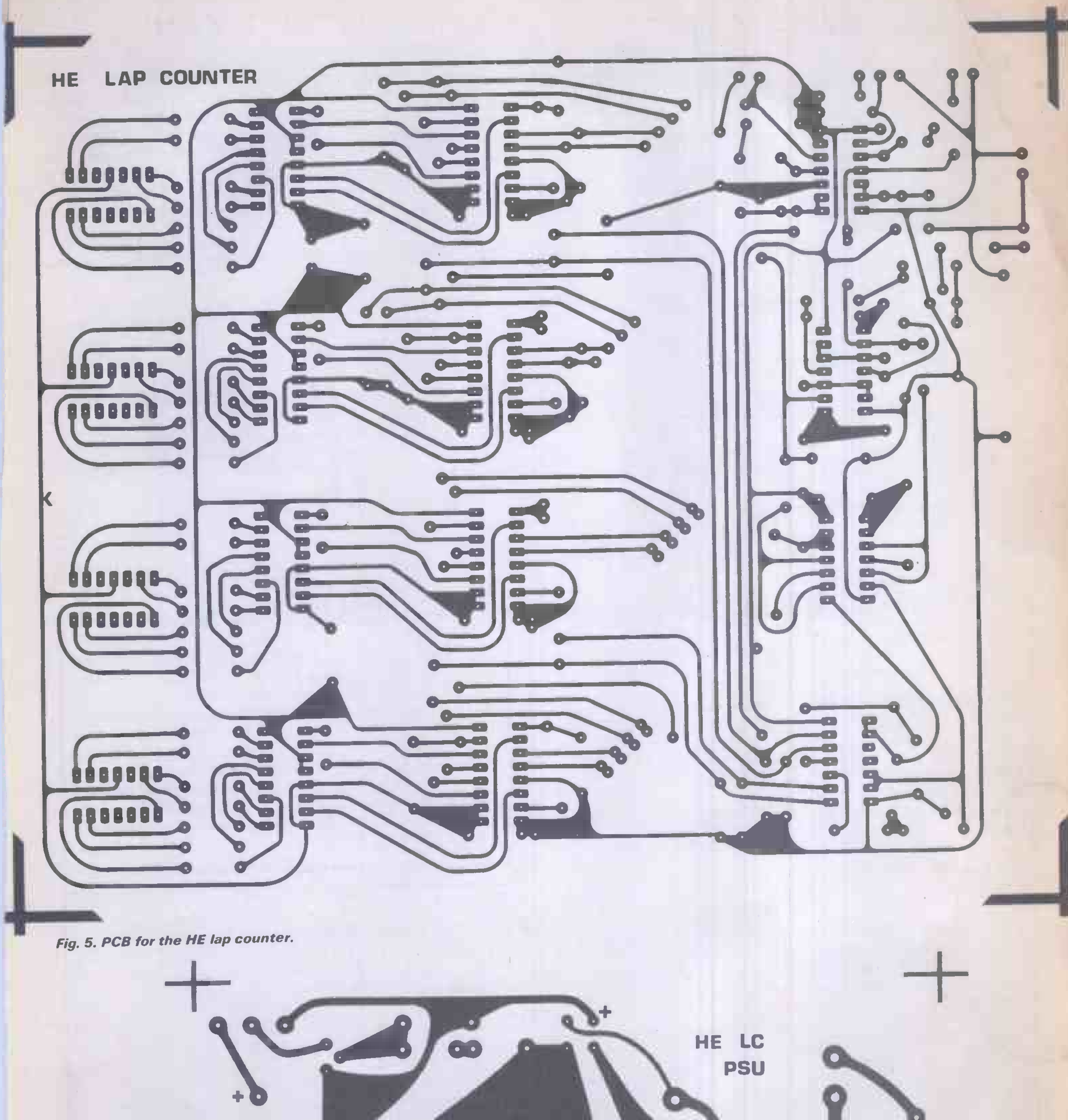


Fig. 5. PCB for the HE lap counter.

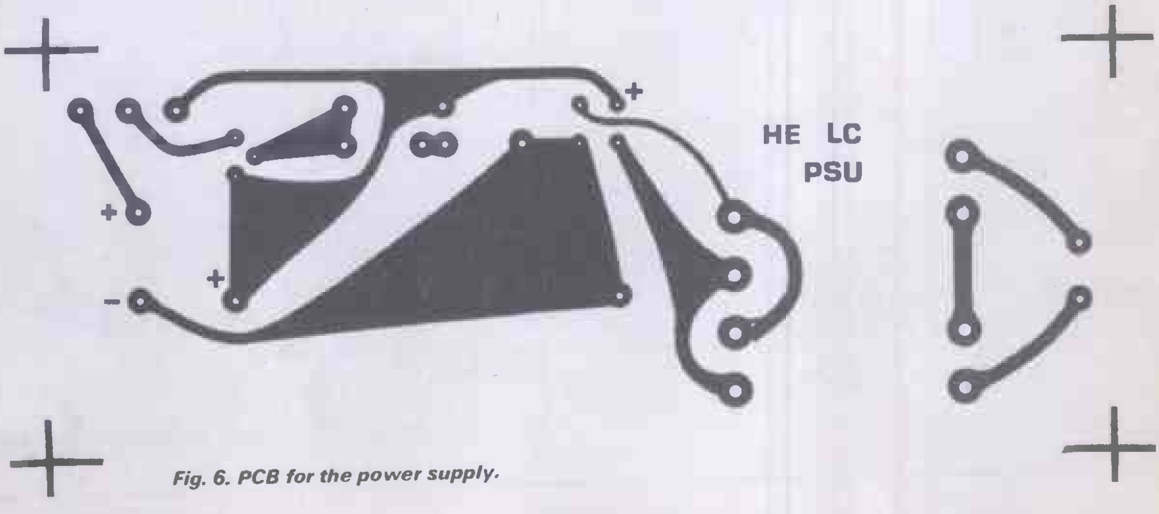


Fig. 6. PCB for the power supply.

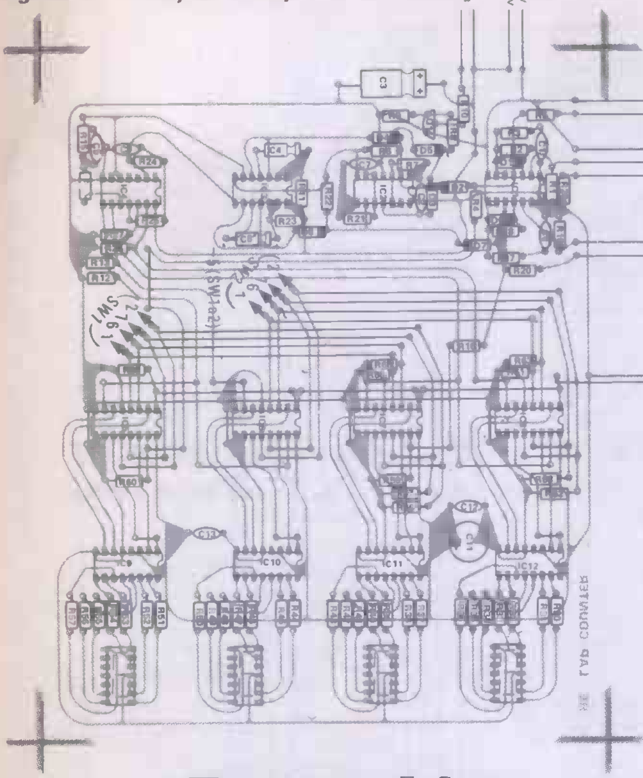
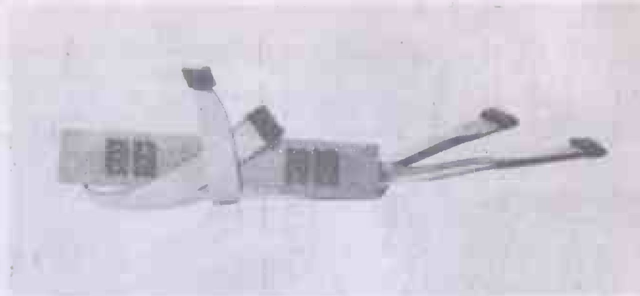


Fig. 7. PCB overlay for the lap counter.


We used ribbon cable to interconnect the displays.

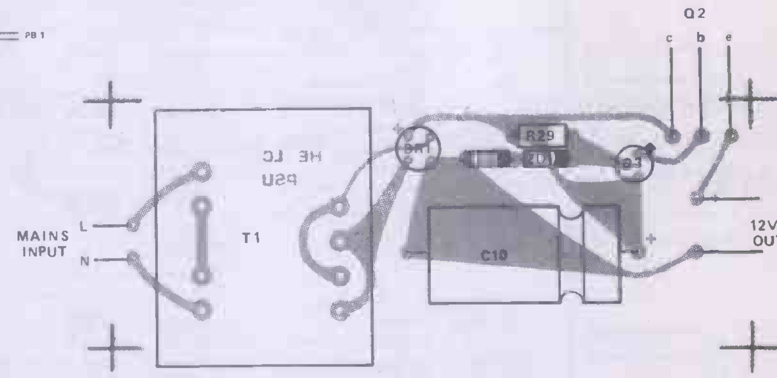


Fig. 8. PCB overlay for the power supply.

Parts List

RESISTORS (All ¼W, 5%)

R1, 19	330k	R8, 9, 15, 24	4k7
R2, 18	1M5	R10	82R
R3, 17	1k2	R11, 23	1M0
R5, 5, 16, 20	2k2	R14, 21, 25	100k
R6, 12, 13, 22, 26, 27, 61-68	22k	R28	390R
		R29	1k
		R30-58	470R
R7	68k	R59, 60, 69	18k

SEMICONDUCTORS

IC1	4093B
IC2	4011B
IC3, 4	4001B
IC5-8	4029B
1C9-12	4511B
Q1	BC 182L
Q2	2N3055
Q3	BFY 50
D1-8	1N4148
BR1	1 amp 40V Bridge rectifier
LED1, 2	TIL 209 or similar
IRLED 1, 2	TIL 32 Infra red diodes
IRD 1, 2	TIL 78 Infra red detectors
ZD 1	3V9 Zener diode
ZD 2	10V Zener diode

Buylines

The P.C.B mounting transformer can be obtained from ACE MAILTRONIX LTD of Tootal St, Wakefield (phone 0924 250375 for details).

The BCD thumbwheel switches are available from MAPLIN along with the 7-segment displays — look in their present catalogue for details.

The TIL32 infra red diodes and TIL78 infra red detectors can be obtained from Watford Electronics.

The case we used was a BOCON desk type from WEST HYDE DEVELOPMENTS, order no. BOC 670 (phone 0296 20441).

CAPACITORS

C1, 6, 12, 13	100n polyester
C2, 5, 7, 9	10n polyester
C3	470u Elect 16V
C4, 8	4u7 Elect 16V
C10	2200u Elect 25V
C11	470u Elect 16V PCB mounting

MISCELLANEOUS

2 x Thumbwheel switches (BCD output)
4 x 0.3" seven segment displays — SEE BUYLINES
12-0-12V PCB mounting transformer
Case to suit
PB1 — push to make switch
SW1 — mains DPST toggle switch
5 pin DIN plug and socket
8R Speaker
I.C. holders
SPEEDBLOCK type DIL connectors and ribbon cable (if used).

Minature TV Survey

Keith Brindley has spent the last few weeks getting a severe case of eyestrain peering at the screens of the latest crop of mini TVs. Find out now what he sore.

Some of the Mini-TVs we reviewed, picture quality is best judged in the shop, see a selection.

IT SEEMED an easy enough task on first glance! Find out how many portable televisions are on the market (must only be half a dozen or so) — ring up the manufacturers and arrange to review their models and then tabulate the findings and write an article. Well, it would be easy — if there were only half a dozen or so available, the problem is that there are in the region of 60 or 70, and more than 60% of them are black and white. So even by restricting the survey to only b/w tellys there was still no way that it would all fit into the allotted number of pages. The next stage in elimination was to cut the survey down to TVs with a five inch, or less, screen. Even this leaves the almost unbelievable number of 24 known televisions — it really began to seem as though the manufacturing and marketing of portable televisions is definitely controlled by a buyers' market and that the companies who produce these sets must be fighting for customers.

As the final report we hit upon the solution that the whole scene should be quickly looked at and "six of the best" chosen and surveyed in the article. These final six were chosen with reference to what we considered necessary in a portable television. The following headings represent those assets which are advantageous in such a TV. Table 1 on page 18 also gives a full description of each device for quick comparison. This table is only meant as a guide.

Fig. 1 The Binatone Micro TV

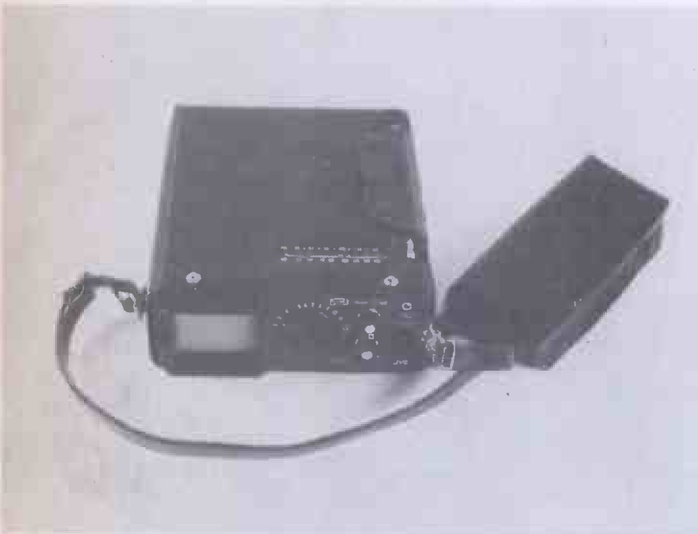


Fig. 2 JVC P100

Fig. 3 The Crown TV65R

QUALITY OF PICTURE

Because the survey initially compares televisions and only compares the radios, cassettes etc as being 'extra' then the picture quality must be of prime importance. To be fair to the companies involved, it should be pointed out that all of the TVs gave a good picture in most places. Each was tried in a number of situations including a crowded department store; on a train journey; in a car; in bed?; and in the HE office. In what must approach 99% of all test areas all of the models gave a good picture using the internal aerial, however, if you happen to live in that other 1% of places there is no chance of obtaining a good picture without an external aerial.

For clarity of detail we could not find any TV which produced a picture like the two micro TVs — at most test areas their picture production was excellent (even on a British Rail train an acceptable standard was maintained the majority of the time!). We have one small grouse over the lack of external contrast and brightness controls on the Binatone Micro though, they are adjusted internally, this means that individual preferences cannot be catered for and we found the contrast down and the brightness up on our set, making a slightly wishy-washy picture.

QUALITY OF WHOLE DEVICE

The 'extras' present on some of the models eg radio cassette, were judged on individual merit, bearing in mind the relative cost. This was the only fair way of comparing those devices with fewer or no 'extras'.

The best radio appeared to be that of the JVC 3060 although there wasn't a great deal of difference between it and the Crown.

The best cassette recorder was undoubtedly that in the Sony 412 which gave reproduction, the like of which we have never heard parallelled in any mono cassette system.

However, the superior sound quality overall was given by the 3060, which offers separate bass and treble controls together with the largest speaker.

PORTABILITY

This is a slightly tricky area, perhaps best tackled by first giving an appropriate definition of what we class as portability. We mean *easy* to carry — the larger models (412; 3060) were 'carry-able', yes, but at the expense of stretched arms if you attempt to carry them any great distance. Mind you, they are infinitely more maneouverable than the so called "portable" 12 inch screen televisions. You surely take our point.

The Crown and Sony 511 were quite easily carried, but still do not compare with the two micro TVs which fulfill all criteria which we class as portable.

RUNNING COSTS

Given that each television will run for approximately the same period, say 6-8 hours, on a fresh set of batteries, then we need only compare the price of the batteries to find relative running costs. The cheapest sets to run were evidently the micros taking four AA sized cells costing about £1, giving costs of around 15p an hour.

The larger screened televisions need correspondingly larger batteries and more of them. Consequently the running costs of these sets become increasingly disproportionate, around £3 to £4 for a full set of D sized cells or about 50p an hour.

Obviously, rechargeable cells must be the ideal supply, with regards to a portable television — the 3060 and the 65TVR feature the inclusion of a cell recharger which can recharge said cells when a mains point is available. This is a very valuable asset.

All of the models can be powered by mains or 12 V battery (eg a car battery) and running costs are correspondingly much cheaper using these methods of power.

OVERALL VALUE FOR MONEY

Well, it really does boil down to personal choice in the end. All of the models which we surveyed were excellent pieces of equipment, each having their own points of value.

For instance, if portability is your main concern and you wish, or need, to see TV programmes at odd times of the day or when you are travelling, then either of the two micros is your model, depending on whether you also require a radio. However, the P100 is a fair but more expensive than the Binatone. A small outlay of money extra on the P100 however, can buy you a battery recharger which in the long run will save you money.

We felt the Sony 511 was slightly ungainly in its shape (looking something like ex-army equipment) but also very reasonably priced. It offers typical Sony good quality.

Best value overall is the Crown — apparently last year this model took a large proportion of the market in Britain and in our opinion, quite rightly so. It is a good quality TV which features a good radio, in a stylish cabinet which is not so heavy as to make it too difficult to carry around. It can also be obtained with discount for a very reasonable price. Most extras which the other sets need additionally, are standard with the Crown (including rechargeable cells and a charger).

Either the 412 or the 3060 are a must if good quality cassette and sound are required. These two models really are the tops, so to speak, but as you must expect are slightly higher priced. They can be bought at around twice the price of the Binatone Micro if you shop around and they feature the cassette and radio above that device. Running costs are high but can be reduced with rechargeable cells.

As with most pieces of domestic electronic equipment, shop around. Many so-called discount houses offer attractive reductions over the High Street shops.

One final point worth bearing in mind with miniature TVs. Because the screens are very small the viewing distance must be less than with a conventional TV. Consequently eyestrain may result from prolonged viewing. We advise that mini-TVs only be used for relatively short periods, say a maximum of two or three hours only. Otherwise your eyes will ache too much for you to read next months HE. **HE**

Fig. 4 The Sony TV511

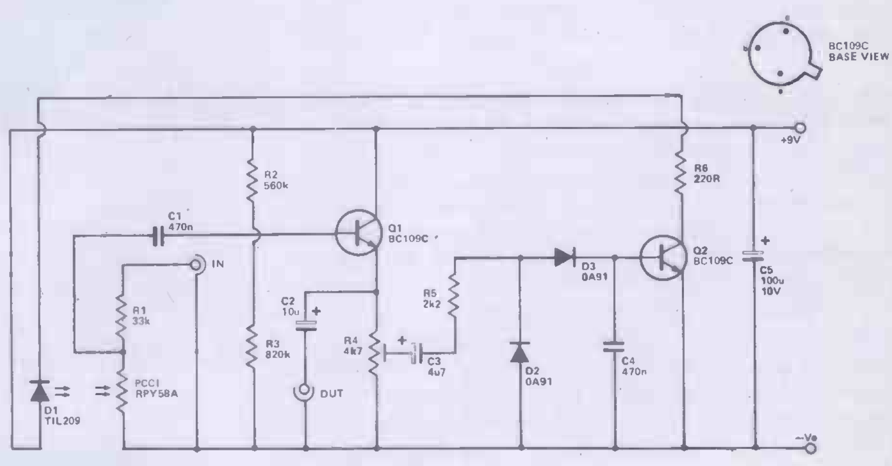
Fig. 5 The JVC 3060

Fig. 6 The Sony FX412

	TELEVISION CHANNELS	SCREEN SIZE (INCHES)	RADIO BANDS	CASSETTE	AUDIO POWER	SIZE (INCHES)	APPROX WT (Kg)	STANDARD EQUIPMENT	AVAILABLE ACCESSORIES	POWER	APPROX. RETAIL PRICE
BINATONE MICROVISION	21 – 68	2	NONE	NO	100mW	3½ x 2½ x 7	2/3	CARRYING CASE EARPHONE VIEWING HOOD	MAINS ADAPTOR CAR SUPPLY LEAD EXT. AERIAL CONNECTOR	4 x AA CELLS MAINS (+ ADAPTOR) 12V CAR BATT (+ LEAD)	£100
JVC P100	21 – 69 + VHF 2 – 12	2	FM & MW	NO	150mW	6 x 2 x 7½	1 Kg	CARRYING CASE VIEWING HOOD EARPHONE MAINS ADAPTOR	BATT. CHARGER/ ADAPTOR. RECHARGEABLE BATT. PACK. CAR SUPPLY LEAD. EXT. AERIAL CONNECTOR. MAGNIFYING HOOD.	4 x AA CELLS MAINS RECH. CELLS (+ ADAPTOR) 12V CAR BATT (+ LEAD)	£150
SONY TV 511	21 – 68	5	NONE	NO	N/A	12 x 7 x 12	3.3 Kg	EARPHONE MAINS LEAD	CAR SUPPLY LEAD CAR AERIAL	9 D CELLS MAINS 12 V CAR BATT	£115
CROWN TV 65R	21 – 69	5	FM, MW & LW	NO	N/A	12 x 4 x 10	2.5 Kg	RECHARGEABLE CELLS CELL CHARGER CAR SUPPLY LEAD EARPHONE VIEWING HOOD	NONE NEEDED	MAINS RECH CELLS CAR BATT	£130
SONY FX 412	21 – 68	4	FM, MW & SW	YES	N/A	12 x 4 x 9	3 Kg	CASSETTE TAPE EARPHONE MAINS ADAPTOR VIEWING HOOD	CAR SUPPLY LEAD CAR AERIAL	6 D CELLS MAINS CAR BATT (+ LEAD)	£160
JVC 3060	21 – 69 + VHF 2 – 12	3	FM, MW & SW	YES	3 WATTS	16 x 12 x 5	5 Kg	EARPHONE CAR SUPPLY LEAD MAINS LEAD	RECHARGEABLE BATT. PACK	6 D CELLS RECH CELLS MAINS CAR BATT	£175

Short Circuit

AUDIO LIMITER



When making tape recordings, especially of "live" performances, it can be very difficult to set the correct recording level. This can easily lead to an excessive recording level and consequent distortion occurring unless the recording level control is kept well backed off. The price one then has to pay is a low recording level and subsequent low signal to noise ratio. The normal way of overcoming this problem is to use an audio limiter circuit ahead of the tape deck. This device normally passes the signal straight through to the recorder, but if the input exceeds a preset threshold level it attenuates the signal so that the output level is not sufficient to overload the recorder.

In this circuit the input signal is applied to an attenuator which is formed by R1 and PCC1. Normally PCC1 is in total darkness and exhibits a very high resistance (typically a few megohms) causing minimal losses through the attenuator. This stage feeds into the high input impedance of the emitter follower buffer stage formed by Q1 and its associated components, and this ensures little loss of signal level. Thus the input signal is normally fed straight through to the output socket with only a marginal loss of amplitude.

Some of the output signal is fed from the slider of R4 to a rectifier and smoothing circuit which is comprised of D2, D3, and C4. If the input signal is sufficiently strong, the positive bias produced by the circuit will be adequate to switch on Q2 and light emitting diode D1 which is connected in its collector circuit. The light output from D1 is aimed at the sensitive surface of PCC1 (the surface to which the leadout wires do not connect) and this causes a large reduction in the resistance of PCC1. This gives the required attenuation of the signal. The larger the input signal is made, the more strongly D1 glows, and the greater the reduction in circuit gain. This process has the effect of preventing the output level from rising far above the level at which D1 begins to initially switch on. On the prototype this threshold level is at about 230 mV (with R4's slider at the top of its track) and increasing the input level to 4 volts RMS causes the output to rise to only about 320 mV. Higher threshold levels can be obtained with R4's slider adjusted down its track to the appropriate point. The attack and decay times of the circuit are both quite short so that the unit quickly responds to changes in signal level and is not normally conspicuous in operation.

Construction of the unit should be quite straight forward, but the unit must of course be housed in a light proof box so that PCC1 is shield from the ambient lighting. D1 and PCC1 are mounted as close together as possible. The current consumption of the circuit is only about 1 to 5mA. depending on the input level.

Back Numbers From HE

Shown here are all of the backnumbers still available. They are **£1.00 each** inc. P&P. When ordering please quote the issue number, i.e. Nov. 78 is issue 1 Vol. 1. Next to each issue is the relevant Hobbyprint code letter, please note that Hobbyprints are still available for every issue.

FEBRUARY 79 (Hobbyprint D)
Projects: Short Wave Radio. Sine/Square Generator, Scratch/Rumble Filter, Car Alarm Project.
Features: Video Tape Recorders, Radioactivity, CA 3130 Circuits, Computer Glossary etc.

MARCH 79 (Hobbyprint E)
Projects: Light Chaser, To... oller, Photographic Timer, Cassanova's C...
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JUNE 79 (Hobbyprint H)
Projects: GSR Monitor, Envelope Generator, Drill Speed Controller.
Features: Citizen Banned, Display Techniques, Moving Coil Meter, Electronics in Music Pt 2, etc.

JULY 79 (Hobbyprint I)
Projects: Shark, Baby Alarm, Point Controller, Linear Scale Ohmeter.
Features: Cassette Decks and Tapes, Binary Numbers, Fixed Resistors, Short Circuits Special, etc.

AUGST 79 (Hobbyprint J)
Projects: Home Security Sound System, LED Tachometer, Injector/Tracer, Constant Volume Amplifier.
Features: Security Installation, Variable Resistors, Tools, Satellite Power etc.

SEPTEMBER 79 (Hobbyprint K)
Projects: Combination lock, Light dimmer, Starburst, Ultrasonic Switch.
Features: Electronic Timekeeping, Thyristors, Radio Control, FET Special.

OCTOBER 79 (Hobbyprint L see Hobbyprint Ad)
Projects: Tantrum, Hobbytune, Analogue Frequency Meter, Multi Siren.
Features: Home Computing, Electronic Games, Microwave Cooking, Breaker One-Four.

NOVEMBER 79 (Hobbyprint M)
Projects: Hebot, R2, D2 Radio, Guitar Tuner.
Features: Data Supplement, TV Broadcasting, Miniboards.

DECEMBER 79 (Hobbyprint N)
Projects: Scalextric Controller, Ring Modulator, Bargraph Voltmeter, Hebot II.
Features: TV Receivers, Project Fault Finding, Data Supplement.

We regret to say that copies of the November, December, January, April and May issues of Hobby Electronics have sold out (we did warn you!). However Hobbyprints A, B, C, F and G are still available.

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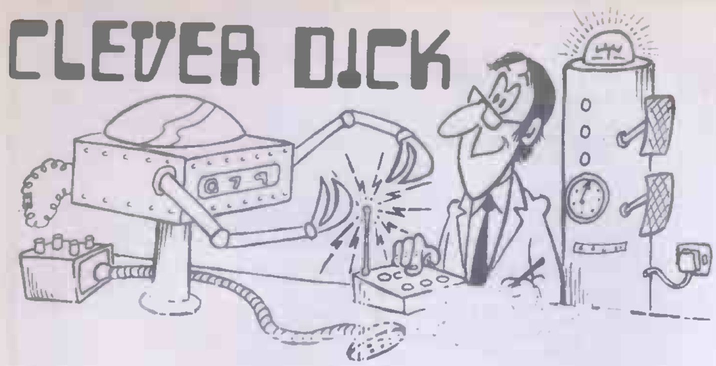


Digital Panel Meters and Negative Ion Generators are just two of the subjects covered in Clever Dick this month, have you got an electronic problem? Then why not write to Dick.

JUST TO SET THE RECORD STRAIGHT, all of the letters in Clever Dick *are* genuine. We get many letters a month addressed to this page and we promise you that not even us, with our fertile imaginations could make them all up. Hope that answers your question Mr Tim Cooper.

The Kit Review feature always prompts a few enquiries, this letter from J A Davis raised an interesting point.

Dear Dick,

I am building the PSU which appeared in the May edition of HE and would like to know how the Digital Panel Meter (Kit Review October 79) could be used in place of the moving coil meter used in the design. Could you also suggest a circuit which could run the Digital Meter from the PSU.

J A Davis
Wolverhampton

No real problem here, the Digital panel Meter, built up in the Voltmeter mode and connected across the PSU output should work very well. As for a power supply we would suggest that you retain the PP3 9V battery for simplicity, the Panel Meter will draw only a few microamps so a good mercury or Alkaline type battery should last well over a year in continuous use.

Thanks to Mr P J Ford of Norfolk for his suggestion about publishing an index, as you will see we have. We will have an Index in HE every year in the January issue.

Now for a very common question regarding availability of components etc, used in HE projects. Richard Savage writes:

Dear Dick,

Following your request for shorter letters and simpler questions . . .

Why doesn't HE indicate the box or case size for a project? This would save guessing games when ordering.

Why is it that, whatever the project, there always seems to be one component not listed in the catalogue, making it necessary to use more than one company with a resulting duplication of posting and packing rates?

Why don't more suppliers offer complete kits for magazine projects, taking the aggravation out of ordering and again the possibility of postage and packaging duplication?

Good magazine, though, hoping to purchase a legal CB rig soon, keep up the good work.

Richard Savage
Wiltshire.

Thank goodness it wasn't a long letter. Right, point number one. From our quite considerable experience we have discovered that only about five per cent of you ever build the circuit exactly as we describe it and if you think about it, that's what it's all about. Experimentation, improvement and variation. After all the only real way to learn about a subject like this is to experiment. If you just want to blindly build other people's projects there are plenty of other magazines that tell you exactly what to do, right down to the last nut and bolt. At the end of it all you have is a perfect copy of someone else's idea and it hasn't taught you a thing. But, point taken, some of our cases may be a bit out of the ordinary, so if in future we do use something a little 'special' we'll let you know where to get it.

Point two, when we design a project, we try, as far as possible to use easily obtainable components, unfortunately we couldn't stick to just one supplier, that would be favouritism and besides, that supplier may not stock every single component needed. We're afraid it's still going to have to be a case of shopping around. Why don't you try to persuade a local trader, a radio shop, say, to stock a few components, many do.

Lastly, there are kit suppliers around, in fact one major company should be offering a very comprehensive service quite soon. As we said earlier though, most people like to go their own way and that's the best way to learn.

Now for a couple of quick ones, the first from Mr E Armstrong asks about international TV standards.

Dear Dick,

Please could you help me? I would like to know what is the difference between PTSC and PAL colour TV systems, are they compatible and is it possible for a device with an NTSC output to be connected up to a PAL TV?

E Armstrong
Middlesex.

The simple answer is no, but with several exceptions. We have seen several TV games designed for the American market using the NTSC (National Television Standards Committee or Never The Same Colour, depending upon your sense of humour) that quite happily work on PAL (Phase Alternation Line) sets but on an almost identical set refuses to work at all. Basically PAL was developed from NTSC but there is very little similarity, even the number of lines and frames per second are different, so unless you're either very lucky or prepared to carry out extensive modifications you're stuck — sorry.

Now for something a little out of the ordinary.

Dear CD,

As a Hay Fever sufferer I would like to try 'Negative Ion Therapy' but the cost of commercial units is such that are prohibitive, especially for an experiment which may fail. Consequently, I'm writing to ask:- What's inside an Ioniser? Or, could HE publish a design before the next Hay Fever season starts?

T H Cameron
County Devon

This letter started us thinking and may well result in a project soon. As far as we can make out a Neg Ion Generator consists of EHT (Extra High Tension) generator producing voltages in the order of several kilovolts this ionises the air directly, producing that 'Ozone' smell. In the meantime may we suggest that you sniff the back of your TV set as the voltages used to drive the tube are guite good at producing negative Ions. But seriously this is an area of reserach that is generating quite a bit of interest at the moment, particularly in the 'States, so it shouldn't be too long before something more concrete is known about this effect which is claimed to cure everything from Hay Fever to broken legs.

Lastly we have a request for the address of the supplier of those coloured knobs we use on some of our projects. This comes from David Taylor;

Dear CD,

As a follower of your Hobby Electronics magazine I would like to know where I can purchase the coloured 'chunky' knobs you use on your constructional projects, in Hobbytune and Multi-Option Siren in the October issue, they look very classy.

Just to be awkward I would like to ask one last question, could you give me any information on the TIL 209LED. Will continuous use of this device shorten its life?

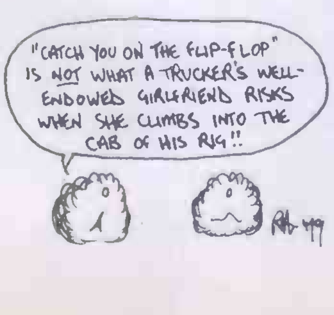
Congratulations on the CB article.

David K. Taylor
Worcester

Thank you for your comments on CB. Your first question is easy enough. The knobs we use come from Electrovalue Ltd, they can be found at; 28 St Judes Road, Englefield Green, Surrey. TW20 OHB.

Your second question may be a little difficult, manufacturers specifications vary considerably but generally they quote figures of several hundred thousand hours continuous use. (8,000 hours is approximately one year).

Times up again for another mouth, as this issue is the last one before Christmas I take the opportunity to wish you all a Merry Christmas and a problem free new year. Dick.



CMOS Special

Another in our series of popular 'close-ups', highlighting particular components. This month its the turn of the CMOS IC. As usual plenty of buildable, practical circuits

This article has been adapted from '50 CMOS Circuits' by R. A. Penfold. It is available from Babani Books price 95 pence.

ALTHOUGH CMOS ICs are a range of digital devices they are suitable for a range of applications which is far more diverse than one might expect. In fact, there can be little doubt that these ICs are the most useful range of digital devices for the average amateur user, and are perhaps even the most useful range of ICs of any type.

When CMOS devices were first introduced in the early 1970s they were much more expensive than their alternatives in other logic families. This is not the case these days and they are now about the cheapest ICs available. The more simple of the devices in the CMOS range cost less than many ordinary transistors, and on a cost basis these ICs are just about unbeatable.

Earlier families of digital devices suffer from three main disadvantages which limit their usefulness to the amateur. They require relatively high supply currents (about 20 mA for a simple quad gate IC), supply voltages are rather critical (5 V ± 10% for TTL devices for instance), and input impedances are usually rather low, often being only in the region of a few hundred ohms.

CMOS devices do not have any of these disadantages. They require only very modest supply currents. and even some quite complex devices, such as the 4046 low frequency phase locked loop will operate at supply currents of less than 1 mA. Simple gates, when they are in a static condition, use virtually no power at all.

The supply voltage range over which a CMOS device will operate depends upon the suffix given after the type number. The devices usually supplied to amateur users, and specified for the projects in this book, have an 'AE' suffix. The 'A' of the suffix denotes that the unit has an operating voltage range of 3 to 15 V and the 'E' indicates that it is contained in a standard DIL plastic encapsulation.

Input impedance of CMOS ICs are extremely high indeed, being something in the order of 1,000,000 Megohms. For all practical purposes they can be regarded as having an infinite input impedance, and are voltage rather than current operated devices.

BASIC GATES

The most simple of CMOS devices is the inverter, which uses only two active devices. The circuit of an inverter is shown in Figure 1. This uses a single P Channel Igfet (insulated gate field effect transistor) and one N Channel Igfet. This is, of course, a switching device and the input is therefore only maintained in one of two states. It is either high, which means that it is at or near the positive supply potential, or it is low, which means that it is at or near the negative supply potential. These states are often referred to as logic 1 and logic 0 respectively.

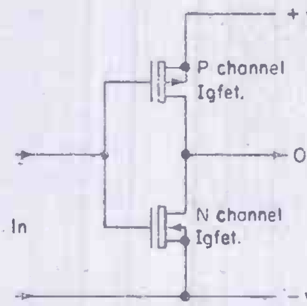


Fig. 1 Basic CMOS inverter circuit.

The output of the circuit can also have only two stable states, and again these are the high and the low states. The purpose of the inverter, as its name suggests, is to have an output state which is the opposite of the input one.

Operation of this circuit is quite simple to understand. An IGFET has a very high drain to source resistance when its gate is at around the same potential as its source. If a forward bias of a couple of volts or more is applied to its gate then the drain to source resistance falls to a value of only a few hundred ohms.

Thus, when the input of the inverter is low Q1 is turned hard on and Q2 is hard-off, and the output of the device is in the high state. When the input is high, Q1 is off and Q2 is on, and the output is low. The transistors are acting as simple SPST switches and Figure 2(a) shows the effective circuit of the unit in the high output state, and Figure 2(b) shows the effective low output circuit.

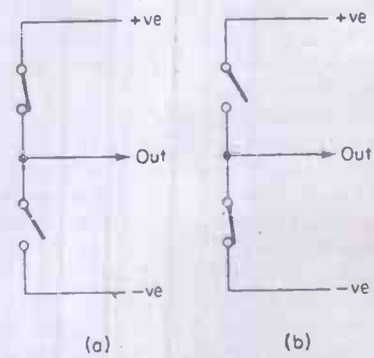


Fig. 2(a) The effective high output circuit, and (b), the effective low output circuit.

One could gain the impression from this that the circuit never consumes any current, but this is not the case. The transistors do not form perfect switches, and they have a resistance of a few hundred ohms when on, and a few thousand Megohms when off. Thus a minute,, but for most purposes an insignificant current does flow through a static inverter.

A very brief pulse of current is consumed by the device as it changes state, as in effect, one switch closes before the other opens as the circuit goes from one output state to the other. Therefore, the more frequently the device changes state, the higher its current consumption. When used at fairly low frequencies CMOS ICs have very low current consumptions, but when used at high frequencies the current consumption can rise to many mA per device. Because of this it is usual to confine the use of CMOS ICs to medium and low speed applications.

Many of the projects described in this feature are based on inverters but these are not the type just described. Instead it is more convenient in use to use NOR and NAND gates with the inputs connected in parallel. For most circuits either a 4001 quad two input NOR gate or a 4011 quad two input NAND gate is specified. Four inverters can be made from each device, and they have the same characteristics as the basic inverter just described.

MANUFACTURERS

CMOS ICs are manufactured by more than one company and each company uses a different prefix to the type number. Most CMOS ICs offered to the amateur seem to originate from RCA and have their CD prefix (CD4011AE for example). Some firms offer Motorola devices which have a 1 prefix (such as 14011), and others just give the basic type number. Any of these ICS will work perfectly well in the circuit described here.

CMOS PROTECTION

As many readers will be aware, IGFETS are easily damaged by high voltage static charges. Such charges exist in most households these days due to the widespread use of plastics which tend to generate static charges. Even someone wearing a nylon shirt is said to be a potential source of destruction as far as an IGFET is concerned.

One might think that CMOS devices were very delicate and virtually impossible to use. This is not in fact the case, as all recent CMOS ICs are equipped with internal protective diodes which limit voltages at the inputs to a safe level.

Even so, it is still advisable to obey a few simple rules when handling and using CMOS ICs, these devices are usually supplied with their leadouts embedded in a piece of conductive foam. It is a good idea to leave the device in this form until it is actually going to be used. Do not plug or unplug a CMOS IC from an IC holder while the supply is connected. Make quite sure that the supply is connected with the correct polarity. When using IC holders it is an easy matter to accidentally plug an IC into a socket the wrong way round. This results in the supply being connected with incorrect polarity, and almost certainly causes the destruction of the device when the power is switched on.

In many of the circuits to be described here, some of the gates of an IC are not used. It is not a good idea to simply ignore the unused gates. There is little risk of the gates being damaged by static charges and other sources of electrical signals, but these will operate the inputs of the gates.

As mentioned earlier, a static gate uses no significant current, but it is switching continually from one state to the other, it will use supply current. Therefore, the inputs of unused gates should be connected to one or other of the supply lines (whichever happens to be the most convenient), as otherwise stray pick up will operate the gates causing a waste of power.

FINAL POINTS

CMOS devices have a wide operating temperature range, the actual range being −40 to +85 degrees centigrade for the plastic DIL version (−55 to +125 degrees centrigrade for the ceramic and flatpack versions). They are therefore perfectly suitable for use in automotive and similar outdoor applications.

If the output of a CMOS device should happen to be accidentally short circuited to one of the supply lines, a current of many mA will flow, The amount of current that flows will depend upon the power supply voltage used, but the resistance of the output transistor which is turned on will limit the output current to a safe level and will protect the device against damage.

CMOS ICs have a high level of fanout as although they have only a comparatively low output current drive capability, input current requirements are extremely low The level of fanout is only really limited by the input capacitance of the devices, and the minimum fanout figure for CMOS devices is 50.

TOUCH SWITCH

Touch switches seem to have become quite popular these days and although this is probably mainly due to their novelty value rather than any practical advantage, they do have certain practical advantages over more conventional forms of switch. Probably the main one in most applications is that they can be designed to have no moving parts to wear out. This makes them as reliable and hard wearing as the main (electronic) part of the equipment they are controlling.

The circuit diagram of a simple touch switch using a CMOS bistable circuit is shown in Figure 3. This will provide on/off switching for any piece of 9 volt battery operated equipment which does not have a current consumption of more than 100 mA (the maximum operating current for the BC179 transistor).

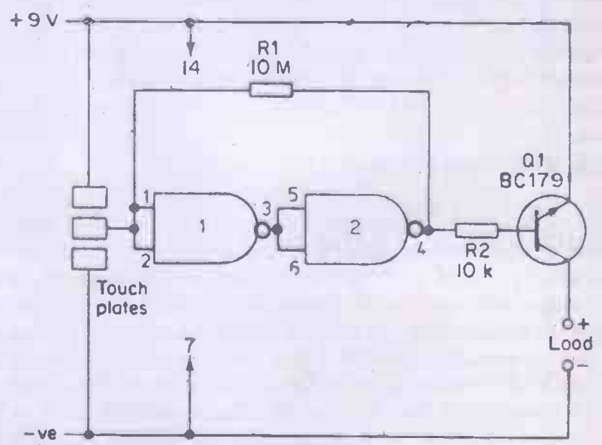


Fig. 3 The touch switch circuit.

CMOS ICs are ideal for use in this particular application since they can easily provide the necessary very high input impedances, and they also consume no significant current when they are not driving a load. The current consumption of this circuit in the off state is very low, being actually less than 1 micro-amp. There is subsequently no significant battery drain when the equipment is turned off. and the battery life should not be significantly less than if a mechanical switch were used.

Extra current is consumed when the unit is in the on state, this mainly being the base current to turn on Q1. This is unavoidable, but the additional current consumed is less than 1 mA, and is likely to be of no significance in the majority of applications.

The circuit operates in the following manner. When the power is initially connected to the device the output of the bistable will go into the high condition. Q1 is cut off and no power is applied to the load.

It is possible to alter the state of the bistable by touching the lower set of touch contacts. The resistance of the operators skin then takes the input of the bistable low, and the output of the bistable will then also go low. A base current is then applied to Q1 which is biased into saturation and virtually the full supply rail potential is supplied to the load.

The unit can be switched off again by touching the upper set of touch contacts. The input of the bistable is then connected to the positive supply by way of the skin resistance of the operator's finger, and in consequence both the input and output of the bistable take up the high condition. Q1 is therefore cut off once again, with no significant current being supplied to the load.

R1 provides the necessary latching action by holding the input in whatever state it was in when the finger of the user is removed from the touch contacts. If necessary, the sensitivity of the circuit can be boosted by raising the value of R1. Resistors having values of more than 10 Megohms are not readily available, and so an increased value for R1 can only be obtained by adding two or more resistors in series to make up the required value.

R2 is needed in order to prevent Q1 from passing an excessive base current. It also limits this current to an economical level. If the unit is being used to control a fairly high current level. If the unit is being used to control a fairly high current load, say 25 mA or more, it is, necessary to reduce the value of R2 to 1 k.

With a little ingenuity it should not be too difficult for the constructor to fabricate suitable touch contacts. A piece of stripboard can be used to make a very simple but effective touch plate, or an even better one can be etched from a piece of copper laminate board. Even three screws (Pan or Countersunk heads) mounted on the front panel of the main equipment could be used if they are suitably positioned.

CRYSTAL OSCILLATOR

Crystal oscillators have been used since the early days of entertainment broadcasting whenever a highly stable RF oscillator is required. They are probably used more now than at any time in the past, and apart from use in crystal calibration oscillators and similar radio applications they are often used in digital clocks and other digital equipment where they generate a stable timebase signal.

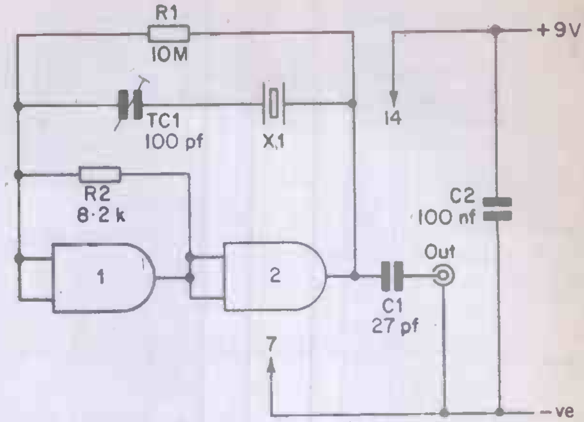


Fig. 4 A simple crystal oscillator.

CMOS ICs can be used as the active devices in good quality crystal oscillators having operating frequencies up to about 10 MHz or so. Figure 4 shows the circuit diagram of a simple CMOS crystal oscillator which uses a couple of inverters.

The two inverters are used to provide an amplifier which has its input and output of the amplifier via TC1, and at the series resonant frequency of the crystal (where it has a very low impedance) positive feedback will be applied to the circuit and it will oscillator.

VC1 enables the oscillation frequency of the circuit to be finely trimmed to the nominal frequency of the crystal. If this feature is not required VC1 can be omitted, with the crystal then being connected in parallel with R1.

At first sight R1 may appear to perform no useful function, but it was found to be necessary to add this as otherwise the oscillator often failed to start when power was applied to the circuit. C1 is the output DC blocking capacitor and C2 is a supply decoupling capacitor.

This circuit seems to operate satisfactorily over a wide range of frequencies with the component values shown, and the prototype oscillated properly with any crystal having a frequency from a few tens of kHz to many MHz.

CAPACITANCE METER

Most multimeters are equipped to measure wide ranges of voltage, current, and resistance, but few, if any, are capable of capacitance measurements. As a result of this, most electronics enthusiasts are unable to undertake capacitance measurements. and this must lead to many useable capacitors being discarded simply because their identification markings have become erased. Some means of testing capacitors is also very useful when one is engaged on servicing faulty equipment.

A capacitance meter is therefore a very useful piece of equipment to have in the workshop. A simple capacitance meter can be based on an astable and a monostable multivibrator, and it is possible to make one using a single CMOS IC as the only active device. The circuit diagram of such a unit is shown in Figure 5, and this uses a single 4001 IC.

Gates 1 and 2 are connected as the astable circuit and gates 3 and 4 form the monostable multivibrator. The astable operates at a frequency of about 100 Hz, and its output is fed to the trigger input of the monostable. Thus

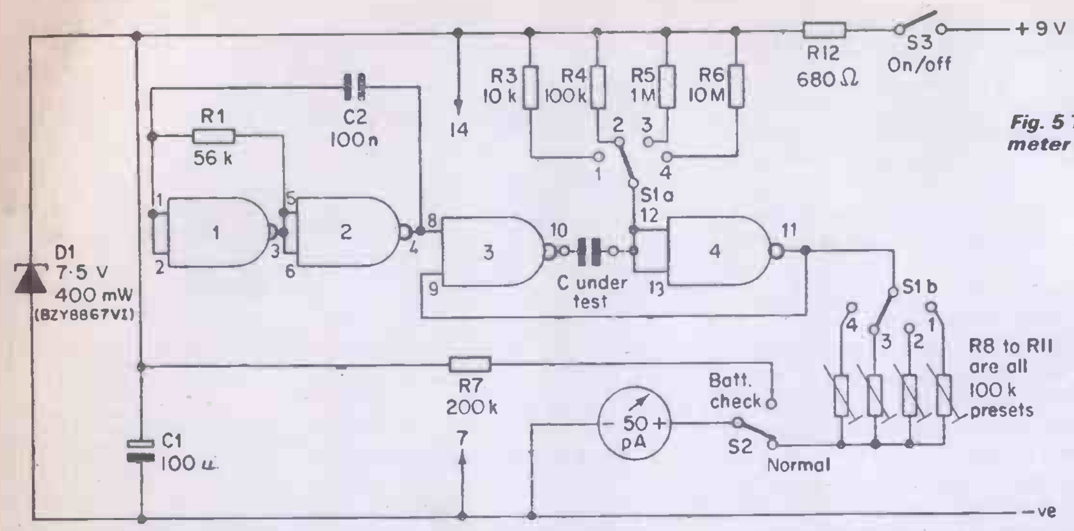


Fig. 5 The direct reading capacitance meter circuit (use only IC 4001).

one hundred times per second the monostable will produce an output pulse. The length of this output pulse is determined by the values of the timing components, and the timing capacitor under test. The timing resistor is one of the four resistors, R3 to R6, and is whichever one is switched into circuit by S1.

By using four timing resistors the unit is able to provide four measuring ranges. These are as follows:

Range 1	0 to 500 nF
Range 2	0 to 50 nF
Range 3	0 to 5 nF
Range 4	0 to 500 pF

The unit thus covers most normal amateur requirements. The circuit values have been chosen so that the monostable acts as a pulse shortener. For instance, with the unit switched to Range 1 and a 500 nF test capacitor in circuit, the output pulse from the monostable will only be about half the length of the trigger pulse from the astable. Lower values of test capacitance will produce an even shorter monostable pulse length.

A voltmeter circuit consisting of M1 and one of the set of four preset resistors (R8 to R11) is connected at the output of the monostable. Each time the output of the monostable goes high, a pulse of current will be fed to the meter. A constant string of pulses are generated when a test capacitor is connected to the unit, and the meter will respond to the average output voltage.

With a 500 nF capacitor in circuit, R9 is adjusted to produce FSD of the meter. If, for instance, a 100 nF capacitor is connected in place of the 500 nF one, the length of the output pulses will only be one-fifth of the previous duration. The rate at which the monostable is triggered is the same, and so the pulses still occur at the same frequency. Therefore, the average voltage across the meter circuit will only be one-fifth of its original level and the meter will read one-fifth FSD.

It will be apparent from this that there is a linear relationship between the meter reading and the value of the test capacitor. The unit thus functions very effectively as a linear reading capacitance meter.

On Range 2 the timing resistor is ten times the value of that used on Range 1. Only one-tenth of the previous test capacity is therefore needed to produce an identical meter reading. For example, 500 nF was needed to produce FSD of the meter on Range 1 whereas only 50 nF will be needed on Range 2. In practice this is not quite the case since the tolerances of the timing resistors will prevent such a precise relationship from being obtained. In order to ensure that good accuracy is obtained on all four ranges, a different preset resistor for each range is provided in the meter circuit. This enables each range to be calibrated against a close tolerance capacitor.

An alternative approach is to use 1% tolerance components for R3 to R6, and a single calibration preset. The unit would then only need to be calibrated on one range, with good accuracy being automatically obtained on the other three ranges.

D1 and R12 are used to stabilise the supply voltage of the circuit and this is essential if consistent and reliable results are to be obtained These are two reasons for this. Firstly, the frequency, of the astable circuit will vary slightly with variations in supply rail potential. If it should speed up at all, then there will be more pulses applied to the meter in a given period of time, and increased meter readings will be obtained. If the speed of the astable should decrease, then obviously all meter readings will be below.

Secondly the more importantly the output voltage pulses of the monostable are virtually equal in amplitude to the supply rail voltage. If the supply rail alters (due to battery ageing for example), then the meter readings will alter proportionately.

A simple battery check facility is incorporated in the circuit, and this merely consists of S2 and R7. When S2 is in the position shown, the circuit functions normally. The meter is connected across the stabilised supply rail when S2 is in the other position. It is connected via R2 which converts the meter into a 0 to 10 V voltmeter. This can be used to monitor the supply potential and when it falls below its nominal level of 7.5 V, this indicates that a new battery is required.

Calibrating the unit is quite straightforward, and four close tolerance capacitors are required for this. For example, a 470 nF 2% capacitor could be used to calibrate Range 1. With this connected across the test terminals and the unit set for normal operation on Range 1, R10 would be adjusted for a reading of 47 on the meter.

It is best not to use a calibration capacitor which has a value corresponding to less than half FSD of the range being calibrated, as this will result in inferior accuracy being obtained. It is advisable to initially adjust all the preset resistors for maximum resistance before commencing calibration of the unit.

FLASHER

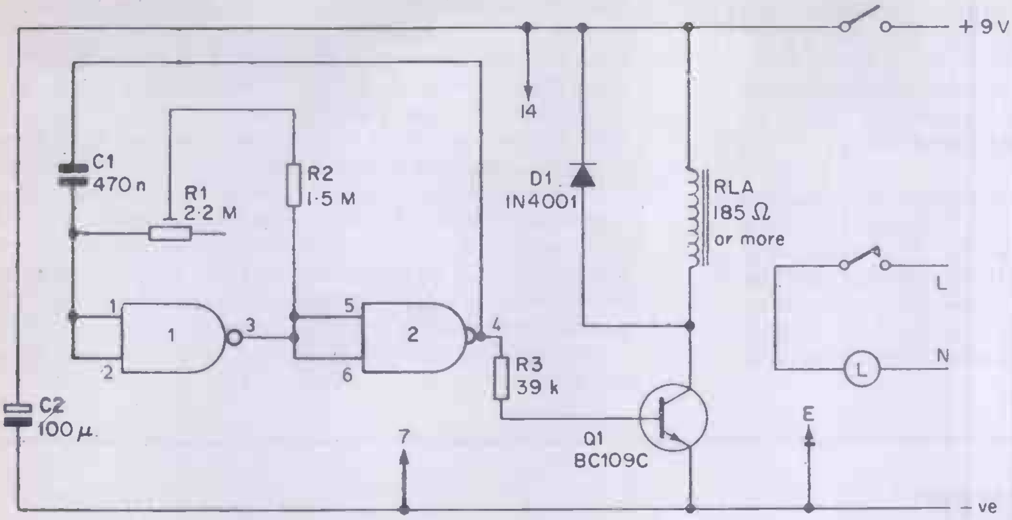


Fig. 6 Christmas tree lamps flasher.

Several useful gadgets can be made by using a multivibrator to drive a relay, and a popular example is a Christmas Tree Lights Flasher. This will provide a much more regular flashing rate than can be obtained by using a bi-metal flashing bulb, and the flashing rate can also be made variable. The circuit diagram of this device appears in Figure 6.

The two inverters are connected as a low frequency astable circuit, and the operating frequency of this is variable over a range of about 0.5 to 1.5 Hz by means of R1. The output of inverter 2 drives common emitter amplifier Q1 via R3. R3 is a current limiting resistor.

Q1 has the relay coil as its collector load, and the relay will be energised when the output of inverter 2 is high. The relay will be of when the output of inverter 2 is low A single set of relay contacts (either normally closed or normally open ones) are used to control the lights. These will therefore switch on and off at a rate determined by the setting of R1.

D1 is a protective diode, and this is needed to protect the circuit against the high reverse voltage which is developed across the relay coil as the power to the circuit is switched off. This voltage is generated by the magnetic lines of force quickly decaying and cutting through the relay coil. Because of the speed at which this magnetic force dies away, quite a high voltage can be produced, but it is at a high impedance. D1, in effect, shorts out this voltage and is protected against passing an excessive current by the high source resistance of the signal. D1 should not be omitted from the circuit as this voltage spike is quite capable of destroying both the IC and Q1.

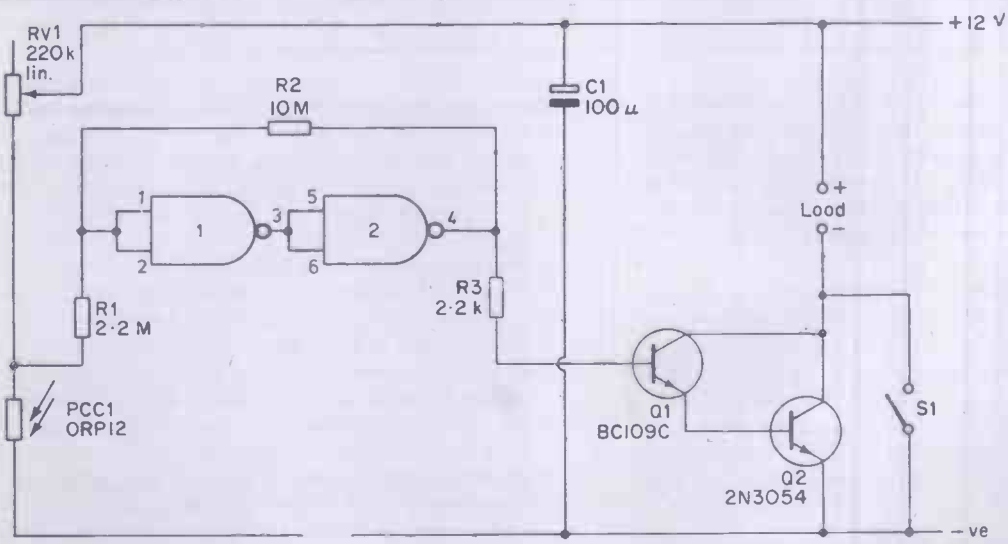


Fig. 7 An automatic parking light.

AUTOMATIC PARKING LIGHT

In applications where a light switch is to be used to operate a low voltage DC load it is usually possible to use a relayless circuit. An automatic parking light for a car is one such example, and a suitable circuit is shown in Figure 7.

Here the circuit is triggered when the light level falls below a level which causes the voltage at the junction of RV1 and PCC1 to exceed the trigger voltage of the Schmitt trigger. The trigger circuit then provides a base current to a high gain Darlington pair using Q1 and Q2. Q2 is a power transistor which is capable of handling the relatively high current drawn by a parking light. S1 enables the light to be turned on indpendently of the automatic circuitry.

In this circuit the current consumption of the device is of secondary importance since it will be powered from a high capacity car battery. However, it is obviously desirable to have the lamp switching cleanly from one state to the other. Perhaps less obviously it is necessary for the circuit to avoid intermediate output states in order to illiminate the possibility of damage to Q2 due to overheating.

This could occur if Q2 was partially switched on with about half the supply voltage being present at its collector, as it would then have to dissipate several watts of power. This could be overcome by using a large amount of heatsinking for Q2, but it is probably better to use a trigger circuit, as Q2 can then only rest in the hard on or fully off state. The dissipation in either case can only be low, as when it is turned hard on very little voltage is produced across it, and when it is turned hard off it passes no significant current. It will dissipate a significant amount of power when it is turned on, and if a high current lamp is being controlled a certain amount of heatsinking will be necessary, but this will only need to be minimal. In all the light switches just described it is possible to adjust the circuit by means of RV1 to produce a switching threshold at almost any required light intensity.

ELECTRONIC EGG TIMER

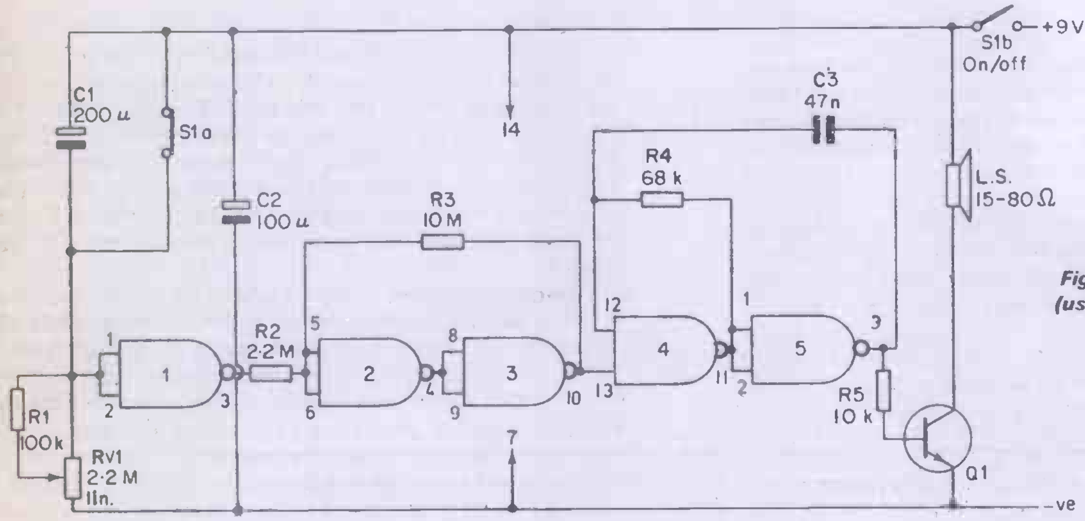


Fig. 8 Electronic egg timer circuit (use 4011 only).

Simple timers which provide an audible output at the end of a variable timing period are always interesting. Such circuits are limited to a maximum timing interval of only about 10 seconds, because using a longer time constant would result in the tone generator being turned on only gradually, which would obviously not be satisfactory.

The timer circuit shown in Figure 8 uses an R—C timing network and an astable multivibrator tone generator. The multivibrator itself is controlled via a control voltage which is fed to one input of gate 4. This terminal is normally low and the astable circuit is muted. The output of gates is also normally low with Q1 being cut off and passing no current. This is very important, as if it were normally high, Q1 would be biased on and there would be a very high static current consumption.

Gates 2 and 3 are used as the Schmitt trigger, and this has its input fed from an inverter which in turn has its input fed from the R—C timing network. C1 is the capacitive part of the timing network and R1 — RV1 are the reistive part.

S1a opens when the on/off witch (S1b) is closed and this starts the timing interval. C1 begins to charge up through RV1 and R1 and eventually the voltage across R1 and RV1 will fall to the transfer voltage of gate 1. When this happens, the output voltage of gate 1 will gradually begin to rise. After a short while its output voltage will reach the trigger voltage of the Schmitt trigger circuit, and the output of inverter 3 will immediately go high. This turns on the multivibrator and the audible alarm tone is produced from the speaker.

When the unit is switched off, S1a discharges C1 and the unit is then ready to start another timing period when it is switched on once again. RV1 enables the length of the timing interval to be varied from less than 30 seconds to more than 6 minutes, and the unit is thus suitable for use as an egg timer, or indeed for a multitude of uses in the house. A timer of this type can be much more useful than one might imagine.

A dial calibrated in minutes should be marked around the control knob of RV1, and there is unfortunately no quick way of doing this. It is a matter of finding all the calibration points using a process of trial and error.

Note that this circuit can only be built using a 4011 IC, as gate 4 must be a NAND type. In actual fact it requires two ICs, since five gates are employed in the circuit and only four are contained in each 4011 IC.

ELECTRONIC GAME

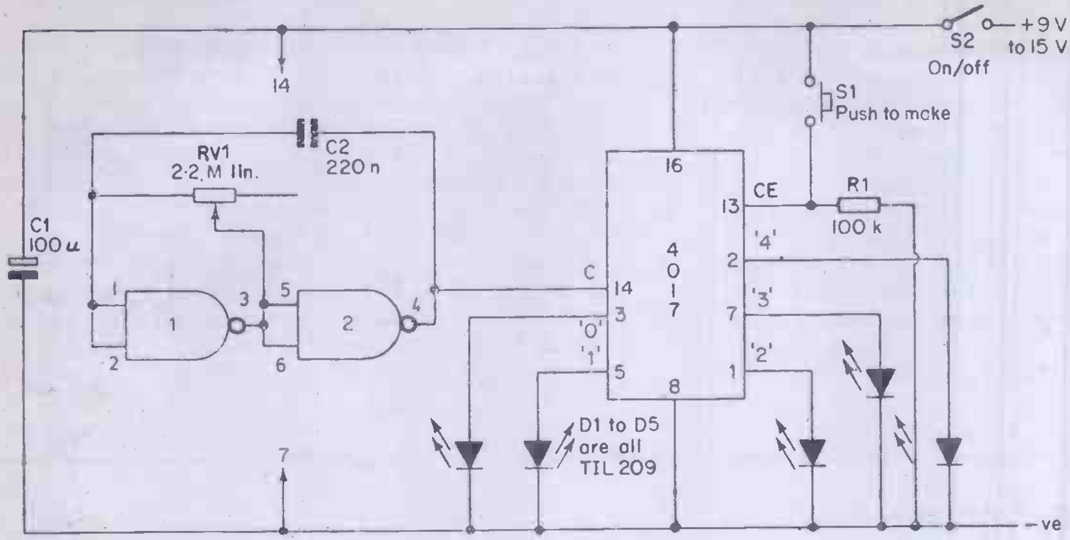


Fig. 9 Simple electronic game.

The diagram above shows that the 4017 IC has ten outputs apart from the usual carry out one. Five of these outputs are utilised in the circuit of Figure 9 which shows how the device can be used as the basis of a simple electronic game. It also demonstrates the properties of the 4017 IC.

The two inverters are used in an astable multivibrator, and the operating frequency of this can be varied from less than 1 Hz to over 100 Hz by means of RV1. The output of the multivibrator is used to drive the clock input of the 4017.

The clock enable terminal of the 4017 is connected to earth through R1, and so when S2 is closed and power is applied to the circuit, the 4017 will start to operate. The first input cycle will cause pin 3 (the '0' output) to go high, and the first LED will light up. At the commencement of the next clock input cycle pin 3 will return to the low state and pin 5 (the '1' output) will go high for one complete input cycle. Then pin 5 goes low and pin 1 goes high, and so on until all the LEDs have turned on in sequence.

There is then a pause during which none of the LEDs come on, and this is the period during which the unconnected outputs go high. When all five of these outputs have gone high the cycle starts once again from the beginning, with the five LEDs turning on in sequence followed by a break.

In practice the LEDs are mounted in a row along the front panel of the unit, and the idea of the game is to stop the sequence when the middle LED (D3) is on. The sequence is stopped simply by pressing S1 which is a push to make non-locking push button switch. When this is operated it takes the clock enable input high, and this blocks the clock signal and holds the 4017 in whatever state it was in when at the instant S1 was closed.

The circuit is reset ready for a new round by releasing S1. The sequence then continues from where it left off. The speed at which the circuit operates, and therefore the degree of difficulty, is controlled by the setting given to RV1. The circuit may appear to be one that tests the reaction speed of the competitor, but it is really more a test of co-ordination and anticipation.

It is possible to use the circuit from a 9 volt supply, but the LED display will not be very bright and it is better to use a supply voltage of about 12 to 15 volts. **HE**

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Crosshatch Generator

The HE project team have 'hatched' a new piece of test gear that we believe will be a winner

IF YOU'VE BEEN PAYING ATTENTION over the past few months you may have come to the conclusion that we have a somewhat unnatural interest in television. You would be perfectly correct because we feel that the TV set is probably the most 'domesticated' piece of home electronics. It may not be the most complex in terms of circuit function, everyone would agree that the pocket calculator or digital watch holds that honour but when was the last time you tried to repair an IC?

This project is not designed to make you 'rip' the back off your telly, that would be extremely foolhardy, not to mention downright dangerous but rather, if you do have a fairly good grounding in TV repair and maintenance, provide you with one of the most useful pieces of test gear available to the TV technician.

LINING UP

Some basic TV theory now, this device is primarily intended for use with a colour TV using a Delta-Gun tube. As you are probably aware a colour TV uses three electron guns, one for each colour. Because it would be physically impossible for all of the guns to be in exactly the same position, the three 'beams' will have slightly different trajectories. Circuitry within the receiver is designed to 'deflect' the three beams so that they 'strike' only the coloured phosphor dots relating to each gun.

Two methods are used, the first is called Static convergence and relies upon magnets around the neck of the tube to adjust the convergence at the centre of the screen. The second method, the one we're concerned

The HE Crosshatch Generator connected up to a TV set. Convergence errors are most noticeable at the corners of the picture.

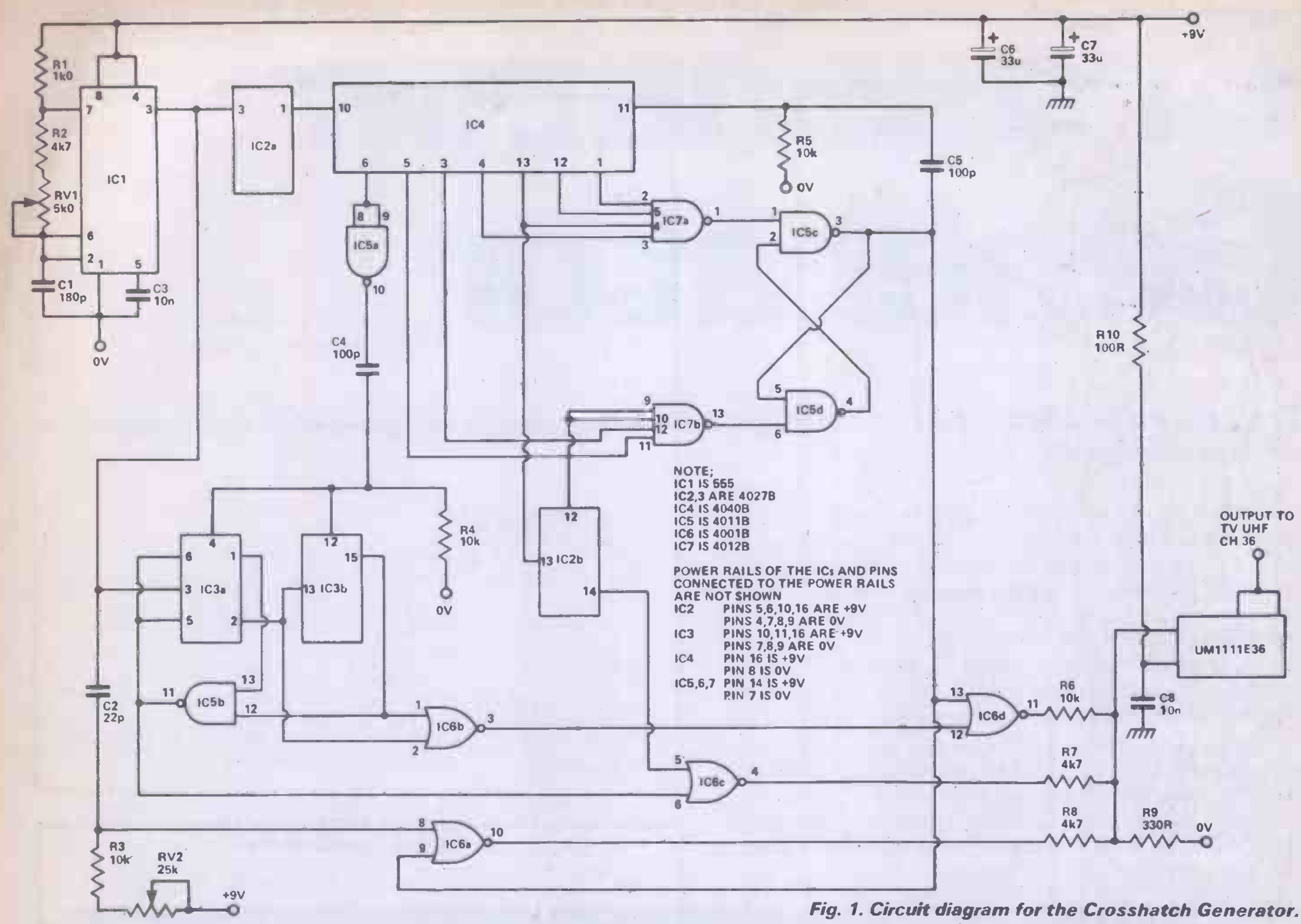


Fig. 1. Circuit diagram for the Crosshatch Generator.

How It Works

A TV picture is made up of a series of horizontal lines equally spaced down the screen with the information transmitted in a serial form along with the necessary synchronization pulses. There are 625 lines in each complete picture but these are transmitted as two "frames" each of 312½ lines with the second frame interlaced between the first giving a total of 625 lines. This is to reduce the flicker of the picture which would otherwise occur.

To simplify our circuit and prevent a double horizontal line we have used 624 lines which eliminates the interlacing.

To synchronize the TV set we need a 192µs wide pulse every frame (20ms) and a 4µs wide pulse every line (64µs). All pulses, including the information, are derived from a single 249.6 kHz oscillator IC1. This is divided by 2 in IC2a and then by 2496 by IC4 giving an output of 50 Hz. This IC is a 12 stage ripple counter which, while normally dividing by 4096, can be forced to divide by 2496 by decoding (IC7) the outputs from the 7th, 8th, 9th and 12th stages and resetting IC4 back to zero. The output of IC7 toggles the RS flip flop IC5/c, IC5/d which resets IC4 via C5. This flip flop is reset by the decoded output from 4th and 5th stages of IC4. This occurs 192µs later; thus the output from IC5/c is the frame sync. pulse.

To generate the line sync, pulse the output from the 3rd stage of IC4 (15,600 Hz) is used to reset both halves of the dual JK flip flop IC3. This IC is then toggled by the 249.6 kHz clock until, after three pulses, both "Q" outputs are '1' when IC5/b detects this and disables IC3/a, IC6/b decoded the second of these clock periods and this becomes the line sync. pulse. These pulses are combined in IC6/4 to give a combined sync. pulse.

The 249.6 kHz is differentiated by C2/R3 and after being squared up by IC6/a is used to generate 16 white spots on each line which results in vertical lines. These pulses are deleted during the frame sync. period to prevent interference to synchronization. Due to variations in the CMOS a trim potentiometer is provided to give equal width to the vertical and horizontal lines.

The horizontal line is generated by IC2/b (JK flip flop) and this IC is toggled by the 8th output (487.5 Hz) of IC4 and is reset by the output of the 4th stage (64µs later). This gives a single white line every 16 lines. To prevent this line interfering with the line sync. pulse the output of IC2/b is combined with that of IC5/b which is high for a period 4µs before the line sync. pulse to 4µs after the pulse. This gives a short black region on both ends of the line (normally off the screen). The outputs of IC6/b, IC6/b and IC/c are combined by R6-R8 to give a composite video signal. Note that the video information gives positive pulses while the synchronization pulses are negative.

Crosshatch Generator

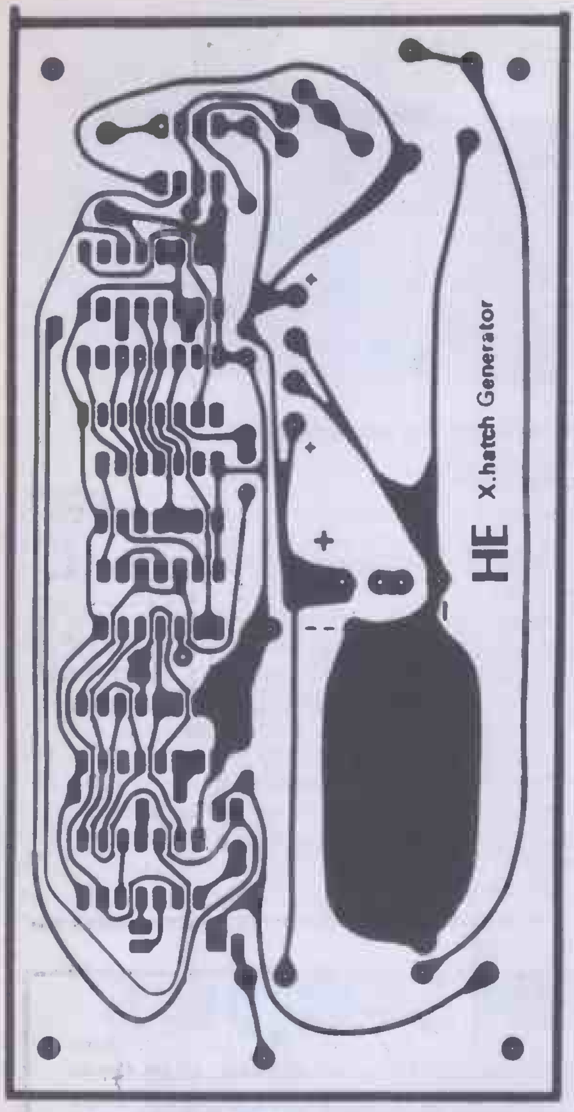


Fig. 2. Above: PCB foil pattern, take extra care to avoid solder splashes around the IC pads.

Parts List

RESISTORS	
R1	1k0
R2, 7, 8	4k7
R3, 4, 5, 6	10k
R9	330R
R10	110R
POTENTIOMETERS	
RV1	5k miniature preset
RV2	25k miniature preset
CAPACITORS	
C1	180p ceramic
C2	22p ceramic
C3, 8	10n polyester
C4, 5	100p ceramic
C6, 7	33u 16 V tantalum
SEMICONDUCTORS	
IC1	555
IC2, 3	4027B
IC4	4040B
IC5	4011B
IC6	4001B
IC7	4012B

MISCELLANEOUS
PCB as pattern, case to suit, output socket, single pole toggle switch, 9 V battery, Astec UMIIIIE 36.

Buylines

The only component liable to be difficult to obtain is the Astec UHF modulator. These are available from most suppliers of TV game kits, Watford Electronics and Teleplay are examples. Make sure you get a vision modulator, sound modulators look the same but will not work in this application! All the CMOS and other components are widely available. The PCB will be available from usual suppliers who advertise regularly in the magazine.

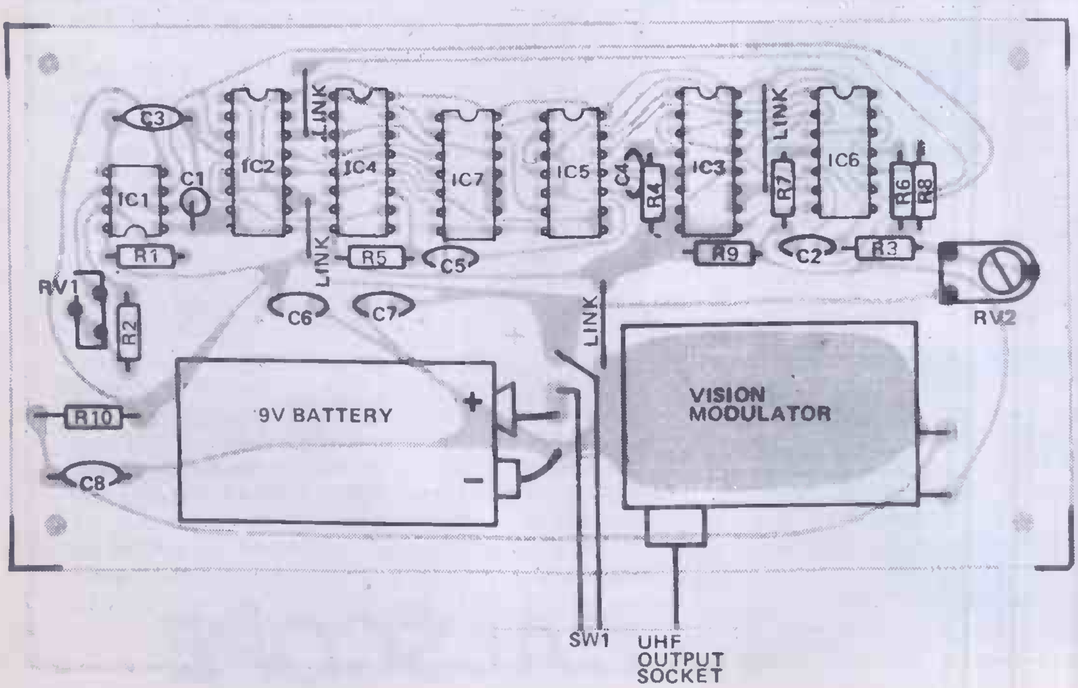


Fig. 3. Left: Overlay diagram of the Crosshatch Generator, note the position and orientation of all polarised components.

which is called Dynamic convergence and involves 'modifying' the waveshape fed into the Line and Frame scanning signals within the deflection coils around the neck of the tube and sometimes a further set of coils sited behind the 'yoke' assembly to further converge the beams.

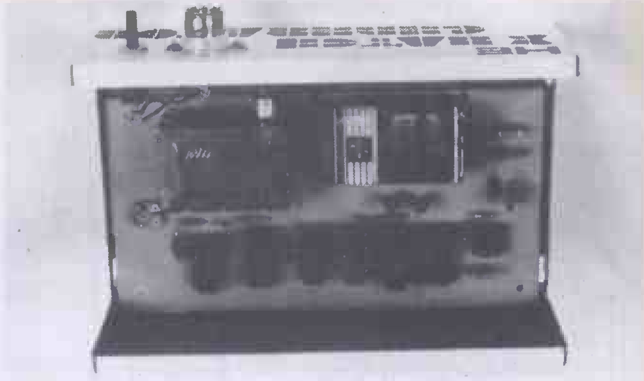
In addition to setting up the convergence the pattern produced by the generator can be used to adjust up the Linearity or picture shape of the raster. Further to this it will also act as a general-purpose 'video signal generator', very useful when dealing with a 'dead' set, particularly during times when there is not a broadcast signal handy.

MODERN MODULATION

Many of the inexpensive pattern generators on the market have no provision for injecting into the RF stages of the TV set, the HE Generator has an on-board UHF modulator enabling it to be directly connected to the set's aerial socket. Because of this the generator also provides its own 'sync' waveforms and this together with the crosshatch pattern is modulated onto a carrier wave operating on channel 36 UHF.

CONSTRUCTION

Assemble the PCB according to the overlay taking care to follow the usual procedures when handling delicate components. We mounted the prototype into a small metal case, big enough to accommodate the battery and modulator comfortably. The metal case also gives a degree of protection against drift due to wandering hands, etc and it also provides good shileding.



Inside the Generator, everything fits neatly.

ALIGNMENT

The easiest method of alignment is to monitor the output on pin 1 of IC4, connect either a 'scope or frequency counter to this point and adjust RV1 to give 50 Hz, it's as simple as that.

Connect the unit via a coaxial cable to the TV set. (Make sure you use a UHF coax as audio coax will tend to 'cramp' the signal resulting in breakup or sync loss.) RV2 should be adjusted to give vertical lines approximately the same width as the horizontal.

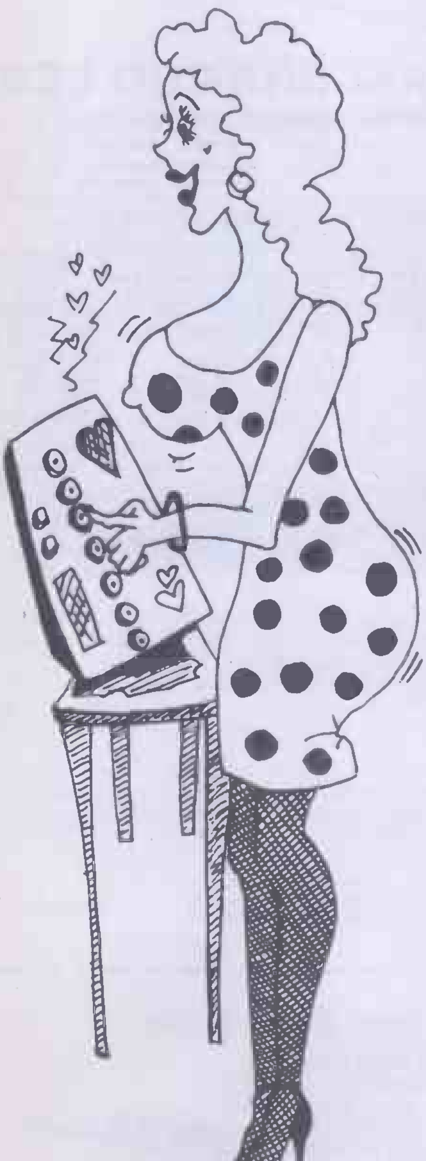
The generator is now ready for use but may we suggest that before you undertake any adjustments of a colour receiver you consult the manufacturers service guide as the convergence circuitry alone may consist of anything up to twenty presets that must be adjusted in a strict sequence.

HE

Next Month

Hobby Electronics

PASSIONMETER



Months of fearless research (mainly on calibration) have led to the design we hope to be publishing next month. It is primarily intended to visually display (via a column of LEDs) the degree of passion being experienced by the subject.

Measurement of passion is made by inserting the subject's finger into an orifice in the case to contact with a sensor array. Use of CMOS circuitry enables the unit to function for many months without being switched off. This project, whilst a little tongue-in-cheek should prove a great success at parties and may just provide a few surprises!

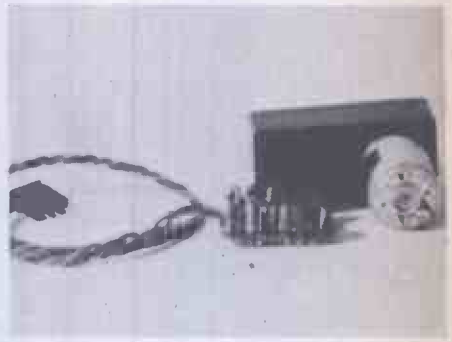
KEZY DOES IT

Unless you've heard it you will find it almost impossible to believe, American radio that is. Rick Maybury hot foot from Los Angeles brings back a report of one particular AM/FM station, KEZY. In a city that has over 80 other stations catering for just about every taste KEZY manages to capture a very large audience. Find out about this and the American radio scene in general in next month's issue.

INTO CONSTRUCTIONAL ELECTRONICS

Are you thinking about taking that first step into the wonderful world of electronics? Ian Sinclair begins a major new series just for you.

Many newcomers are often daunted by the thought of building that first project. This series is designed to take you gently by the hand, through the jungle of jargon and coloured bits and pieces and hopefully leave you with the confidence and expertise to tackle just about anything. Much of the series is centred around the Eurobreadboard so why not drop a few hints to Father Christmas so you can be ready.



KIT REVIEW SPECIAL

Two kits this month. Even though we've delayed the Radio Control system for a few months we will still be presenting the review of the Servo Kit we hope to be using with the system.

Our second kit comes from THE kitmakers — Heathkit. They may be a bit pricey but they are the best. The one we're reviewing is probably one of the finest pieces of test equipment we've ever seen. It's the Digital Multimeter with an LCD readout. If you think a price tag of around £80 is a bit steep then see what we think next month.

INFRA RED CONTROL

Look out for a new remote control system using Infra Red techniques. Coming next month.

The February issue will be on sale January 11th

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

HE MARKET

LCD CHRONO

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

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

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

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

£11.95

ALARM-CHRONO LCD

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

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

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

£19.95

To:
LCD Watch Offer
HE Magazine
145 Charing Cross Road
London WC2H 0EE

Please find enclosed my cheque/PO for £11.95 (payable to HE Magazine) for my LCD Chronograph.

Name . . . .

Address . . . .

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To:
ALARM/CHRONO LCD WATCH Offer
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Please find enclosed my cheque/PO for £19.95 (payable to HE Magazine) for my Alarm/Chrono LCD watch.

Name . . . .

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Please allow 28 days for delivery

PLACE

DIGITAL ALARM CLOCK RADIO

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

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

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

An example of this clock can be seen and examined at our Charing Cross Road offices.

£10.60

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

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

The cylindrical construction is in keeping with the very modern styling. The tuning dial is actually incorporated into one of the end caps!

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

An example of this Clock Radio can be seen and examined at our Charing Cross Road offices.

£17.95

To: Hanimex Alarm Offer
HE Magazine
145 Charing Cross Road
London WC2H 0EE
Please find enclosed my cheque/PO for £10.60 (payable to HE Magazine) for a Hanimex Digital Alarm Clock.

Name ....

Address ....

....

....

To:
CLOCK RADIO Offer
HE Magazine
145 Charing Cross Road
London WC2H 0EE
Please find enclosed my cheque/PO for £17.95 (payable to HE Magazine) for my Clock Radio.

Name ....

Address ....

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All offers inclusive of 15% VAT and Postage

Spacelab

A re-usable orbital vehicle, Spacelab is being readied for its first flight, scheduled for mid-1981. The first mission will carry 76 scientific and technological experiments from European, American and Japanese agencies. The results are likely to have a profound effect on the development of science and technology into the next century. It has been said that the Spacelab missions are a greater step for mankind than man landing on the moon.

DURING THE PAST TWENTY YEARS quite a number of highly trained astronauts have been rocketed into orbit, carrying out much pioneering research in gravity-free environments.

These astronauts have to be able to withstand accelerations of up to about ten times that due to gravity on the earth's surface.

However, the US Space Shuttle should become available reasonably soon. It will not only allow people and other payloads to be lifted into orbit much more economically, but the maximum acceleration of a Shuttle launch is only about three times that of the earth's gravity (3g) and that of a shuttle landing about 1.5g.

It is therefore logical that the Shuttle should be used to launch a manned space laboratory, known as Spacelab, in which scientists, engineers and technicians rather than astronauts will be able to conduct experiments in earth orbit.

No long and rigorous pre-flight training courses are envisaged for the Spacelab crew. Those men and women who fly in Spacelab should be in good health, but their training will be short, and will include experiment operation, briefings on flight plans and procedures, familiarisation with zero gravity conditions, exercises in spaceflight "house-keeping" and emergencies, and total system simulation.

Spacelab, like the Space Shuttle, will be re-usable — probably about fifty times. The Shuttle Orbiter vehicle, with Spacelab in its cargo bay, will be boosted into earth orbit by two solid fuel booster rockets (jettisoned at a height of 69 km) and by the main engines of the Shuttle vehicle which obtain their fuel from a huge external fuel tank which is jettisoned just before the orbital altitude is attained.

The Shuttle and Spacelab, will orbit for up to twelve days, although this may be extended up to thirty days in later flights.

The nominal duration of a typical mission is seven days. Although the Shuttle is a space vehicle, it is unique in that it can land like an aeroplane and will return Spacelab to earth.

A team of up to four experimental operators (women as well as men) will be able to work in Spacelab in orbit. They will be able to make adjustments to the orbiting equipment and to control the measurements being made.

On their return to earth they will bring the acquired data back with them. The Spacelab crew will eat and sleep in the cabin of the Orbiter Shuttle vehicle with the four astronauts who form the Shuttle crew, but they will be able to move through a connecting tunnel into Spacelab when necessary.

This first Spacelab mission is scheduled for about the middle of 1981.

Spacelab is being constructed for the European Space Agency by an industrial team of nearly 40 manufacturers in 10 European countries, the leading contractor being VFW-Fokker/ERNO of Bremen, Germany.

Detailed design and development work on Spacelab began in June 1974. A Memorandum of Understanding was signed by the European Space Agency and the US National Aeronautics and Space Administration (NASA) in August 1973 which provides for the delivery to NASA (who will be responsible for the launching) of one Spacelab engineering model and one flight unit.

NASA has undertaken to buy more Spacelabs from the European Space Agency, subject to certain conditions. The engineering model is scheduled for delivery in the second half of this year and the first flight unit proper about a year later.

EARLIER SPACESHIPS

The early astronauts had to be content with very uncomfortable living quarters in spacecraft designed to ensure survival rather than to transport a large amount of equipment into orbit.

The Russian Salyut I was perhaps the first orbiting laboratory designed to carry many instruments into orbit, the role of the crew being to ensure their satisfactory operation.

This satellite was 14 metres long with a maximum diameter of 4 m. The internal volume of nearly 100 cubic metres included about 36 cubic metres for the crew. They could sleep in beds, enjoy a dining room with a kitchen corner with reheated dishes, and had a bathroom and toilet room.

Later Salyut spaceships were of the same general design, very like that of a submarine; this is not surprising, since in both spaceships and submarine there is a great pressure difference between inside and outside the ship.

In 1973 NASA launched the Skylab orbital and scientific space station, this being an extension of the Mercury-Gemini-Apollo programs.

The internal volume of Skylab is about 600 cubic metres, of which about 100 cubic metres are inhabitable.

Salyut and Skylab were launched unmanned, since if the rocket were to explode the station would be destroyed. Neither can they be brought safely back to earth, since they could not withstand the mechanical and thermal strains of re-entry.

The crew of these stations therefore had to travel separately to and from the vehicle, Salyut had an engine, but Skylab had no engine of its own, although it could use the Apollo ship to which it was coupled as a locomotive. A main disadvantage of both of these craft is that almost all the equipment on board is lost except for a few small rather precious items which the astronauts can bring back to earth with them.

The space available in the vehicles used for transporting men to and from the space station is very limited; the astronauts in Soyuz II returning from the Salyut I station died because they were so encumbered with the equipment they were bringing back to earth that they could not move to reach a device to stop the accidental depressurisation of the craft. Such problems will not occur in this form with future Spacelabs.

Neither should Spacelab vehicles cause danger to people on this earth. After the fiery death of Cosmos 954, the nuclear reactor equipped Russian satellite which crashed in northern Canada in January 1978, people are becoming wary of space equipment which may crash down on to their country even if there are no radiation dangers involved.

NASA is concerned both about the possible hazards of such craft striking a populated region and also about losing its investment in the station, which cost about £1000 million.

SPACELAB MODULES

The Spacelab station has been designed on a modular basis so that it can be changed to meet specific mission requirements. The two main components are a pressurised module or laboratory which provides a shirt-sleeve working environment and an open pallet in which materials and equipment can be directly exposed to the space environment.

The pressurised module is made in two segments, each being a cylinder 4.1 m in diameter and 2.7 m long. The core segment will be used in all Spacelab missions in which a pressurised module is required; it contains various supporting facilities (such as data processing equipment) and laboratory facilities such as working benches, floor-mounted racks, etc.

The second pressurised module, known as the experiment segment, is used to provide more laboratory working space. It will not be used unless this additional space is required. This segment contains only floor-mounted racks and benches.

When both segments are assembled with their end cones, the maximum external length is seven metres.

Five pallet segments, each three metres long are also available. These are designed for large instruments, for experiments requiring direct exposure to the space environment and for work requiring unobstructed or broad fields of view. For example, various telescopes, antennae, sensors, radiometers and radar antennae will be carried in one of the pallets. Each pallet can also be used to cool equipment, to provide electrical power and to furnish connections for commanding and acquiring data from experiments.

If the pallets only are used without any pressurised module, the essential support systems for various experiments, including power and communication systems, are protected in a small pressurised and temperature-controlled housing called an igloo.

The pressurised cabin of the Orbiter Shuttle vehicle is connected by a tunnel with the pressurised module of Spacelab. The tunnel is segmented so that its length can be changed as required. An airlock module can be attached to the tunnel to provide an additional access to external space.

Pallet-mounted instruments will normally be powered and controlled from within the pressurised module but could be controlled from the orbiter Shuttle vehicle cabin when the flight is a 'pallet-only' mode with no pressurised module. The pallet can accommodate a variety of experiments in which manned attendance is unnecessary, but where services such as electrical power, temperature control, etc. are needed.

Several kilowatts, both AC and DC will be available to operate experimental equipment during a Spacelab mission. Continuous voice and data transmission facilities will normally be made available between the experiments in Spacelab and the ground observers so that the experimenters can obtain expert advice rapidly.

The relationship between Spacelab and the Shuttle has been compared with the between trailers and tractors.

A number of Spacelabs are in various states of preparation for their voyages, but relatively few Shuttle Orbiter vehicles are required, since the turnaround time of the Orbiter vehicles is quite short.

Maximum use can be made of the Shuttle Orbiter vehicles, while the Spacelabs can be outfitted at the user's premises. But in most cases, the individual experiments will be brought to a central location and integrated into one of the Spacelabs.

FLEXIBILITY

The Spacelab missions offer flexibility. The Shuttle Orbiter flight parameters can be varied so that the orbit inclination and the orbit altitude meet the requirements of the particular mission concerned. For example, the altitude of the orbit can be varied between 200 km and 900 km.

The Kennedy Space Centre on the East coast USA will be used during the first few years of operation of the Shuttle, providing a possible range of inclinations of 28.5° to 57°.

Later the Vandenburg site on the West coast will become availble and this will make orbital inclinations of up to 104° possible.

The orientation of the Orbiter vehicle can be adjusted as can the flight time. For example, the Orbiter may fly inverted to give a view of the earth.

Mission flexibility is also provided by the choice of various module-pallet configurations — such as module only, module plus pallet or pallet only — and variations of the module and pallet lengths.

In general only equipment required for a particular mission is carried so as to reduce the weight. Up to five pallets may be flown on the Orbiter.

The Spacelab can carry greatly increased weight and

ATMOSPHERIC PHYSICS

The first Spacelab flight will be in the relatively low circular orbit of 250 km +/-5 km altitude with an inclination of 57° favourable for experiments in atmospheric physics. It is expected that important new results about the physics of the atmosphere will be obtained during this flight in which various groups from the USA, France and Belgium are involved.

The University of Michigan Group will be responsible for an imaging spectrometric observatory which will simultaneously observe the 20 nm to 1200 nm wavelength region with a resolution varying between 0.3 nm and 0.6 nm over the spectral range. This permits the study of the airglow spectrum by observing radiation emitted by excited atomic and molecular ions and also neutral particles in the atmosphere.

The Jet Propulsion Laboratory of California are working on an TMOS (Atmospheric Trace Molecules Observed by Spectroscopy) project using interferometry. Groups from France and Belgium are planning a Grille spectrometer for the high resolution passed through the atmosphere at sunrise and sunset.

French and Belgian groups will also study Lyman-Alpha emission by hydrogen and deuterium in the atmosphere.

PLASMA PHYSICS

Plasma physics experiments for the first Spacelab flight have been designed by groups in Japan, the USA, France, Norway, Germany and Austria. Although magnetospheric research is one of the earliest fields of space research, Spacelab offers a new dimension for such work, since on-board particle accelerators can be used to investigate the electric fields parallel to the magnetic field lines; gas plumes, optical and electron detectors and, on later Spacelab flights, small satellites can be employed.

Artifical auroras produced by particle accelerators on board will be observed by a low light television system, whilst natural auroras and the small partical contamination around the Orbiter will be observable.

The latter is an important paramter for the success of the astronomical observations from Spacelab. A similar system for the detection of low-energy electrons can detect the natural electron flux and fluxes induced by the particle accelerators.

SUN-EARTH RELATIONS

Various groups of European and US workers are preparing equipment which will provide data about the influence of the sun on our daily weather. For example, Figure 1 shows that there is a very strong correlation between the 22 year sunspot cycle and the July temperature in central England, but much more information is required about the energy input from the sun to the earth.

Two absolute solar radiometers on the first Spacelab mission will measure the total energy flux from the sun over the whole spectrum from the far ultra-voilet to the far infra-red. It is hoped to achieve an accuracy of 0.1%, which is why two instruments making the same measurements are to be used on the same flight.

A further instrument will measure each part of the solar spectrum over the range 190 to 4000 nm; three precision monochromators will achieve a relative accuracy of 0.1% and will permit the identification of the particular spectral elements responsible for any changes in the amount of energy reaching the earth.

This work is regarded as the first of three flights spread over a period of about ten years so that long term changes in the solar energy input can be studied.

ASTROPHYSICS

The Far Ultraviolet Space Telescope (FAUST) has been designed for the observation of extended and point sources in the 120 nm to 300 nm wavelength range, flown on previous rocket flights. It can be used for objects down to magnitude 18.

Another instrument is the wide field camera which will form images of a large fraction of the sky to assist in the study of large scale phenomena in the Universe. A 60° angle will be used with filters for 130-300 nm for stars down to the 11th magnitude. This camera will be used for investigations of the milky way, nebulae, dark clouds and the distribution of galactic and extra-galactic matter.

Another piece of equipment will involve the use of a gas-scintillation-proportional counter for X-ray spectroscopy. This will be the first time this type of detector will be used in orbit.

MATERIALS SCIENCES

Quite a number of materials science experiments will be carried by Spacelab on its first mission; they have been designed to test the capability of the system for producing desired results in conditions

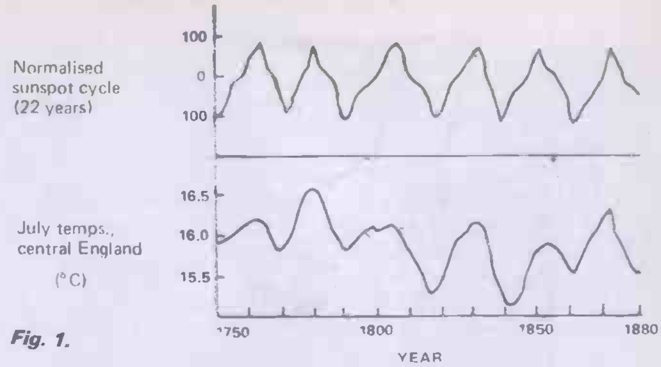


Fig. 1.

of virtually zero gravity rather than to produce materials in commercial quantities.

A tribology experiment will test the characteristics of lubricants for bearings under zero gravity (such as their spreading, wetting and operating characteristics). A geophysical flow experiment will permit laboratory studies of the dynamics of the oceans and atmospheres of rotating planets and stars; a dielectric fluid will be employed between concentric rotating conductive spherical shells with an electric field between them to generate a gravity-like force in the miniature model. This work is impossible in a ground based laboratory.

There will be a total of 37 materials science experiments in the first Spacelab payload. The equipment will include three furnaces and a fluid physics module.

EARTH OBSERVATIONS

Two instruments to be carried aboard the first Spacelab flight are designed to test its capability of performing earth-surface remote sensing work. The metric camera will be attached to the optical window of Spacelab to produce small-scale high-resolution photographs of the surface of the earth from space and to test the capability of making maps and revising maps from such photographs at scale of 1:50000 or smaller. The camera is similar to that used on aeroplanes.

The microwave facility is rather remarkable in that is measures the long wave energy spectrum of the ocean waves as a function of wave number and direction. The long wave region of the ocean spectrum (taken as the 10 to 500 metre section) contains the largest part of the wind-induced surface wave energy. The global distribution of these waves is closely related to the global wind fields and to the atmospheric pressure distribution at sea level. It is intended that this technique will be used from future satellites to help improve weather forecasting.

This microwave facility, which employs a 2 metre by 1 metre antenna, can also be used as a synthetic aperture radar from orbital altitudes. This technique makes it possible to use the craft's velocity for scanning the spatial electromagnetic field near the craft created by backscattering from the surface of the earth. The data obtained should provide an all-weather day and night time surface mapping of the earth with high spatial resolution by a process which is the microwave analogue of optical holography.

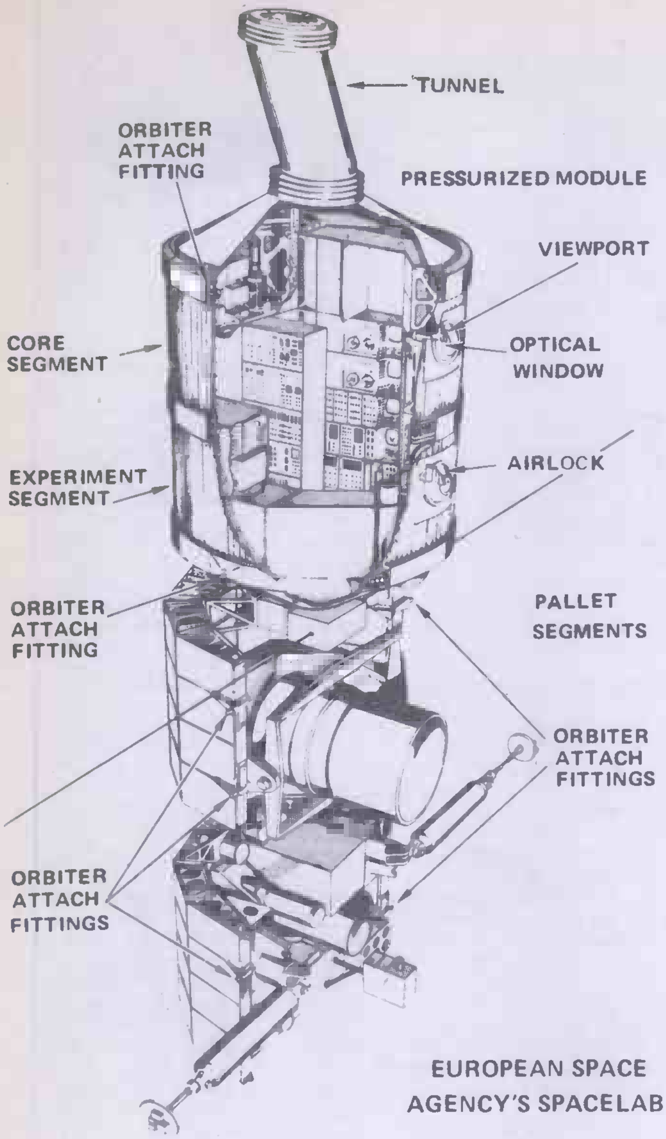
LIFE SCIENCES

The Spacelab environment enables experiments to be performed on the behaviour of man and other organisms in a gravity-free environment, whilst the effects of high energy cosmic particles from space can also be investigated. In the life sciences field 16 experiments have been accepted for Spacelab's first flight.

Blood samples will be taken from the crew members at regular intervals during the concentrations after the flight. Other work will investigate how the body fluid pressures will react to near zero gravity, whilst further experiments will investigate any changes in the number of cells in the blood and whether the cells which provide our immune responses are altered.

During their growth plants exhibit helical movements and an experiment with *Helianthus annuus* will test how this is affected by gravity. Other work will look into the effect produced by the absence of the normal daily variation of light and darkness on a fungus which produces patches of extensive growth once every 24 hours; this may shed light on the 'biological clock' mechanism.

Ballistocardiography experiments will record the body accelerations in three dimensions of the crew by attaching accelerometers and the effect on the heart activity and blood movement will be found. The crew members will be equipped with personal miniature tape recorders to monitor their electrocardiograms; electroencephalograms, etc. under gravity free conditions. They will also wear various radiation dosimeters.



EUROPEAN SPACE AGENCY'S SPACELAB

volume compared with other space transportation systems, and at relatively low cost. The cargo bay of the Shuttle Orbiter vehicle is 4.5 metres in diameter by 18 metres long.

The ability to carry experts in their field with the experimental apparatus so that they can immediately make adjustments will maximise the usefulness of the results obtained. The return of the complete spacelab equipment to the ground after every mission is also very attractive and economical.

Shared mission costs also keep expenditure down, but there are some types of work for which the Spacelab system is not ideal — such as work requiring more time in space than the Shuttle Orbiter is designed to spend.

OVERVIEW

The cost of Spacelab is about 1000 million pounds, provided by ten European countries — Italy, France, West Germany, the United Kingdom, Belgium, Spain, The Netherlands, Denmark, Switzerland and Austria.

NASA provides the launching facilities. The importance of Spacelab can be seen from the following figures of its frequency of Shuttle launchings.

During the first 12 years of Shuttle operation about 1000 payloads are scheduled on 487 flights up to 1992. Spacelab will be caried on 201 or 41% of these flights, the number of Spacelab payloads being 464.

The other 54% of the Shuttle launches will be used for free flying satellites (46% of launches will be for communications satellites, deep spacecraft for interplanetary missions, high altitude explorer craft, research satellites, etc.).

Other Shuttle launches will convey the Space Telescope and various Landsat, Seasat, earth resources, meteorological and astronomical satellites.

The Spacelab missions provide the first opportunity for a European to orbit in space. There will be only one non-American on the first Spacelab flight, which will be the Shuttle's seventh mission.

The European Space Agency put forward 54 candidates (including one woman) who had been preselected to travel on the first Spacelab mission. In May 1978 the Agency selected three of these candidates from whom the one European to travel on the first Spacelab mission will be chosen. The three are:

Mr Ulf Merbold, a 37-year-old German physicist who has worked as a solid state physicist on crystal lattice defects and low temperature physics.

Mr Claude Nicollier, a 34-year-old Swiss astronomer who has worked on the photomeric classification of the supergiant stars and who is a qualified professional pilot. He is a part time pilot in the Swiss Air Force.

Wubbo Ockels, a 32-year-old Dutch physicist who has been involved with prompt gamma ray decay and position sensitive detectors, apart from developing a data handling system.

These three were chosen from a maximum of five candidates put forward by each country.

The maximum age was 47, a degree was required in natural sciences or engineering with at least five years' experience, and fluency in written and spoken English.

The candidates had to undergo psychological tests to ensure they will be able to cope with the considerable stress of the Spacelab workload and environment. Very good memory and reasoning ability, good concentration, low aggressiveness and high motivation were among the requirements.

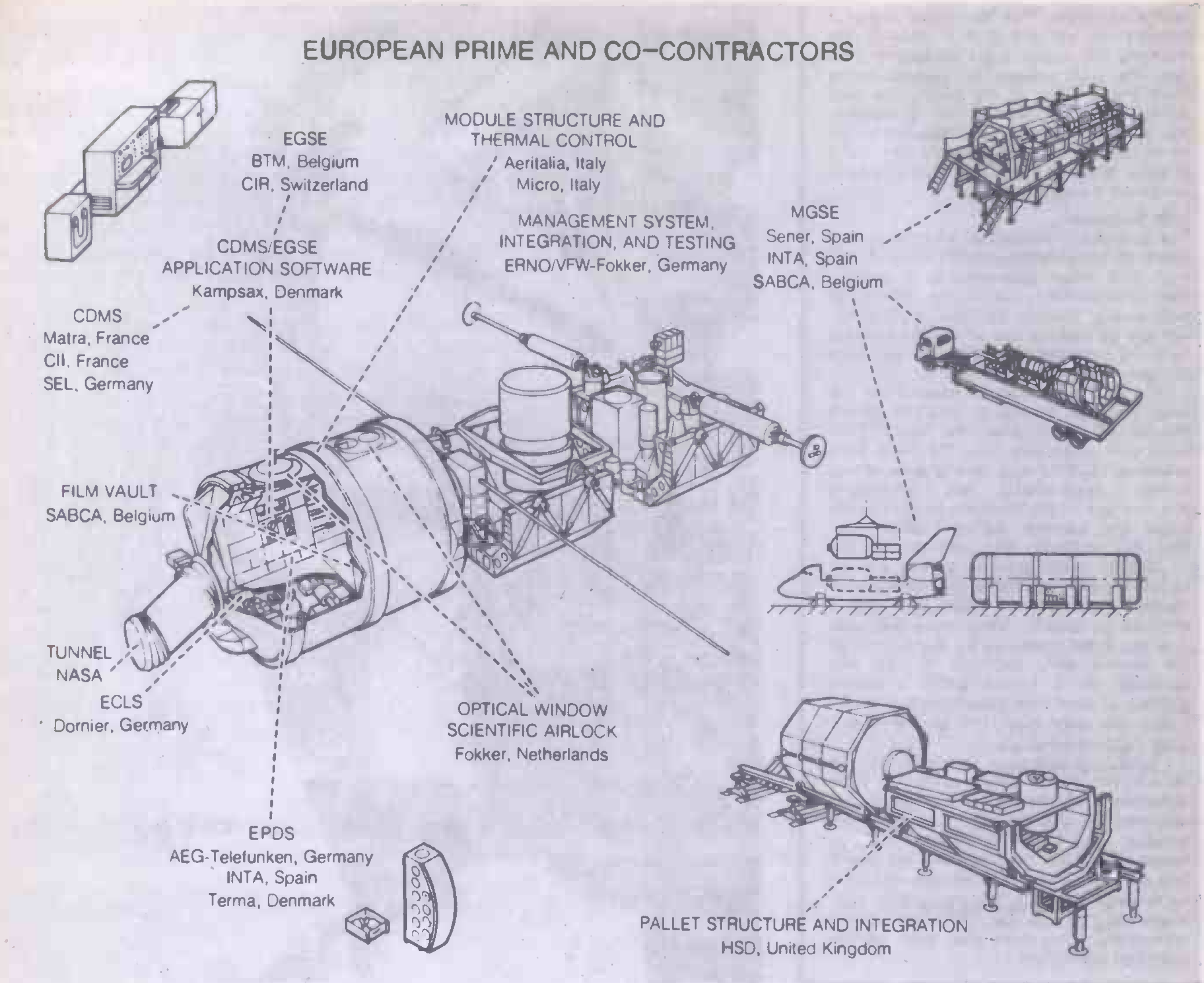
NASA has selected Mr Michael L. Lampton, a 37-year-old-physicist and Mr Byron R. Lichtenberg, a 30-year-old scientist for the first Spacelab flight. One of these two Americans will accompany the selected European.

The experimenters aboard Spacelab are called the payload specialists. These people are nominated for the flight by the particular organisation which is sponsoring the payload concerned. They are accepted, trained and certified for a flight by NASA.

They co-ordinate their activities in space with experimenters on the ground and with the crew of the Space Shuttle Orbiter.

The Orbiter crew includes its commander, the pilot, and the mission specialist who is responsible for the management of the Shuttle resources and equipment which supports Spacelab.

Experimenters aboard the earlier Skylab craft found it uncomfortably large. The crew found themselves floating out of reach of all of the grip bars, whilst time



was lost in moving considerable distances and they became tired very quickly.

One cannot use one's lower limbs for walking in conditions of near zero gravity. It was therefore decided that the ideal space station is one composed of compartments, each not much bigger than a man.

In such a compartment a man can stand erect, but can always touch something. This principle has been used in the design of the Spacelab pressure module (which is much smaller than that of the Shuttle Orbiter payload bay), but the bay can be filled with pallets.

The Shuttle Orbiter also contains a two-deck living unit with the control station on the top deck and the quarters for both the Shuttle crew and the Spacelab specialists on the lower deck.

The specialists will work in the pressure module in shifts during missions when this module is carried and will return to the Shuttle living quarters to eat, sleep and relax.

Salyut I carried 1000 kg of instruments, Salyut 4 more than 2000 kg, but Spacelab will initially carry about 5790 kg, increasing to 9350 kg on later flights in which three pallets are used.

PRINCIPAL USES

The early manned orbiting vehicles involved experimental programs mainly biological in nature. Aboard Spacelab a much wider variety of experiments will be undertaken.

Spacelab offers an environment where gravity is extremely small (about one millionth of that on the earth), although strictly speaking the gravitational field is only zero at the centre of gravity of the whole Orbiter (including Spacelab) when there is no retardation by the atmosphere.

Such a micro-gravity environment should offer entirely new possibilities for separating biological materials to obtain pure preparations of cells for transplantations, for preparing concentrated antibodies for the treatment of certain diseases and for purifying vaccines, etc.

Ultra-pure metals, semiconductors and glasses can be processed for research applications in electronics. Perfect crystals for computers, communications and other electronics uses may be processed in Spacelab as well as new materials of improved strength at high temperatures.

Spacelab will be flown above the atmosphere, so it will provide for experimental work in the fields of astrophysics, ultra-voilet, optical, infra-red and X-ray stellar, planetary and solar astronomy.

Atmospheric ionospheric (plasmas) and magnetospheric physics can also be investigated by flying Spacelab at an appropriate height. Remote earth sensing for meteorology, land-use planning, resources, pollution control and other purposes can be carried out with more flexibility than is available from existing satellites dedicated to one of these purposes.

Biological experiments will be some of the most important work aboard Spacelab. There is still much to be learned about the growth and behaviour of cells in conditions of zero gravity — apart from the effect of such an environment on such a complex creature as a man.

It is intended to use Spacelab to study sea sickness phenomena for which purpose a special "sled" has been designed. A man will be rocked in a seat with various amplitudes at frequencies of between 0.01 hz and 1 Hz; this movement can also be combined with a rotary movement.

THE FIRST MISSION

The total number of scientific and technological investigations chosen by NASA and the European Space Agency (ESA) for the first Spacelab mission scheduled for 1981 is 76; of these experiments, 60 are European, 15 American and one Japanese.

This first mission has been jointly planned by NASA and ESA, the available Spacelab weight for equipment, power and crew time being shared between these two organisations. The ESA will provide some of the basic experimental equipment such as a microwave sensor, a metric camera and a vestibular sled.

About 130 investigators from Europe, 80 from the USA and a few from Canada, India and Japan will be involved in the 76 experiments.

The primary objective of the first Spacelab flight will be to verify the performance of the various systems and subsystems. The second objective will be to obtain useful data and to confirm the broad capability of Spacelab for a wide variety of space research.

The first flight will last 165 hours (about seven day), but the time for experimental work will be 140 hours.

No access to the payload will be available during the final nine days before the launch nor during the first 30 hours after landing.

As the Shuttle verification equipment on the first flight will be much more extensive than on succeeding Shuttle flights, the total payload carrying capacity will be reduced to about 4000 kg and the total energy available to about 100 kW-hr. A total of 100 man-hours will be available from the two payload specialists.

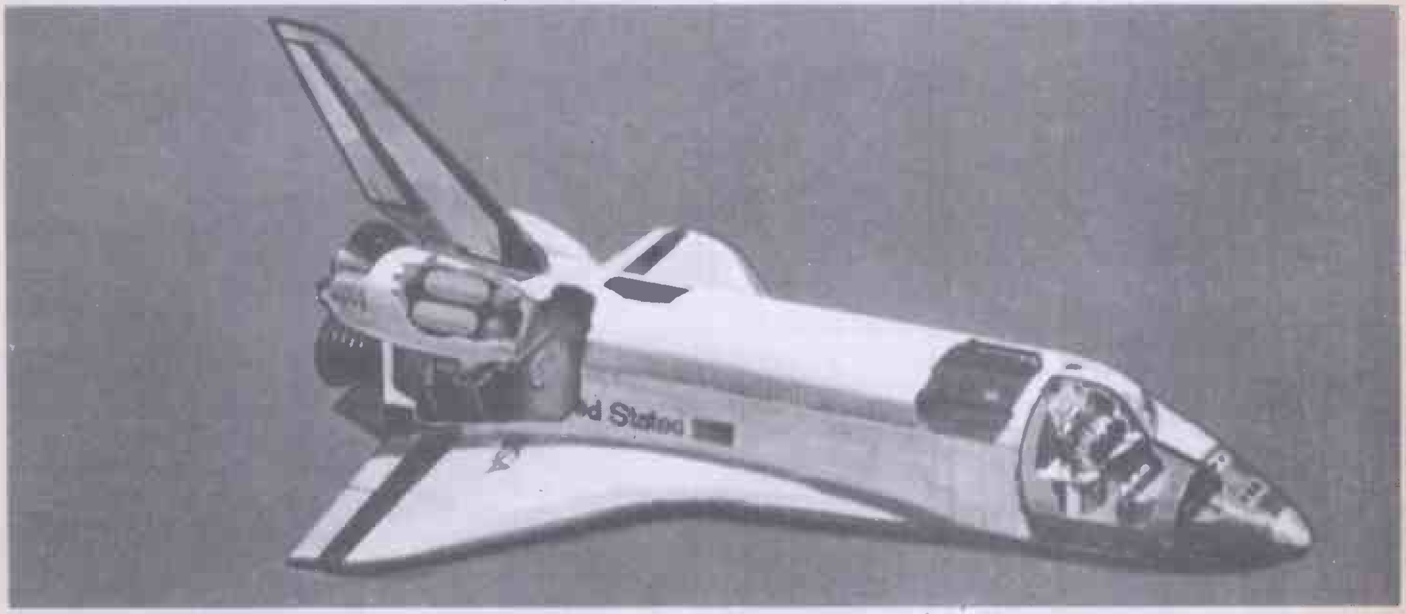
The experiments to be performed by the first Spacelab mission have been deliberately chosen from a wide range of disciplines including atmospheric physics, plasma physics, Sun-Earth relations, astrophysics, material sciences and technology, life sciences and earth observations.

CONCLUSION

It is often said by people who know little about the subject that they feel it disgraceful huge sums of money should be spent on space research when man cannot cure many forms of human disease. It seems likely that the availability of the Space Shuttle together with Spacelab will bring an enormous number of advantages to the human race, both to people who are ill and to those in good health, but progress in this expensive field of technology is inevitably limited in pace.

However, if one thinks back a few years, one can appreciate how rapidly the developments in space work have actually occurred. Man has been on the earth for a very long time yet it is only in the last twenty-two years that he has been able to leave his world temporarily and return safely to it.

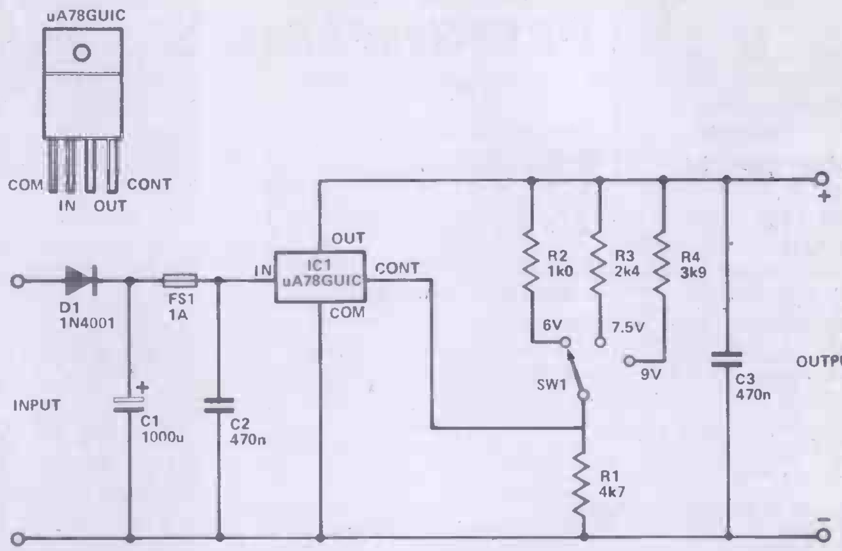
It is interesting to note that the first element of Spacelab hardware has already been delivered to the USA. One of the pallets (fabricated by British Aerospace at Stevenage) was delivered to the Kennedy Space Centre in 1978 so that NASA can use it for Orbital tests of the Space Shuttle in 1980 as part of a pre-operational Orbiter payload. **HE**



The Shuttle Orbiter vehicle showing cut-away views of engine, payload and pilot areas.

Short Circuits

CAR CASSETTE POWER SUPPLY



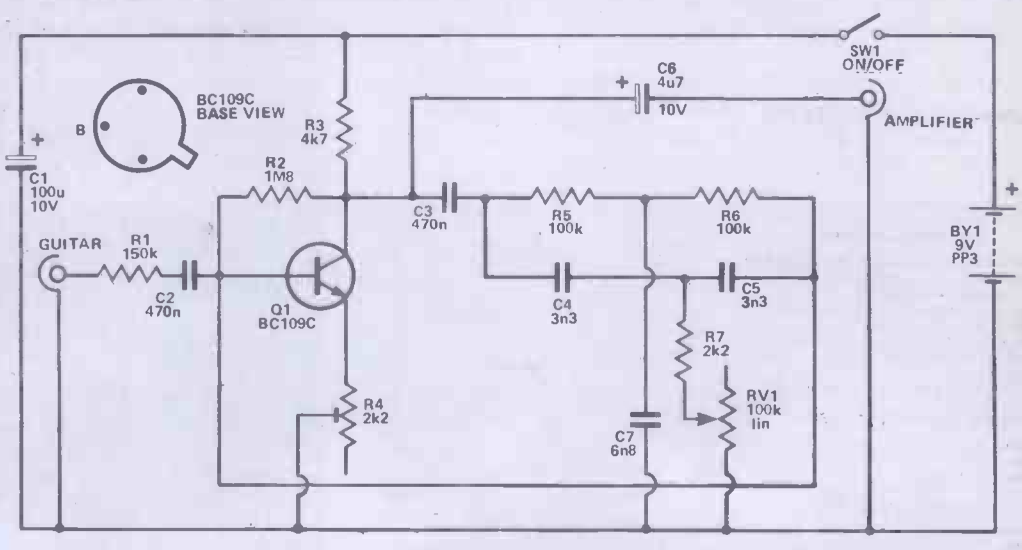
When using a portable cassette recorder in a car or boat it is far cheaper to run the unit from the vehicle's battery than from internal batteries. Many recorders have a socket for an external power source, and it is not usually too difficult to adapt recorders not having this facility to operate from such a source. This circuit will give an output of 6, 7.5, or 9 V from a nominal 12 V input with a maximum output current of 1 A. It can therefore be used to match most recorders to a 12 V supply.

The circuit uses a four terminal monolithic voltage regulator (ICl) to give the voltage stepdown and provide a well stabilised output. The input to the regulator is obtained via D1 which blocks the supply if it is connected with the wrong polarity, and fuse FS1. The input will probably contain a certain amount of noise which is smoothed by C1. C2 and C3 are decoupling capacitors which aid the stability of the circuit, and should be connected as close to IC1 as possible.

The output voltage of IC1 is set by a potential divider connected across the output and feeding into IC1's CONT (control) terminal. A negative feedback action stabilises the voltage at the CONT terminal at 5 V, and the output at a level equal to 5 V plus the potential dropped by the potential divider. The value of R1 sets the potential divider current at just over 1mA, giving a drop of about 1 V across R2, 2.5 V across R3, and 4 V across R4. SW1 can thus be used to select output voltages of 6 V, 7.5 V, and 9 V by switching the appropriate resistor into circuit. If only a single output voltage is required, SW1 is omitted and the appropriate resistor is connected directly between IC1's CONT terminal and the output.

IC1 must be mounted on a heatsink, and this can be the case of the units if a metal type is used. The heat-tap of the device connects internally to the COM terminal, and so the tab must be insulated from the case in the usual manner if the latter is earthed and the unit is installed in a positive earth vehicle. The uA78GU1C has thermal overload protection circuitry and foldback output current limiting incorporated in its design.

WAA-WAA UNIT



The popular and well known Waa-Waa effect is produced using a filter which boosts a narrow band of frequencies, and has a level of gain which falls away repidly outside the boosted band. The position of the boosted band within the audio frequency spectrum is varied up and down; sometimes automatically, but usually manually, as in the case of the design featured here. Normally a manual Waa Waa effects unit is controlled using a pedal, but the mechanics of the unit are left to the ingenuity of individual constructors.

The circuit is based on a twin T filter; one of the T shaped networks being comprised of R5, R6, C7, and the other one consisting of C4, C5, RV1. This type of filter gives a narrow rejection notch of extremely high attenuation. This is, of course, the exact opposite of what is required in this application! The twin T filter is made to give the required effect by connecting it between the input and output of a conventional common emitter stage based on Q1. A common emitter amplifier inverts the signal between its base and collector terminals, resulting in negative feedback being applied through the twin T filter. This reduces the gain of the amplifier to only a low level. However, there is little or no feedback at or close to the operating frequency of the twin T network, and so at these frequencies the amplifier exhibits its full gain, or very nearly so. Thus the required boost to a narrow range of frequencies is obtained.

By varying the value of RV1 up and down it is possible to sweep the boosted band of frequencies backwards and forwards over a large part of the audio spectrum. Ideally all three resistances in the twin T network should varied together, but this is not really practical. The circuit seems to work quite well in this simplified form anyway.

R4 controls the gain of the amplifier, and if this is set for too low a resistance the circuit will break into oscillation at some settings of RV1. It should be set for a resistance which is just high enough to prevent this from happening. If this gives an effect which is too sharp, R4 can be backed off a little further.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Digi-Die

Take a gamble on HE's roll-your-own digital die project.

DIGI-DIE is a solid-state electronic die that gives a visual output on seven light-emitting-diodes, arranged in the pattern of a conventional die face. The die display number changes, in a random fashion, each time a 'spin' button is pressed and released. The electronic die gives very fast 'spin' action, enabling several spins to be made in the time that a conventional die would take to make a single roll, thereby enabling games to be greatly speeded up.

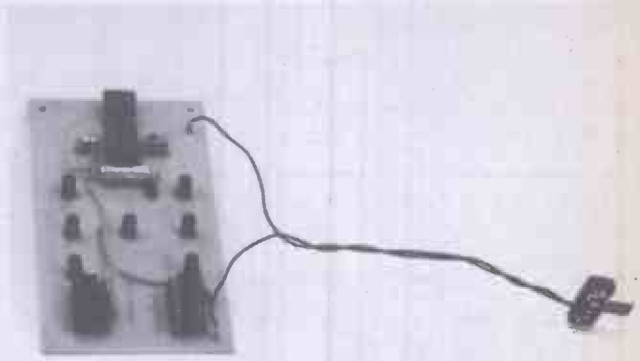
The HE digi-die has a few unusual features. It incorporates an electronic time switch that connects power to the LEDs when the 'spin' button is pressed but then automatically removes the power a few seconds after the button is released. This feature eliminates the need for a separate ON/OFF switch and causes the display to blank automatically when it is not required. All seven LEDs illuminate when the 'spin' button is held down.

The second unusual feature of the unit is its cost. By using inexpensive ICs and ingenious circuit design we've managed to keep the total building cost down to about £3. So how can you NOT build such a splendid project?

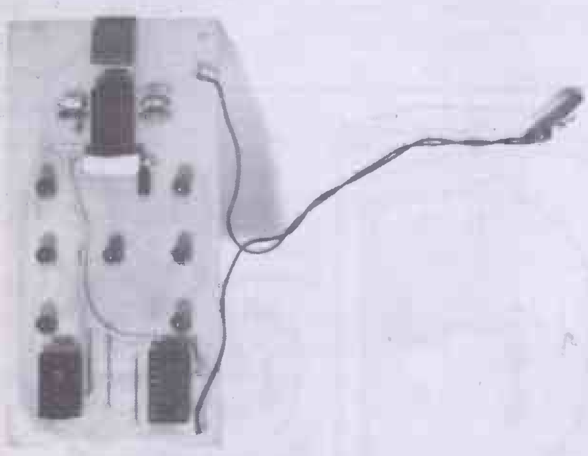
CONSTRUCTION

There really is not a lot to say here. Just remember to fit the links to the PCB as indicated and observe the polarities of C1 and the semiconductor devices and that's it. We used IC holders on our prototype, but they're not essential if you take sensible precautions when soldering the CMOS ICs in place. Don't forget to check the functioning and polarity of the LEDs before soldering them into place.

If your project doesn't work correctly first time it will be because you've either blown up an IC or have fitted the LEDs the wrong way round.



The Digi-Die before mounting in a case. Choice of case is left up to the constructor.



The actual layout is not critical, using our PCB design results in a neat, attractive project.

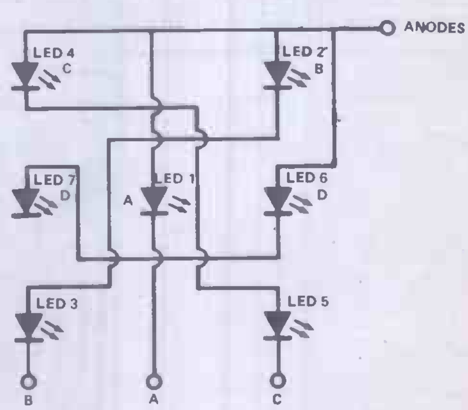


Fig. 1. Display layout for Digi-Die

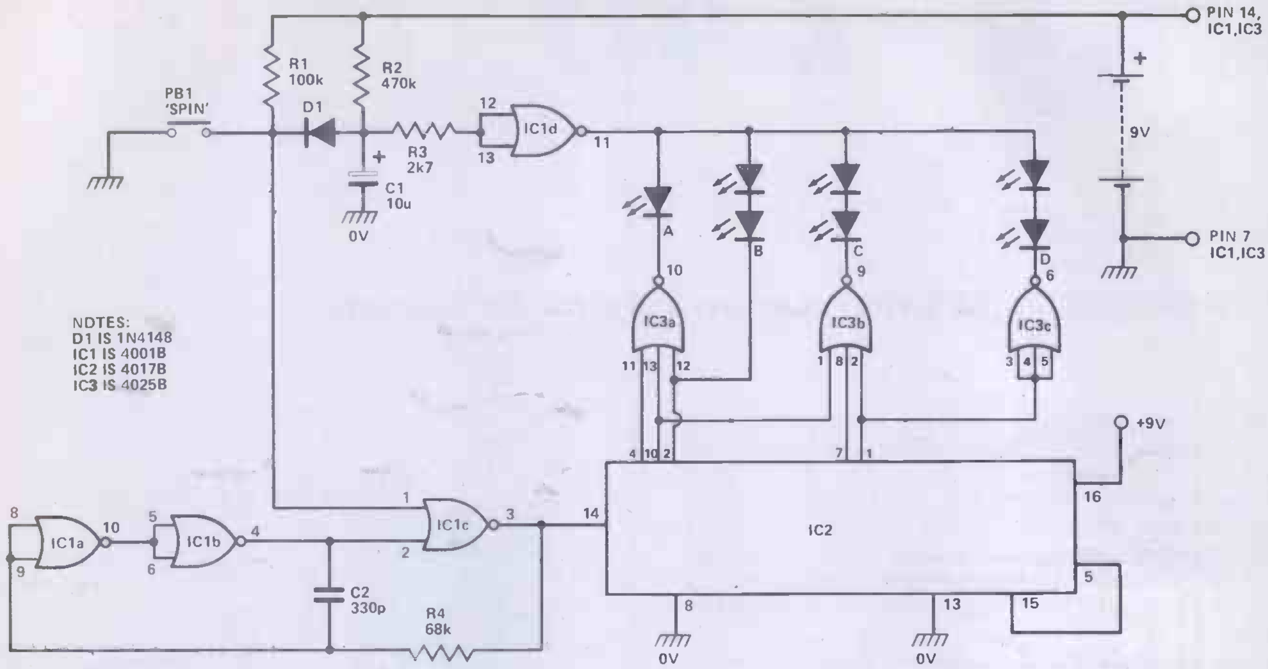


Fig. 2. Circuit diagram for the HE Digi-Die

How It Works

IC1a to IC1c are wired as a gated ring-of-three fast astable which has its output fed to the 'clock' input terminal of the 4017B counter. Nine of the ten outputs of this counter are normally low, but the outputs go high sequentially when the counter is fed with a series of clock input signals. The 4017B is wired as a 'divide-by-six' counter and has its output states decoded by IC3 and fed to a 'die' matrix of seven LEDs, which in turn are gated on or off by IC1d. Normally, all LEDs are gated off and the entire circuit consumes a quiescent current of only 1 uA or so.

The circuit action is initiated by momentarily pressing and releasing PB1. As PB1 is pressed the fast astable is gated on and applies clock pulses to the counter. Simultaneously, the input of IC1d is pulled low via D1 and the output of IC1d goes high and enables the LED display. Under this condition all seven LEDs illuminate as the counter repeatedly runs through its counting sequence.

When PB1 is released again the astable stops operating, having fed an unknown or 'random' number of pulses into the counter. The counter display 'freezes' at this point, giving some randomly determined fixed display on the die matrix. As PB1 is released, C1 starts to charge exponentially via R2 and drives IC1d input towards the positive supply rail voltage. Eventually, after a delay of a few seconds, this voltage rises to such a level that the output of IC1d switches low and disables or 'blanks' the LED display. The circuit's quiescent current then drops back to a few uA and the circuit action is complete.

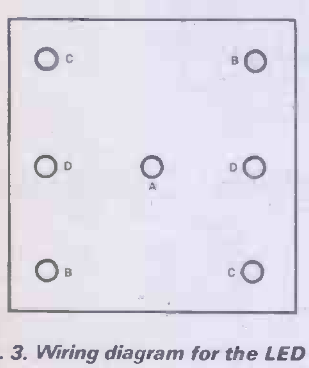


Fig. 3. Wiring diagram for the LED display

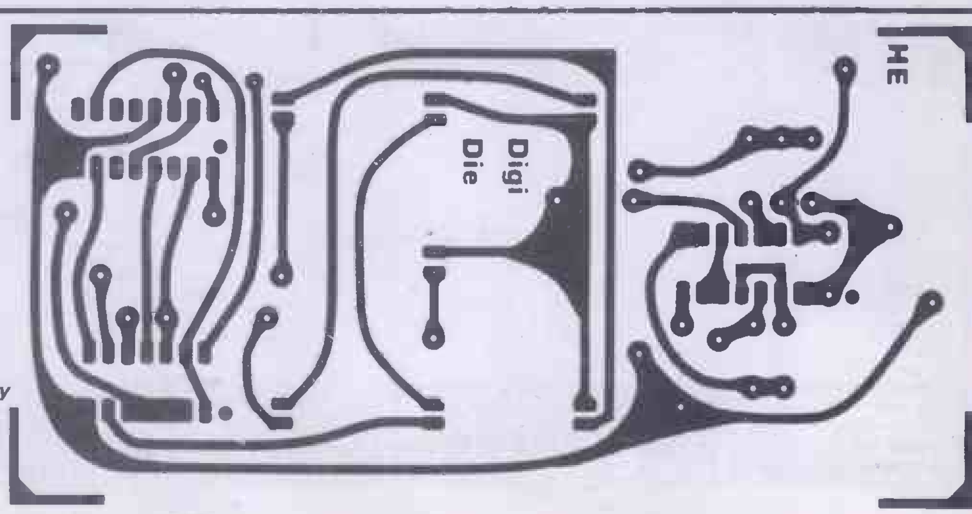


Fig. 4. PCB foil pattern for HE Digi-Die

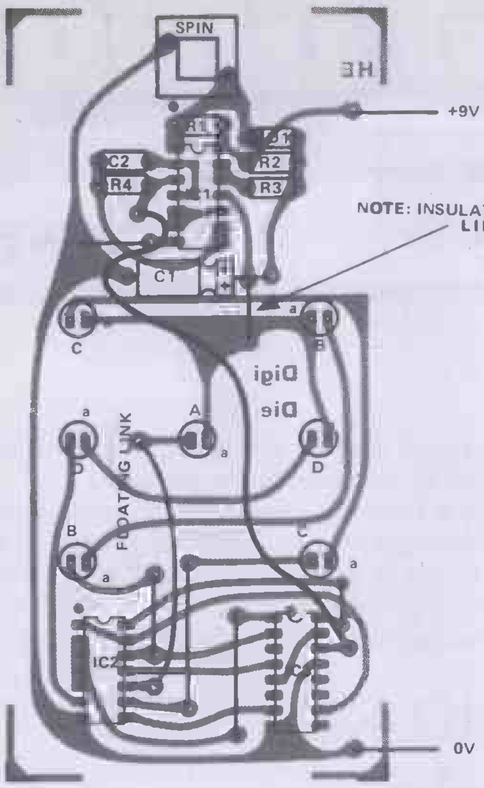


Fig. 5. PCB Overlay, watch out for polarised components.

Parts List

RESISTORS

R1	100k
R2	470k
R3	2k7
R4	68k

CAPACITORS

C1	10u electrolytic
C2	330p polystyrene

SEMICONDUCTORS

IC1	4001B
IC2	4017B
IC3	4025B
D1	1N4148
led 1-7	standard 0.2" red leds

MISCELLANEOUS

PP3 battery. PCB foil pattern. 1 push button (momentary action).

Buylines

No problems here. All components used in the project are standard items.

electronics today international

What to look for in the February issue: on sale January 2nd

CMOS 555

Now you all know about the CMOS version of the 555 timer chip — because we told you about it last month in Designers Notebook, so no excuses in the back row please.

Only thing to do now was to get Tim Orr, the country's leading circuit man, to spend a few eons playing with the device and produce one of his superb circuit filled features all across ETIs pages next month. This is good stuff of the highest quality. Be there with your soldering irons, there are circuits for just about everything under the sun — and if we can find a heater element big enough we'll see you with a design for one of them next year.

ONE FIVE THREE SEVEN

Whatdeyer mean that you've never heard of this? Of course you have. It's a brilliant Voltage Controlled Attenuator thingy for which Keith Brindley will explain at least a million applications and designs next month. Well, not actually a million but quite a few. He also gives you a breadboard design to go away and do your own things with. What more could you possibly want? Stand up the boy in the back who said "Felicity Kendal".

MODULAR SYNTHESISER

Next month ETI presents a new series of synthesiser circuit modules which represent the forefront of modern music technology. Not only that but they're a bit new as well. And somewhat of a departure for us. The complete design will be a sophisticated machine comparable to the very best available today at any price and with more facilities than the Playboy Club.

However we are aware that not everyone has a use for such a machine, and that there are a large number of you out there who wish to experiment with sound effects circuits, without the requirement for a fully fledged synthesiser system. And So . . .

Our latest machine will be presented in modular form, with each separate unit mounted on a 'front panel' assembly, *and* housed in a common box. As the PSU requirements will be standardised, you can build as many — or as few — of these superb designs as you need when you need them.

CASIO FX502P/FA1

The best thing since sliced bread. Honest. If you don't believe us read our comprehensive report on this ten program 256 step, 100 label, cassette jumping calculator and music adaptor in next month's ETI.

The abacus will never seem the same again.

CASSETTE HEAD DEMAGNETISER

Sometimes we're so ingenious we amaze ourselves! And sometimes we're so dumb we amaze everyone else.

Apart from that though this *is* a good idea — demagnetising your cassette player heads reduces all the nasty things that you don't really wanna hear anyway and makes those that you do sound even better.

Ours naturally has something a bit special about it — something that makes it both easy to use and more effective. But we're not gonna tell you what cos we want yer to buy next month's magazine instead!

VMOS 2M PA

One for all the hams of this world. Put some POWER in your words with our VFET Power Amp. Based on the latest circuit techniques this is a design to burn out the receivers of the universe. Don't just broadcast — BROADCAST with ETI!

SIGNAL TRACER

This is instead the only way to find that sinewave that went into that phono socket half an hour ago and hasn't come out yet.

For the sake of all lost waveforms everywhere build this one.

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4011	13p	4029	50p	4081	13p
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		LM324	45p	RC4136	100p
709	35p	LM339	45p	SN76477	230p
741	16p	LM378	230p	TBA800	70p
747	45p	LM379S	410p	TBA810S	100p
748	30p	LM380	75p	TDA1022	620p
7106	850p	LM3900	50p	TL081	45p
7107	900p	LM3909	65p	TL084	125p
CA3046	55p	LM3911	100p	ZN414	80p
CA3080	70p	MC1458	32p	ZN425E	390p
CA3130	90p	MM57160	590p	ZN1034E	200p

TTL

		7473	20p	74141	55p
		7474	22p	74145	55p
7400	10p	7475	25p	74148	90p
7401	10p	7476	20p	74150	55p
7402	10p	7485	55p	74151	40p
7404	12p	7486	20p	74154	65p
7406	22p	7489	135p	74157	40p
7408	12p	7490	25p	74164	55p
7410	10p	7492	30p	74165	55p
7413	22p	7493	25p	74170	100p
7414	39p	7494	45p	74174	55p
7420	12p	7495	35p	74177	50p
7427	20p	7496	45p	74190	50p
7430	12p	74121	25p	74191	50p
7432	18p	74122	35p	74192	50p
7442	38p	74123	38p	74193	50p
7447	45p	74125	35p	74196	50p
7448	50p	74126	35p	74197	50p
7454	12p	74132	45p	74199	90p

TRANSISTORS

				ZTX500	16p
				2N697	12p
		BCY72	14p	2N3053	18p
AC127	17p	BD131	35p	2N3054	50p
AC128	16p	BD132	35p	2N3055	50p
AC176	18p	BD139	35p	2N3442	135p
AD161	38p	BD140	35p	2N3702	8p
AD162	38p	BFY50	15p	2N3703	8p
BC107	8p	BFY51	15p	2N3704	8p
BC108	8p	BFY52	15p	2N3705	9p
BC108C	10p	MJ2955	98p	2N3706	9p
BC109	8p	MPSA06	20p	2N3707	9p
BC109C	10p	MPSA56	20p	2N3708	8p
BC147	7p	TIP29C	60p	2N3819	15p
BC148	7p	TIP30C	70p	2N3820	44p
BC177	14p	TIP31C	65p	2N3904	8p
BC178	14p	TIP32C	80p	2N3905	8p
BC179	14p	TIP2955	65p	2N3906	8p
BC182	10p	TIP3055	55p	2N4058	12p
BC182L	10p	ZTX107	14p	2N5457	32p
BC184	10p	ZTX108	14p	2N5459	32p
BC184L	10p	ZTX300	16p	2N5777	50p
BC212	10p				
BC212L	10p				
BC214	10p				
BC214L	10p				
BC477	19p				
BC478	19p				
BC548	10p				
BCY70	14p				
BCY71	14p				

DIODES

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1N4002	4p	BZY88 ser.	8p

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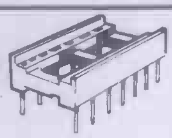
Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		

DISPLAYS

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

SKTS



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2.5 x 3.75	45p	45p	
2.5 x 5	54p	54p	Pin insertion
3.75 x 5	64p	64p	tool 108p
3.75 x 17	205p	185p	
Single sided pins per 100	40p	40p	

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0.5W	1.5p	1.2p	1p

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22 @ 16V, 47 @ 6V, 100 @ 3V . . . 16p

MYLAR FILM
0.001, 0.01, 0.022, 0.033, 0.047 . . . 3p
0.068, 0.1 . . . 4p

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0.15, 0.22 . . . 7p
0.33, 0.47 . . . 10p
0.68 . . . 14p
1.0uF . . . 17p

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			22	33	47	7p
	100					13p
			220			20p
25V	10	22	33	47		5p
	100					8p
		220				10p
				470		15p
	1000					23p

CONNECTORS

JACK PLUGS AND SOCKETS

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

DIN PLUGS AND SOCKETS

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

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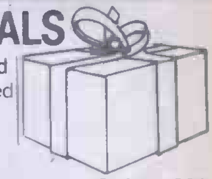

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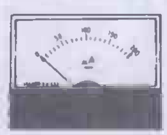

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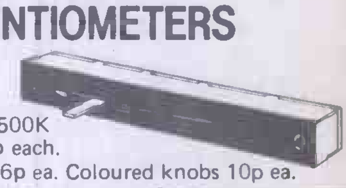

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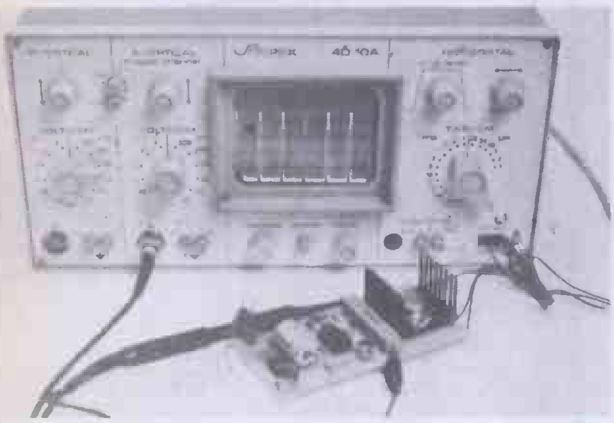
Hebot III

The HEBOT series reaches its conclusion with this article. Here we describe the inductive wire-tracking circuitry with full circuit details. There is also a simple constant-current nicad charger. Full details of all the circuit interconnections are given with notes for expansion. HEBOT is an open-ended project and there is plenty of scope for development. News is beginning to reach us of the two hundred or so HEBOTs already built and we feel sure this is just the start. If you have made any improvements or alterations to YOUR HEBOT we would very much like to hear from you. Watch HOBBY ELECTRONICS for further developments!



You can monitor the loop output current with an oscilloscope.

IN THIS FINAL ARTICLE we will deal with the points arising from the previous two months' designs. Judging from sales of the chassis, we estimate that there may be over two hundred Hebots or sons of Hebot roaming around Britain already. We have seen three of them constructed from kits which all worked first time so if you are having trouble check your soldering and make sure you have inserted all the wire links and connected the flying leads.

Before we go on to look at the monster we have created, a couple of points need to be cleared up. Though we used rechargeable nicad cells to power our Hebot, the circuitry will work quite happily with plus and minus six volt supplies when powered by dry batteries. Unfortunately no pads were provided on PCB1 for the x, y outputs of IC8. Simply solder directly to the copper track between pins 2, 3, and 9, 10 (the x and y outputs respectively).

The second PCB is easier to mount above the first if capacitors C3, 4 are mounted so that they lie sideways. Also, to increase the gain of IC1, 2, 470k resistors should be mounted in parallel with input resistors R1, 2. There are no other changes to make on the first board.

On the second board, capacitors C1 and C10 have caused some problems. These capacitors should have a working voltage of at least ten volts. A 47µ capacitor may be used in place of either component. Resistor R4 should be changed from 100k to 270k and R5 from 820R to 8k2.

Following tests with Hebot tracking a wire energised by the loop driver circuit, it was found that capacitors Cx were unnecessary and wire links should be inserted in their place. Also flying leads should be used to connect pin E to G and F to H as shown in Fig. 1 of the December issue. If you use the REMCON sensor kit it should be assembled and connected as shown in our photographs.

We have arranged our Hebot to perform a 'random walk' until it sees a light (We used a desk lamp placed at ground level) Hebot then steers towards the light unless its pick-up coils detect electromagnetic radiation from an energised loop. Then Hebot will follow the wire loop. If at any time Hebot collides with an obstacle then the normal manoeuvre circuitry takes over to steer Hebot out of trouble. The connections to achieve this behaviour are detailed below.

Note the 470k resistors mounted in parallel with the servo input resistors.

Allow some clearance from the PCB for R12 and Q2.

There are connections to both sides of Q2 collector. We used solder-tags.

The connections to the manoeuvre circuitry remain the same;
pins 2, 3, IC8 to pin 4, IC4
pins 9, 10, IC8 to pin 11, IC4
pin 12, IC11 (Avoid) to pin 13, IC3 random walk' is achieved by connecting: A to pin 1, IC4
B to pin 12, IC4
+ve supply to pin 10, IC3
the letters refer to pins on the second board
for light seeking connect:
P to pin 14, IC4
Q to pin 5, IC4
the phototransistor collectors connect to N (from right sensor) and O (from left sensor). T to pin 11, IC3

The emitters both go to the negative supply and pins are provided on the board.

The connections for wire tracking are:
I to pin 15, IC4
J to pin 2, IC4
M to pin 12, IC3

Hebot's sensors were made from reed relay actuating coils with a resistance of 1.5k. No cores were found to be necessary. The right sensor connects to pin C while the left sensor connects to pin D. The free ends of the sensor coils should be connected to the adjacent pins which are electrically identical with pin 1, IC1.

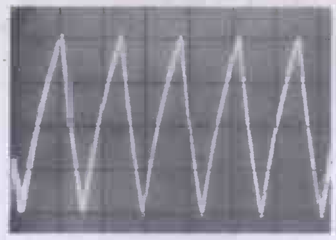
You should now have used all the inputs to IC4. IC5 is not used and this position may be left vacant. The remaining pins of IC3 should be connected as follows. Pins 1, 2, 3, 4 should be connected to the negative supply. This can be simply achieved by soldering a piece of tinned copper wire across all four pins down to the negative pin as shown in our photos. Pins 14, 15 of IC3 remain unconnected.

Our Hebot emits a sqeak when it detects light. To achieve this connect pin Y to pin T. There are now two connections to pin T. This is okay. You can spot when Hebot detects the wire loop by connecting pin S to pin M. The LED will illuminate when the pick up coils are within range of an energised loop. Also, of course, control is transferred to the wire following circuitry unless Hebot encounters an obstacle.

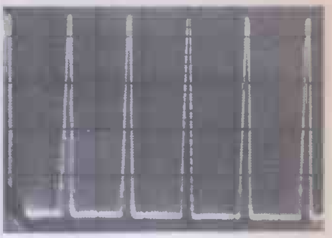
With the Hebot circuitry interconnected as described above, you will have a free roaming robot which can negotiate obstacles, steer towards a light and follow a wire around your home. We found that reliable operation could be obtained with wire-sensor separations of over one inch so Hebot should cope with the thickest pile carpets (though the prototype has an annoying habit of filling itself with fluffl).

The loop driver circuit should be constructed in the usual way. Though not essential, use of our PCB will greatly facilitate construction. Our photos tell all really. We found best operation was achieved with peak currents of 2.5A which gave a mean current drain of 350mA. Under these conditions Q2 hardly gets warm at all. RV1 works in reverse; when fully clockwise there is no output. About mid-way should produce the desired results.

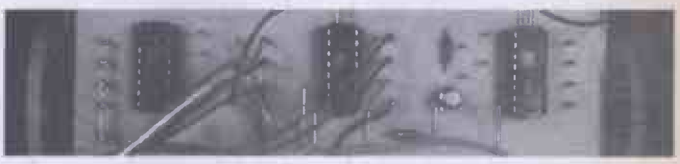
At this stage of development Hebot is an autonomous machine capable of very engaging behaviour. There is plenty of room for development. Board one will support a further four levels of control enabling more circuits to be accommodated on the chassis or control to be relinquished to an on-board micro-processor or via a link to your home computer. The possibilities are infinite and remember . . . We HAVE the technology! **HE**



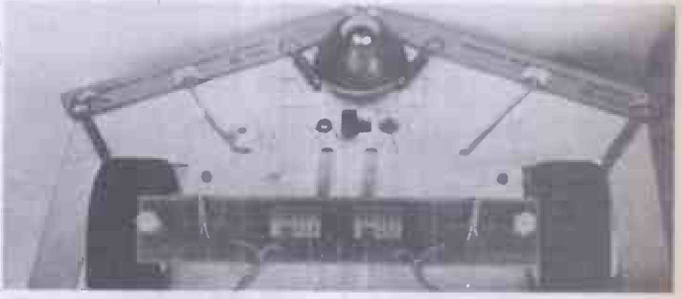
triangle waveform across C2.



output waveform across R12.



The connections to IC3 and IC4. Note the shorting link at the side of IC3.



The pick-up coils and photo sensors mount conveniently on one PCB.

How it Works

Hebot how it works — loop driver
Hebot is able to follow a wire laid on the floor by detecting the magnetic field produced by current pulses flowing in the wire. We tried a number of different arrangements and found that Hebot could follow a single wire carrying current pulses of about two amps at a frequency of around seven hundred Hertz. By using more turns of wire in the loop, accurate tracking can be achieved at lower currents. However, it is difficult to lay out a loop consisting of more than two or three turns of wire and the system chosen represents the best compromise.

Resistor R10 and zener ZD1 provide a stabilised 15 V supply which is smoothed by C1. A 700Hz signal is generated by IC1; a 555 timer configured in the astable mode. A diode is used to bypass R2 during the charging cycle. This enables a duty-cycle of 50% to be obtained. The approximate triangle waveform at the junction of R2, C2 is buffered by IC2b, a unity gain voltage follower, and appears at pin 7. A bias voltage of about 7.5 V is available at pin 14 and supplies IC2a and RV1. IC2a acts as an inverting amplifier with a gain of about 20 whose input is the triangle waveform from IC2b. Adjustment of RV1 enables the output of IC2a to be offset. In this way, the signal at pin 1 may be varied from 0v to positive peaks of up to 12 V. The remaining section of IC2 together with Q1, 2 and R11, 12 forms a voltage to current convertor. For each volt across R9 at the input pin 10 of IC2c, one amp will flow in a piece of wire connected between the positive supply and the collector of Q2. The maximum voltage that can appear at IC2a output is limited to 12 V with a 15 V supply by the op-amp characteristics. Potential divider R8, 9 limits the input to IC2c to 4 V and maximum output current, in a working circuit, is thus limited to 4A.

A suggested power supply is included here. Though the average current is less than 500mA with peak currents of 2½ A, the circuit may demand currents of up to 4A. For this reason, quite high current components have been chosen. If you have a current-limited power supply that can provide 15 V at 500mA you can connect it in place of the bridge-rectifier and transformer. Use good quality components for the capacitors to cope with the high current pulses.

We tried loops of several shapes and sizes with good results. Hebot can cope with turns of up to one foot radius. Power should be supplied to the loop by twisted wires or figure of eight speaker cable. In this way the fields from the two supply wires cancel out and Hebot will not try to climb into your power supply.

Nicad charger
If you have used nickel-cadmium cells to power your Hebot, you will need a charger. We have included the circuit of a suitable charger which will supply a constant current of 40 mA. R2 is the nearest preferred value. With 450mA/H cells a charging current of 45mA should be applied for fourteen hours. Assuming a Vbe of 0.6 V for Q1 then the theoretical value of R2 to produce a current output of 45 mA is 13.333 ohms. You can check the current by inserting a meter in place of the cells and adjust R2 accordingly. A 120R resistor in parallel with R2 would produce the calculated value of 13.333 ohms.

About 18 V is developed across C1. The charging current flows via the cells through Q2, R2. Transistors Q1, 2 form a stabilised current sink. Current flow is determined by choice of R2. A current will flow sufficient to produce a voltage of 0.6 V across R2. This tends to turn on Q1 which 'steals' base drive current tending to turn off Q2. In this way the system reaches a stable operating point.

No PCB is given as the circuit is so simple. A small heatsink should be used with Q2. No other precautions are necessary.

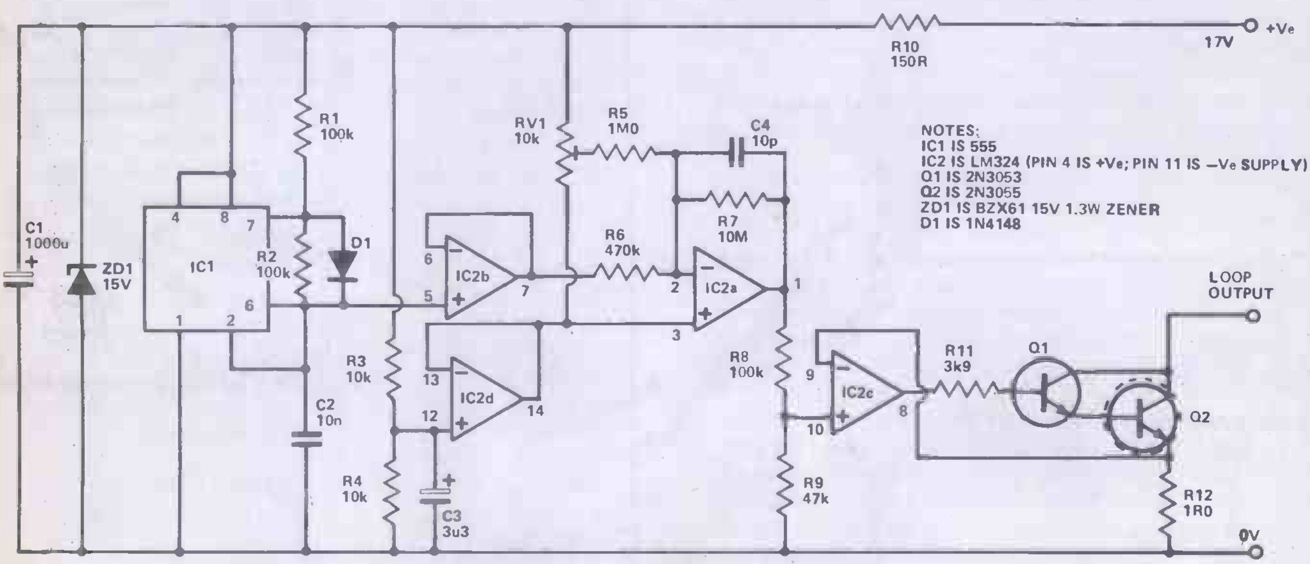
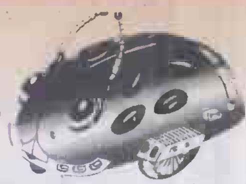


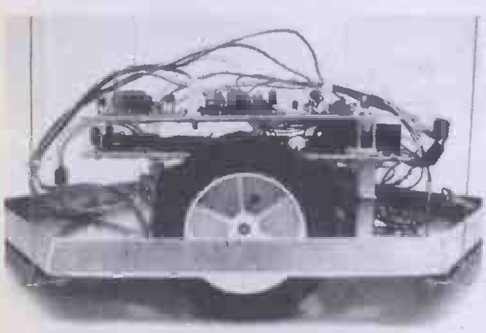
Fig. 1. The loop driver circuit.



Parts List

RESISTORS (All ¼W, 5%)	
R1, R2, R8	100k
R3, R4	10k
R5	1M0
R6	470k
R7	10M
R9	47k
R10	150R
R11	3k9
R12	1R0 10W
POTENTIOMETER	
RV1	10k horiz. preset
CAPACITORS	
C1	1,000 electrolylic
C2	10n polyester
C3	3µ3 tantalum
C4	10p polystyrene
SEMICONDUCTORS	
Q1	2N3053
Q2	2N3055
D1	1N4148
ZD1	BZX61 15V 1.3W
IC1	555
IC2	LM324
POWER SUPPLY	
12V	3A transformer
4A	bridge rectifier
4R7	10W resistor
2x	4,700µ 25V
CHARGER	
RESISTORS (All ¼W 5%)	
R1	1k0
R2	15R
CAPACITORS	
C1	1,000µ 25V
SEMICONDUCTORS	
Q1	BFY50
Q2	TIP33A
BR1	1A 50V bridge rectifier

transformer 12V 100mA



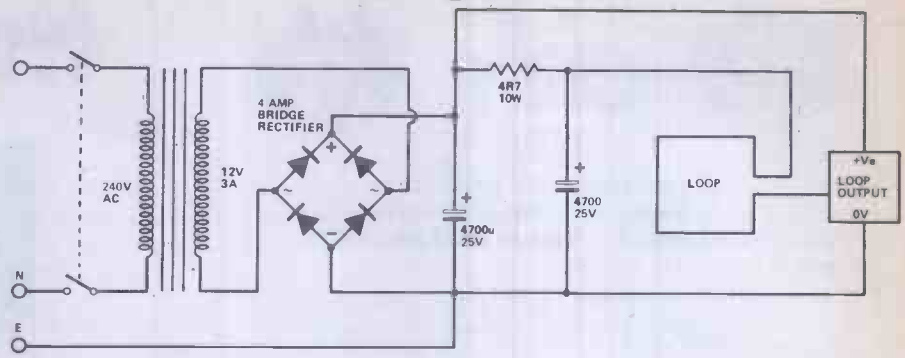


Fig. 2. Interconnections for the loop driver.

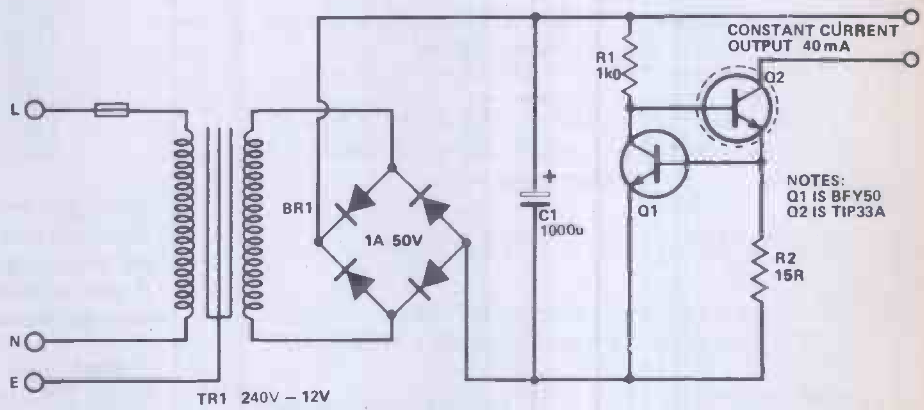


Fig. 3. Simple charger circuit for AA nicad cells.

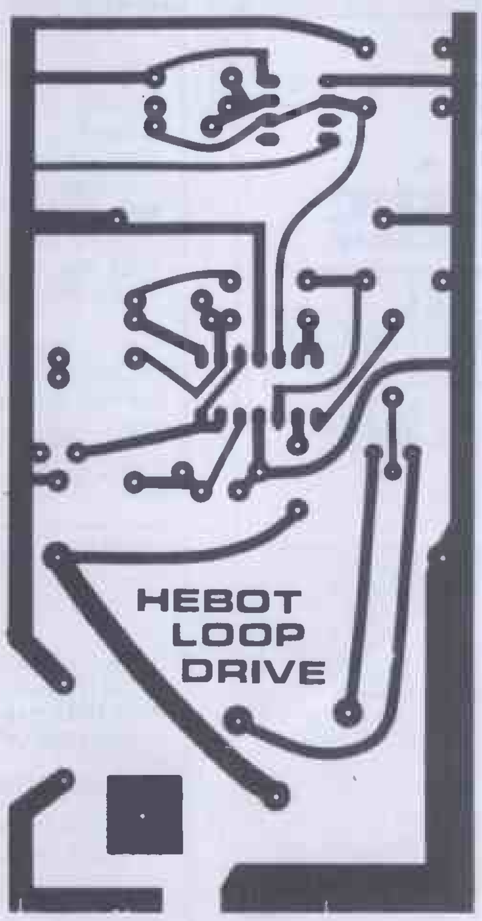


Fig. 4. PCB for loop driver.

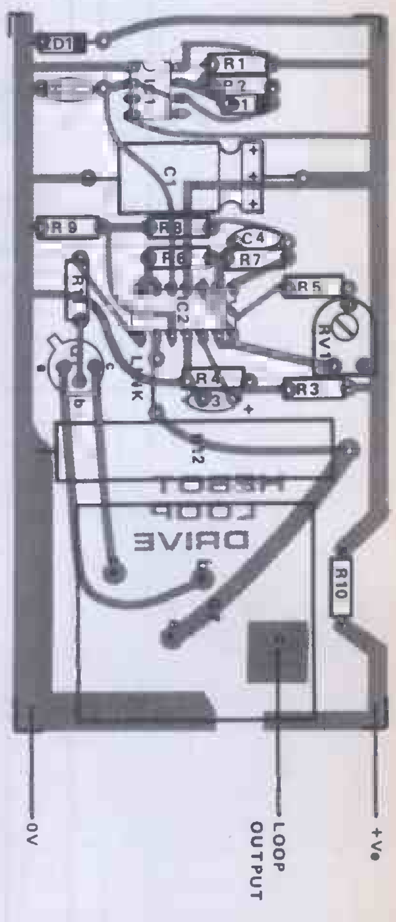


Fig. 5. Overlay for loop driver.

Breaker One-Four

**Send any news, comments, or information you may have to:
Breaker One Four,
Hobby Electronics,
145 Charing Cross Road,
London WC2H 0EE.**

Do not despair, although the announcement wasn't quite what we had hoped for the battle is far from lost. CB will come and your continued pressure will bring it that bit nearer.

QUITE AN EVENTFUL MONTH REALLY. The great announcement which was due to come from the Home Office failed to materialise at the appointed time (November 15th or 16th) and was supposedly delayed until the 25th. At this time (November 26th) we have heard that the Home Office have in fact issued a statement (although we haven't seen it). We understand it to say that they cannot find any 'technical' reasons why CB should *not* be introduced but they anticipate some problems in the administration of such a service.

If this information is correct, then it would seem that the fight is far from over, although the biggest hurdle has been overcome.

We must now change our tactics, we no longer have to prove that a CB service is needed it is now up to us to show that we can use it responsibly and that any administration can be kept to a minimum.

The obvious answer from the government will probably be along the lines that in these times of government cut-backs it would be foolish to create more 'red tape' but we feel that time and time again it has been shown that a licence fee of around £5.00 would more than cover any administrative costs and would in fact be self financing.

Several rumours flying about at the moment seem to suggest that there may be a couple of demonstrations in the near future. Before anyone jumps the gun we strongly suggest that some serious talking between the clubs and any other interested parties take priority.

PRESSURE

It is important now, more than ever for local clubs to bring these matters to the attention of their MPs in the first instance and to the Home Office on a wider basis. Lobby your MP, write to the Home Secretary now and let them know how you feel.

CB SPECIAL

We are sorry to have to tell you that the CB Special has finally sold out. Our distributors tell us that it has been a runaway success. We are currently toying with a few ideas for the future so keep your eyes peeled in the coming months for news.

CB STICKERS

You guessed it, we've just about run out of stickers too. The few we do have left we will be giving away at the Breadboard Show at the beginning of December. Sorry to anyone still without, but don't despair; our future plans may just include some new stickers.

MESSAGE TO CLUBS

By the time you read this the proposed meeting between the CB clubs will have taken place. It was moved to December 2nd in view of the delay in the government statement. Look out next month for a full report on just what happened. It should be quite interesting as Patrick Wall MP (chairman of the all-party committee on CB) and representatives from the media will be attending.

MAGAZINES ABOUT TURN

You may have read some of the other electronic journals last month and been surprised how they seem to have changed their attitude towards CB. Could it be that they have been reading HE? You never know.

STATESIDE CB

Remember last month's report on US CB? Watch out for a somewhat longer feature on how West Coast CB has been operating. Our reporter has been using CB and had occasion to call on the services of the channel '9' emergencies service. Coming up soon.

CB SLANG

Thanks again to everyone for the hundreds of entries to the slang competition. One of our plans for the future may include a proper CB slang dictionary.

One or two of our regular cartoonists may be doing the illustrations for this special so it should be well worth waiting for. More details in the coming months.

TAPE COMPETITION

Breaker One Four has got ten Cassette tapes to give away. They are entitled 'Everything You Need to Know To Operate a CB Radio'. (American CB that is.) We reviewed this tape some time ago so you should be familiar with it. They come from Dave Mills who is currently selling them for £2.50 each, so to win one you have got to do some homework.

There are three questions, all of which should be fairly simple.

(1) What is the transmitting frequency of channel 14 (US CB)?
(2) What does SWR stand for?
(3) What is a 'Firestick'?

Lastly give an 'English' slang term for the following (try to be as original as possible).

(1) Production line car.
(2) Police (clean please).
(3) Home Office Wireless Regulatory Department (clean again please).

Please try to keep the slang printable or if that is difficult, genuinely funny. After all the American equivalents, ie 'Bears' and 'Uncle Charlie' (FCC) are not really rude at all.

Send your entries to:
CB Tape Competition,
Breaker One-Four,
Hobby Electronics,
145 Charing Cross Road,
London WC2H 0EE.

MORE CLUBS

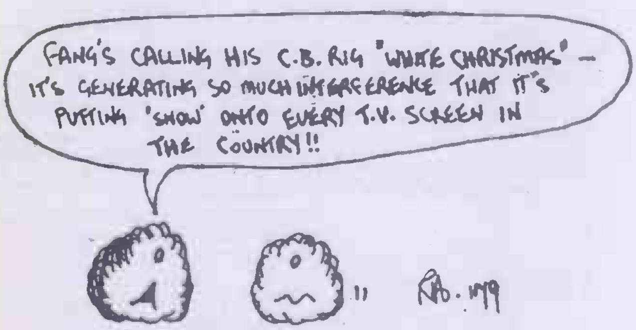
In response to our plea for more northern clubs we have heard from the CB-NE (Citizens Band Radio North East). They are exceptionally well organised to the extent of having a PR man. They have made several contributions to local TV and radio and are very active in getting publicity for the cause. The man to talk to is Ian Morrison at:
CB-NE,
PO Box 61,
Sunderland,
Tyne and Wear,
SR3 1EZ.

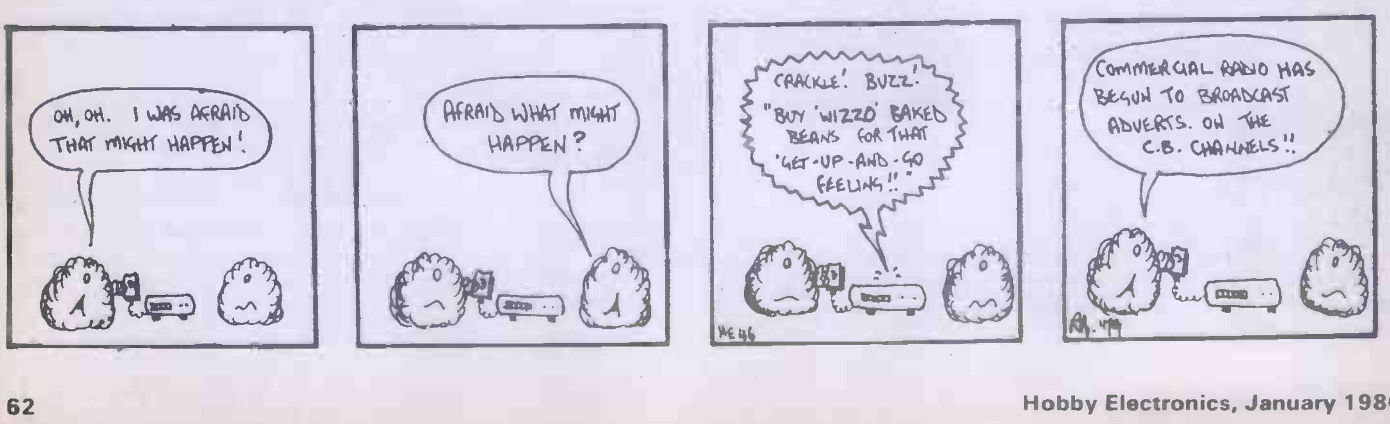
Another club worth noting has just opened its doors. Anybody interested in becoming a member should send a postcard to the address below with your phone number if possible.
F. W. McKeown,
29 Russell Avenue,
Preston,
PR1 5TP.
Lancs.

Please keep information for clubs coming in, clubs that we may have already mentioned might like to let us know how they are doing.

That's it for another month, as we said earlier do not despair, we're nearly there. Stay lucky and Breaker Break.

C-Beasties





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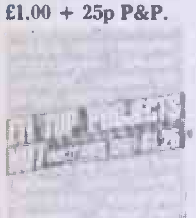

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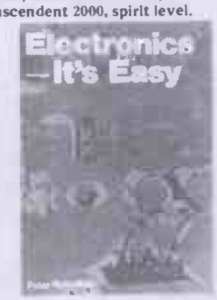

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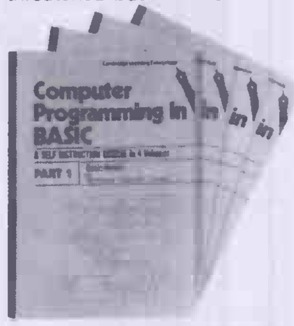

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Into Linear ICs

By Ian Sinclair Part 7

In this, the final part of Into Linear ICs, Ian Sinclair looks at voltage regulators and Phase Locked Loop Linear ICs, but we're not finished yet. Look out next month for another major new series.

THE LAST BIG important group of linear ICs we need to take a look at is the voltage stabiliser IC. Before we can start on them, though, we need to know why and how voltage supplies are stabilised. Stabilising a voltage supply means controlling it so that output voltage doesn't change. Why should it change? For one thing, the mains AC voltage isn't absolutely constant; you may have seen the way a kitchen light dims when an electric kettle is switched on. More important, any power supply will have some resistance, often called its internal resistance. This resistance behaves like a resistor wired in series with the power supply (Fig. 7.1) so that when current is taken from the supply, the output voltage drops. There's nothing we can do to eliminate this resistance; all we can do is to use transformers with low-resistance; all we can do is to use transformers with low resistance secondary windings, rectifier diodes with low resistance, and so on. As far as battery supplies are concerned, rechargeable cells like lead-acid cells, but we still have this internal resistance present.

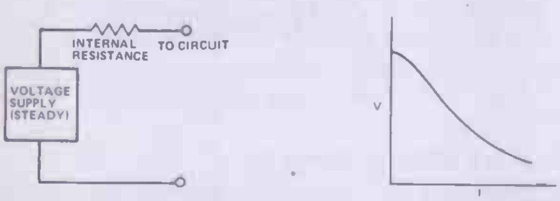


Fig. 7.1 Internal resistance. (a) Any power supply behaves as if it had two components, a steady voltage supply and a resistor in series. (b) This causes the output voltage to decrease as more current is drawn.

Now a lot of problems are caused by this internal resistance. For one thing, if any pieces of electronic circuitry takes a varying current and the internal resistance of the supply will cause the DC supply voltage to vary when the current varies. Class B amplifier stages, for example, take much more current when they're working at full volume than when they're just ticking over, which means that they have to put up with a lower supply voltage when they're going full blast — and that's not exactly ideal. For one thing it usually means that your stereo amplifier which claims to give 50 watts per channel will have a hard time to deliver 35W per channel when both channels are working hard — the makers usually point this out in very small print.

Digital circuits which operate with brief pulses of current, also suffer when these pulses of current are converted to voltage pulses by the internal resistance of the power supply, because these pulses can cause unwanted feedback. The remedy in each case is a voltage stabiliser.

Now a voltage stabiliser isn't magic, it can't raise the amount of volts on the supply line above the amount the power-pack can supply. What it can do, however, is to keep the supply line voltage steady at a voltage equal to the lowest voltage it would normally drop to.

RASIN THE CURRENT

Let's explain that a bit more clearly. Suppose we have a circuit (Fig. 7.2) which works on a 12 V supply, but because of sudden current pulses, the supply voltage can drop to 9 V. Nothing we can do can make this 9 V rise to 12 V while a lot of current is being taken, but if we started, say, with a 15 V supply, with a bit of luck it might only drop to 12 V at full current. What a voltage stabiliser can do is to regulate the 15 V supply down to 12 V when the circuit is not drawing much current, and to relax control when full current is being drawn, so that the voltage supplied to the circuit is still 12 V. In practice we would probably settle for a 18 V input to the stabiliser circuit to ensure that we could keep the output at 12 V even when the circuit was drawing its maximum current and the mains voltage was a bit low.

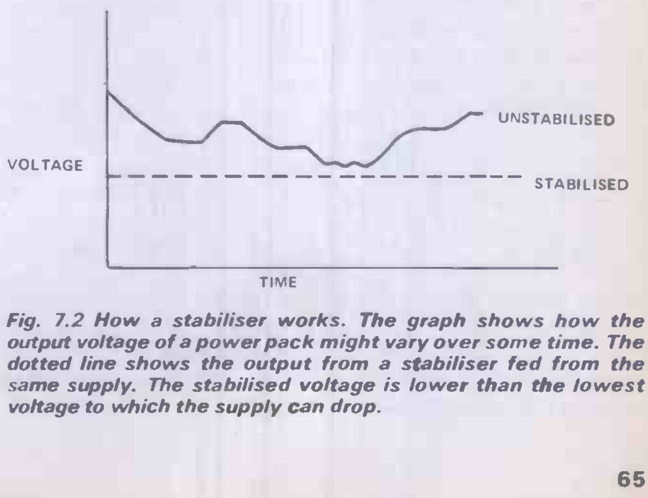


Fig. 7.2 How a stabiliser works. The graph shows how the output voltage of a power pack might vary over some time. The dotted line shows the output from a stabiliser fed from the same supply. The stabilised voltage is lower than the lowest voltage to which the supply can drop.

A simple stabiliser circuit is shown in Fig. 7.3, using a comparator and a pair of transistors which keep the output voltage steady. It works something like this. One input of the 741 is returned to a steady voltage which is the voltage across a zener diode. A zener diode has a steady voltage across its terminals, even when the current through the diode varies by quite a large amount. The other input of the comparator is fed with a fraction of the voltage at the output of the stabiliser, so that the comparator will switch over when these two voltages are equal. In the circuit of Fig. 7.3 if the output voltage is low, then the voltage at the — input of the comparator is lower than the voltage fixed by the zener diode at the + input of the comparator, and the comparator output is high. This, in turn, causes the transistors to be biased so that more current can flow, raising the output voltage (because more current through the load must, by Ohm's law, mean more voltage across the load). On the other hand, if the stabiliser output voltage is too high, the — input of the comparator is at a higher voltage than the + input, the comparator output voltage is low, the transistors cut off, and the current shuts off or is throttled back, so allowing the voltage at the output of the stabiliser to drop. As a result, the output voltage of the stabiliser settles at a level which makes the voltages at the two inputs of the comparator equal, and keeps them that way.

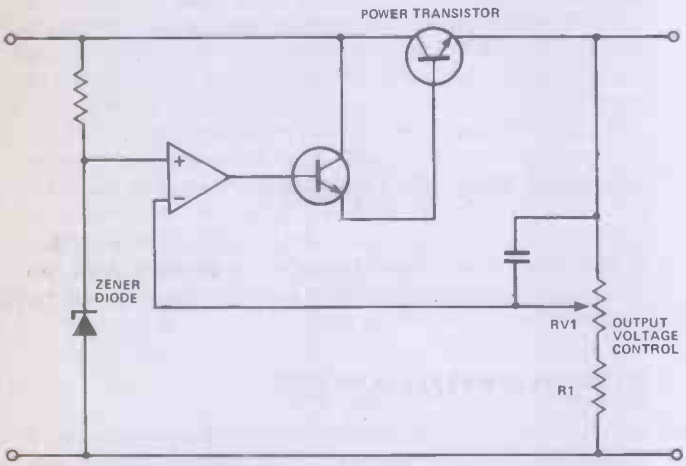


Fig. 7.3 A simple stabiliser circuit. RV1 varies the output voltage. The minimum possible output voltage in this circuit is equal to the zener diode voltage. The value of R1 has to be calculated so that the stabiliser will still operate correctly when RV1 is turned to the maximum voltage setting.

The stabiliser circuit of Fig. 7.3 has used separate transistors, but it's much easier to make the whole circuit in integrated form. Another advantage is that it becomes possible, at practically no extra cost, to incorporate various types of protection circuits into the IC, protecting the IC in the event of overheating or excessive current. Voltage stabilisers operate with several volts between the input and the output, and quite large currents can flow, so that there is often a large power dissipation. For example, a 5 V stabiliser working from a 9 V supply and passing 0.5 A has a voltage across it of $9-5=4$ V, and a power dissipation, given by VOLTS x AMPS equal to $4\times0.5=2$ W. Stabilisers which are intended for this sort of use are provided with metal tabs or studs so that heat-dissipating fins can be attached. The packages which are used for stabilisers are generally the same as those used for power transistors, since the heat dissipating problems are so similar.

THE 78 SERIES

One very popular family of stabilisers carries type numbers such as 7805, 7812, 7815; the 78 prefix is the family number, and the last two digits indicate the stabilised output voltage. Fig. 7.4 shows the connections for a 7812 12 V stabiliser. The unstabilised input from the rectifiers and smoothing capacitors must not fall to less than 14.5 V with 1 A flowing, and must not exceed 30 V when no load is connected. The IC has short-circuit protection, so that with the output shorted, the current which can flow is limited to 350 mA. Two styles of case can be obtained, the flat plastic type of the 'top-hat' can; output voltages from 5 V to 24 V are standard. Table 7.1 shows the output voltages, minimum and maximum DC input voltages and the code numbers for these voltage regulator ICs.

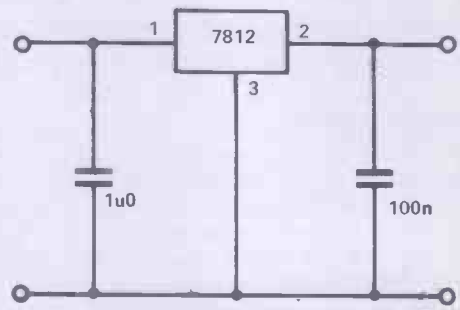


Fig. 7.4 The connections for a 7812 regulator. The capacitors must be wired as close to the pins of the IC as possible. They do not replace the smoothing capacitor but are essential for stability.

Type No.	Voltage out	Max. Current	Ripple rejection	Input range
7805	5 V	100 mA	62 db	7 V-30 V
7812	12 V	100 mA	54 db	14.5 V-35 V
7815	15 V	100 mA	51 db	17.5 V-35 V

These figures are for the lowest-power stabiliser ICs. The power ratings are indicated by letter codes which differ from one manufacturer to another. For example, the 1 A output ICs are labelled UC by one manufacturer, P by another, and CP by a third, so that careful study of the specification is needed if you are looking for stabiliser ICs with more than 100 mA output.

TABLE 7.1 STABILISER ICs

TBA435

This is a regulator which is built into a T039 type of case such as is used for small transistors. The unstabilised input voltage can be up to 20 V, and the stabilised output is 8.5 V, which makes this regulator ideal for mains supplies which are to replace batteries, or for running 9 V equipment from 12 V car batteries. The small size of the regulator IC makes it easy to include inside transistor radios or cassette recorders, and the current rating of up to 150 mA is quite enough to cope with most of the applications which would otherwise be powered by a battery. Like all modern voltage stabiliser ICs, the TBA435 has overload and short-circuit protection. Typical circuits are shown in Fig. 7.5; the stabiliser can be used for either positive or negative supplies.

These fixed-voltage stabiliser ICs can be used to provide a variable stabilised supply whose voltage is

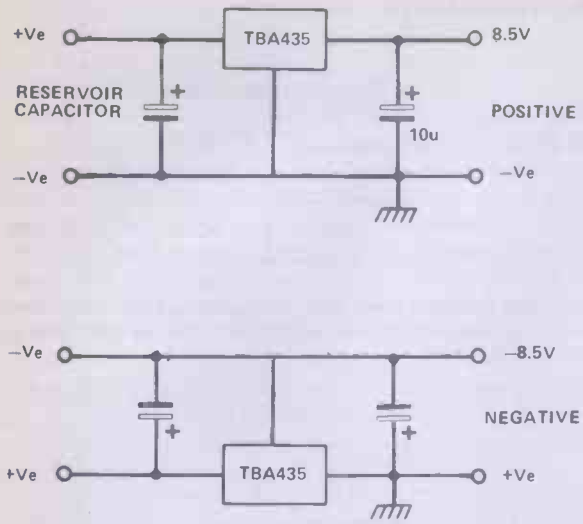


Fig. 7.5 Using the miniature TBA435 as a regulator for 9 V circuits, positive or negative.

greater than that of the stabiliser IC. For example, we can use a 5 V stabiliser to provide a 9 V stabilised output, but we can't use a 9 V stabiliser to provide a 5 V stabilised output. The circuit for an adjustable voltage supply is shown in Fig. 7.6 This makes use of the connection to the stabiliser IC which normally acts as the earth return for the stabiliser current, and which is normally earthed.

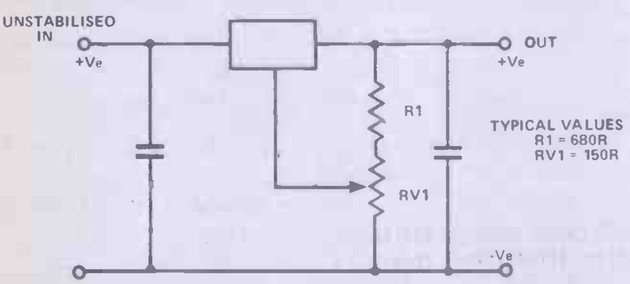


Fig. 7.6 Using a fixed-voltage regulator to supply a variable-voltage output.

By returning this terminal to the voltage divider circuit consisting of the fixed resistor R1 and the potentiometer RV1, the stabilised voltage output can be made variable. It's possible to use this circuit to get stablised outputs which are twice the normal voltage of the stabliser or more, but the stability isn't so good, and it's better to use this circuit for a smaller range of variation. For a

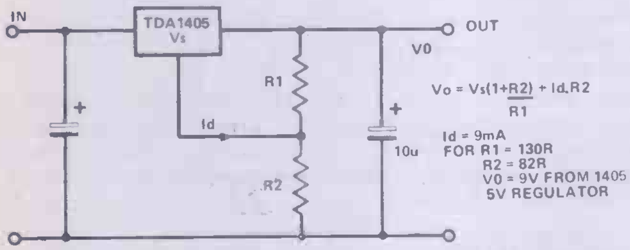


Fig. 7.7 Higher fixed voltages can be obtained using a potential divider as shown, with design formula based on the TDA 1405 5 V regulator IC.

TDA1405 5 V regulator, the formula for the voltage output, using fixed resistors R1 and R2, is shown in Fig. 7.7.

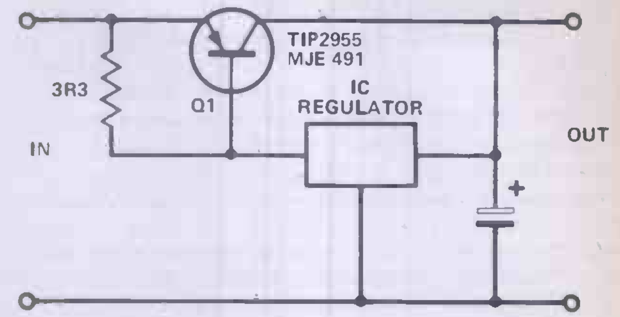


Fig. 7.8 Using an IC regulator to control a power transistor so that higher currents can be obtained. Q1 should be on a substantial heat-sink.

The output current from any stabiliser can also be increased by using the IC to control a power transistor. For positive voltage power supplies, a PNP power transistor such as the MJE491 or TIP2955 can be added to the stabiliser circuit, using the arrangement shown in Fig. 7.8. In this circuit, the supply into the stabiliser IC is taken through a 3R3 resistor which has the base and emitter terminals of the power transistor connected across it. For low currents, the voltage across the 3R3 resistor is less than 0.5 V, and the IC stabiliser handles all of the current, but at currents above about 150 mA, the transistor switches on and provides another path for current. Since the transistor is controlled by the stabiliser IC, the output voltage remains fixed, but the current can be as high as the power transistor will permit — and when a good heat sink is fixed to the transistor that can be pretty high, 5 A or more. We can, of course, combine this extra current circuit with the extra voltage circuit of Fig. 7.7.

SPEED REGULATION

Now for something quite different. Many high-quality modern record players and stereo cassette recorders use DC motors whose speed is electronically regulated. This method of providing a constant speed drive has many advantages over the methods which were previously used, such as mechanical governors or AC motors. The speed regulator supplies the motor with current, and the current supply is regulated so that the motor speed remains constant even if the supply voltage, the load on the motor and the temperature of the motor all vary. Regulators of this kind are particularly important for cassette players that are intended to be used in cars, because the voltage of a car battery can vary from less than 12 V (everything on, engine not running) to more than 16 V (charging heavily), and there is also a very large range of temperature inside a car, ranging from well below freezing point (in winter) to 35°C or more for a car parked in the sun in summer.

The speed regulator operates by sampling the voltage across the motor, which is proportional to the motor speed, and regulating the current to the motor so as to keep this voltage constant. Fig. 7.9 shows the circuit which is used. The resistor R1 has a value which is about equal to the resistance of the motor, and the variable RV1 then acts as the speed control.

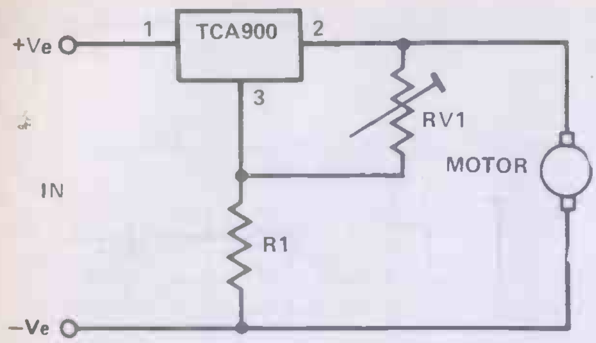


Fig. 7.9 Using the TCA900 motor speed controller. The resistors RV1 and R1 have to be chosen to match the motor resistance.

CURRENT DIFFERENCE AMPLIFIERS

Current-difference amplifiers (CDAs) are a type of operational amplifier which for some applications can be more versatile than the 'old faithful' 741. Typical, and by far the best known, of these CDAs is the LM3900 by National Semiconductor (a similar IC is made by Motorola) which consists of four CDAs in a single 14-pin DIL package. What makes CDAs different is that they don't need the two separate power supplies of the 741, nor do they need a 'half-supply-voltage' on the + input when a single supply voltage is used. Another important feature is that the output voltage of a CDA can be taken much closer to the supply voltage limits than is possible with a 741. We can, for example, run a LM3900 from a 15 V supply, and drive the output voltage as low as 0.1 V or as high as 14.2 V. A 741 operated from the same supply voltage could not be made to give output voltages so high or so low when single supply voltage is used.

At first sight, the CDA looks as if it's identical to any other operational amplifier, but there is a very important difference which is implied by the name — current differencing amplifier. The output voltage of the CDA is controlled by the difference in the currents fed to the two inputs, not the difference in voltage (which is never large enough to be measurable). This makes the bias arrangements for the LM3900 very much simpler than those used for the 741, and the low currents which are needed allow us to use very large resistor values in the bias circuits.

The actual voltage at both inputs is about 0.6 V above earth (assuming a single supply line), which is the voltage across a IC transistor junction, and the minimum amount of current which is needed at each input is very small, around 30 nA (a nanoamp, nA, is one thousandth of a microamp). The output can supply a current of up to 10 mA, or sink a current (that is a current going into the output terminal) of just over a milliamp.

Fig. 7.10 shows a typical LM3900 circuit for a voltage amplifier. The bias system for the + input is very simple — just a resistor connected from the + input to supply positive. This has to be a large value resistor to avoid passing excessive current, and will usually be around 1M to 4M7. As usual, the operating conditions are stabilised by feedback to the — input, but we have to remember that this is feedback of current, and we're aiming to have the same current flowing into the — input as flows into the + input. Now the current into the + input is fixed by the value of the supply voltage and R1 — it's equal to supply voltage divided by the value of R1

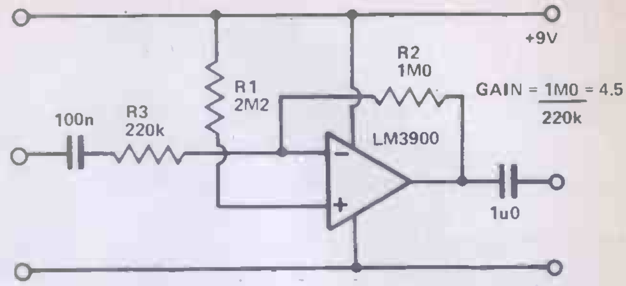


Fig. 7.10 The LM3900 used as a voltage amplifier. The gain is low in this example, but higher gain figures can be obtained by reducing the size of R3.

— and if we made the value of R2 the same as that of R1, the output voltage would have to be the same as the supply voltage to pass the same current. If we make R2 equal to half of R1, though, we need only half of the supply voltage at the output to pass the same current through R2 as the full supply voltage can pass through R1. This sets the normal output voltage, with no signal input, at half supply voltage, the value we need for good linear amplification. It's so much simpler than the 741 that you begin to wonder why the LM3900 isn't used to a much greater extent, especially when you get four amplifier units in one IC. As it happens there are some applications for which the LM3900 can't really replace the 741, and the very high resistor values are sometimes a nuisance, particularly now when so few components suppliers keep resistors or more than 1M in stock. Nevertheless, many of the uses we have for operational amplifiers can be filled more easily by the LM3900.

In the circuit shown in Fig. 7.10 the gain is given by the resistor ratio R2/R3. The input resistance is practically equal to R3, and capacitor coupling is needed because there is a small bias voltage (0.6 V) at the — input. With the values shown the voltage gain is 4.5 and the input resistance is 220k.

A complete listing of all the possible LM3900 circuits would take more space than we have (look out for HE Specials on this and other ICs), but Fig. 7.11 shows an interesting circuit — an amplifier with its gain controlled by a bias voltage. The input is to C1, but a small DC bias to R2 will alter the gain of the amplifier from around zero, when Vdc = 0, to about 12 times when Vdc is about 1 V.

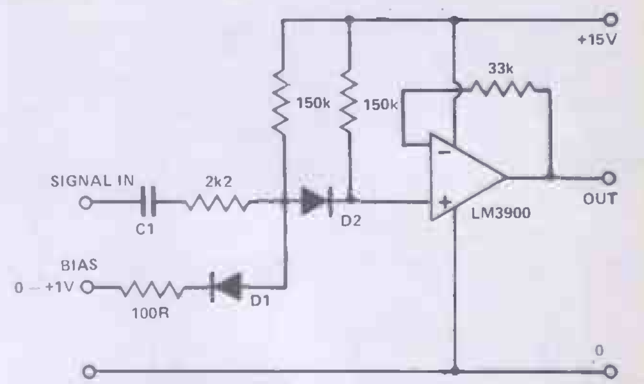


Fig. 7.11 The LM3900 used as an amplifier whose gain is controlled by a DC bias.

CMOS ICs

One type of IC we haven't mentioned so far, mainly because it's used so much more for digital circuits than for linear types, is the CMOS IC. The letters CMOS mean Complementary Metal Oxide Silicon; the complementary part of the title means that some of the silicon is P-type and other parts N-type, and the metal-oxide part of the name indicates that the currents through the silicon are controlled by the voltage of bits of metal which are separated from the silicon by the insulator, silicon oxide. A CMOS IC is an IC made from field-effect transistors, rather than the familiar junction (or bipolar) transistors, and for some purposes these ICs can provide features which can't be equalled by the more common types of bipolar ICs.

Two features of CMOS ICs are valuable in linear circuits. One is the very high input resistance which can be obtained, and the other is the use of these circuits as resistors which change value as the voltage bias changes. Before we look at some practical circuits, though, a warning is needed. Because of the very high input resistance, a CMOS input cannot discharge the voltages caused by electrostatic charging. Your body can be charged to several thousand volts by simply walking over a dry nylon carpet, and such a voltage applied across two pins of a CMOS IC from your fingers will destroy the IC completely. A bipolar IC such as the 741 is unaffected because its input resistance is low enough to discharge the voltage harmlessly. CMOS ICs should be kept in the holders in which they are supplied, and connected into the circuit only after all the other components are in place. Many constructors prefer always to use CMOS ICs in holders — so that the Eurobreadboard is ideal — rather than soldering into place. Certainly if these ICs are soldered in, an earthed iron must be used, and the other components must be connected in place first. When several CMOS devices are on one IC, then no inputs must ever be left unconnected. In the Eurobreadboard diagrams which follow, the unused inputs are earthed by wire links which must be in place before the IC is plugged in, and which must not be removed while the CMOS IC is in place. Similarly, the IC must never be plugged in or out while the supply voltage is switched on, and the pins of the IC must never be touched — you soon develop the habit of holding the body of the IC and transferring it from its wrapping to the board or back again without letting the pins come into contact with anything else.

The CD4007 is a versatile circuit which consists of three pairs of complementary MOSFETs inside one package, with enough separate connections to allow the unit to be used for a variety of purposes. The most useful connection for linear circuits is as three separate inverters, as shown in Fig. 7.12. These can each be used as common-drain amplifiers, as shown in Fig. 7.13 making use of the very high input resistance and the fact that no bias is needed.

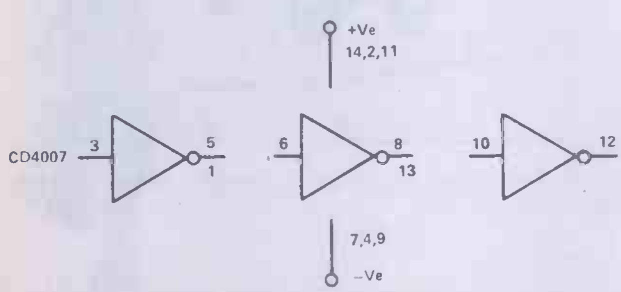


Fig. 7.12 The three inverters contained in the CD4007 CMOS IC.

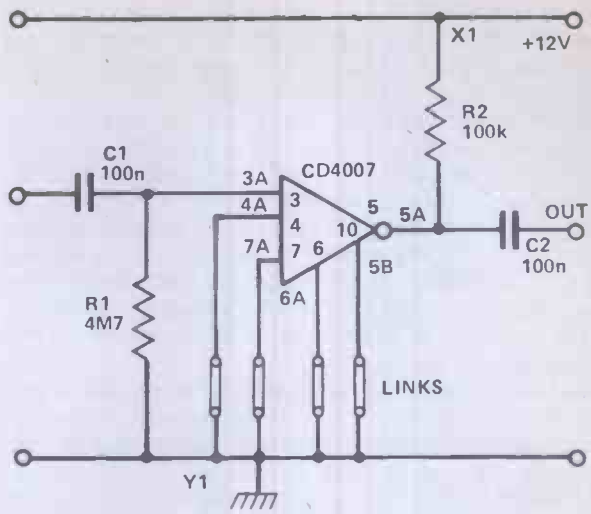


Fig. 7.13. Using one section of the CD4007 as an inverting amplifier.

PHASE-LOCKED LOOPS

The phase-locked loop is a type of IC which is rather more specialised than the ones we've looked at earlier in this series, but it's a circuit which is nowadays used to such an extent that we can't ignore it. The block diagram of a phase-locked loop (PLL) is shown in Fig. 7.14, it consists of an oscillator whose frequency can be controlled by a steady (DC) voltage, along with a phase comparator (or phase-sensitive detector). The phase comparator does pretty well what its name suggests — it compares the phase of two signals and gives an output whose amplitude and sign depends on the phase difference. Let's make that a bit clearer. Suppose we have two inputs A and B to a phase-sensitive detector, and we have sine-wave signals of the same frequency at each input. We can arrange the detector so that if the phase of the signal at A is earlier than the phase of the signal at B, the output of the detector is a positive DC voltage whose size depends on the amount of the phase difference, perhaps 200 mV for every 20° of phase difference.

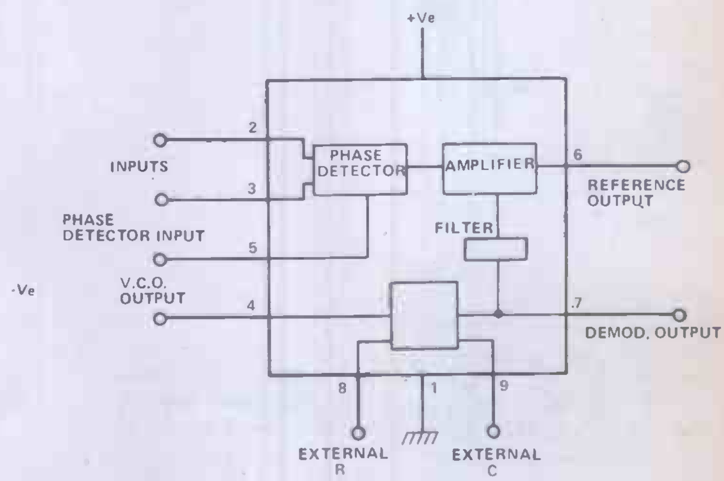


Fig. 7.14 A block diagram of the NE565 PLL.

Similarly, if the phase of the signal at A is later than the phase of the signal at B, the output of the detector is a negative voltage whose size depends on the amount of the phase difference. The output is zero only when the phases of the two signals are identical, or when the frequencies are so different that the detector can't operate.

What happens in a phase-locked loop is that external components, usually a resistor and a capacitor, are used to set the frequency of the oscillator inside the PLL IC. Another signal applied to the input will, if its frequency is sufficiently close to that of the oscillator, cause the phase detector to generate a voltage. This voltage, the correction signal, is then used to change the frequency of the oscillator (it's a voltage controlled oscillator, remember) so that it is 'pulled in' to be equal to the frequency of the input signal.

How can we use this? One use is in 'cleaning-up' signals. If we have s signal which started as a sinewave but which has been affected by noise, tape drop-outs, or interference, then using it as the input to a PLL will cause the PLL to generate a 'clean' output waveform of exactly the same frequency, and in the same phase as well. This can, incidentally, also be used to remove all traces of amplitude modulation from a signal.

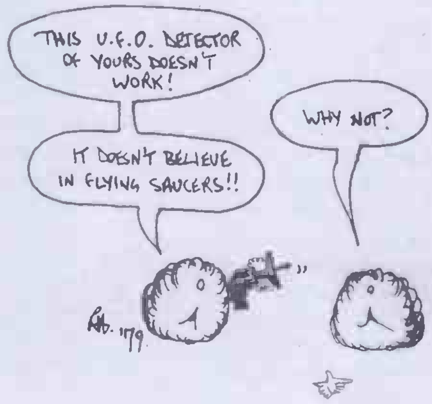
Another application is to FM demodulation. If the signal into a PLL is an FM IF at a reasonably low frequency (the normal IF for an FM receiver is 10.7 MHz, which is a bit high for most IC PLLs), then as the frequency of the input signal changes, the voltage of the correction signal will also change to make the oscillator keep in step. We can make use of this correction voltage — it's the audio signal from the demodulated FM and its voltage is exactly proportional to the frequency of the input.

Other uses? Metal detectors are another obvious use for the PLL, and they are also being seen more and more in the application which they were designed for (the PLL, that is) which is cleaning up the signals from tape recorders to feed into computers, and to convert computer signals into a form which can be transmitted along telephone lines.

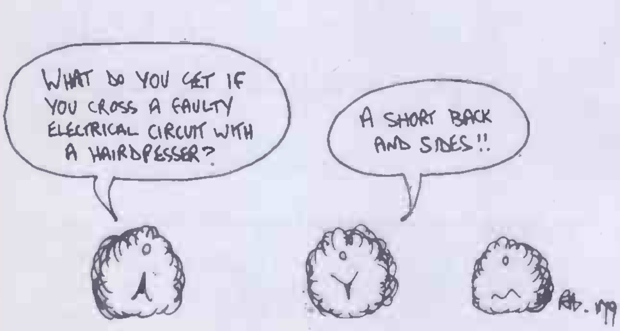
We've covered a lot of ground (and circuit board) since we started on Part 1 of this series, and looked at a lot of linear ICs. But now, you should be able to identify how a linear IC is used in any circuit, and your practical experience now lets you construct linear IC circuits with complete confidence. What more do you want? Digital ICs? Watch this space!

HE

CARTOONS



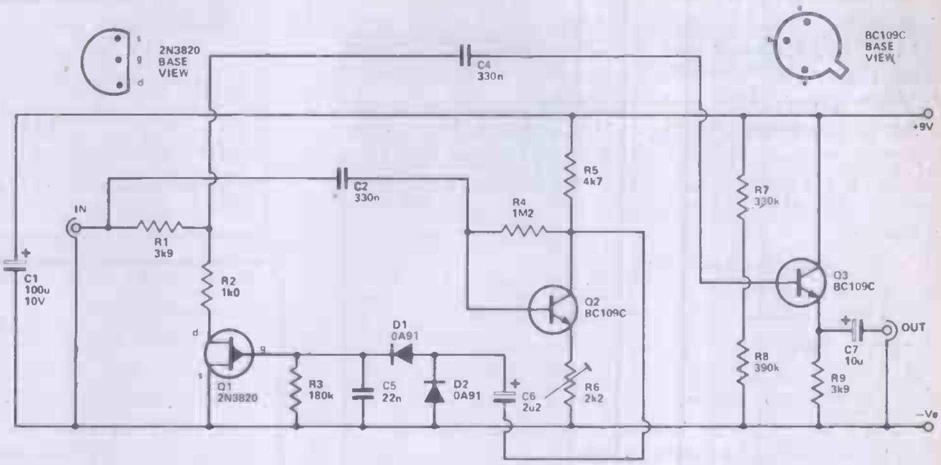
"WHAT MAKES YOU THINK HE HAS A CB?"



Short Circuit

NOISE GATE

Noise gates are primarily used in communications equipment, but they could, no doubt, be used in public address equipment and other applications where there is the problem of a high background noise Level. The purpose of a noise gate is simply to reduce the gain of the equipment when there is only a low signal level. Thus, during brief pauses that occur during normal speech the background noise is attenuated, but while the speech signal is present the gain of the equipment is returned to its normal level. The true signal to noise ratio is not actually improved at all, but the monotony of the continuous high noise level is removed, making the signal easier to listen to and aiding intelligibility.



Q1 is an N channel JFET which is used here as a voltage controlled resistance. Under quiescent conditions Q1 gate is biased to the negative supply rail by R3, and this switches the device hard on so that it exhibits a low resistance of only about 100 ohms. The input signal is applied to an attenuator which has R1 as the series element, and R2 plus the drain to source resistance of Q1 as its shunt element. With Q1 switched on there is a loss of about 11dB through the attenuator.

Some of the input signal is amplified by a common emitter amplifier based on Q2, and then fed to a rectifying and smoothing circuit which is comprised of D1, D2, and C5. If the input signal is of sufficient strength this produces a strong enough positive bias to switch off Q1, causing its drain to source resistance to increase to many megohms. There is then very little attenuation of the signal. pauses that occur during normal Thus, low signal levels (noise only) are reduced while high signal levels (noise and wanted signal) are allowed to pass virtually unaffected. The attenuator must feed into a fairly high impedance or the action of the circuit will be impeded. An emitter follower buffer stage based on Q3 is therefore interposed between the attenuator and the output. The time constant of the circuit has been made quite short so that there is a quick response to changes in signal level.

The circuit will operate with an input level of between about 50 mV and 2 V. RMS. R6 is adjusted for virtually the lowest resistance that does not cause the background noise to activate the unit.

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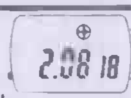

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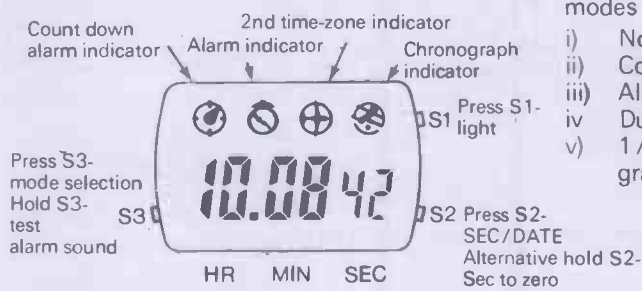

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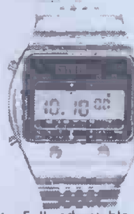

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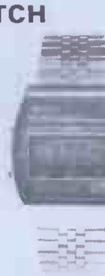

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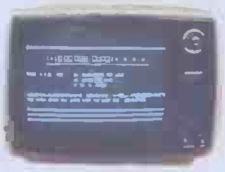

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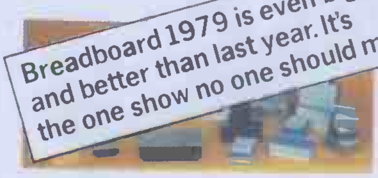

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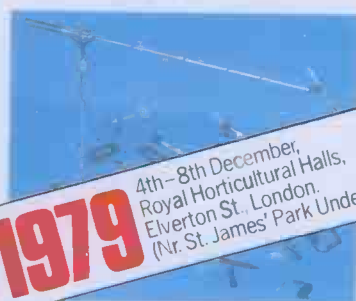

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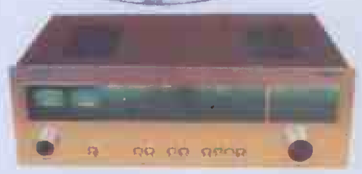

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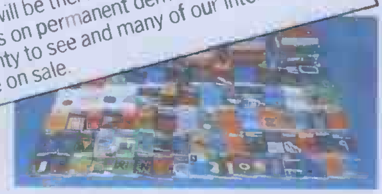

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