EVERYDAY WITH PRACTICAL ELECTRONICS

MARCH 1994

INCORPORATING ELECTRONICS MONTHLY

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ELECTRONIC FORMULAE WALL CHART

CCD TV CAMERA
AND COMPUTER INTERFACE

SMART KEY IMMOBILISER

AUDIO/RF MONITOR

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THE No. 1 INDEPENDENT MAGAZINE for ELECTRONICS, TECHNOLOGY and COMPUTER PROJECTS

EVERYDAY WITH PRACTICAL
ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY

VOL. 23 No. 3 MARCH 1994

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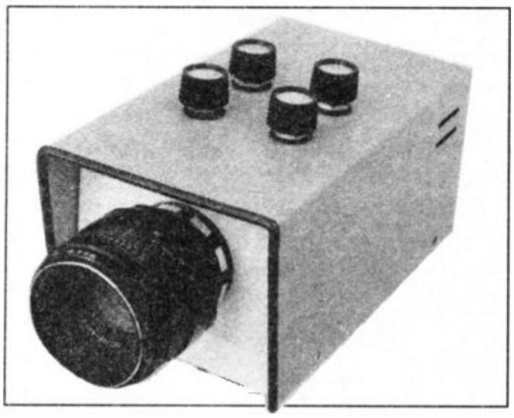
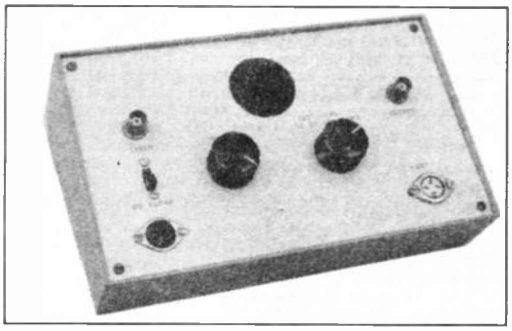
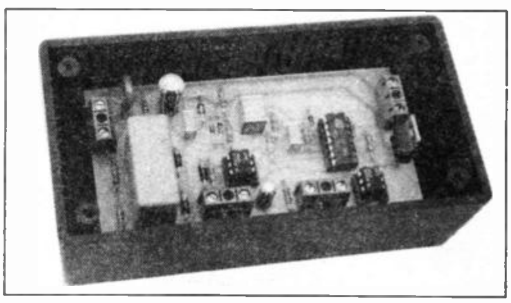
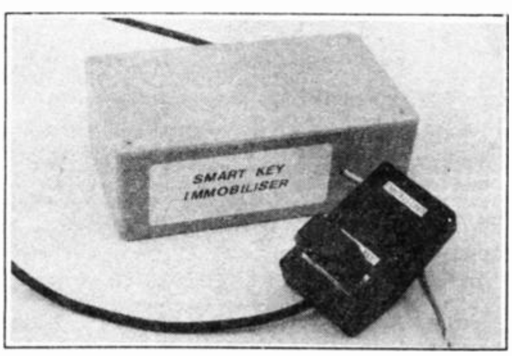
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .









Our April '94 issue will be published on Friday, 4 March 1994. See page 179 for details.

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NEXT MONTH

EPE SOUNDAC

Put your beep to sleep and astound with sound or (if you want to be really corny), the art of cheap noise!

Since its introduction the IBM compatible PC has improved in so many ways – in terms of speed, ease of use, and smaller yet faster boxes.

One area that has been slow to develop is sound, and even now few PC's are capable of anything more than a "beep". Commercial sound cards are readily available, but are still fairly expensive. These fall into two categories – pure f.m. synthesis such as the Ad-Lib card, and those with digital to analogue conversion (DAC), for example the Sound Blaster.

Microsoft Windows requires the latter type since it makes extensive use of digitally sampled sound files. These have the extension ".WAV" and consist basically of a short header indicating playback speed and length, followed by a stream of 8-bit sampled data. The most effective WAV files are unusual sound effects, such as breaking glass and explosions, or running water!

One disadvantage of a commercial board is that it isn't easily shared between two PC's – and what if you own a laptop which doesn't take expansion cards?

This project describes a simple, high quality unit which sounds just like a £100 commercial card, yet costs very little and simply plugs into the PC's printer port.

Your computer will be dumbstruck if you miss it!

FREE! *Our second Electronics Formulae wall chart – just like the first one in this issue but with different formulae – honest!*

FRAME GRAB

Add a gear box interface to a PC-compatible computer for high speed analogue data collection and distribution.

The Frame Garb is a two-way interface unit which enables high speed analogue data to be processed by a PC compatible computer. It was designed principally for use with the CCD TV Camera in this issue, but it can also be used for other analogue data interfacing purposes.

The camera generates live data at a rate faster than the software run on most PC compatible computers can handle directly. The purpose of the Frame Grab, therefore, is to act as "gear box" slowing down the data to a more readily accessible rate.

The Frame Grab consists of a high speed analogue to digital converter (ADC) whose output data is recorded by a 128Kb memory at half the full output transmission rate of the camera. When the memory has been filled, its contents can be read and processed by the computer at a slower rate suitable to the software.

MOSFET VARIABLE BENCH POWER SUPPLY MkII

Based on the highly popular design published in our February 1988 issue. The MkII version has been completely redesigned with more components on the p.c.b. thus reducing off-board wiring to the bare minimum. The radical new design incorporates a low frequency switching pre-regulator which reduces the voltage before the main MOSFET. This results in much lower heat generation and much lower power losses – so much so that the heatsink is no longer required.

Like the original the MkII provides 0-25V with adjustable current limit of 0-2·5A, it has twin panel meters to display volts and amps plus a current limit mode l.e.d. indicator. A punched, painted and printed case will be available to provide a professional finish to this essential piece of test gear.

EVERYDAY WITH PRACTICAL ELECTRONICS

APRIL ISSUE ON SALE FRIDAY MARCH 4th 1994

A SELECTION OF NEW SURPLUS LINES FROM OUR MASSIVE STOCKS!

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- Cross fader and full cueing facilities
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- Rack mounting brackets

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SUPER TRANSFORMERS

12V @ 2A - 16V @ 2A

Price - £3.50 each
Box of 20 - £50
100 + £2.00
1000 + £1.65

Overall size 64 x 53 x65mm

Memory Back-up Capacitors

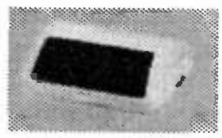
Miniature large capacitance type

SPEC:
47,000 µF 5.5V
Discharge time (5 -2V)
23 hrs @ 3µA.
Made by NEC. Size 8x11.5mmØ
Current list price £1.77 each
Our Special low prices:

Z3144 pack of 3 **£2.00**
25 + 0.55
100 + 0.35
1000 + 0.27

Air Purifier & Ionizer

A compact, stylish ionizer and air purifier designed specifically for car, truck and bus use with a coverage volume of 14m3. Removes unpleasant smells, airborne dust, bacteria, tabacco smoke, etc. Supplied with a double sided self adhesive pad.



Power 12Vdc 1.8W
Dims . . . . .110 x 110 x 65mm

Normal Price £9.95
Price **£6.95**

MINI STROBE

Top quality mini strobe with a very high light intensity for its size. Flash rate adjustable up to 15 flashes per second. Steel case with adjustable mounting bracket.

Flash rate . . . . 15 per second max.
Max tube power . . . . .15W @ 15 flashes/second
Power 220/240Vac 50Hz
Dims . . . . 125 x 85 x 55mm

Normal Price £22.95
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Size: 25x20x15mm
Volts: 12V
RPM: 15,000 no load
Current: 50mA
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100 + 0.14 1000 + 0.10

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£9.95

ELECTRONIC ANTI-DAZZLE MIRROR

THE MIRROR THAT DIPS BY ITSELF

Reduces eye strain & tiredness
Automatic operation
Safety glass
Easily fitted
Uses internal or car battery
Made in the UK
Removes headlight dazzle from behind
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Complete with accessories
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Plastic Briefcases

W89 Black plastic briefcase 400x270x90mm has many uses - sample case, documents, tools, hobbybox, sewing box - even lunch box!. Comfortable carrying handle and secure fastenings

SUPER PRICE **£3.95**

W68 A smaller more compact version - this case measures 270x175x50mm, and has a moulded-in handle and snap shut catch.

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CD04 - Neat rectangular style CD Headphones, compact design with extremely good sound. These retail for up to £19.95 (depending on how posy the store is!). Spec: 16-22,000Hz Somarium cobalt transducers. Gold plated 3.5mm plug & adaptor. 32R impedance

SUPER PRICE **£4.95**

MDR20 - Personal stereo headphones. Again, top quality using somarium cobalt transducers. Spec as CD04 alongside. Attractively packaged with spare covers

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of interest to Manufacturers, Distributors, Retailers & Hobbyists

12 Million components from a VCR manufacturer. Pack of samples *£2 post free.*
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74LS04	£0.14	4007	£0.17
74LS05	£0.14	4008	£0.31
74LS08	£0.14	4009	£0.19
74LS09	£0.14	4010	£0.23
74LS10	£0.14	4011	£0.16
74LS107	£0.23	4012	£0.16
74LS109	£0.21	4013	£0.21
74LS11	£0.17	4014	£0.30
74LS112	£0.21	4015	£0.31
74LS113	£0.21	4016	£0.18
74LS114	£0.21	4017	£0.27
74LS12	£0.14	4018	£0.27
74LS122	£0.31	4019	£0.19
74LS123	£0.31	4020	£0.31
74LS125	£0.21	4021	£0.31
74LS126	£0.21	4022	£0.32
74LS13	£0.14	4023	£0.16
74LS132	£0.21	4024	£0.21
74LS133	£0.18	4025	£0.15
74LS136	£0.16	4026	£0.59
74LS138	£0.24	4027	£0.18
74LS139	£0.25	4028	£0.22
74LS14	£0.25	4029	£0.36
74LS145	£0.56	4030	£0.17
74LS147	£1.26	4031	£0.70
74LS148	£0.70	4033	£0.56
74LS15	£0.14	4034	£1.24
74LS151	£0.25	4035	£0.31
74LS153	£0.25	4040	£0.29
74LS154	£0.70	4041	£0.31
74LS155	£0.25	4042	£0.22
74LS156	£0.36	4043	£0.28
74LS157	£0.25	4044	£0.35
74LS158	£0.25	4046	£0.31
74LS160	£0.32	4047	£0.25
74LS161	£0.32	4048	£0.31
74LS162	£0.32	4049	£0.20
74LS163	£0.32	4050	£0.20
74LS164	£0.26	4051	£0.36
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74LS170	£0.30	4053	£0.25
74LS173	£0.24	4054	£0.56
74LS174	£0.24	4055	£0.34
74LS175	£0.24	4060	£0.48
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74LS242	£0.32	4082	£0.17
74LS243	£0.32	4085	£0.28
74LS244	£0.32	4086	£0.26
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74LS247	£0.32	4093	£0.18
74LS251	£0.24	4094	£0.31
74LS257	£0.24	4095	£0.56
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74LS373	£0.32	4518	£0.27
74LS374	£0.32	4520	£0.26
74LS375	£0.34	4521	£0.62
74LS377	£0.32	4526	£0.40
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74LS38	£0.19	4528	£0.40
74LS390	£0.25	4529	£0.44
74LS393	£0.24	4532	£0.32
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74LS399	£0.62	4536	£1.00
74LS40	£0.14	4538	£0.37
74LS42	£0.25	4541	£0.33
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74LS73	£0.17	4560	£1.18
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4.7	–	–	£0.05	£0.08	–
10	£0.05	£0.05	£0.06	£0.08	£0.48
22	£0.05	£0.05	£0.09	–	–
47	£0.06	£0.06	£0.11	–	–
100	£0.06	£0.09	£0.11	–	–
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1000	£0.22	£0.29	–	–	–
2200	£0.37	£0.57	–	–	–
4700	–	£1.11	–	–	–

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1.0	–	–	£0.10	£0.10	£0.19
2.2	–	–	£0.10	£0.10	£0.22
4.7	–	£0.09	£0.10	£0.10	£0.34
10	–	£0.12	£0.12	£0.12	–
22	–	£0.09	£0.13	£0.17	–
47	£0.10	£0.11	£0.16	£0.20	–
100	£0.10	£0.13	£0.21	–	–
220	£0.13	£0.18	£0.42	–	–
470	£0.21	£0.24	£0.69	–	–
1000	£0.33	£0.40	£1.05	–	–
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EVERYDAY WITH PRACTICAL ELECTRONICS

INCORPORATING ELECTRONICS MONTHLY

VOL. 23 No. 3 **MARCH '94**

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CHART

It's many years since we gave away a wall chart. At one time these were often part of the magazine, usually carrying semiconductor data of one type or another, but these days this is rather pointless as many suppliers give all the necessary information in their catalogues. We have, however, recently been asked for the various electronics formulae in an easy to refer to form and the wall charts seem to meet this need rather well. Next month's issue will also contain a similar chart which gives more useful formulae.

The charts also provide a nice back-up to *Calculation Corner* which has proved to be a very popular series. It still has another seven parts to go so, as you can see, it will cover quite a lot of ground. We hope you find both the series and the charts helpful either for "revision" or as in introduction to circuit calculations.

DIGITAL CAMERA

This month's major project is also a bit different being a *CCD TV Camera*. Once again it is many years since a TV camera has been published and nowadays the ability to interface to a PC adds a new range of possible uses. The cost of this project can be kept down by using a slightly sub-standard CCD chip and a "second-hand lens".

The "Frame Grab" interface gives you the ability to get pictures into a computer where they can be modified, coloured, saved to disc, printed to paper, etc. So, not only is this an interesting and useful project in its own right, it can also greatly expand the versatility of a PC.

We have a number of other unusual and (for the hobbyist) innovative projects lined up for the next few months so keep reading these pages.

Mike Kenward

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We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers.

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We would like to advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the UK. Readers should check the law before using any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use. The laws vary from country to country; overseas readers should check local laws.

SMART KEY IMMOBILISER

NICHOLAS WATKINS

A simple but very effective car immobiliser. The unit is difficult to fool and has built in prevention for "hot wiring" the vehicle.

IN THE the UK approximately 25 cars are stolen every 15 minutes. Living in an inner city area, you have a 1 in 10 chance of having your car stolen. Auto crime accounts for nearly 30 per cent of all nationwide crime.

With statistics like this, it makes sense to install some sort of car alarm/immobiliser. Commercial anti-theft devices can range from £10 to £1000. Top of the range devices feature sophisticated micro-processor control with anti-scan circuitry, (due to devices available to thieves which send out a high speed random bit "scanning" pattern). Also a changing encryption pattern is used – where each time the alarm is set – the deactivate code changes.

The design featured here, is a coded "Smart Key" Immobilisier, which features anti-scan circuitry; fuel pump cut-off; ignition cut-off and a facility which prevents "Hot Wiring" (Bypassing the keyswitch with jumper leads).

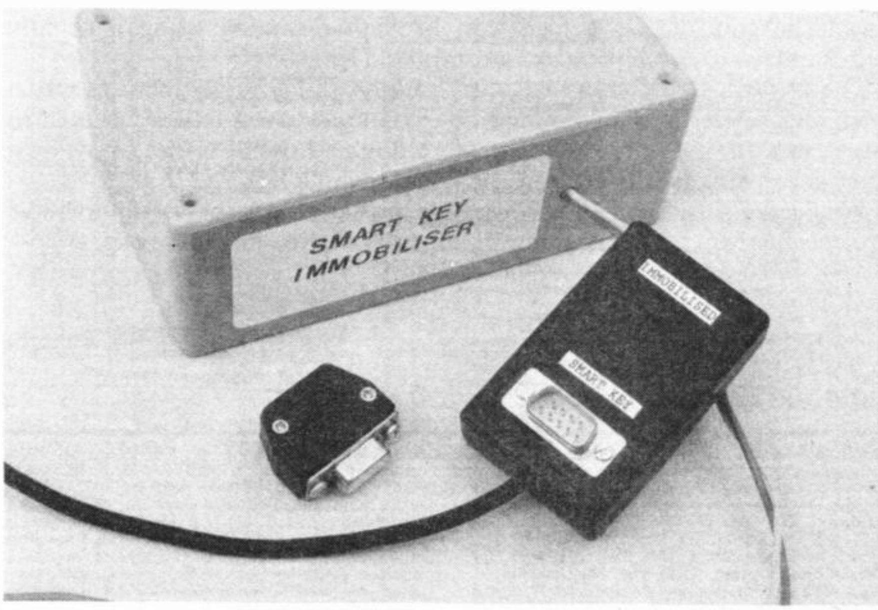
This design is also suitable for boats/lorries/vans, the only ammendment required being a suitable voltage relay i.e. 24V for lorries.

CIRCUIT DESCRIPTION

The heart of this design is the Smart Key, which has three "useful" connections. A short circuit across pins one and two and a pre-determined resistor across pins three and two. See Fig. 1. Various values of R1 can be used – see Fig. 2.

When the key is inserted into the socket, the circuit positive supply is made "live" (Fig. 3). This starts capacitor C3 charging via resistor R8. When the voltage across C3 reaches the level set by resistor R9 and resistor R11 (i.e. +Ve/2) the op.amp saturates and goes high, switching transistor TR2 on (resistor R12 limiting current drawn by TR2).

With TR2 on, the gate of thyristor CSR1 is held low and cannot now be turned on. Thus if the thyristor is not already on it CANNOT be turned on whatever the value of resistor R1, hence providing the anti-scan circuitry i.e. a variable resistor (potentiometer) cannot be attached and just varied until the thyristor latches. To Reset, the smart key must be removed and C3 given time to discharge before the key can be re-inserted.



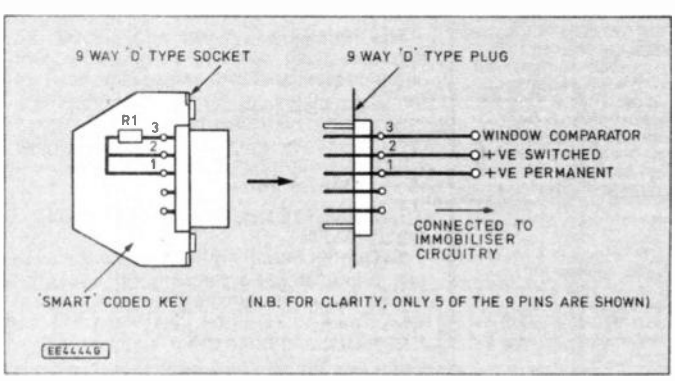


Fig. 1. "Smart Key" connections using a 9-pin D-type plug and socket.

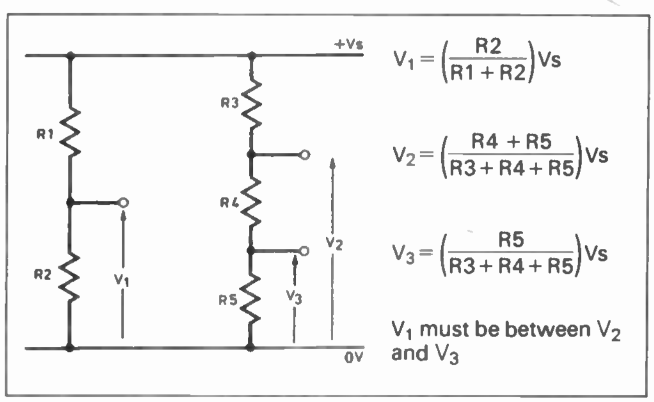


Fig. 2. Calculation of resistor values for R1 to R5. This allows various values of R1 to be used.

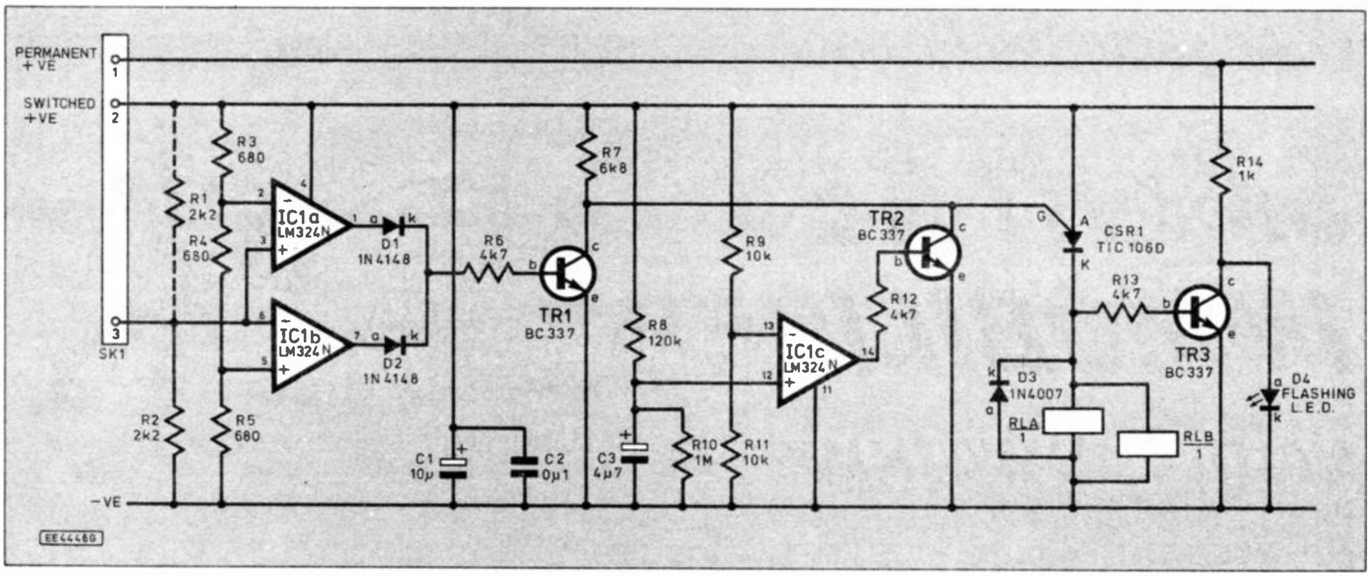


Fig. 3. Complete diagram of the Smart Key Immobiliser. R1 is housed in the "key".

The smart key resistor R1 forms a potential divider circuit with R2. This value is fed into the window comparator IC1a and IC1b, with high and low reference values set by resistors R3, R4 and R5.

If the input value falls within the set window, then IC1a and IC1b outputs will be low, hence transistor TR1 is off (TR1 acting as an inverter) With TR1 off, the input to the tryristor CSR1 is high through resistor R7. Note: this is assuming that TR2 is off, i.e. time lock-out has not occurred.

When CSR1 receives a gate signal, it is forced into conduction and hence activates relays RLA and RLB. Diode D3 is included to stop the relay coils back e.m.f. destroying the thyristor.

With CSR1 off, there is no bias voltage for transistor TR3 so it is also off – allowing current to flow through resistor R14 to supply the flashing l.e.d. D4, signifying immobilisation. When CSR1 turns on the cathode (k) becomes high, turning on TR3. With TR3 on, R14 is shorted down to "ground" hence turning off D4.

COMPONENTS

Resistors

R1, R2	2k2 (2 off)	see Fig. 2.
R3, R4, R5	680 (3 off)	and text
R6, R12, R13	4k7 (3 off)	
R7	6k8	
R8	120k	
R9, R11	10k (2 off)	
R10	1M	
R14	1k	

All 0·25W 5% carbon film

See SHOP TALK Page

Capacitors

C1	10µ axial elect. 25V
C2	0µ1 ceramic
C3	4µ7 radial elect. 25V

Semiconductors

D1, D2	1N4148 signal diode (2 off)
D3	1N4007 1A 1000V rec. diode
D4	5mm flashing red l.e.d.
TR1 to TR3	BC337 *npn* silicon transistor (3 off)
CSR1	TIC106D 400V 5A thyristor
IC1	LM324N quad op.amp

Miscellaneous

RLA, RLB	12V 30A car relay
SK1/PL1	9-pin D-type plug and socket (see text)

Stripboard 0·1 inch matrix, size 31 holes × 17 strips; ABS plastic case, size 150mm × 90mm × 55mm; 14-pin d.i.l. socket; in-line fuseholder, with 30A fuse; small dashboard plastic box for "smart key", size to choice; l.e.d. mounting clip; 5-core screened cable; auto connecting wire; fixing nuts and bolts; solder etc.

Approx cost guidance only **£13**

IMMOBILISATION

There are a number of ways of immobilising a car, these include: 1 – Disable Starter Motor; 2 – Disconnect Ignition Circuit and 3 – Disconnect Fuel Pump Circuit (if applicable – some cars have engine driven mechanical fuel pumps). These functions are achieved by using the normal closed (n.c.) and normal open (n.o.) contacts on the relays RLA and RLB. See Fig. 4.

Note: If while the car is immobilised, the thief tries to use connector leads to bypass the keyswitch and make the ignition coil/fuel pump/starter motor "live" then he will effectively be shorting the battery out. This means that an in-line fuse MUST be, installed in the battery +Ve side – See Fig. 7. If this condition is realised, a very large current will be drawn hence blowing the fuse very quickly – and causing negligible damage to the cars wiring due to the very small time involved.

For the more adventurous, here are two novel ways of disabling a car:

1 – Carburettor with auto choke: By removing the voltage supply from the heater element on the autochoke, the butterfly flap will never open fully – hence causing an excessively rich mixture, which will cause the engine to cut out and not re-start.

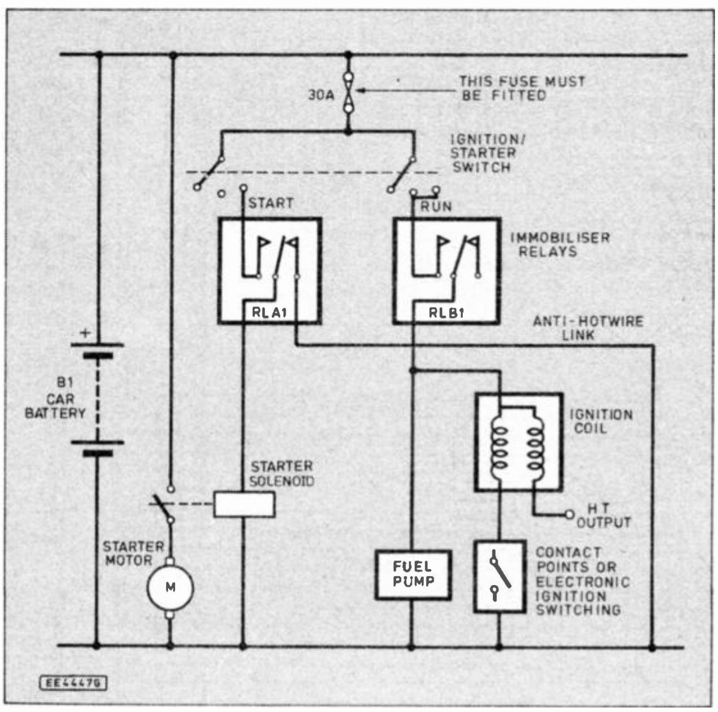


Fig. 4. Wiring of RLA1 and RLB1 to disconnect the starter solenoid, fuel pump and ignition circuit.

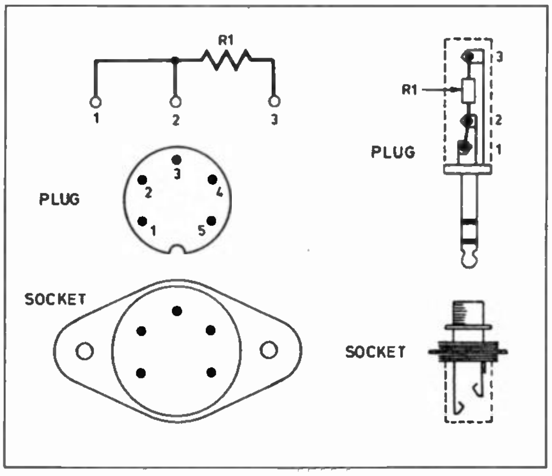
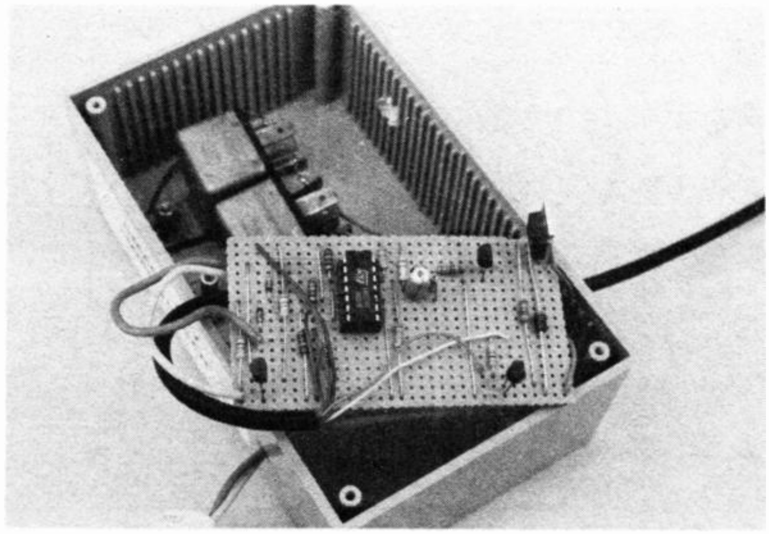


Fig. 5. Using a DIN, or an ***insulated*** *jack, connector in place of the D-type plug and socket.*



2 – Fuel injection with fifth injector for cold start/acceleration enrichment. By feeding the fifth injector (4-cylinder engines) with battery +Ve (*via a diode*) the engine will very quickly flood with excess fuel, cut out and not restart (until the fuel has evaporated which can take some hours!)

It should be pointed out that in vehicles still under warranty that adding or modifying the vehicles' wiring or electrical/fuel systems can invalidate such warrantees.

SOCKETS

It cannot be stressed enough that the more unique the installation the longer it will take the thief to fathom it out.

One of the easiest ways to do this is to change the smart key socket type and configuration. This design is based around the 9-pin D-type plugs and sockets.

Note since only three connections are used, there are many different possibilities available. For example, see Fig. 5. It is possible to select connectors with a greater number of pins than three, so the dummy pins present another source of confusion to the would be thief.

CONSTRUCTION

Construction of the smart key immobilser is based on a circuit panel made from a piece of 0·1 inch matrix stripboard, size 17 strips by 31 holes. The topside component layout and details of breaks required in the underside copper tracks is shown in Fig. 6.

Construction of the circuit board should commence with the insertion of the wire links and the i.c. holder for IC1. This should be followed by the resistors, diodes and capacitors.

Finally, the transistors and thyristor should be soldered in place. Before soldering the transistors and CSR1 in place, double check that the devices are the correct way round. Also, double check the polarities of the diodes and the two electrolytic capacitors C1 and C3.

A fuse of approximately 30A **must be fitted between the battery positive (+Ve) and the relay/circuit (+Ve) connections. See Fig. 7.**

CASE

Case size is unimportant, the relays can be mounted inside or outside the case. For ultimate security it would be worth mounting the relays inside the case, connect all the wiring, then fill the box with potting compound – making the unit waterproof and tamperproof.

However, the socket MUST BE MOUNTED AWAY FROM THE MAIN UNIT e.g. on the dashboard or say in the centre console. The main unit should be mounted in one of the least accessible places in the car e.g. deep behind the dashboard. Remember, the easier it is for you to install the unit, the easier it will be for the thief to find it!

The deterrent – a flashing l.e.d. which indicates the car is immobilised, should obviously be mounted in a visible place in the car. For instance, this could be in the dashboard by the front windscreen. □

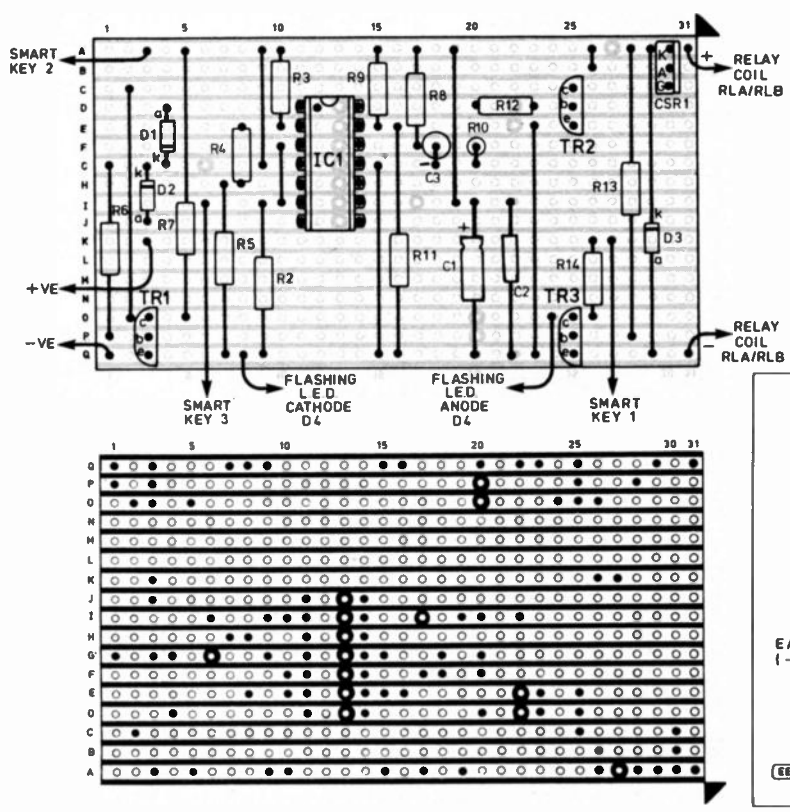
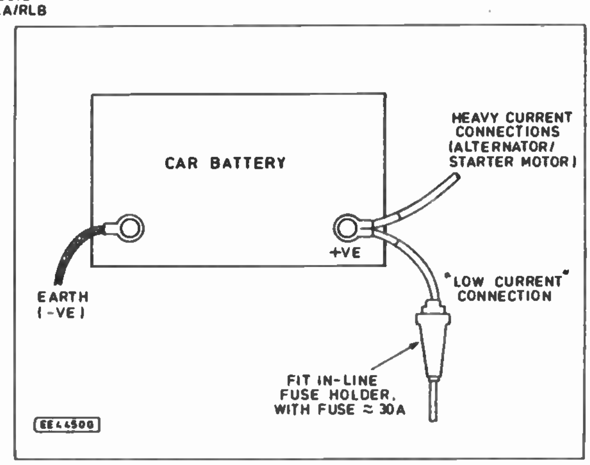


Fig. 6. (left) Stripboard layout and wiring for the Smart Key Immobiliser. All wiring to the car ***must be heavy duty car type wire*** *and employ grommets where it passes through body panels etc.*

Fig. 7. (below) An in line fuse ***must be fitted*** *in the permanent supply connection.*



Innovations

A roundup of the latest Everyday News from the world of electronics

YOUNG INVENTORS

The *1994 Duracell Science & Technology UK Schools Competition* is up and running for the second year and registrations are expected to exceed last year's figure of 1000. In the first instance students are invited to submit a written entry form giving details of an original battery-powered invention or device by 15 March 1994. Of those entries, 75 will be selected for final judging, at which point the devices themselves must be submitted. Ownership of the devices remains with the students.

Designed to link directly into the national curriculum for science and technology, the competition aims to encourage 15 to 17 year-olds to pursue these subjects into further education and beyond, by showing science and technology can be both fun and rewarding.

Professor Ian Fells of Newcastle University and one of the panel of judges said, "By challenging students to use their skills in a creative and practical way, this competition is giving secondary science and technology education a wonderful boost."

PRIZES

This year the prizes have been increased. The five first prize winning entries will receive £250 for the student, or team of students, and £1,000 for the school. Ten runners up will receive £50 for the student or team and £250 for the school. Of the five first prize winning entries, the device showing outstanding imagination and creativity will win, for the student or team of students and their teacher, an all expenses paid trip to the USA.

Last year, Leo Currie of Hilpark Secondary School, Glasgow, who submitted an automatic bath filler which filled a bath to a preset level and temperature, won the coveted USA trip. Leo said, "Inventing gadgets is enormous fun. I was really excited to win the competition and to travel to the USA. The competition is a great idea because, as well as being fun and giving you an opportunity to win some money, even if you don't win, the work still forms part of your exam course work."

Heads of Science and Technology Departments in all UK secondary schools and sixth from colleges have been mailed with an information leaflet. On registration for the competition a resource pack is mailed and up to ten entries per department will be accepted.

Mike Amos, Duracell's Director of Human Resources for Europe said "Duracell was delighted with the interest the competition attracted in its first year and we hope to increase the registrations above the 1000 received last year. Duracell is aware of the necessity to encourage students to pursue science and technology into further education. To maintain any country's research base and to enable its industry to keep up to date in a highly competitive world, an adequate supply of people with specialist scientific and technical skills is essential."

So come on kids get inventing!

ROBERTS RADIO OOPS!

We must apologise for putting the wrong price against the excellent 4 Band Radio – the R309 from Roberts Radio – mentioned last month. The £17.99 price tag belongs to the RP3 model which is an f.m., l.w., m.w. portable in a similar style case to the R309 shown last month. The highly specified R309 in fact costs £54.99, we apologise for any inconvenience caused to readers.

Roberts Radio Co. Ltd., Dept EPE, 127 Molesey Ave., West Moseley, Surrey, KT8 2RL.

DRY CELLS AGAIN

Our thanks to reader Jon Aldridge from Purley who has sent us an advert that has appeared in the American magazine *Popular Science* for a few months. The advert is from Rayovac for their Renewal battery system, this is a recharging system for the Renewal alkaline batteries.

Rayovac say that their cells can be reused up to 25 times or more without problems caused by "old-fashioned" rechargeables – presumably they mean NiCads. The Renewal batteries also hold their charge for up to five years which makes them suitable for applications like powering clocks where NiCads cannot be used.

So much for the UK battery manufacturers claims that it should not be done, our *Dry Cell Charger* (Sept '91) and the various commercial chargers now available make it possible and the idea now appears to have the backing of a major US battery manufacturer. If the UK manufactures go on burying their heads in the ground surely they will soon be loosing out heavily.

The Ultimate Phone!

For the business man who has everything – the *Inmarsat M* portable terminal called the Saturn MiniPhone provides world-wide communication. Claimed to be the worlds smallest satellite telephone for voice, fax and data communication the complete unit is housed in a 9kg briefcase.

It can operate on any power source from 10 to 34 volt d.c. or 90 to 276 volt a.c. The operation of the terminal is similar to a mobile telephone, where all functions are handled from keypads on the handset.

Full operational flexibility is provided by integration of the antenna and the radio-frequency electronics in the detachable weatherproof lid. This allows easy remote loaction of the antenna. A three-metre cable is included in the set, but by the use of an extension cable the antenna can be placed up to 100 metres away.

Providing worlwide contact from places without ordinary communication services, the unit can be helpful to rescue units in disaster areas, mineral and oil exploration crews, field engineers and construction contractors, foresters, newspaper and radio reporters, as well as business people on the move.

The services provided are digitally coded voice, fax at 2400 bits/s and data communication at 2400 bits/s by means of an RS232 Hayes-compatible PC interface.

Inmarsat M provides advantages over the now congested Inmarsat A system as to both availability and price for voice communication. The capacity of Inmarsat M will be more than five times that of the Inmarsat A system, and traffic charges for Inmarasat M can be lower than those for international telephone calls from hotels. The Saturn MiniPhone is available from ABB Nera Satellite Division (Dept. EPE), PO Box 91, N-1361 Billingstad, Norway.

SMART SECURITY

X-SECURE, a UNIX Security Card (USC) which allows users to protect their personal workstation from access by unauthorised persons has been introduced by Orga Card Systems UK. Standard UNIX log-in procedures are replaced by a PIN (Personal Identification Number) check and authentication of the chip card by the system. The functions of the application environment which are relevant to security can be protected by means of an access protection using the USC.

Paul Hill, Marketing Director for Orga said: "The Smart Card is an ideal authentication medium for UNIX systems. It provides the user with a mobile key which can only be used by one person. Even if other people know the PIN, only the current owner can use the card. In addition, the same Smart Card can also have other functions such as a company ID card, a key to the building, a payment card in the canteen, an ID card for the telephone and as a key to EDP."

Orga Card Systems (UK) Ltd., Dept EPE, Nobel House, 6 Greys Rd., Henley-on-Thames, Oxfordshire, RG9 1RY.

SERVICE!

The Edition 18 Catalogue of Technical Books has recently been published by Mauritron Technical Services. The catalogue lists everything from a CB Radio Circuits Manual through diagnostic PC software to Military Surplus service data and even a Telephone Code Location Guide – look up the dialling code and it tells you the town.

If you want unusual servicing information – or any service information come to that – then this might not be a bad place to start looking.

Mauritron Technical Services, Dept EPE, 47A High St., Chinnor, Oxfordshire OX9 4DJ.

SOLDERING ON

Be quick and you can just catch this special offer on the SK5 soldering Iron Kit from Maplin. If you are new to electronics this month's *Techniques* article covers soldering, if you are an "old hand" this might offer a good opportunity to upgrade your present iron.

The kit comprises the 17W 240V, Type CS soldering iron for light electronic work, a soldering iron stand type ST4 with tip cleaning sponge and a coil of solder. All neatly packaged with full instructions on how to use the iron plus some additional hints on the art of soldering.

The present reduced price is £11.95 including VAT but this special offer price will end on Feb. 28th 1994. Available from Maplin stores nationwide or by mail order from Maplin Electronics, (Dept EPE), P.O. Box 3, Rayleigh, Essex, SS6 8LR. Tel. 0702 554161. The order code for this kit is FY68Y (CS Kit SK5).

FREQUENCY COUNTER/FINDER

A high sensitivity pocket sized frequency counter/finder has been introduced by Quantek Electronics. The model FC2000 is capable of measuring frequencies from 1MHz to 2·4GHz.

Conventional frequency counters typically have a specified sensitivity of 10mV, the sensitivity of the FC2000 is less than 1mV between 10MHz and 850MHz and is typically 225µV at 150MHz, this enables the FC2000 to be used for measuring transmitted radio frequency signals as well as for laboratory bench measurements.

The compact and rugged design of the FC2000 makes it ideally suited for use by field service engineers, other users include radio amateurs, scanning receiver owners for frequency finding, and counter surveillance operatives.

The FC2000 costs £119 plus £5 post and packing and is available direct from the manufactures Quantek electronics, Dept EPE, 3 Houldey Rd., Birmingham B31 3HL.

SPICE IT UP!

Users of TopSPICE, the popular low cost SPICE simulator, can now enter information graphically using TopNET, a new optional Schematic Capture package that follows SPICE rules when generating a netlist file. TopNET costs just £149 but is also available FREE of charge together with TopSPICE in a 20 component evaluation version to anyone who sends a 1·44Mb PC formated 3·5 inch DS HD disk to: TopNET Offer, Dept. EPE, CRaG Systems, 8 Shakespeare Road, Thatcham, Newbury, Berkshire, RG13 4DG.

TopNET transparently generates complete SPICE circuit files and includes full support for SPICE macromodels. Users can include SPICE simulation commands, models, elements or comments in a seperate command file which is automatically added to the SPICE netlist file. SPICE node numbers can be displayed on the schematic and node names may be given to wires or pins by placing a label close by. TopNET is fully integrated with the TopSPICE control shell. "Zip mode" allows the user to save, make the SPICE netlist, exit and start the simulation using a single keystroke.

TopNET provides an easy to use graphical interface with all commands available through pull-down and pop-up menus as well as through the keyboard. The package includes symbols for all SPICE circuit elements including digital parts and sophisticated voltage and current sources. Users can also easily create new symbols and add them to the library using an ASCII text editor. Most symbols can be mirrored and/or flipped and symbols are based on geometric operation rather than raster images. A snap-to-grid mode makes for easy placement of parts and wiring connections. Complete edit commands include cut, paste, move, rotate, mirror, flip and change attribute. Double-clicking enables editing of any object.

TopNET runs on IBM XT/AT/PS2 or compatible PCs with at least 640K of RAM, MS-DOS 3.3 or later, hard disk and at least VGA graphics.

EXHIBITIONS

Two dates for your diary:

National Computer Shopper Show, March 24 to 27th at the NEC Birmingham.

Spring All Micro Show, Radio Rally & Electronics Fair, April 16th. Bingley Hall, Staffordshire Showground, Stafford.

There have been two Computer Shopper Shows a year recently with a claimed annual attendance of over 60,000 visitors, with the newly launched National Computer Show now taking place in Birmingham, to meet the demand in the Midlands, that figure is expected to rise.

For further details contact the organisers Blenheim, Exhibitions and Conferences Ltd., Dept EPE, 630 Chiwick High Rd., London W4 5BG. Tel: 081 742 2828, Fax: 081 742 3182.

The AMS (its short for All Micro Show, Radio Rally and Electronics Fair) is in its sixth consecutive year at Bingley Hall. This is the first Spring Show following requests by both traders and the public.

Last year's Autumn Show saw over 70 trade stands covering the computing spectrum, including – PC, Amiga ST and Atari 8-bit; plus accessories, software, books, components, shareware, media, hardware, radio, satellite and a huge electronics bring and buy stall.

The entrance price has stayed the same, at £2 from the very first show 7 years ago – proving some things are inflation proof!

As usual the show is supporting local charity stalls, has free parking, licenced bar from 11a.m., plus refreshments, meals, cateteria etc.

For further details and advance/fast lane tickets contact the organisers Sharward Services, Dept. EPE, Upland Cente, 2 Upland Rd., Ipswich IP4 5BT. Tel: 0473 272002, Fax: 0473 272008.

New Technology Update

Ian Poole investigates the latest research developments in light communications, liquid crystal displays, hifi sound and i.c. cooling techniques

A VARIETY of different developments this month. With the need for better displays for use in today's computerised equipment higher definition displays are now needed. Also a look at an idea which could revolutionise hi-fi systems. Methods of removing heat from i.c.s are very important with the ever increasing size and complexity of chips and there are new ideas to help overcome these problems. But to start a look at developments in data communications.

Light Communications

Optical and infrared data transmission is becoming increasingly popular as a means of communication over short distances. It enables high data rates to be obtained over distances of a few hundred metres. Whilst its use is increasing, more traditional forms of radio communication still maintain advantages in some areas. In particular radio can be used more easily for communications between moving stations.

Traditionally optical forms of communication have used very narrow beam widths and this has meant that accurate alignment of the transmitter and receiver is needed. Now a company in Israel, called Jerusalem Optical Link Technologies has developed a scanning system capable of transmitting signals over an angle of 35 degrees and receiving them over a range of 60 degrees.

To achieve this performance a unique autoscan system has been developed. Initially the system scans over a wide field of view and then once the link is set up a narrow field is used. Once data is flowing the actual angle is sufficient to allow movement at either end of the link without the scanning system loosing the signal before it can re-align itself.

Using the small field of view allows the performance to be optimised. In this way the transmitter power and receiver gain are maximised to give sufficient distances. With current prototypes distances of around 200 metres can be obtained although atmospheric conditions naturally affect this figure somewhat.

The system can handle very high data rates of up to 125Mbits per second. On its own the basic autoscan system would not be able to provide sufficient bandwidth to allow this because the capacitance in the system is the limiting factor. To achieve the performance further development work was needed to produce some specialised ultralow capacitance circuitry. This is now in the process of having patents approved.

The new system promises to find a wide variety of applications. It has been suggested that it will be ideal for use in road toll collection, general vehicle short range communications, and it could even prove ideal for aircraft manoeuvring at airports.

Liquid Crystal Display

High definition l.c.d.s are becoming more common these days. Whereas a few years ago people had to be content with low resolution displays this is no longer the case. To demonstrate this fact Matsushita have developed a 1·25 inch liquid crystal display containing nearly a third of a million pixels in a 496 x 656 matrix.

To achieve this high resolution the engineers at Matsushita have had to overcome a number of problems associated with the drive circuitry. As a result of the increase in the number of pixels, the drive circuitry which is multiplexed has had to cope with an increase in duty cycle. The new circuitry is able to handle the increase whilst still being able to maintain its very tight constraints on size.

The new display is expected to find uses in a wide variety of applications from domestic to professional equipment. Particular areas at which it is aimed include TV games, professional test equipment, and graphic displays.

Sound Improvements

Sound reproduction has long been a subject of great interest to electronics enthusiasts. In an attempt to be able to recreate the original sound more accurately tremendous improvements have been made in the past few years.

With the introduction of the CD just over ten years ago, and now the Digital Compact Cassette and Sony Minidisc enormous strides forwards have been achieved. Noise levels have been reduced to almost nothing, frequency responses are much flatter and distortion levels considerably improved.

Even with all these developments many people still feel that there is room for improvement. Recordings do not reproduce the spacial effects of live sound as accurately as might be desired. Even a stereo system set up in ideal conditions cannot completely recreate the original sound in terms of its spacial effects.

To overcome this problem, engineers at Thorn EMI have started to employ some of the latest digital signal processing hardware in experimental audio systems. Using 24 and 32 bit processors together with some specially written and patented software tremendous improvements have been made.

Now they are able to recreate the positional information of the sounds far more accurately than before. In fact this can be accomplished using a standard CD player, amplifier and a pair of loudspeakers.

The system involves the use of a specialised microphone which replicates the head. The signals are then passed into the digital signal processor where complicated algorithms are used to compensate for the features which make the sound appear unnatural when played back over standard speakers. Characteristics including the phase, delays, and crosstalk between the ears are all included.

The new system is a major step in creating a virtual reality sound system for the home. It is probably one of the most important developments to hit the hi-fi scene since the introduction of stereo.

Cooler I.C.s

One problem which i.c. designers hit time and again is that of removing heat from the more current hungry areas of a chip. With i.c.s becoming larger and more complicated, this criterion is often the factor which limits the size of an i.c. As a result there are many research projects concentrating purely on methods of removing heat from hot spots. Possibly one of the most interesting and novel solutions to be revealed in recent months is the use of a coolant inside the chip itself.

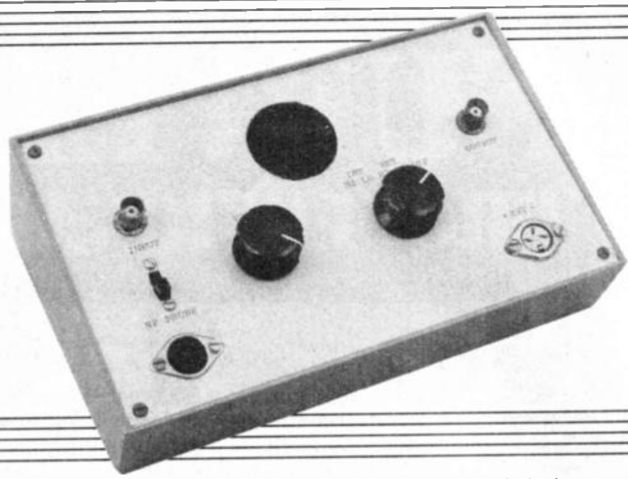
Staff at a Texas University have succeeded in developing a process where minute pipes are embedded into the silicon. A coolant is then added to the pipes which are about 80μm in diameter so that heat can be carried away from the hot spots. In this way heat is removed far more efficiently and quickly than before.

It is found that the coolant boils in the hottest areas and then travels down the pipes to cooler regions where it condenses and releases its heat. The evaporation and condensing cycles produce a pressure along the pipes which ensure that there is a continuous movement around the chip. This guarantees that the heat is evenly distributed and can be removed into the substrate far more easily.

Heat Analysis

Along with the new methods of removing heat from the i.c.s new computer aided methods of producing thermal models of complicated i.c.s are now being used. The new Intel Pentium processor has been analyzed by a thermal analysis company called Flowmerics. Using their Flowtherm software, computational fluid dynamics techniques have been developed to characterise the temperature profile. It uses a knowledge of the heat characteristics in the chip as well as the air flow outside it.

An accurate picture of the temperature is needed because the chip dissipates around 15 watts which is not at all easy to remove.



AUDIO/R.F. MONITOR

IAN HICKMAN

With its high audio sensitivity and facility for monitoring r.f. signals, this monitor will prove a useful addition to any home laboratory.

THIS project started life when the writer wanted to monitor the i.f. output from a TV tuner with which he was starting to experiment. A quick lash-up with a detector diode and a rather elderly lab. amplifier was only partially successful, due among other things to mains hum – the lab. amplifier was mains powered.

A small self-contained battery operated amplifier, specifically designed to operate with a matching r.f. detector probe was therefore designed and built. It seemed sensible at the same time to construct the amplifier so that it was also suitable for monitoring audio signals directly, over a wide range of amplitudes, and the resulting instrument is described here.

HOW IT WORKS

The monitor is designed to handle an exceptionally wide range of input signal amplitudes, which requires the use of both amplifiers and attenuators. This is best explained with reference to the simplified block diagram of Fig. 1.

A switch selects either a direct Audio input, or the audio recovered from a modulated signal by an r.f. probe. In the former case, the signal can either be applied to the first amplifier stage A1 (which has a gain of 30dB or about times thirty) direct, or after having been attenuated by 60dB, i.e. to one thousandth of its amplitude.

The output of A1 is applied to amplifier A2, which has a switchable gain that can be set to either 30dB, or 0dB (i.e. a gain of unity). The output of A2 is applied to another amplifier (A3) with a gain of 30dB, via a volume control. The latter can either pass the signal unattenuated, or attenuate it by up to 40dB or more.

The output of A3 is applied to the output amplifier A4. Although this has a voltage gain of unity, it supplies considerable power gain, being used as a buffer to drive a 64 ohm loudspeaker.

With suitable settings of the various controls, this monitor can provide full output from an input signal as small as 50 microvolts r.m.s., whilst accepting a signal of 50V r.m.s. or larger without overloading. Thus with suitable settings of the controls, you can hear signals as small as five microvolts or less, or monitor the signal from the largest "hairiest" power amplifier directly at its output.

CIRCUIT DESCRIPTION

The full circuit diagram for the Audio/R.F. Monitor is shown in Fig. 2. The functions of the two multi-way rotary switches S1 and S2 are also shown.

The audio input is applied via screened socket SK2, a BNC type being employed on the prototype. The input is d.c. blocked by capacitor C1 and connected, via a 10k resistor (R2), to position 1 of slide switch S1b, then via R3 to position 2 and thence via R4 to "ground".

In position 1, the input is effectively connected directly to the non-inverting input of op.amp IC1a, whereas in position 2 it is attenuated by 60dB first. In the direct connection, damage to op.amp IC1a could result from the inadvertent application of too large a signal, so S1a introduces clamping diodes D1 and D2 as a safety measure – they will not introduce any distortion since full output results from a mere 1·5mV input signal.

However, with the 60dB attenuator formed by resistors R3 and R4 switched in, the signal at the junction of R2 and R3 could be very large, so the diodes are then switched out of circuit. They are not needed either in position 3 of S1, where the R.F. Probe is brought into circuit.

In this case, the input signal is the detected output produced by the probe, which consists of a capacitor C2, diode D3 and resistor R18, connected to the amplifier via the R.F. Probe input socket SK1. This socket has in fact five pins as it also serves other functions, covered later. Diode D3 is a "hot carrier" type which will thus operate up to u.h.f. and beyond. To increase its sensitivity, it is slightly forward biassed by the bias current from the non-inverting (+) input of IC1a. This has a *pnp* input stage, the bias current of which flows via resistor R18 and the diode to ground.

The r.f. is d.c. restored negative going by the diode and the resulting mean value – the audio – picked off by the lowpass filter formed by R18 and the capacitance of the screened lead – about 70cm of miniature screened cable.

NEGATIVE FEEDBACK

The audio input from whichever source is amplified by 30dB in IC1a, the gain of which at d.c. is however unity, since the presence of capacitor C3 results in 100 per cent negative feedback at 0Hz. This is important, otherwise with the R.F. Probe in use, the standing volt drop across the diode would be amplified by a factor of 30, overloading IC1a and causing its output to sit at the positive rail.

The output of IC1a is applied, d.c. blocked by capacitor C5, to IC1b. This stage amplifies the audio signal by a further 30dB if switch S2a is in the Hi gain position, or unity (0dB) in the Lo posi-

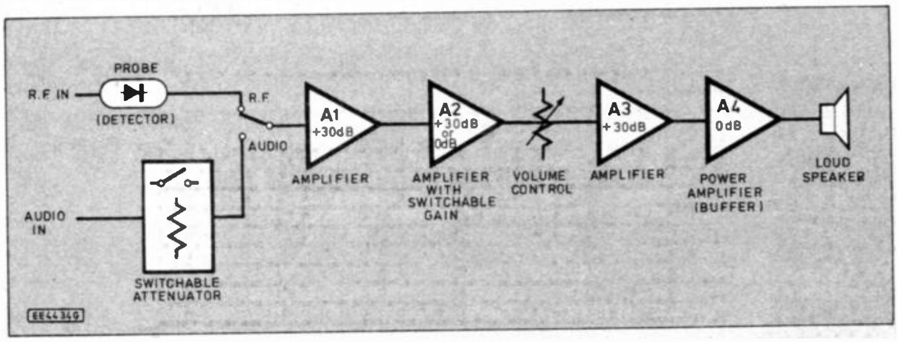


Fig. 1. Block diagram of the Audio/R.F. Monitor

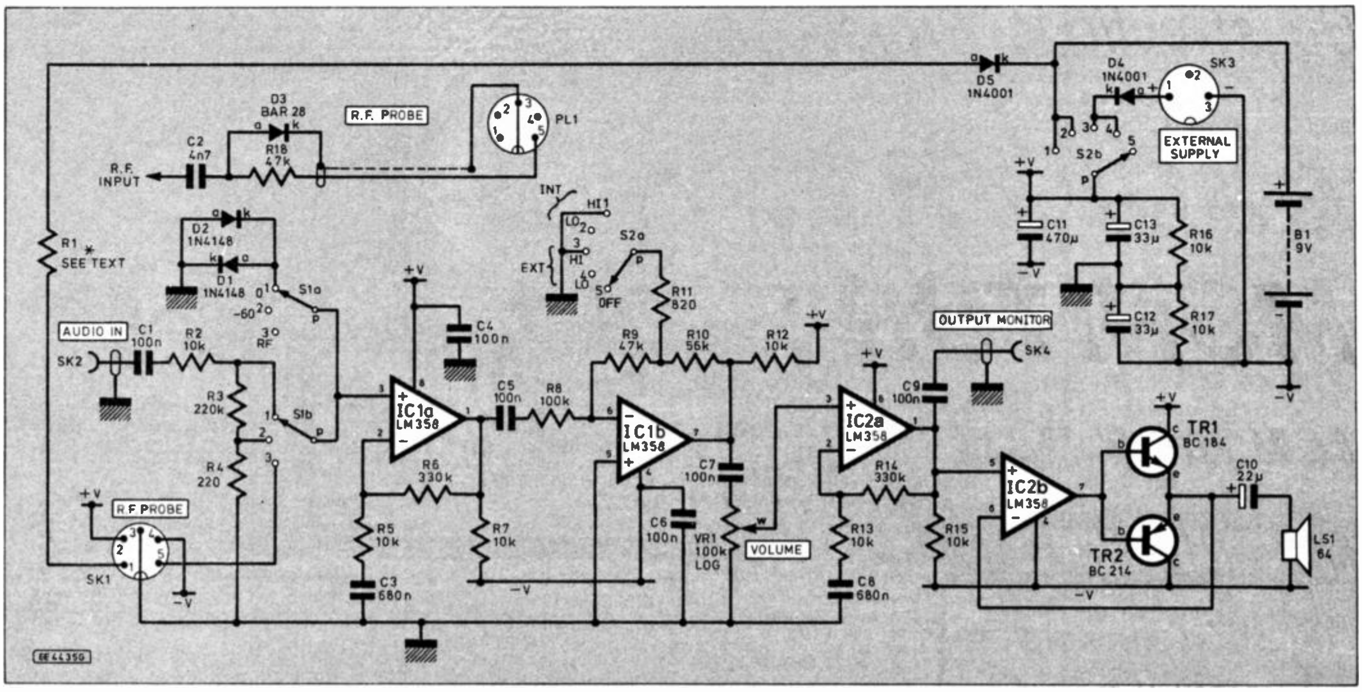


Fig. 2. Complete circuit diagram of the Audio/R.F. Monitor

tion, the gain at 0Hz being zero in either case, due to the a.c. coupling via capacitor C5. The gain reduction is brought about by switching in resistor R11, turning IC1b's negative feedback resistor into a "T"-attenuator.

The output of IC1b is a.c. coupled via capacitor C7 to the Volume control VR1, the signal at its wiper being applied to the non-inverting input of IC2a. This provides a further 30dB of gain and its output is made available (d.c. blocked by C9) at a BNC monitor socket SK4 labelled Output on the front panel. This enables the amplifier to also be used as a high gain preamplifier in conjunction with other instruments, e.g. an oscilloscope.

The other half of IC2, is used as the output buffer to drive the loudspeaker, via the *pnp* and *npn* complementary emitter follower pair transistors, TR1 and TR2. The standing current drawn by this output stage is virtually zero, as there is no forward bias applied to the transistors, which therefore work in pure class-B.

Distortion is avoided, however, since the whole of the open loop gain of IC2b is available to force its inverting input, and thus the voltage across the loudspeaker, to follow that at the non-inverting input. For the same reason, there is no need to select a matched pair for TR1 and TR2.

POWER SUPPLY

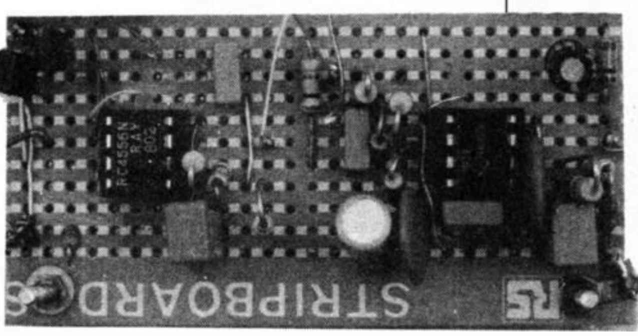
Capacitor C11 decouples the 9V supply, whilst resistors R16 and R17, in conjunction with capacitors C12 and C13, provide a supply centre tap, used as "circuit ground", with a low impedance to audio frequencies. Note that only low level signals flow in the ground line, due to the loudspeaker LS1 being returned to the negative rail. Current through the loudspeaker is drawn directly between the supply rails on positive half cycles of the output, when TR1 conducts, and from the stored charge in C10 on negative half cycles, when TR2 conducts.

Resistors R7, R12 and R15 perhaps call for some comment. When an op.amp such as the LM358 is called upon to provide 30dB of gain across the whole audio band, crossover distortion can appear, since internally the device's output stage operates in class-B. At lower demanded gains, there is sufficient loop gain left (loop gain equals open-loop gain minus demanded gain) to prevent the occurrence of this distortion, but when demanding 30dB of gain, the crossover distortion can become very noticeable at the higher audio frequencies.

This distortion can be avoided, as here, by tying a load (resistors R7, R12 and R15) from the op.amp's output to one or other supply rail, causing the output stage to run in a single-ended class-A mode. In the prototype, an LM358 was used as IC1 and, an RC4556 as IC2, but another LM358 may be used here too.

CONSTRUCTION

The prototype unit was constructed on a piece of stripboard, size 13 strips × 29 holes, and mounted together with all the other components (except the battery) on the rear of the front panel of one of the popular small sloping front instrument cases available from various suppliers. The circuit board topside component layout and details of breaks required in the underside copper tracks is shown in Fig. 3.



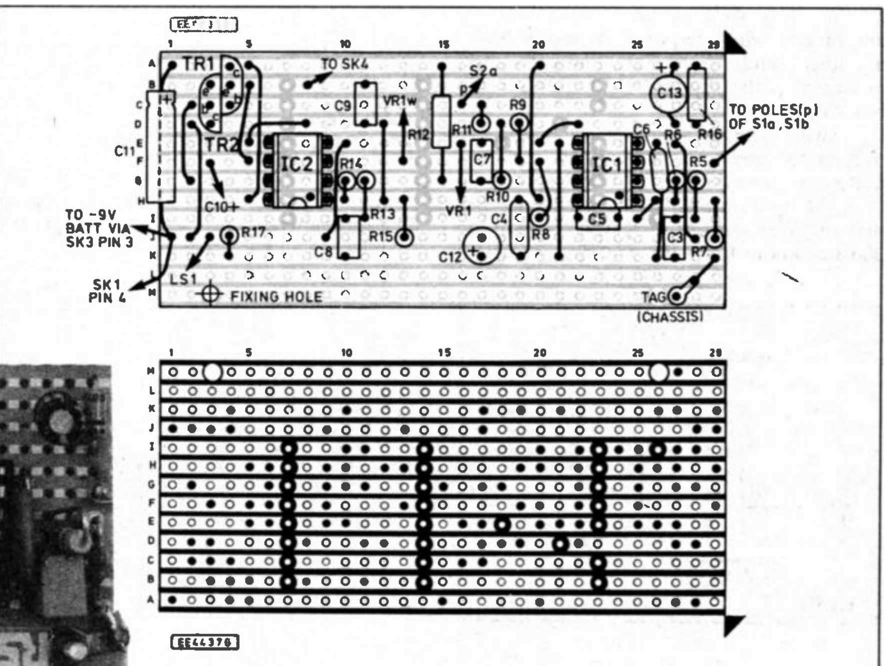


Fig. 3. Stripboard layout and wiring.

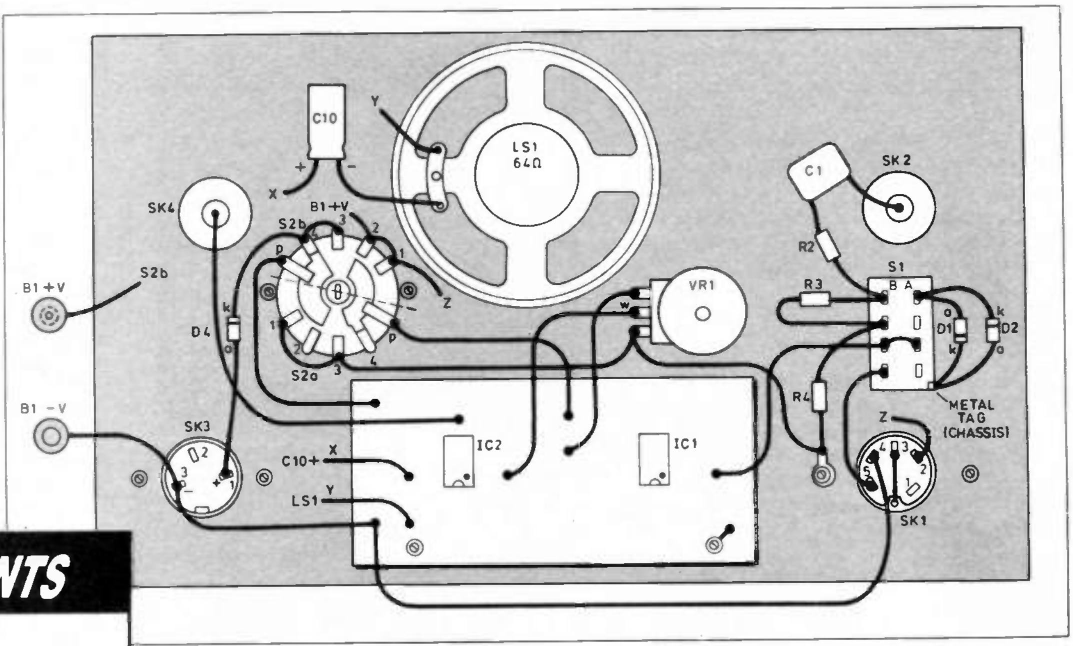


Fig. 4. Interwiring for the complete Monitor. The metal panel is at 0V. Note that one of the circuit board fixing nuts also links the 0V track to the metal panel, completing the 0V line.

COMPONENTS

Resistors

R1	see text
R2, R5, R7, R12, R13, R15 to R17	10k (8 off)
R3	220k
R4	220
R6, R14	330k (2 off)
R8	100k
R9, R18	47k (2 off)
R10	56k
R11	820

All 0·25W 5% carbon film

See SHOP TALK Page

Potentiometer

VR1	100k rotary carbon, log.

Capacitors

C1, C4 to C7, C9	100n polyester, 63V (6 off)
C2	4n7 polyester, 63V
C3, C8	680n polyester, 63V (2 off)
C10	22μ radial elect. 16V
C11	470μ axial elect. 16V
C12, C13	33μ radial elect. 16V

Semiconductors

D1, D2	1N4148 signal diode (2 off)
D3	BAR28 Schottky diode
D4, D5	1N4001 50V 1A rec. diode (2 off)
TR1	BC184L *npn* signal transistor
TR2	BC214L *pnp signal* transistor
IC1	LM358 dual op.amp
IC2	LM358 or RC4556 dual op.amp

Miscellaneous

SK1/PL1	5-way 270° DIN socket and plug
SK2, SK4	BNC coxial chassis mounting socket (2 off)
SK3	3-way 270° DIN socket
S1	2-pole 3-way slide switch
S2	2-pole 5-way rotary wafer switch
LS1	64 ohm 65mm dia. or larger (to suit case) loudspeaker

Plastic ABS console case (with sloping metal front panel), size 215mm x 130mm x 78/47mm; 0·1 inch matrix stripboard, size 13 strips x 29 holes; 8 pin d.i.l. socket (2 off); plastic knobs (2 off); speaker grille material; PP7 or PP9 battery (see text), with clips; multistrand connecting wire; screened cable; adhesive; solder etc.

Approx cost guidance only **£18** *excl. battery*

Take care to space the two dual op.amps well apart, keeping the components associated with each nearby. Remember, there is in excess of 90dB of gain in the circuit, so poor layout can result in oscillation. For the same reason, do not try to use a single package quad op.amp in place of the two duals – you would never keep it stable!

The use of BNC sockets was adopted for the Audio In and monitor Output sockets, with DIN sockets for the connection of the R.F. Probe and an External Power Supply. The latter socket, SK3, was a 3-pin 180 degree DIN type, the external supply being connected to pins 1 and 3 of the mating plug; pin 1 being positive (Fig. 4).

To avoid any possibility of reverse supply connection, diode D4 is connected between pin 1 and the Ext. supply positions of switch S2b. Separate Ext. and Int. supply positions on S2 prevent the external supply from ever being bridged across the internal battery, an event which could have unfortunate consequences.

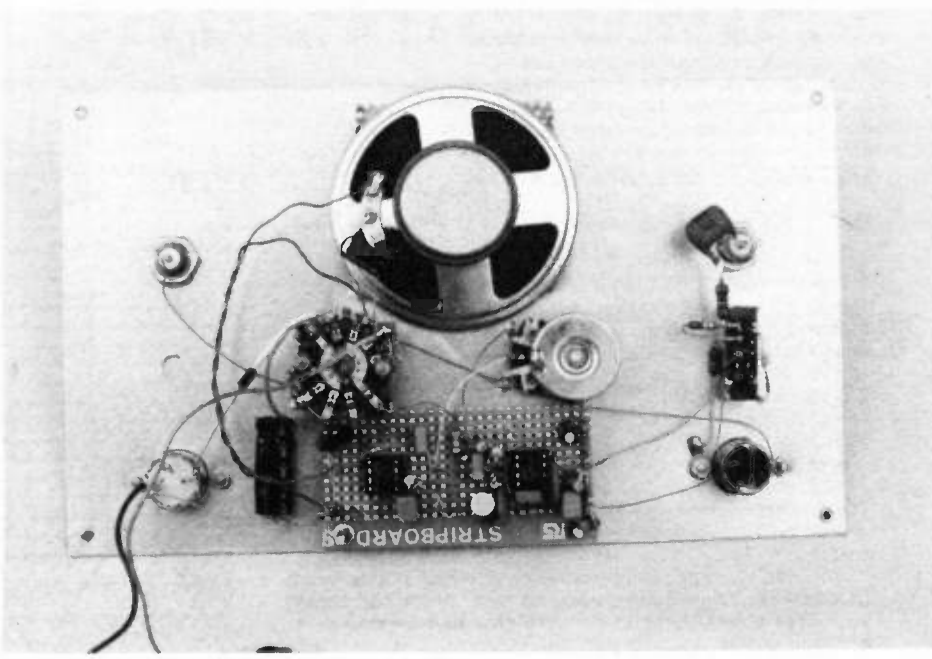
The plug on the probe lead connects to the unit via a 5-pin 270 degree DIN socket; it cannot accidentally be plugged into the Ext power socket, or vice versa. The probe head was constructed in a scrap of copper tubing 3·5cm in length, with capacitor C5 almost projecting from one end so that its lead, shortened to 6mm formed the probe tip.

Diode D3 and resistor R18 were connected to the other end of C5 and housed within the tube, which was connected to the cathode (k) of D3 and the outer of the screened lead. The self capacitance of the latter should be about 300pF.

The R.F. Probe connection uses only two of the pins of SK1, pin 3 (also connected to the metal shell of the socket) being ground and pin 5 signal. Pins 2 and 4 make the positive and negative supply rails available, so that if the unit is being used while developing, say, a small preamplifier or whatever, the R.F. Probe socket of the Audio/R.F. Monitor can also be used as a convenient supply, to power the circuit under development, either from the internal battery or via the unit from the external supply.

BATTERY SUPPLY

If using a dry battery for the internal supply, it pays handsomely to use the



largest possible size. For example, the large PP9 9V battery will last over twenty times as long as the ubiquitous little PP3.

There was no room in the case of the prototype for a PP9, so the next largest size, a PP7, was used and this will last about nine times as long as a PP3. If there isn't room even for a PP7, the next choice could be a PP6 which will last about three and a half times as long as a PP3.

Bear in mind that there is little difference in price between any of the battery types mentioned!

At a higher initial cost but a much lower running cost thereafter, a NiCad battery can be used. In this case, a suitable resistor R1 (see Fig. 2) can be fitted so that the battery can be recharged without removal from the unit, via a plug mating with SK1. (Additional leads for charging or using the internal battery may connected to the pins of the R.F. Probe plug and left coiled up out of the way when not in use, so that an extra 5-way 270 degree DIN plug is not required. The additional leads should be terminated in an insulated terminal strip to prevent them shorting.) The charging resistor should be such as to supply the NiCad battery with the recommended C/10 charging current, taking into account the voltage of the charging source.

The fitting of a "silly ass" diode D5 is, as usual, a wise precaution. Another wise precaution would be to line the inside of the plastic case with aluminium foil and to arrange that when the front panel is fitted, it is in contact with it.

This will reduce any stray hum pick-up, which is always a possibility, given the very high sensitivity of the circuit at maximum gain. To minimize this possibility, all wiring associated with the input facilities should be neatly dressed down to run snugly up against the front panel.

FREQUENCY RESPONSE

The time constants associated with capacitors C1, C3, C5, C7 and C8 are all such that the corresponding -3dB points are less than 25Hz, so the frequency response of the unit, in the bass region, will be very well maintained at the Monitor output socket. To permit the use of a compact case, the prototype included a 65mm diameter speaker which will limit the frequencies reproduced to those above about 300Hz.

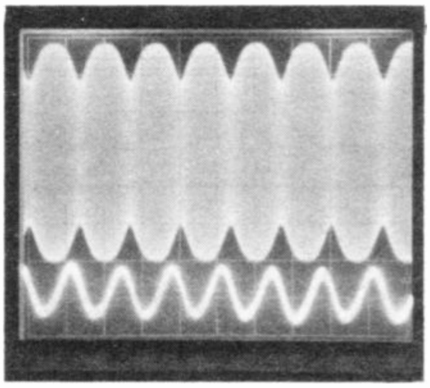


Fig. 5. Demodulated a.m. signal.

The circuit is never going to be in the hifi league, but if a more extended bass response is desired, a larger case – incidentally permitting the use of a PP9 battery – will be required, so that a larger speaker can be used. Speakers designed for compact hifi systems have notoriously low efficiency and so are not suitable for use with this design, in view of the limitations of the output stage, but if a 64 ohm speaker of 100mm diameter or more can be found, it would be well worth using it for the extended bass response. Capacitor C10 should then be increased to 100µF and C11 to 2200µF.

USING THE MONITOR

For general audio monitoring, the Audio Input socket SK2 is used, preferably with a screened lead to connect the signal under test. Screening will be essential to avoid electrostatic (high impedance) hum pick-up when using one of the higher gain settings, unless the source is of very low impedance. Given the monitor's very high sensitivity, hum due to "earth loops" is another point to watch out for.

Take care to keep the signal levels in the circuitry to sensible levels. For instance, it would be silly to try and cope with a signal approaching 1V r.m.s. by setting switch S1 to 0dB, S2 to Lo. gain and winding the Volume control VR1 right down; IC1a would be overloaded.

For such large signals, the 60dB input attenuator should be used. In general, the Volume control should be kept near maximum, though some reduction will reduce the background hiss in the high gain positions.

The input circuitry is almost bombproof, since the audio input is either connected via a 60dB attenuator, or – if direct – clamp diodes downstream of resistor R2 are in circuit. Given a suitable voltage rating for C1, the unit would even survive momentary accidental connection across the mains: Extended connection would burn out R2 since it would dissipate about six watts.

R.F. MONITORING

For r.f. monitoring, the R.F. Probe will demodulate a.m. signals, as shown in the photograph (Fig. 5) In many instances it will also allow f.m. signals to be heard; for example by off-tuning a receiver slightly, the amplitude of an f.m. signal will vary in sympathy with its frequency variations, allowing "slope detection" by the R.F. Probe. It can thus be traced through the various stages of an f.m. receiver.

An h.f. choke with a high reactance at the frequency of interest, connected between the probe tip and case, can be useful in avoiding electrostatic hum pick-up.

Watch out for earth loops when using the R.F. Probe; these can be particularly troublesome, resulting in hum components at 50Hz, 100Hz and/or 150Hz, when a number of mains powered items such as a signal generator, external modulation oscillator, oscilloscope are all in use together. In this case, a search coil of a few turns of wire in place of the h.f. choke may prove better, enabling the signal of interest to be picked up by r.f. coupling, with no direct metallic connection to the equipment under test. □

RING BINDERS FOR EPE

This ring binder uses a special system to allow the issues to be easily removed and reinserted without any damage. A nylon strip slips over each issue and this passes over the four rings, thus holding the magazine in place (see photo).

The binders are finished in hard wearing royal blue p.v.c. with the magazine logo in gold on the spine. They will keep your issues neat and tidy but allow you to remove them for use easily.

The price is £5.95 plus £3.50 post and packing. If you order more than one binder add £1 postage for each binder after the initial £3.50 postage charge, (for overseas readers the postage is £6.00 each to everywhere except Australia and Papua New Guinea which costs £10.50 each).

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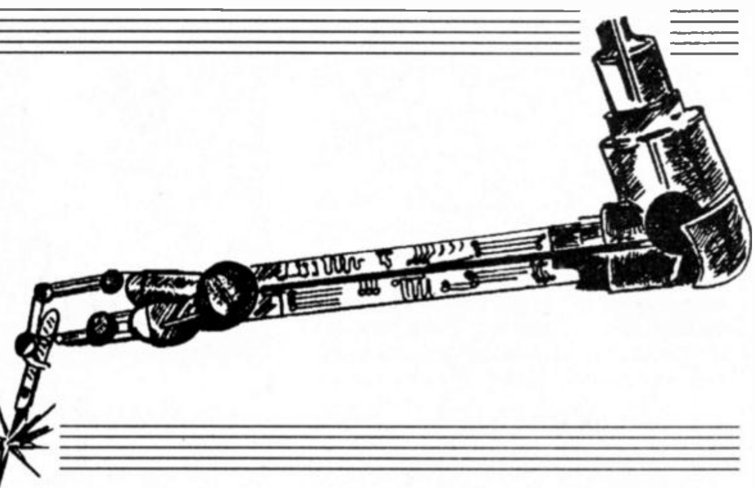
Regular Clinic

CIRCUIT SURGERY



ALAN WINSTANLEY

Circuit Surgery ***is our column specially written to try to help out with general queries related to electronics where we attempt to explain topical matters or answer readers questions. In other words, we share problems and pass on circuit suggestions and tips we feel may be of interest to fellow constructors. The wide scope of readers' queries means that sooner or later there will be something which appeals to you. This is your chance to talk to us, so why not write to Alan at the address given at the end of this month's*** **Surgery!**

Bulk Bargain?

An interesting question which I guarantee will send many constructors running for their multimeters, came from a regular *Circuit Surgery* correspondent. ***Mark McGuinness*** of Tallaght, Co. Dublin in Ireland asks a "testing" question related to checking out dubious transistors:

I recently purchased a large quantity of surplus transistors but I do not know how many of these devices are actually working. They are a mixture of npn *and* pnp *types. Could you describe a simple way of testing them, say with my multimeter?*

Certainly! There are several tests which you can perform with an ordinary moving-coil multimeter which will help you to identify good from bad. As you probably know, it's possible to buy multimeters with built-in transistor testing functions. I own several meters including such a tester, but to be honest I rarely need to use it for checking troublesome transistors. Instead, it's quite easy to obtain "go-no-go" results with an ordinary multimeter set to a resistance (Ohms) range.

To start with, it's worth looking briefly at the fundamentals of diode and transistor physics. Bipolar transistors consist of *npn* and *pnp* semiconductor material, usually based on silicon.

The "bipolar" or "two polarities" tag refers specifically to the fact that electric charge is carried in these transistors by ***two*** types of charge carrier – negatively-charged *electrons* and positive "*holes*". A semiconductor which has plenty of free electrons is termed "*n*-type, so "*p*-type" material has a surplus of those positively-charged holes instead.

By joining the two semiconductor types together and hooking up a connecting wire at either end, you form a basic ***pn-junction diode,*** whose familiar symbol is shown in Fig. 1. Current will flow one way only, in the direction of the arrow head from anode (a) to cathode (k). With silicon diodes such as the 1N4148 or the 1N4001, the anode must be about 0·7V more positive than the cathode for current to flow. Under these circumstances the diode is said to be *forward biased.* The anode and cathode are *p*-type and *n*-type material respectively, as shown.

Bipolar transistors contain in effect *two* of these junction diodes. Fig. 2(a) shows how two *pn*-junction diodes form a *pnp* transistor. You will see that the three terminals connected to a *p-n-p* semiconductor are emitter (e), base (b) and collector (c) respectively with the base being common to both diodes. Similarly Fig. 2(b) shows how the diode polarities are reversed, so the terminals are connected to *n-p-n* material. Hence, *pnp* and *npn* transistors are formed.

To test a suspect transistor, we could maybe start by checking the individual diodes' function with an ordinary multimeter. Note that not all of the following experiments may work with a *digital* multimeter (DMM). These contain extra input amplifiers which are not present in ordinary moving coil multimeters, and may give misleading results. A modest moving coil meter will be just fine! If you use a DMM, select the *Diode check* range instead (when the DMM might display the diode's actual forward voltage).

Diode dilemma . . .

Multimeters have an internal battery which provides a current source for testing resistance. It's important to note that this test current comes out of the ***negative*** terminal of most multimeters (though a digital multimeter such as my AVO type may source current from the ***positive*** terminal instead). When testing an intact diode, you're looking for a fairly *low* resistance (say five kilohm – 5k – or so) in the "forward" direction and a *very high* resistance in the "reverse" direction.

To demonstrate, first test any available diode by checking its resistance with

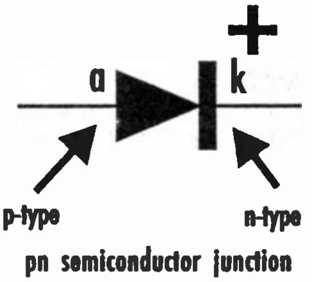


Fig. 1. Basic pn*-junction diode*

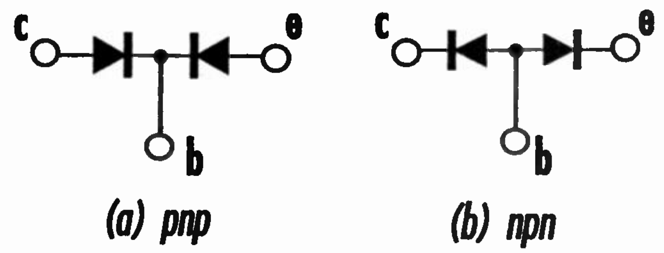


Fig. 2. Transistors formed from two pn*-junction diodes*

a moving-coil meter set to a middle resistance range. Note the reading then reverse the connections to the diode.

A ***high*** resistance in ***both*** directions indicates that the diode is probably open-circuit and therefore useless. A ***low*** resistance in ***both*** directions suggests a short circuit – equally useless.

When you note a reading of say 5k to 10k, then the diode is forward biased and is carrying current supplied by the meter's internal battery. This current flows out of the negative socket so the diode terminal connected there must be the ***anode (a).*** This is the key to testing your transistors, Mark.

...and transistor trials

Some common pin-outs for small signal transistors is shown in Fig. 3, and supplier's catalogues contain a wealth of extra data so check there too. Fig. 3(b) for the TO-92 case might not be much help because there are several different arrangements produced so you might need to experiment or refer to data.

If you're stuck then you can use the following method as a guide to separate *npn* from *pnp*. It should at least identify the base but may not determine which is the collector or emitter because they both seem to behave the same way in this test.

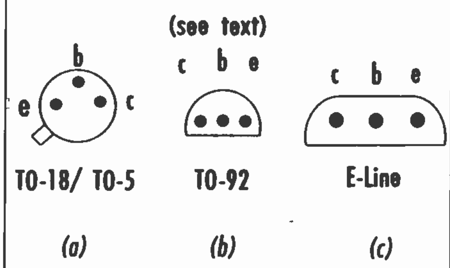


Fig. 3. Common small signal transistor outlines (base view).

With Fig. 2 and Fig. 3 in mind, connect the negative meter lead to one of the transistor's pins and test the resistance of the other two pins. Change to another pin if necessary until you suddenly note a low reading (several kilohms) – you've hit on one of the "cathodes" of the internal diodes. A *pnp* transistor has one cathode (the common base) and two anodes (emitter and collector). The reverse is true for a *npn* device which will appear to contain two cathodes and one common anode (base) instead.

Hopefully using this technique you can go around the pins to determine the polarity of the transistors, their pinouts and whether they are serviceable or "bin-worthy." Having selected the fully functional devices, we can now try to grade the devices according to two parameters: *leakage* and *gain*.

First, the parameter I_{CEO} measures how "leaky" a transistor is: it's the "leakage current" between emitter and collector with the base open (unconnected). Connect the negative lead of your Ohmmeter to the collector (*npn*) or emitter (*pnp*) and hook the remaining emitter or collector to the +socket as shown in Fig. 4(a). Leave the base open circuit.

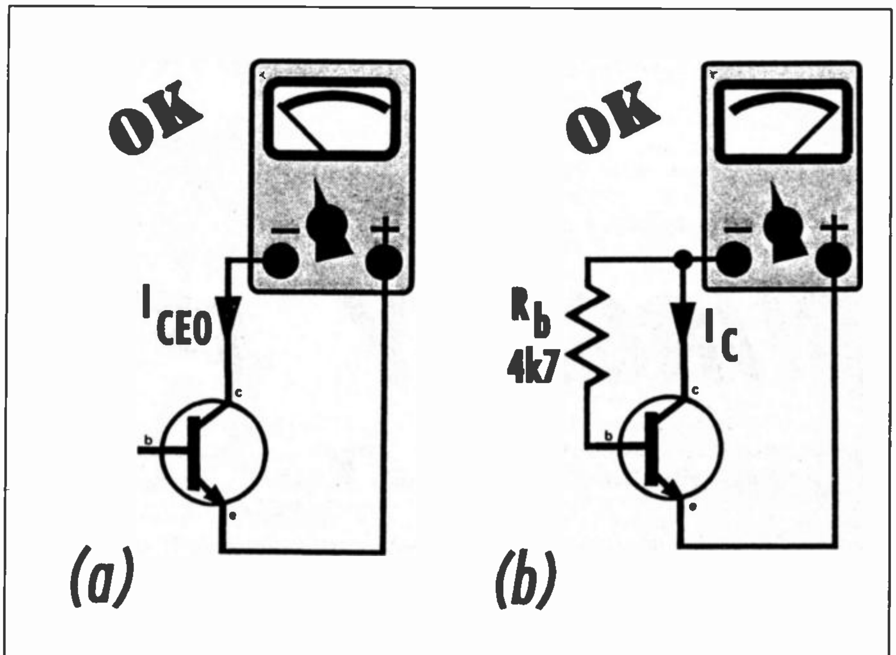


Fig. 4. Testing leakage current and gain.

There should be ***no*** meter deflection at all on a good silicon transistor. Any meter reading proves that leakage current is flowing between emitter and collector: the higher the deflection, the worse the leakage. A leaky transistor is definitely suspicious: germanium types are much worse in this respect.

As another experiment, you might care to sacrifice a transistor or two when monitoring I_{CEO}, by heating it up with a hot air gun or soldering iron, then letting it cool. The leakage current will slowly but surely rise with temperature, until eventually the effect becomes irreversible after which the transistor has been damaged. A silicon device is rated up to 150 degrees Celsius maximum – so watch what happens to the I_{CEO} reading on the meter scale when the transistor loses its cool!

The final test involves monitoring the *small signal gain* h_{fe} of the transistor. It's a very basic *qualitative* test which involves applying some "forward bias" to the transistor base while checking the leakage current. The bias current is again supplied by the Ohmmeter's battery.

For a *npn* device, add a small resistor (say 4k7 to 10k) between collector and base as shown in Fig. 4(b). A *pnp* transistor base should be shunted to the emitter instead.

There should now be a large deflection on the meter scale because the transistor should be biased into conduction rather than just "leaking". The better the gain, the larger the deflection. A *small deflection* is a sign of a poor transistor.

So, hopefully you can now sort out your *npn* and *pnp* transistors and then grade them for both leakage and gain. Isn't it amazing what a simple multimeter will tell you?

Fuse fundamentals

From ***Mr. S. A. Wohlert*** of Ashford came a letter regarding an earlier *Circuit Surgery* topic – fuses.

Could I return to the subject of fuses which you discussed in December's Circuit Surgery? *I recall that many old stagers as well as newcomers to electronics regard a fuse as being a zero resistance link in a circuit. In fact a fuse of "zero" resistance would never rupture because this "ideal" component would not dissipate any power whatsoever, even under extreme overload conditions.*

Thus when using a multimeter, particularly a digital type to check a fuse, one should always anticipate a resistance reading commensurate with the fuse rating. I recall taking measurements on a quantity of 60mA fuses of reputable manufacture, and each was found to be approximately 24 ohms!

You are quite correct, of course – a fuse inherently possesses an electrical resistance, and is calculated to dissipate excessive power when subjected to an overload. This produces an I^2R heating effect which after a predetermined "time factor" results in the fuselink melting, interrupting the circuit. Fuses do *not* have zero resistance otherwise it would be impossible for them to dissipate power as you rightly say, and a fuse resistance of several tens of ohms may not be unusual.

Nearly always, if testing a suspect fuse then all we need is a go-no-go indication, so regardless of which meter range you select, it should be easy to distinguish between a low (near zero) resistance and infinity. It's rather like the simple experiments we described earlier for the transistors, when all we wanted was a simple *qualitative* "yes or no" test result, rather than *quantitative* readings of what the gain or leakage actually were.

Power Mad

Mr. S. Conway of Gateshead raised some interesting issues in a recent letter:

Could you design a suitable thyristor or triac-based circuit to control a specialised incandescent lamp rated at 240V a.c. 1000 Watts. The dimmer circuit needs a variable resistor to adjust the brightness level.

As a regular reader of Circuit Surgery, *could I also add that suggested circuits are* *only ever given in circuit diagram form, but if you could also give stripboard layouts like the projects in the rest of the magazine, many constructional errors would be avoided and assembly itself would be far more simple.*

Your circuit query first. By far the neatest, simplest and therefore safest way of dimming a lamp is to use a complete power controller i.c. which is specially designed for this type of application.

I'm afraid it isn't the cheapest method but if ease of assembly and *safety* are more important than cost considerations then I strongly recommend using an i.c. rather than using individual discrete components which may all be working at *mains potential*. Either way, ***the following project though quite simple, is definitely NOT intended FOR BEGINNERS due to the risks involved with mains voltages – so please take care.***

Lamp Dimmer

You require at least a 6A "phase controlled, a.c. mains power regulator" device to control a 1kW lamp. I suggest the RS 300-344 or the Farnell 170-630, see Fig. 5. They can withstand peak switch-on surges of typically 100A or more.

All you do is hook up a potentiometer with standard hook-up ***mains-rated*** wiring and then connect the load (lamp) via a fuse using 13A mains-rated wire for safety (through a 13A socket if you wish), as denoted by the thicker lines in the circuit diagram. Neatly solder the three leads to the i.c. pins. The mounting tab of the device is electrically isolated and requires fixing to a heatsink rated at between 7 to 8°C/W. You ***must*** ensure that the enclosure you use is "fully Earthed", and that ***absolutely every connection*** in the circuit is fully insulated from the user so that there is ***no possibility*** of exposure to electric shock.

These types of "phase control" circuits are similar to traditional domestic dimmer-switches, and are notorious for producing r.f. interference. If this is likely to be a problem, use a ready-made mains-voltage suppressor rated at 5A 250V a.c. or more. I have used can-type combined inductance and delta-capacitor suppressors to great effect in similar circuits. Again, I am afraid that they are not terribly cheap – expect to pay around £10 or so.

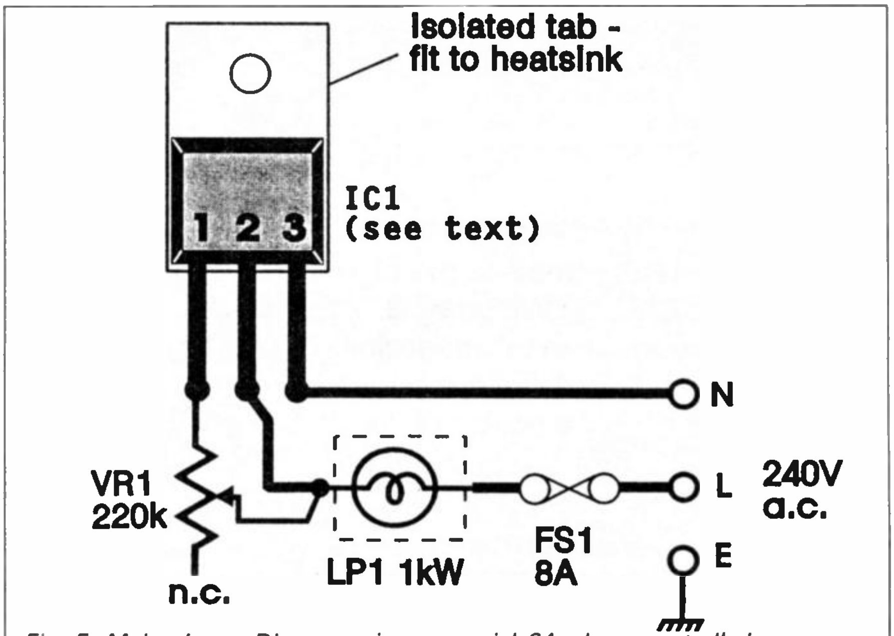


Fig. 5. Mains Lamp Dimmer using a special 6A phase controlled a.c. power regulator chip.

Turning to your second point, *Circuit Surgery* is of necessity limited in page space, and if I included stripboard or p.c.b. layouts then there would be less to distinguish the column from the constructional projects we already publish, and there would be less space to publish readers' letters too. On the down side, regrettably it means that some readers' ideas cannot be accommodated in this column, because they're too complex or there just isn't the space to do them justice.

In the case of the Lamp Dimmer, although it's a simple circuit to follow, this suggested circuit is specifically aimed at more experienced users who are fully confident about the assembly of mains voltage equipment. Otherwise *Circuit Surgery* encourages readers to experiment for themselves or pass on their experiences, based on the information and circuit diagrams given.

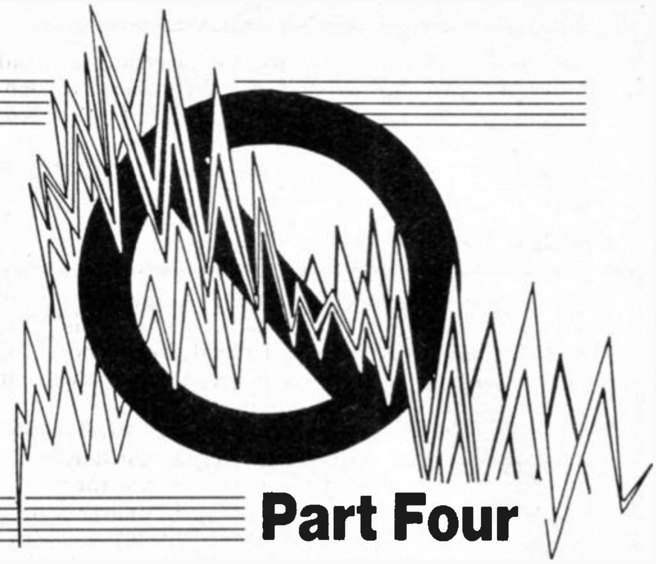
Don't despair: as Ed. says, we're a two-way magazine and we welcome your ideas for potential constructional projects.

Next Month: I will be investigating back-up battery systems again, this time by popular request, incorporating the ICL7673 i.c. with rechargeable batteries for the reserve. Also I take the lid off astable and monostable multivibrators constructed from logic gates.

If you have any suggestions, queries or comments for possible inclusion in this column, then write to me: c/o *Circuit Surgery*, 6 Church Street, Wimborne, Dorset BH21 1JH. I cannot promise an individual reply but I do read every letter and will try to help if possible.

Special Series

SAFETY FIRST!



T.R. de VAUX-BALBIRNIE

Part Four

Staying alive with electrical equipment

THIS is the fourth and final article in a short series concerned with household electrical safety. We shall continue last month's work by looking at a few situations where the use of low-voltage power supplies (batteries and mains-operated) brings a risk of fire.

We shall then look at some chemical hazards associated with the use of modern components and materials used in electronics. Those working in industry and education are reminded of the need to seek specific guidance and overseas readers should check their own national safety regulations.

LIGHTING CIRCUITS

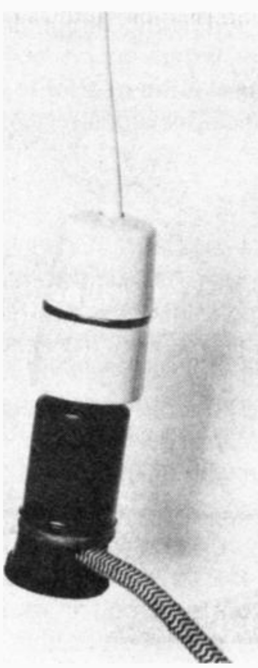
One common cause of fire touched upon last month is a high-current appliance being operated from a household lighting circuit. It used to be fairly common to use an adaptor so that an electric iron could be plugged into a hanging lampholder together with the lamp itself. This, presumably, was effective in keeping the wire out of the way of the ironing board and so prevented rubbing and consequent damage to the insulation.

However, this practice is dangerous for two reasons. Firstly, it overloads the circuit as we shall see in a moment and, secondly, there is no earthing provided to the metal case of the iron by the lamp holder. In the event of a fault developing where the live wire touched the case inside the appliance, an *earth-loop* shock could result when someone touched it. Readers who have not been following the series should note that this type of shock was discussed in some detail in Part 2.

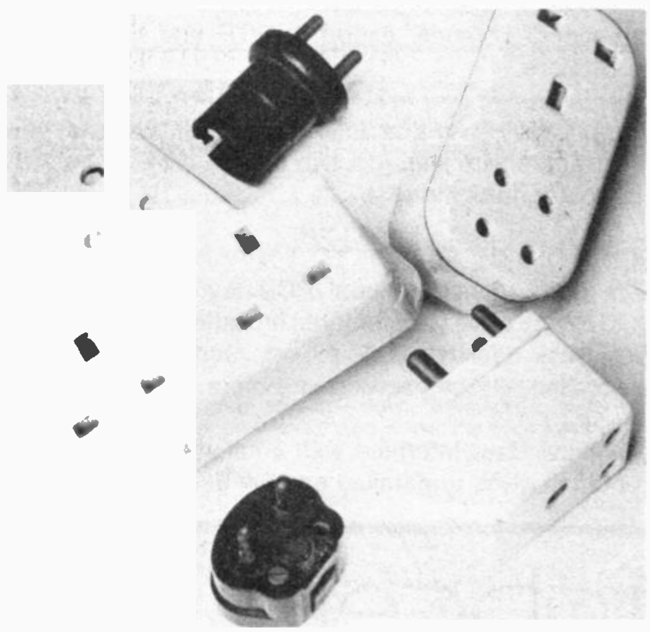
Normally a mains lighting circuit is rated at 5A maximum and fused at the main fuse-box with this value. When a high-current appliance is connected to such a circuit the combined current of this, together with some lighting, will be sufficient to blow the fuse (an electric iron is typically rated at 1000W-1200W corresponding to 4A to 5A on 240V mains).

This is where the foolish householder uprates the fuse to prevent it from blowing. However, the fixed cable serving the lighting circuit is only capable of carrying the small current for which it was designed and it may now overheat, melt the p.v.c. insulation and cause a fire.

Very high current appliances such as electric cookers and shower units must be wired up with thick wire rated appropriate to the current being drawn. Using ordinary ring-main type cable would overheat and possibly cause a fire. An immersion heater must have its own circuit – this will have a 15A fuse at the main fuse-box.



***Never** use a high-current appliance in a hanging lighting lampholder.*



A selection of various adaptors – these should only be used if no other solution exists. All 3-pin round types should have been rewired and replaced by now with standard 13A wiring, plugs and sockets.

It has been known for amateur electricians to add a shower unit to the immersion heater circuit. When the shower is switched on, the system is overloaded because this requires some 30A. The fuse will blow but if it is uprated, the cable will overheat with a consequent risk of fire.

BATTERY HAZARD

Mains electricity is not the only cause of fire. Certain batteries are able to deliver a very large current in the event of a short-circuit and pose a significant risk. To understand this, it is necessary to have some knowledge of *internal resistance*. This is the resistance of the material inside the battery or cell due to its structure.

Consider the 6V battery shown in Fig. 1a. This is connected to a 10 ohm resistor (the internal resistance – in this case five ohms – is shown as an external resistor within the dotted box). The battery voltage pushes current through the circuit and on its way it passes through both the internal and external resistances. Since the total resistance of the circuit (that is the sum of internal and external resistances) is 15 ohms, Ohm's Law predicts that the current flowing will be:

$$I = V/R = 6/15 = 0{\cdot}4\text{A}$$

Suppose the battery were to have its ends connected together by a short piece of wire of negligible resistance – that is, a *short-circuit* is produced – see Fig. 1b. The current will now be limited by the internal resistance only and in this case will be:

$$I = V/R = 6/5 = 1{\cdot}2\text{A}$$

Certain types of battery have an exceptionally low internal resistance. Chief among these is the *lead-acid accumulator* used as a car battery and in miniature form as a back-up power supply for a burglar alarm, etc. This type of battery has a typical internal resistance of 50mΩ (that is, 0·05 ohms) or less. Applying Ohm's Law it follows that, under short-circuit conditions, a 12V lead-acid battery will deliver at least 240 amps.

This is an enormous current and will cause even fairly thick wire to become red hot very quickly. Furthermore, a large-capacity battery (such as a car battery) could keep this up for several minutes. If there was any combustible material nearby there could be a major fire and, in the case of a car system, the vehicle could be totally burnt out within minutes.

NEGATIVE EARTH

Of course, no sensible person would ever short-circuit such a battery on purpose – it is likely to damage it

Fig. 1a.

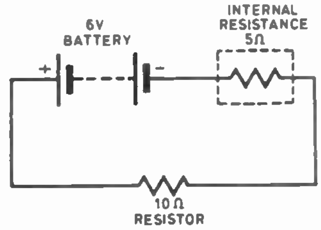
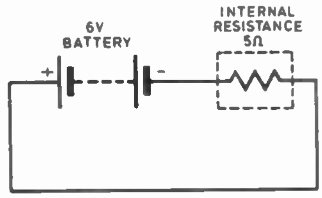


Fig. 1b.

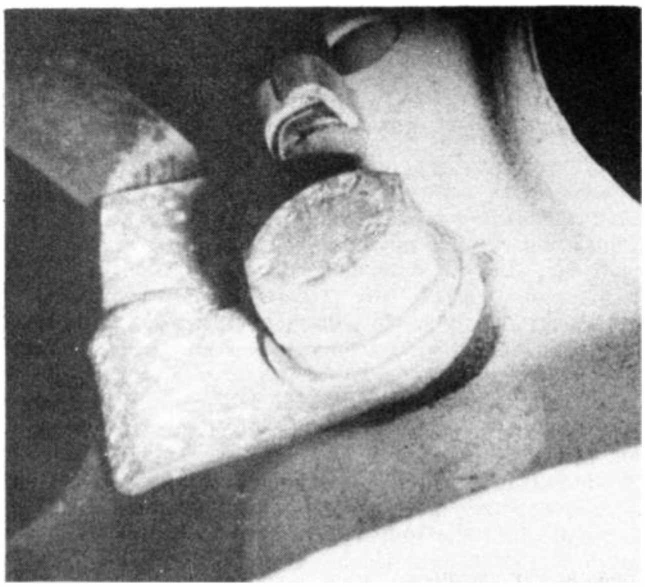


anyway but it can happen by accident especially in a car electrical system. It is standard practice to connect the negative terminal of the battery direct to the car chassis through a thick wire (see photograph). In this way, any metal in the vehicle structure is at battery negative voltage. The reason for this is that accessories may be connected by a single wire to the positive battery terminal (via a suitable switch and fuse) with the circuit completed via the car bodywork. This saves on copper wire and reduces weight and cost.

Suppose the battery positive terminal was being tightened using a spanner (see photograph) and the handle at the other end touched a metal part. This would constitute a short-circuit. The car body and spanner both have little resistance so the current would be limited largely by the internal resistance of the battery – thus hundreds of amps could flow. (For this reason the negative (earth) lead should always be connected or disconnected first when this is necessary.)

There would be violent sparking and the end of the spanner could be melted off. Burns may be caused and pieces of metal thrown into the eyes. If the circuit was completed through a finger ring, a very nasty burn would result. ***This is why it is essential to disconnect and remove the battery before working on a car electrical system, but make sure this will not affect coded stereo equipment or engine management computers on some vehicles which might need expensive resetting.***

During charging the battery can also produce explosive gasses and any sparks caused can result in the battery exploding – see the information on this under The Big Bang section.



Car "earth" terminal (battery negative) is bolted directly to the metalwork (chassis) via a thick wire.

When tightening the battery positive clamp, the spanner MUST NOT TOUCH ANY METALWORK – see text.

HIGH-POWERED ACCESSORIES

Automotive wiring is very different from household wiring. In a car, wires often pass through holes drilled in metal. Such a hole will always be protected by a rubber grommet so that the insulation is not cut through and cause a short-circuit with the metal body.

When a car accessory is wired up, it is essential to follow the same practice. Also, the insulation on any wire must be thick enough to withstand the rigours of use especially the pulling and vibration found in a car. In practice, this means using special multi-strand auto-type wire. Household wire is totally unsuitable.

Readers who have been following the series will remember last month's calculation which showed that high-powered car accessories require very high currents – 1A for each 12W of power. It is essential, therefore, not only to use proper auto-type wire with adequate insulation but to select its current rating according to the load.

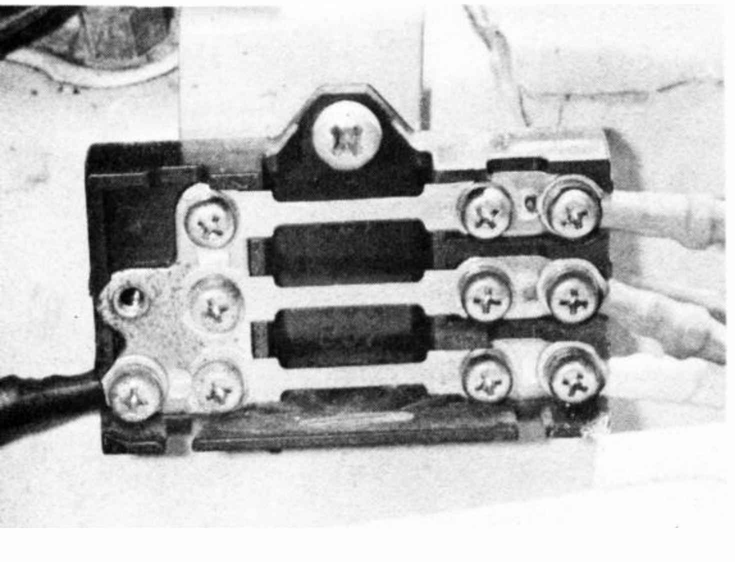
It is particularly dangerous to make a *direct* connection to the car battery positive terminal perhaps by using a crocodile clip. This is because there is then no fuse to protect the circuit. In the event of a short-circuit a very high current would flow with consequent problems of burning insulation. If there were petrol fumes around, a major fire could result. It is best to connect new circuits to the spare fused outlets provided at the fuse-box.

Manufacturers now fit *fusible links* to their cars – these are just "last resort" fuses and are placed first in the battery positive feed wire (see photograph). The only device not powered through a fusible link is the starter motor since this requires a very heavy current. Fusible links are designed to blow with a current of around 50A. This is higher than should normally exist even with all accessories switched on and will only blow under a vast overload – usually short-circuit conditions. Although useful, fusible links will not provide protection if a circuit derives its positive feed direct from the positive battery terminal or the starter motor feed wire at the solenoid unit.

BURNT FINGERS

Other types of rechargeable battery in common use also have a very low internal resistance. These can also provide a high current when short-circuited and can pose a hazard – at least in the form of burnt fingers.

Like a car battery, *nickel-cadmium* cells have a very low internal resistance and a short-circuit at their terminals can cause connecting wires to become red hot and cause injury or fire. For this reason, it is probably better not to use such batteries for experimental work.



Manufacturers now fit "fusible links", designed to blow at about 50A, in car electrics.

If there is an accidental short-circuit on, for example, a circuit panel and the circuit is connected to a nickel-cadmium battery pack for testing, the offending section of track will probably melt, perhaps cause a burn, and ruin the p.c.b. If nickel-cadmium batteries cannot be avoided in this type of work, include a suitable fuse in the positive feed wire.

Even alkaline batteries (such as Duracell) can, when new, supply a current of several amps under short-circuit conditions. This can make thin wire become red hot and cause burns. Also, such a cell will become hot if one member of a pack is placed in the holder the wrong way round this can burn the fingers and could cause the cell to explode..

Manufacturers of standard (non-rechargeable) batteries advise against attempts to recharge them since this may cause overheating and, possibly, an explosion due to the release of gases. This is sound advice unless a properly designed and constructed circuit is used for the purpose. Such devices are commercially available now, also such a device, *Dry Cell Charger* was described in EPE (September, 1991).

MAINS-DERIVED SUPPLIES

Where a low-voltage supply is derived from the mains using a transformer and rectifier, there is a fire risk unless it is correctly rated for the purpose and properly fused. There should be no problems with a good commercial unit providing, of course, any fuses have not been uprated.

Mains-derived low voltage supplies used as part of a home-constructed project may involve some risk unless properly constructed. The transformer secondary has a very low resistance and so can deliver a very high current under short-circuit conditions (a similar situation to the car battery mentioned earlier). The design will specify a fuse in the secondary circuit to protect against such short-circuits and inadvertent overload. *This must not be uprated under any circumstances for example, in an attempt to increase the output current.*

There will also be a fuse in the primary circuit. This may be a separate one situated inside the case or may simply be the existing one in the mains plug. The value must be correct as specified. Including a *thermal fuse* in such equipment (see later for information on this type of fuse) would also be a good idea.

Sub-miniature mains transformers, of the type built into compact equipment, often become warm during use. However, there is a chance of overheating if there are insufficient ventilation holes (or these are covered over). It is wise to use a transformer having a generous current rating perhaps double what is required. Not only will it remain cooler but it will have more stable operating characteristics too. Of course, using a larger transformer is sometimes impossible on grounds of size, cost or weight.

THERMAL FUSES

Thermal fuses (see photograph) are widely used in industrial equipment and certain household appliances. These are effective in preventing fire due to overheating. A thermal fuse, unlike an ordinary fuse, does not "blow" due to the current flowing through it but with direct overheating. Thermal fuses, therefore, do not have a current rating as such but do have a stated maximum current capacity which must not be exceeded.

This is typically 15A for a large one and 3A to 5A for the smaller variety. However, their main specification is *the temperature* at which they blow. The available range is from around 72°C to 250°C.

A thermal fuse may be incorporated in any equipment where unexpected overheating could cause a problem. Care must be taken when installing one because some types have a metal case which becomes live in operation so it is essential that it does not touch any metal part. An electric iron often contains a thermal fuse – this will remain intact unless the thermostat fails, the contacts stick together and the temperature rises above the maximum operating value. This used to be a common cause of fire.

One practical point is that thermal fuses should never be *soldered* into a circuit – this is likely to blow them due to heat from the soldering iron conducting along the connecting leads. To avoid this, the connections should be *crimped* in place or screw terminals used. Thermal fuses are non-resettable and must be replaced if they ever do blow. It may not be possible to obtain a replacement locally but they are stocked by all major mail-order suppliers.

THE BIG BANG

Where electrolytic capacitors are used for smoothing or other purposes it is essential that they are used correctly. In practice, this means that they must always be connected the correct way around in the circuit (the polarity is marked on the body). It also means that they must never be used in alternating current (a.c.) circuits.

A further point is that the working voltage (marked on the body together with the value) must never be exceeded even *slightly*. In fact, it is wise to choose a capacitor having a working voltage perhaps 50 per cent higher than required to allow a safety margin. If these precautions are not observed, the capacitor may explode violently throwing pieces of aluminium can and chemicals over a wide area and this may cause eye injury.

There are at least two chemical hazards arising from the use of car batteries and other types of lead-acid accumulator. Thankfully, these have been reduced to some extent by the modern type of sealed-for-life unit. The traditional battery with removable caps is more dangerous but any lead-acid battery must be treated with respect.

The liquid inside consists of reasonably strong sulphuric acid. This is a very harmful and corrosive substance. If it gets on to the skin or clothing, copious amounts of water must be used to remove it. If it splashes into the eyes, it must be similarly washed out thoroughly and *medical* attention sought *immediately*. The metalwork around a car battery is often rusted – witness to these corrosive fumes.

When a car-type battery is fully charged, further current supplied cannot charge it further. The energy now splits the water content of the acid into its chemical constituents – hydrogen and oxygen. That is, *electrolysis* takes place. The products are both gases and, in the traditional form of battery, escape harmlessly through the small vent holes provided in the caps.

However, if there are any sparks due to poor electrical contact nearby or if a flame is used – perhaps to light a gas soldering iron, the mixture of gases can explode very violently. This can easily split the battery case into many sharp fragments and these, together with the flying sulphuric acid, *are very dangerous indeed*. Even the sealed-type of battery is not totally immune from this possibility so beware!.

CHEMICAL NASTIES

There are several rather nasty chemical substances used in the manufacture of electronic components and in the servicing of equipment. An example is mercury. This is used in such items as mercury tilt switches and, of course, thermometers. Mercury is liquid at normal room temperature and, because it conducts electricity, is excellent for these purposes. However, it is poisonous and should not be touched. Spilled mercury slowly releases vapour which if breathed over a period of time can cause serious long-term health problems.

It is essential that tilt switches and certain types of relay and thermostats containing mercury are not broken open to examine the contents. Chemical compounds of mercury; which are particularly poisonous, appear in certain types of cell – notably button cells used in some watches, test equipment, small microphones, etc. These must similarly be left intact and disposed of sensibly.

For measuring temperatures in experimental work, it is best to use an *electronic* thermometer to avoid the possible breakage of a mercury one. Alternatively, use a thermometer containing the much safer coloured *alcohol* as the working liquid. These are available to cover the range of a traditional "laboratory thermometer" i.e. −10°C to 110°C.

Dead nickel-cadmium batteries should not be broken open since there is cadmium and potassium hydroxide inside, both decidedly nasty substances. Care should also be taken with certain materials used in the production of printed circuit panels. Sodium hydroxide (caustic soda) solution, used as a developer for sensititised boards, must be kept off the skin.

When sodium hydroxide is dissolved in water a lot of heat is liberated, spitting can take place and the solution can splash into the eyes. For this reason, rubber gloves and safety goggles should always be worn when using it. If sodium hydroxide does enter the eyes it must be washed out with copious amounts of water and medical attention sought immediately.

Ferric chloride is used as an etchant for p.c.b. panels and should also be treated with respect. This also liberates heat when dissolved in water and can splash into the eyes. Again, the use of safety goggles is advised.

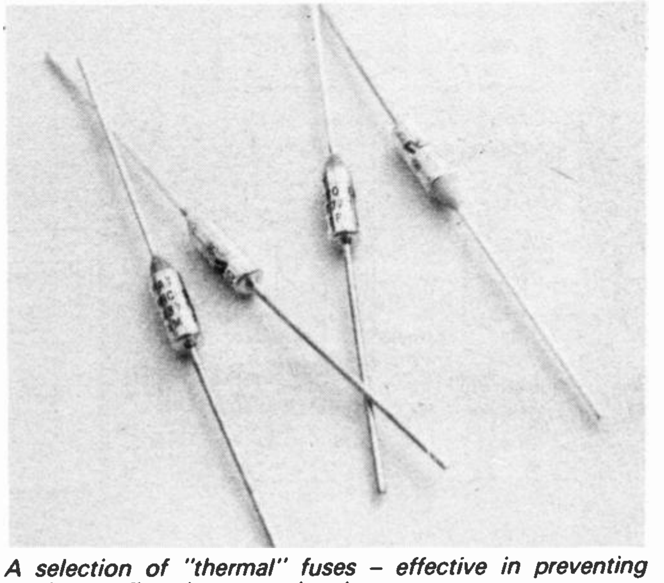
Some old heatproof wiring – perhaps inside an electric fire – contains asbestos. Care must be taken not to breath any of the fibres released from this since it could pose a serious health risk. It is best to dispose of any such equipment. It is *not* a good idea to cut open any electronic components as a number of them, particularly semiconductors, contain hazardous chemicals.

NO SMOKE WITHOUT FIRE

This series would not be complete if we did not sing the praises of the smoke detector. Recommended by fire brigades everywhere and by all concerned with household safety, it is surprising how few people use them especially in view of their low cost.

By detecting smoke, a warning is given before flames develop and cause a large-scale fire. This provides valuable time to tackle the fire or to get out of the house. Smoke is lethal – especially when it comes from modern plastic materials such as those used for wiring insulation, equipment cases, etc. One smoke detector is rarely sufficient – use several units sited in key areas to provide the maximum protection

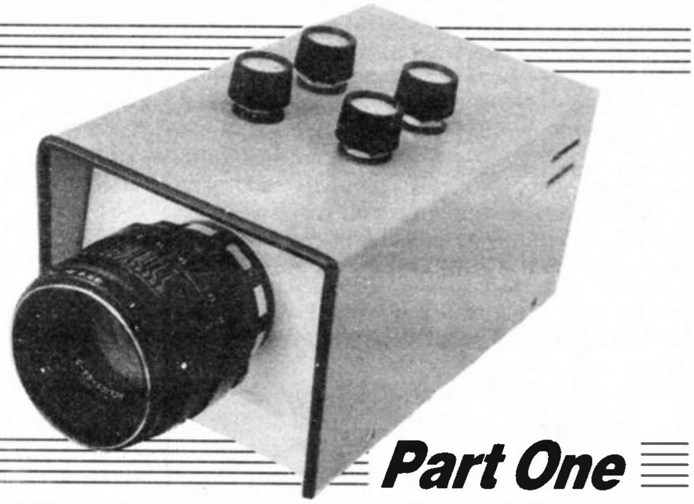
That's the end of the series. Electronics is very enjoyable but safety aspects must always be taken seriously. Hopefully, the information given over the past few months will help in avoiding accidents or at least to reduce their frequency.



A selection of "thermal" fuses – effective in preventing equipment fires due to overheating.

Constructional Project

CCD TV CAMERA



JOHN BECKER

Part One

Give an eye to your computer or neighbourhood watch with this money-saving monochrome monitor.

THIS monochrome closed-circuit television camera was originally designed as a low cost unit for inputting live visual images into a PC-compatible computer for graphical and general amusement purposes. However, following a spate of crimes in the author's locality, its potential as a security camera was recognised and the circuit was expanded to also allow live and recorded image interfacing with a cheap monochrome TV receiver.

The cost of the author's camera was kept low by using a lens from an old 35mm camera, and by the use of an image sensor inexpensively purchased as a slightly sub-standard manufacturing test sample.

In this constructional article, the camera circuitry and its TV receiver interface are described. A follow-up article will describe a PC-compatible computer interface, the "Frame Grab", which allows *live* images from the TV camera to be output to the computer, where it can be displayed, modified, coloured, stored on disc, printed to paper, or output back to the TV screen via the camera unit. Also, programming examples will be included.

The camera can be used on its own without a computer, and the Frame Grab can be used without the camera for other data gathering purposes.

The block diagram for the camera and its interface options is shown in Fig. 1.

IMAGE SENSOR

The camera is designed around the Philips solid-state CCD (charge coupled device) monochrome image sensor chip type FT800P. The chip consists of four active sections, image sensor, storage area, horizontal output register and amplifier. Fig. 2 shows a simplified functional schematic diagram for the image sensor.

The image sensor has 580 rows and 774 columns of light sensitive pixel elements. Light falling on the pixels causes an electrical charge to build up on them relative to the light intensity. The pixels are internally connected in a matrix controlled by a set of four-phase clock signals supplied via lines AX1 to AX4.

Fifty times a second, the charges on the complete block of pixels are rapidly transferred into the matrixed storage area, which is insensitive to light and is controlled by a second set of four-phase clock signals, supplied via lines BX1 to BX4.

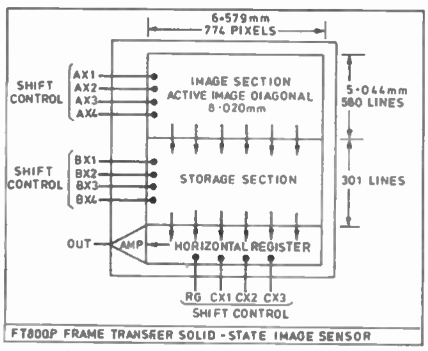


Fig. 2. Simplified functional schematic diagram for the Philips image sensor.

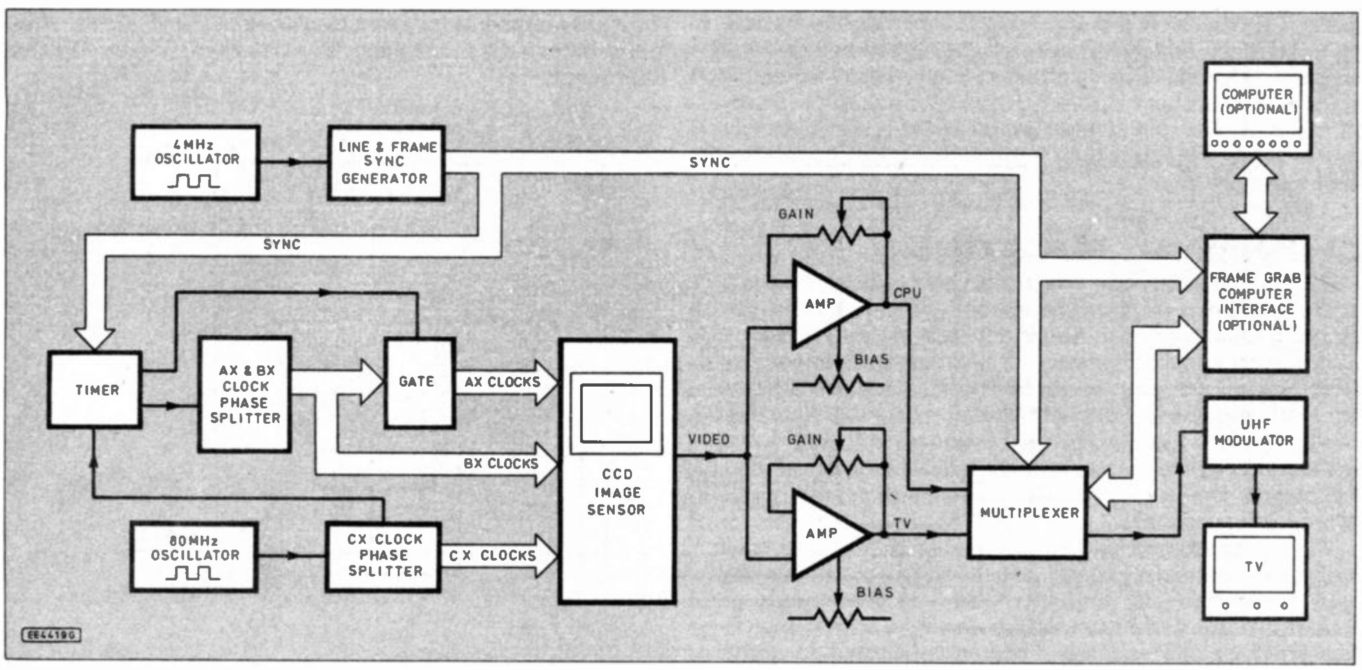


Fig. 1. Block diagram for the CCD TV Camera and its interface options.

During transfer, the AX and BX clock sets are synchronously interlocked.

At the end of the transfer, the AX clocks are stopped, allowing the sensor pixels to acquire a fresh set of light-related charges. The BX clock set, however, now proceeds to shift each line of pixel charges individually into the horizontal shift register.

After each stored line has been transferred, the BX clocks stop while the horizontal register shifts each separate pixel charge into the output amplifier register. The output shifting is controlled by the three-phase CX clock set, accompanied by the RG clock signal which resets the output register between pixels.

After all pixels of one line have been output, the BX clocks shift the next line into the horizontal register. The process continues until all the stored lines have been output, after which the next block of pixel data is transferred to the storage area.

How the four-phase clocks shift the electrical charges across pixels is illustrated in Fig. 3. The principle is similar to the bucket-brigade technique used in audio echo-control chips. More AX, BX and CX waveform data will be shown later when circuit testing is discussed.

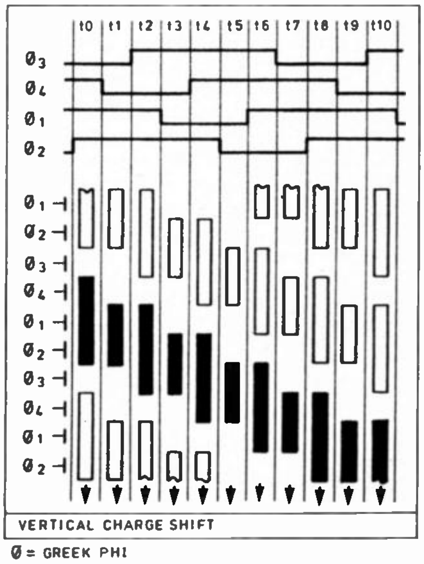


Fig. 3. Image sensor vertical charge shift sequence.

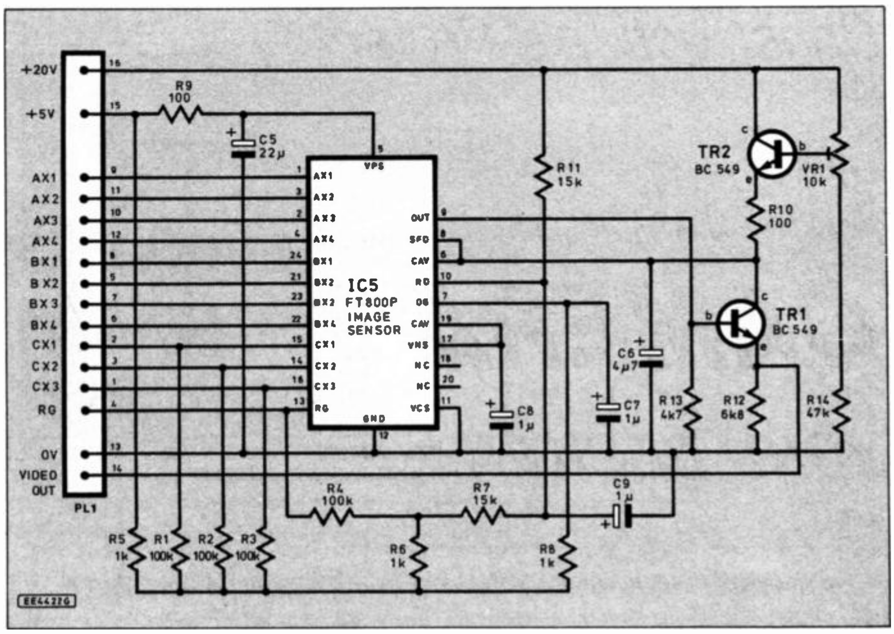


Fig. 4. Circuit diagram of the image sensor section of the camera.

IMAGE SENSING CIRCUIT

The sensor's clock input points and biasing circuit details, which are based upon the manufacturer's recommendations, is shown in the image circuit diagram Fig. 4.

The power supply sources will be discussed later, as will the voltages to be expected at selected points. At present, note only that transistor TR2 and preset VR1 set the bias voltage required by the video output stage, a level which is not critical, and that transistor TR1 buffers the video output signal.

SYNC GENERATOR

It had been hoped to derive all synchronisation signals from one master crystal-controlled oscillator of between 80MHz and 85MHz, the primary frequency range from which the sensor's clock waveforms are generated. Regrettably, a suitable crystal at a reasonable price could not be found. Consequently, it was decided to use a 4MHz crystal oscillator to set the more critical sync timings required by the TV receiver, and to use for sensor clock generation a separate 80MHz oscillator built using CMOS inverters.

In Fig.5, the line and frame sync generator circuit, IC7 is the 4MHz crystal oscillator feeding into IC8 which divides the signal down to three sub-frequencies. Output Q7 produces 15625Hz, the TV line sync frequency. Output Q6 produces 31250Hz which is further divided by IC9 and the AND gate around IC10a and IC10b, to produce a 50Hz pulse (TV frame sync rate) at IC10a pin 6. IC8 output Q8 is used later in the generation of a +20V supply line for the sensor chip IC5.

The 50Hz and 15625Hz signals have their pulse lengths modified by the dual monostable IC18 to suit TV receiver needs. Preset VR3 adjusts the line sync output pulse length.

Positive-going pulses from Q1 and Q2 of IC18 are combined by the OR gate IC6a, whose output is used for TV and Frame Grab synchronisation. Negative-going pulses from $\overline{Q}1$ and $\overline{Q}2$ of IC18 control the image sensor AX/BX transfer timings.

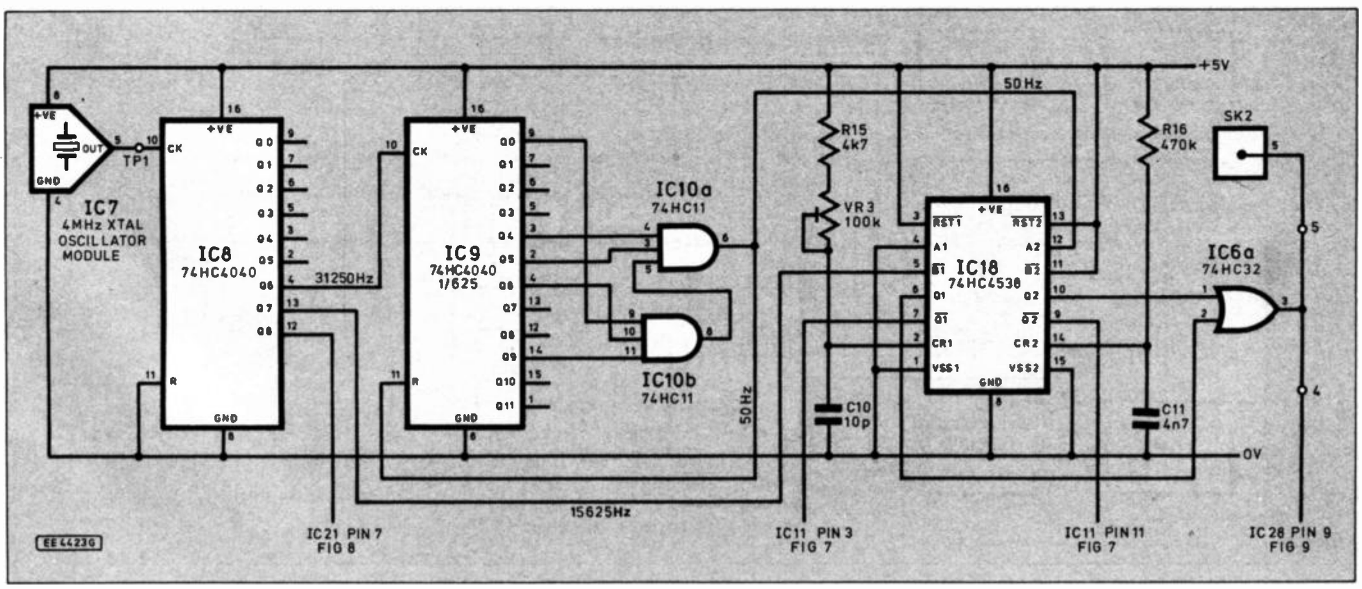


Fig. 5. Circuit diagram of the line and frame sync generator stage for the CCD TV camera.

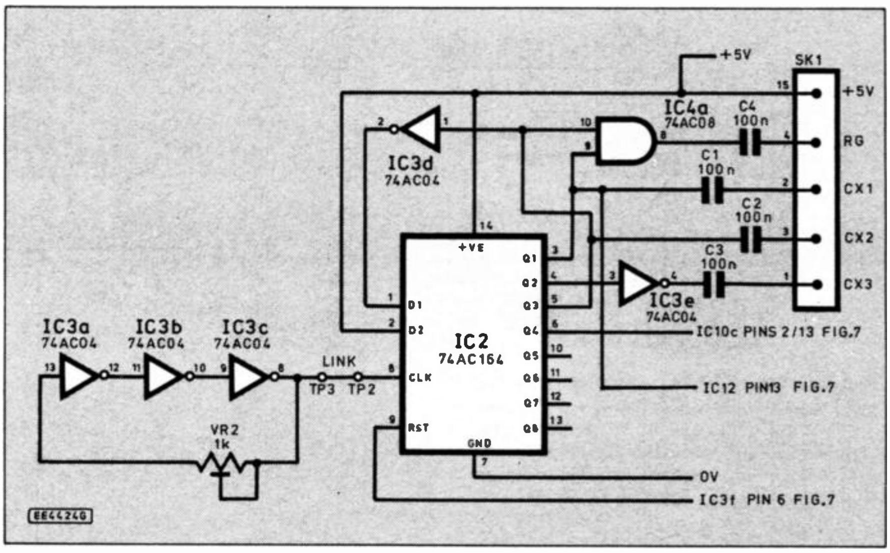


Fig. 6. Circuit diagram of the 80MHz clock generation and CX clock control.

CX CLOCK GENERATION

The CX clock generator circuit is shown in Fig. 6. It is driven by the 80MHz oscillator formed around the three inverters IC3a, IC3b and IC3c and tuned by preset control VR2.

Clocked by IC3c, shift register IC2 generates the three-phase CX waveforms in conjunction with inverter IC3d. Each clock pulse shifts the data on the Q outputs along by one output place.

Since Q3 is inversely connected back to IC2 D1 (data input),via IC3d, the shift register behaves as a divide-by-six counter with a different phase state on each output. The register is synchronised with the image transfer sequence by being reset via IC3f in Fig. 7.

The CX1 and CX2 waveforms are tapped from Q1 and Q3 outputs respectively, and the CX3 waveform is the Q2 signal inverted by IC3e. The RG waveform is the combination of the Q1 and Q3 outputs ANDed by IC4a. All four waveforms are coupled to the sensor chip IC5 via capacitors C1 to C4, respectively.

Output Q4 is not part of the CX control but is used as a clock source for the Frame Grab. The Frame Grab project will be covered in the follow-up article.

Graph D in the "Testing" section illustrates the waveforms. See Fig. 16 (next month).

Only the AC (Advanced CMOS) versions of IC3 (74AC04) and IC4 (74AC08) can be used in the circuit of Fig.6. It is best that IC2 should also be the AC version (74AC164), although at a pinch the 74F164 could be used, but with loss of picture quality. The HC (High speed CMOS) versions are too slow for this part of the camera circuit.

IMAGE TRANSFER TIMING

Output Q1 from IC2 pin 3 is additionally used as the clock source for the image transfer control circuit shown in Fig. 7. The clock signal is first slowed down by counter IC12b whose QB1 output delivers a divided-by-four frequency to the two AND gates IC4b and IC4c. The AND gates are further controlled by the QA and QB outputs of the dual flip-flop IC11.

The AX/BX image transfer routine is initiated by the positive-going edge of the 50Hz pulse from IC18 Q2 in Fig. 5. This pulse triggers IC11b so that its QB output goes high, so allowing the clock from IC12b QB1 to pass through AND gate IC4c to OR gate IC6b and on to the clock input of counter IC12a.

The counter (IC12) outputs QA0, QA1 and QA2 will be cycled through their normal binary divider sequence for as long as input CA is being clocked. Output QA3, though, is connected back to the RA reset input, so effectively IC12a only produces an 8-bit repetitive sequence.

The reset pulse also triggers a counter, IC19, which in conjunction with NAND gate IC20, monitors the number of times

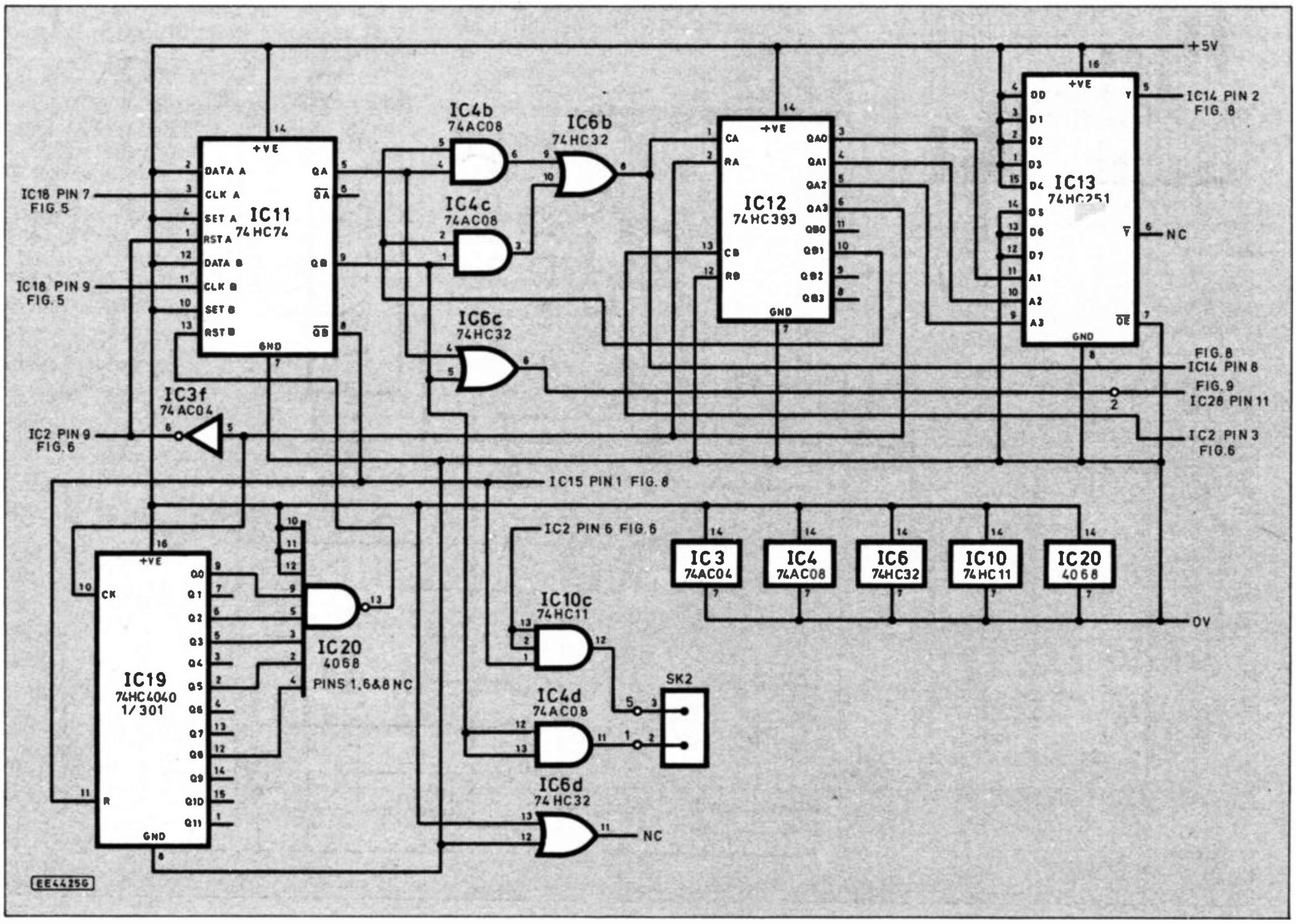


Fig. 7. Image transfer control circuit diagram.

IC12a has performed its 8-bit cycle. After 301 cycles (the quantity required for the full AX/BX transfer operation) following IC11b being triggered, IC20 pin 13 goes low and resets IC11b. As a result, AND gate IC4c is closed, IC12a stops counting, and IC19 is reset by IC11b $\overline{\text{Q}}$B.

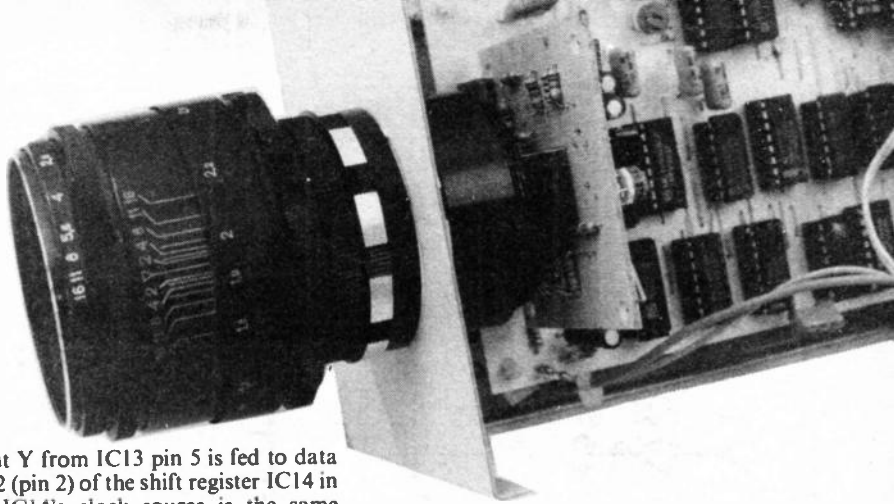
The cycle sequence of IC12a is also controlled by the 15625Hz line sync pulse from IC18 $\overline{\text{Q}}$1 (Fig. 5). The positive-going pulse edge triggers IC11a so that its QA output goes high, allowing AND gate IC4b to pass through clock pulses from IC12b QB1. From IC4b the clock pulses pass through IC6b to IC12a.

In this mode, when IC12a QA3 goes high, it resets IC11a via inverter IC3f so that the counter stops counting immediately on the eighth pulse. The reset pulse from IC3f also resets IC2 in Fig.6. During the 50Hz transfer mode, the effect of IC11a is over-ridden.

Additionally, IC11 QA and QB outputs are combined by OR gate IC6c to provide Frame Grab video sync pulses at the amplifier stage. IC11b QB and $\overline{\text{Q}}$B are used for other Frame Grab sync timings, via IC4d and IC10c.

AX AND BX PHASE SPLITTER

While IC12a is cycling through its 8-bit sequence, the QA0, QA1 and QA2 outputs are controlling multiplexer IC13, cycling its Y output through the logic sequence set on the D0 to D7 inputs. The sequence is set so that the Y output is high for five clock pulses on IC12a, and low for three clock pulses. It is from this data that the AX and BX clock phases are derived.



Output Y from IC13 pin 5 is fed to data input D2 (pin 2) of the shift register IC14 in Fig. 8. IC14's clock source is the same as that driving counter IC12a in Fig. 7. The resulting four-phase waveforms output from IC14 will be seen later in Graphs B and C (Fig. 16) next month.

Since the BX clocks are required in both the AX/BX and BX/CX transfer modes, they are taken directly to the level converter IC21. This raises the BX peak amplitude from the basic +5V to +10V as required by the image sensor. IC22 is used as a buffer to meet the sensor's input loading demands.

The AX clocks are only needed during the AX/BX transfer mode and so are taken first via the control gate IC15, and then to level converter IC16 and buffer IC17. During AX/BX transfer mode, IC15 routes its A0 to A3 inputs to the Y0 to Y3 outputs.

During the BX/CX transfer mode, a control signal from IC11 $\overline{\text{Q}}$B takes high IC15 pin 1, the Select input. This switches IC15 to route the logic levels on the B0 to B3 inputs to the Y0 to Y3 outputs, so holding the sensor's AX lines at the required static logic level.

VOLTAGE CONVERTER

Generation of the +20V supply level needed by the sensor chip is shown as part of Fig. 8. The Q8 output of IC8 in Fig. 5 (which has a frequency of half the TV line sync frequency, to minimise screen interference) has its peak level increased to +10V by IC21c. This is then buffered by IC22c in parallel with IC22d, so increasing the output drive power.

In standard voltage-doubling fashion, the clock signal is passed through capacitor C12, to which approximately 11·4V d.c. is added via diode D1. The combined signal level is rectified by diode D2 and smoothed by electrolytic capacitor C13.

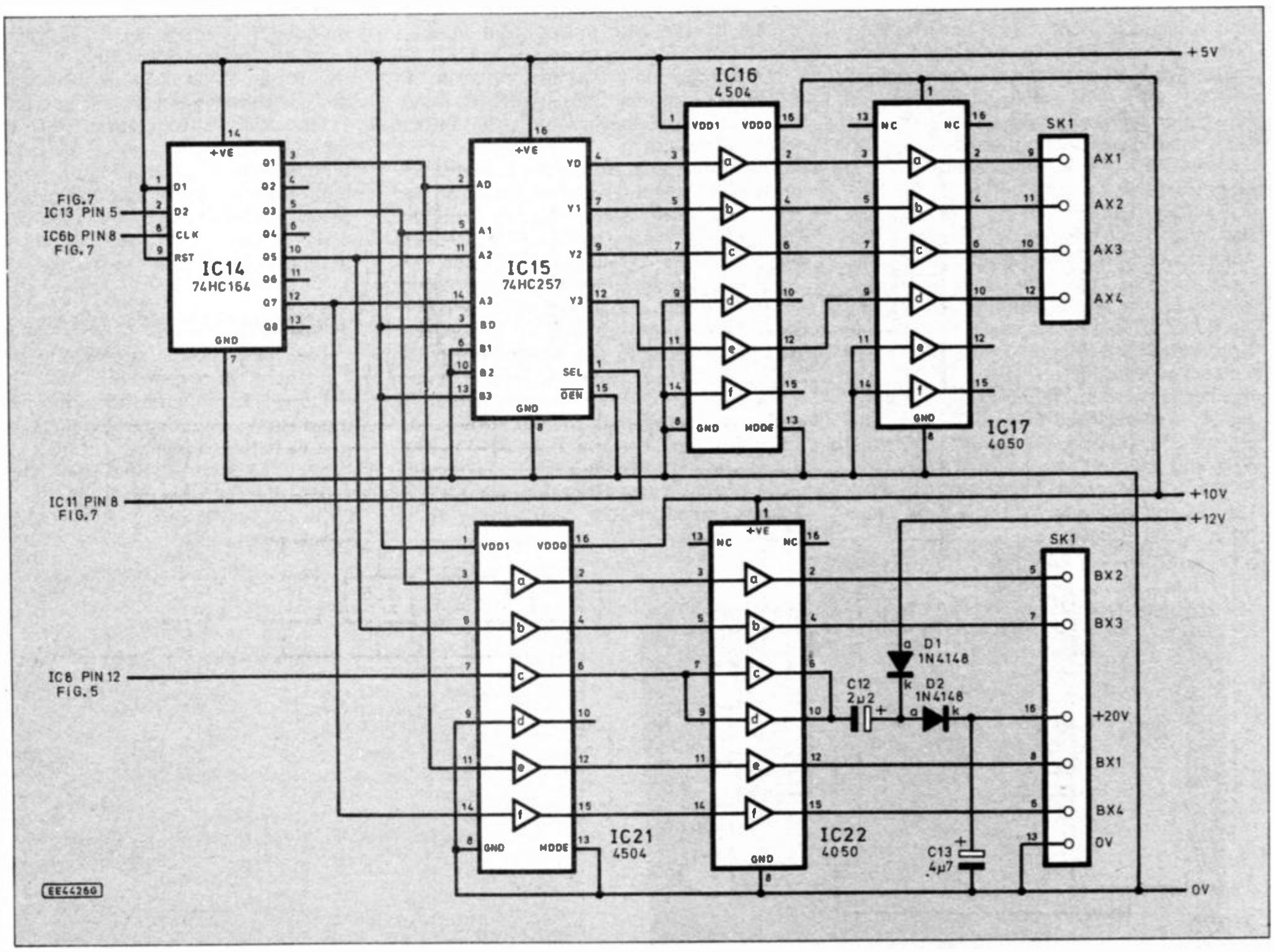


Fig. 8. Circuit diagram for the AX and BX clock control stages of the camera.

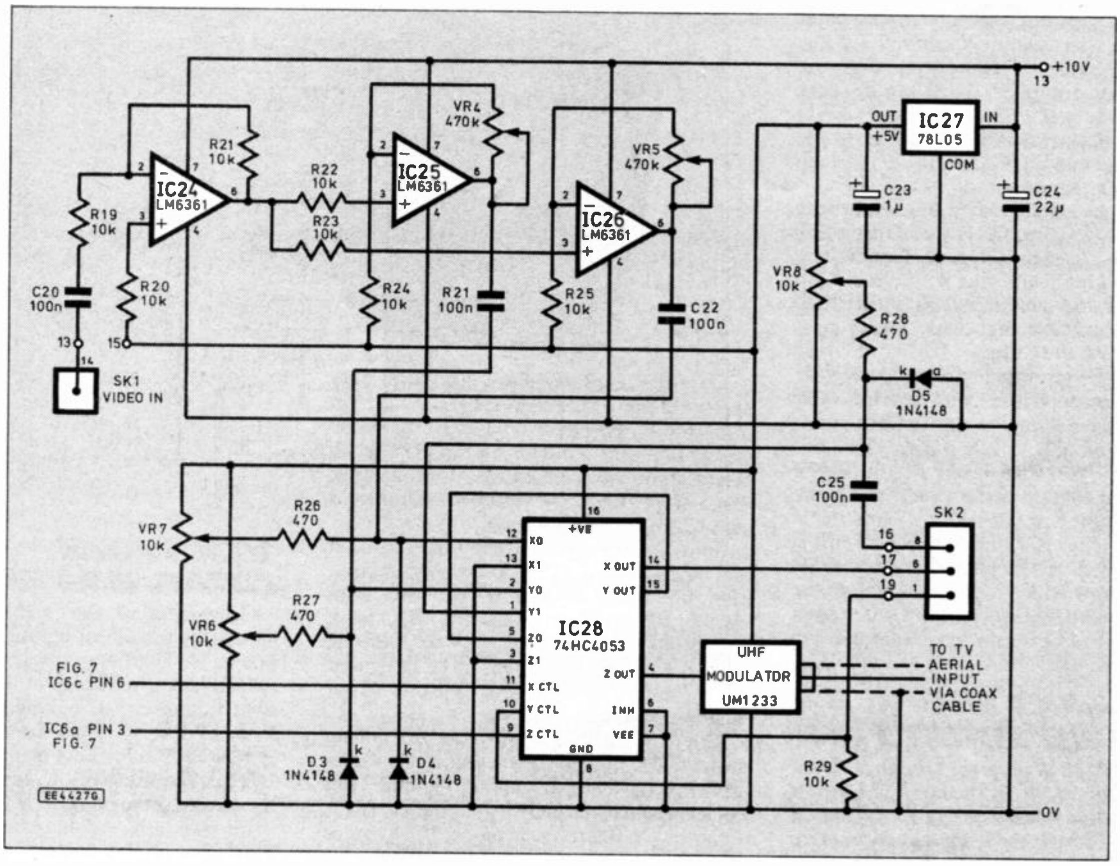


Fig. 9. Circuit diagram for the camera amplifier and a single i.c. multiplex stage.

AMPLIFIER CIRCUIT

Connection of the sensor's control clocks and voltages is made via socket SK1 and plug PL1, which has been designed as an integral part of the Sensor printed circuit board (p.c.b.). The video output signal is also connected via SK1/PL1 and is taken to the simple amplifier circuit shown in Fig. 9.

From SK1, the signal is brought via a screened cable to capacitor C20. Op.amp IC24 then buffers, inverts and doubles the signal level, sending it equally to the amplifier circuits formed around IC25 and IC26. The two amplifiers are identical and are used to separately modify the signals routed individually to the TV and the Frame Grab.

Panel potentiometers VR4 and VR5 adjust the gains of the amplifiers. Both output signals are referenced to ground by the inclusion of C21, C24, D3 and D4. Controls VR6 and VR7 are used to force a d.c. bias level onto the signals, which serves to alter the effective brilliance of the TV or computer screen displays.

Both video signals are taken to the multiplexer IC28. The signal destined for the Frame Grab is taken to input X0, while the X1 input is grounded. Controlled by the sync pulses from IC6c in Fig. 7 and applied to input X CTL, X OUT is repeatedly switched between the X0 and X1 inputs. This places an easily detectable sync marker onto the Frame Grab video line.

The video signal for the TV is first taken to input Y0. Input Y1 is connected to the processed video signal returned from the Frame Grab via capacitor C25 and biased by the network around VR8, R28 and D5. Normally, the signal routing is from Y0 to Y OUT, though a logic-high control signal from the Frame Grab to input Y CTL can switch the route to the Y1/Y OUT path. Output Y OUT is routed to input Z0, and input Z1 is grounded. The signal from the selected Y0 or Y1 path is modulated by the TV sync pulses sent from IC6a pin 3 in Fig. 5 and applied to input Z CTL. In the absence of the Frame Grab, input Y CTL is held grounded by R29, so forcing a Y0/Y OUT routing.

From output Z OUT, the sync-modulated signal goes to the UHF Modulator which superimposes onto it the carrier signal for UHF TV Channel 36. The UHF modulator is pre-tuned by the manufacturer and requires no setting up. Connection to the TV is via normal coaxial cable and suitable plugs.

The UHF Modulator used in the author's unit is type UM1233, a monochrome-only modulator. Although not verified, it seems likely that the UHF colour modulator type UM1286 could be used instead (but still producing a monochrome image).

POWER SUPPLIES

The basic power supply for the TV Camera is shown in Fig. 10. Through socket SK3, the basic 12V supply can be input from a mains operated power supply unit or battery adaptor, or from a 12V car battery. Alternatively, the computer's 12V supply line can be input via the Frame Grab and socket SK2. Switch S1 selects the supply input route.

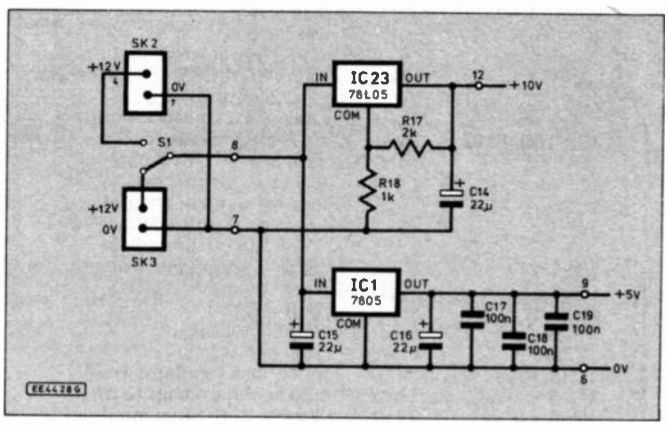


Fig. 10. Circuit diagram for the basic power supply.

The total current consumption is about 165mA. IC1 regulates the 12V supply down to 5V, and IC23 drops the 12V down to 10V with the aid of level-setting resistors R17 and R18.

The 10V line is required by IC16, IC17, IC21 and IC22 in Fig.8. It is also the power source for the op.amps of the amplifier circuit in Fig.9. In that circuit an additional +5V line is produced from the 10V line via regulator IC27. This provides a reference bias for the amplifiers, and the source supply for IC28 and the UHF Modulator. The use of IC27 as a second +5V source (instead of using the output of IC1) reduces noise levels on the amplifier board.

The 20V supply generation circuit was described earlier.

TEST CIRCUIT

The simple test circuit in Fig.11 is intended to help make this TV camera a unit which can be constructed by any reader who is familiar with the basic principles of electronics, has constructed a few projects before, but may not have much in the way of test gear. Admittedly, readers who have an oscilloscope will find checking the circuit much easier than those who do not. However, exploratory trials with the test circuit seem to confirm its usefulness.

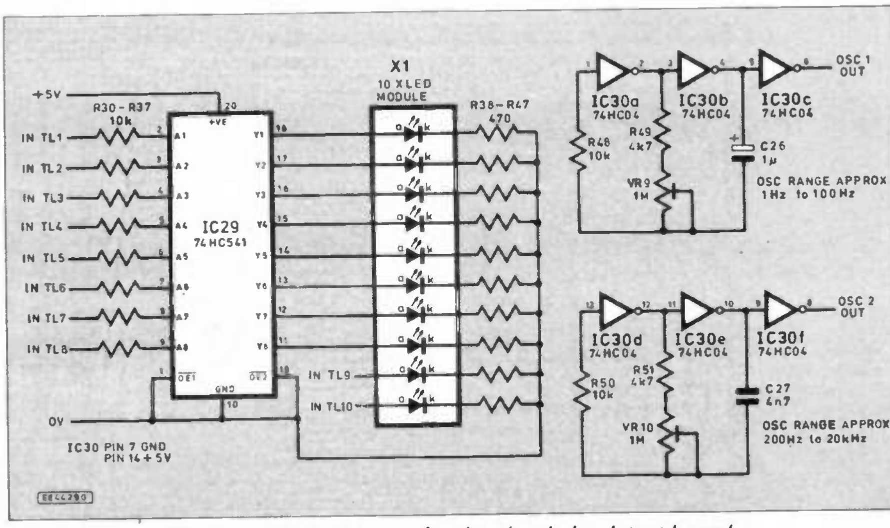


Fig. 11. Circuit diagram for the simple l.e.d. test board.

The circuit consists of 10 l.e.d.s in a single module, and two oscillators. Eight of the l.e.d.s are buffered by resistors R30 to R37 and IC29. Any of the buffered l.e.d.s can be temporarily wired to any point on the logic circuitry, including points which have a +10V peak level. The unbuffered l.e.d.s should only be connected to points which do not exceed +5V.

COMPONENTS

Approx cost guidance only **£110** *(sub-spec. sensor)*

TV CAMERA

Resistors

R1 to R4	100k (4 off)
R5, R6, R8, R18	1k (4 off)
R7, R11	15k (2 off)
R9, R10	100 (2 off)
R12	6k8
R13, R15	4k7 (2 off)
R14	47k
R16	470k
R17	2k
R19 to R25, R29	10k (8 off)
R26 to R28	470 (3 off)

All 0.25W 5% carbon film or better

See SHOP TALK Page

Potentiometers

VR1	10k min. round cermet preset
VR2	1k min. round cermet preset
VR3	100k min. round cermet preset
VR4, VR5	470k rotary carbon, linear (2 off)
VR6 to VR8	10k rotary carbon, linear (3 off)

Capacitors

C1 to C4, C17 to C22, C25	100n polyester (11 off)
C5, C14 to C16, C24	22µ radial elect. 16V (5 off)
C6, C13	4µ7 radial elect. 16V (2 off)
C7 to C9, C23	1µ radial elect. 63V (4 off)
C10	10p polystyrene
C11	4n7 polystyrene
C12	2µ2 radial elect. 63V

Semiconductors

D1 to D5	1N4148 signal diode (5 off)
TR1, TR2	BC549 *npn* transistor (2 off)
IC1	7805 +5V 1A regulator
IC2	74AC164 or 74F164 8-bit SIPO shift register (see text)
IC3	74AC04 Hex inverter
IC4	74AC08 quad 2-input AND gate
IC5	FT800P Philips CCD B&W image sensor
IC6	74HC32 quad 2-input OR gate
IC7	4MHz 8-pin crystal oscillator module
IC8, IC9, IC19	74HC4040 12-stage binary counter (3 off)
IC10	74HC11 triple 3-input AND gate
IC11	74HC74 dual D-type flip-flop
IC12	74HC393 dual 4-stage binary counter
IC13	74HC251 tri-state 8-input data selector
IC14	74HC164 8-bit SIPO shift register
IC15	74HC257 quad 2-input data selector
IC16, IC21	4504 Hex level changer (2 off)
IC17, IC22	4050 Hex buffer (2 off)
IC18	74HC4538 dual monostable
IC20	4068 8-input NAND gate
IC23, IC27	78L05 +5V 100mA regulator (2 off)
IC24 to IC26	LM6361 high speed op.amp (3 off)
IC28	74HC4053 triple 2-channel multiplexer

Miscellaneous

S1	s.p.d.t. min. toggle switch
SK1	16-way 0·1 inch edge connector, p.c.b. mounting
SK2	8-way 0·1 inch edge connector, p.c.b. mounting
SK3	3·5mm mono jack socket (or power supply socket)
PL3	3·5mm mono jack plug (or power supply plug) (PL1, PL2 are part of p.c.b. tracking)

Plugs to suit UHF Modulator and TV aerial sockets (one of each).

Printed circuit boards available from the *EPE PCB Service*, codes 865 (Control – double-sided p.t.h.) and 866 (combined Video Sens., Video Output, Test and Extension Plug); 8-pin d.i.l. socket (3 off); 14-pin d.i.l. socket (10 off); 16-pin d.i.l. socket (11 off); 24-pin d.i.l. socket, with 0·7inch pitch pin spacing for image sensor IC5 (see text); metal box, size 7·8 inch × 3·5 inch × 4 inch (L × H × W), with angled front; UHF Modulator type UM1233 (see text); lens and lens mount (see text); knobs (5 off); p.c.b. mounting supports, with screw hole base (4 off); self-adhesive p.c.b. support pillars (4 off); coaxial cable, length to suit application, screened cable, about half metre; 24 s.w.g. tinned copper wire (see text); multistrand coloured connecting wire; cable ties (4 or 5 off); 1mm terminal solder pins (about 35 off); solder and desolder braid (optional) to correct any erroneous solder shorts.

TEST CIRCUIT

Resistors

R30 to R37, R48, R50	10k (10 off)
R38 to R47	470 (10 off)
R49, R51	4k7 (2 off)

Potentiometers

VR9, VR10	1M min round cermet preset (2 off)

Capacitors

C26	1µ radial elect. 63V
C27	4n7 polystyrene

Semiconductors

IC29	74HC541 octal buffer
IC30	74HC04 Hex inverter
X1	10 × l.e.d. module

Miscellaneous

Printed circuit board available from EPE PCB Service, code 866 (combined board – see Control Board list); 20-pin d.i.l. i.c. socket (2 off)

OPTIONAL COMPONENT DELETIONS

If the Frame Grab Computer Interface will not be used, the following components can be omitted: R25, R26, R28, C24, D4, IC26, VR5, VR7, VR8, SK2, 8-pin d.i.l. i.c. socket, knobs (3 off).

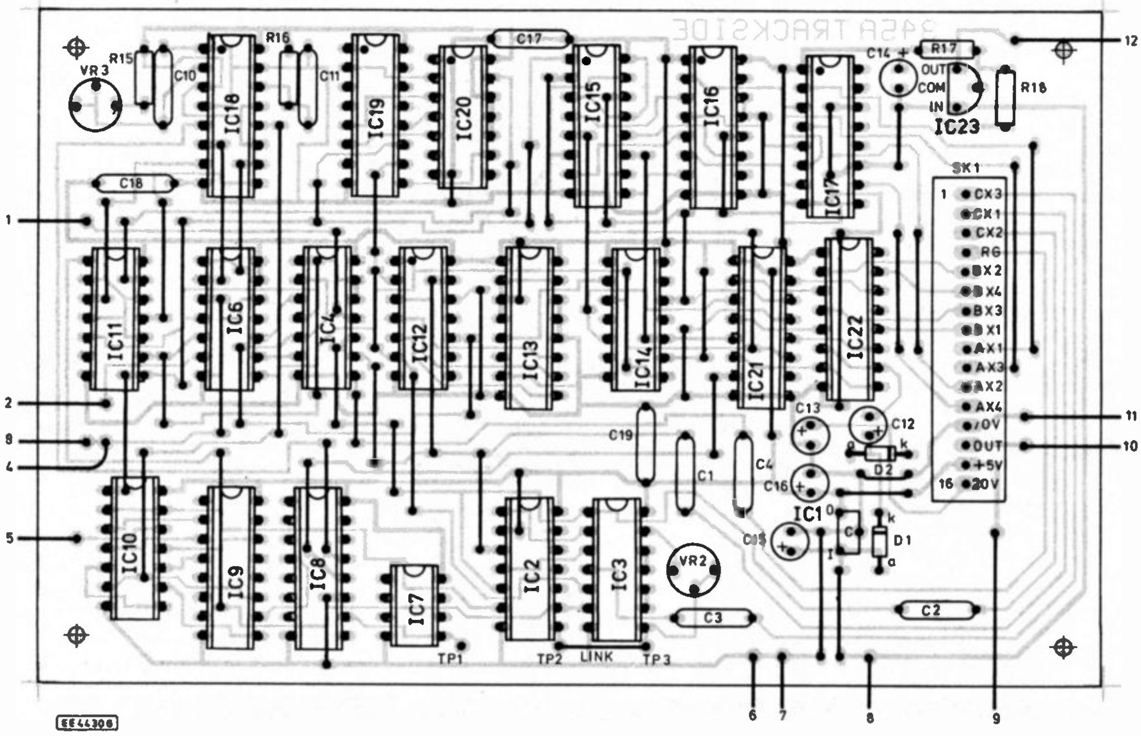
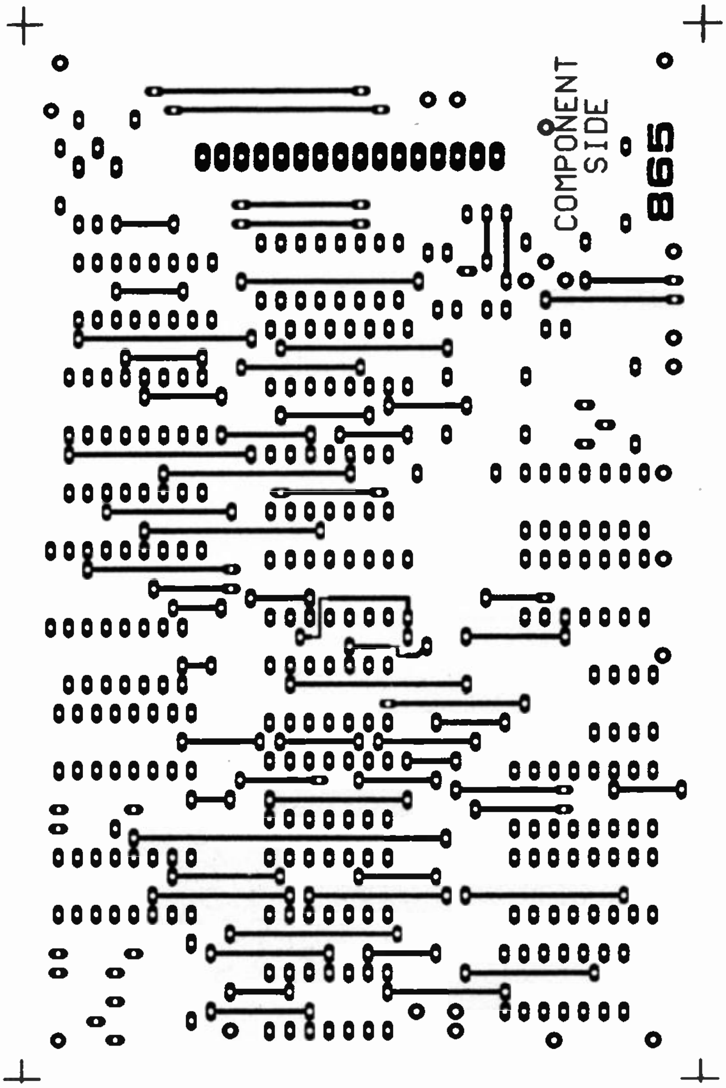
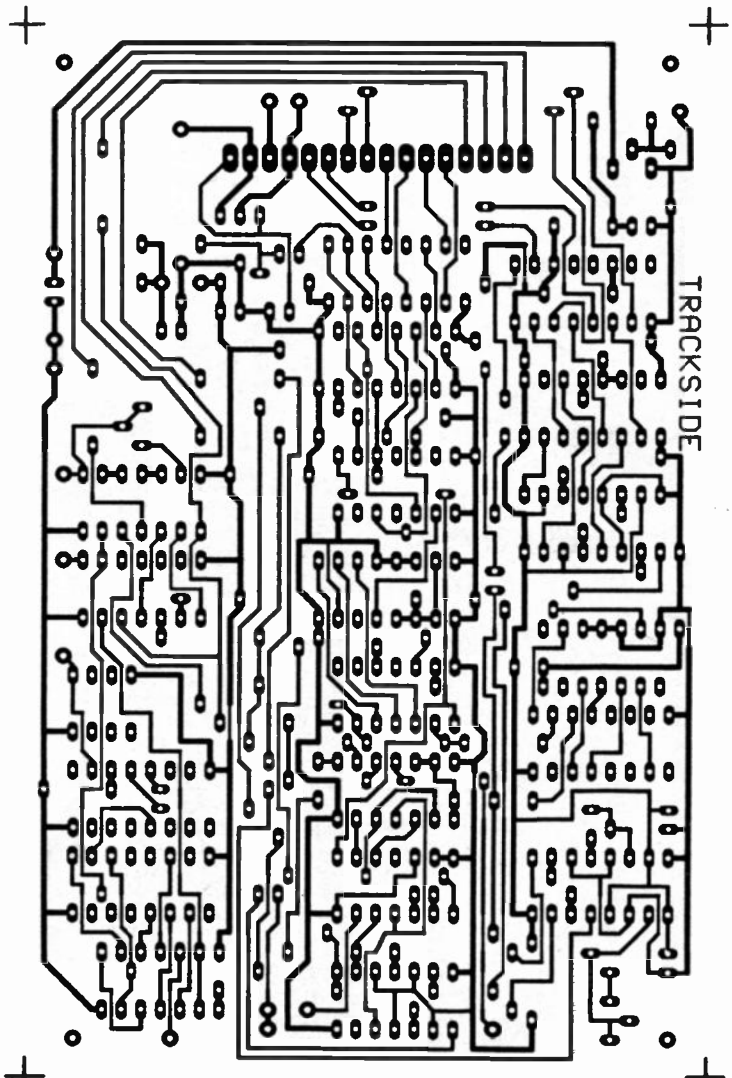


Fig. 12. Printed circuit board component layout for the Control Board. The topside view shown above is for a single-sided version and includes all necessary link wires, some of which have to be inserted under the i.c. holders. The component layout for the double-sided version is identical, without all the link wires. The full size top and bottom copper foil master patterns for the recommended double-sided, plated-through-hole, version are shown below.





The oscillators can be substituted for the 4MHz and 80MHz oscillators and set for much slower frequency rates, allowing the l.e.d.s to show monitored logic levels at a leisurely rate. The majority of the control logic can be checked in this way. The exceptions are logic transitions which occur at a naturally fast rate, such as Reset pulses.

LENS CHOICE

The lens from an old 35mm camera was used with the author's unit. It was secured to the box using sections of a lens-extension tube set. Ideally, a proper lens mounting ring should have been bought and fixed to the box.

Lenses from other sizes of camera can be used if they have focus and aperture controls. Experiments with a cheap disposable camera produced unsatisfactory results because of the lack of these controls.

Note that since the sensor has an active diagonal of 8mm, only a proportion of the field covered by the lens from a 35mm camera will be used.

CONSTRUCTION - CONTROL BOARD

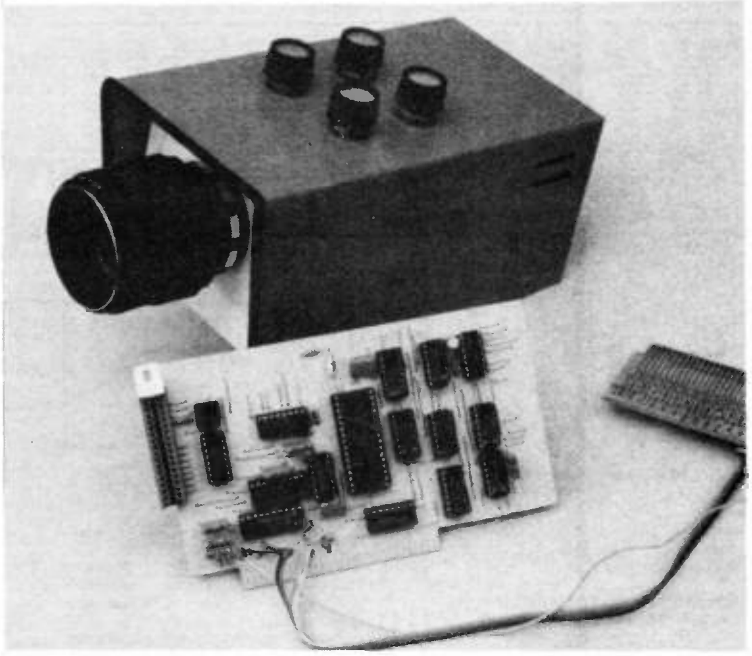
All chips except the regulators and op.amps are CMOS devices and the usual handling precautions should be observed. Touch a grounded (earth) point before handling them to discharge any static electricity from your body.

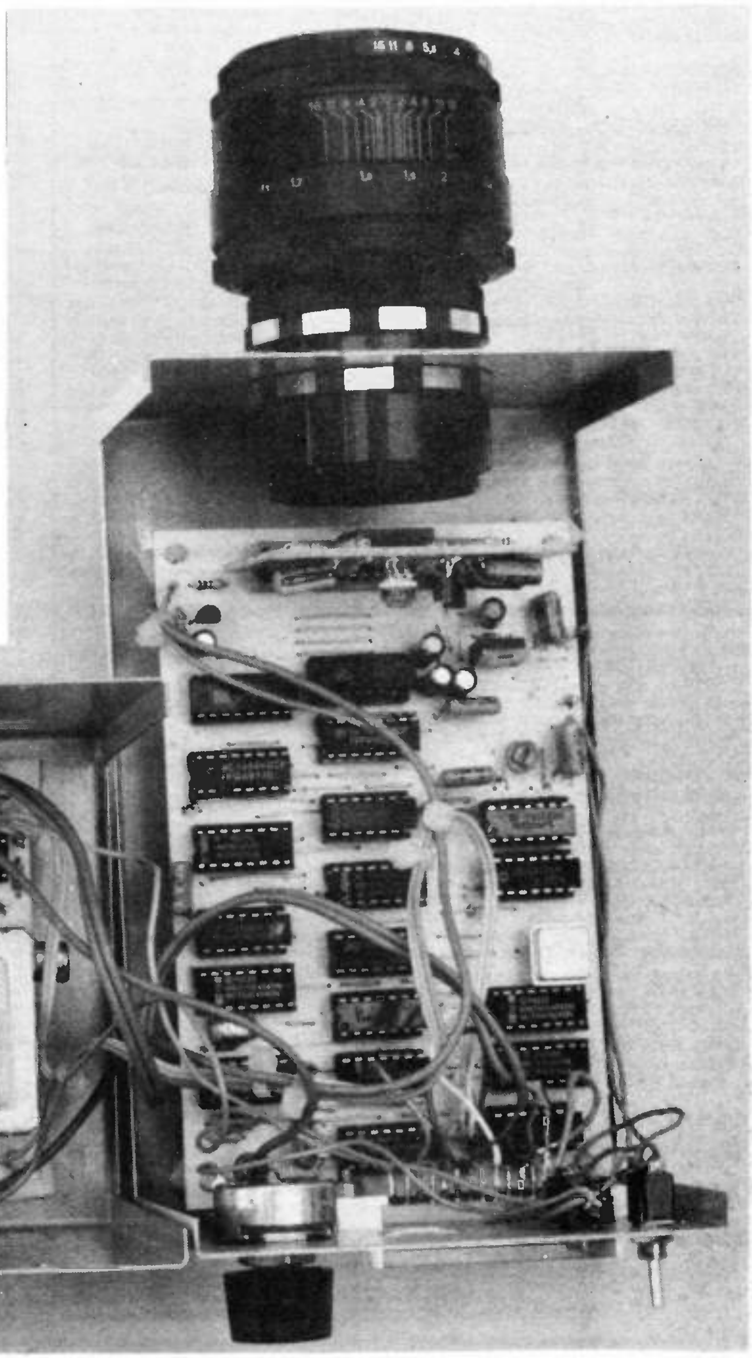
Due to the very nature of this project and the desire to ensure a quality finished product, it was decided that the use of a double-sided, "plated-through-hole (PHT)", board would be the best approach likely to give constructors the most chance of consistent results. We have included a single-sided topside component layout showing all the required link wires for guidance only. With the exception of the link between test points TP2 and TP3, none of the links shown in the topside view are required as they have already been made on the recommended PTH board.

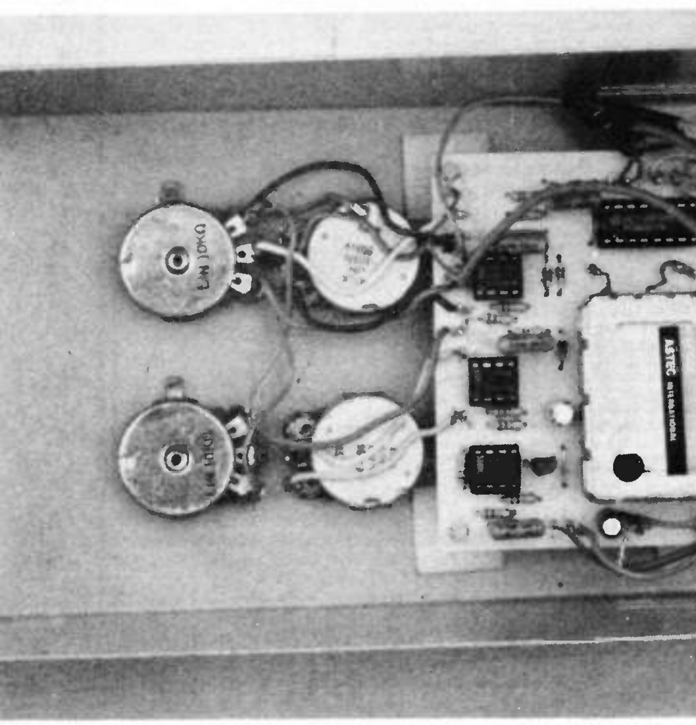
The printed circuit board (p.c.b.) topside components layout for the Control Board and full size underside copper foil master pattern is shown in Fig. 12. This p.c.b. is a double-sided board and the additional topside tracking is also given in Fig. 12. (This board is available from the *EPE PCB Service*, code 865).

If you are attempting to make a single-sided board, then all the link wires shown in Fig. 12 *must* be soldered in position and double-checked before mounting any other components. The use of 24 s.w.g. tinned copper wire is recommended for the links.

Next Month: Sensor board, video output board, test circuit board and the Frame Grab Interface details.







(Above right) The completed camera and next month's prototype Frame Grab interface board. (Below) Layout of all the camera boards inside the metal case.

Special Series

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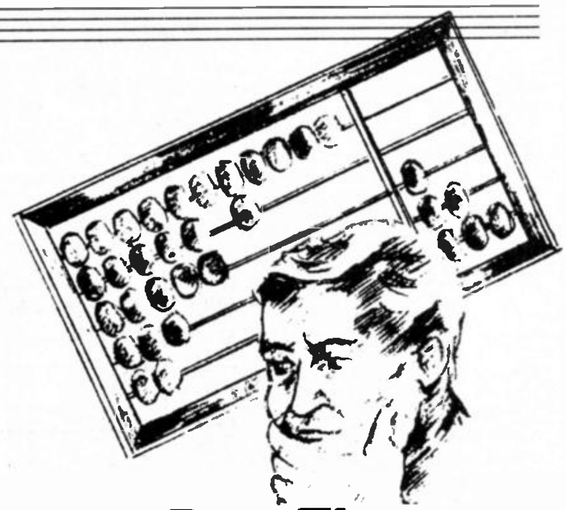


Work, Energy and Power

STEVE KNIGHT

Part Three

This series is designed to help you make your way, at your own pace, through the often imagined fears of mathematics, as this is applied to electronic and electrical engineering matters.

WE ARE all familiar with those days when we get out of bed and complain of having no energy to face the day – we don't feel like doing a day's work. Anything (or anybody) capable of doing work possesses energy. The form of energy which will be of interest to us here is not muscle orientated but comes in the form of electrical energy. By using the appropriate equipment, electrical energy may be converted into other forms of energy, such as mechanical energy from an electric motor, light energy from an electrical bulb or heat energy from a coil of resistance wire through which a current is passing.

Work and energy are often confused, but it is enough for our purpose here to say that *work* is done when a force is applied to something and moves that something from one position to another – like lifting a mass against gravity, for example. *Energy* is simply a measure of the *ability* to do work, and the amount of work done is a measure of the energy used.

Both work and energy are measured by the same unit, the **Joule** (**J**). The joule is defined as the work done when a mass of 1 kilogram is moved through a distance of 1 metre. This is in terms of mechanical work. In the electric circuit, although there may not appear to be any connection to the mechanical interpretation of work, we have an electromotive force which acts to move an electric charge through a potential difference, hence work must be done by the passage of an electric current.

If 1 coulomb of electricity flows in a conductor at an e.m.f. of 1 volt, then the amount of work done is 1 joule. So mathematically we can write

work done (W) = quantity moved (Q) × potential difference (volts)

and since work done is equal to the energy consumed we have

$$\text{energy consumed} = W = Q \times V \text{ joules}$$

Now we know that $Q = It$ coulombs, so if we substitute It for Q into the equation we get $W = I \times V \times t$ joules. Further Ohm's law tells us that $V = IR$, so by substituting IR in place of V in this last equation we get $W = I(IR)t = I^2Rt$ joules. We now have a number of useful formulae for electrical energy.

HEATING EFFECT OF A CURRENT

When a current flows in a conductor there is resistance to the flow and the energy that is expended in overcoming the resistance is converted into heat, a point which must have been apparent to many of us on a great number of occasions!

From the above equation we can deduce that the heat energy generated is directly proportional to the resistance (R), the time (t) and the square of the current (I^2). Hence, if the current is doubled, the heat energy goes up four times. Make sure when using these formulae that you express the parts in the proper units: ohms, seconds and amperes. Here is an easy example:

1. An electric heater of 25Ω resistance is connected to a 200V d.c. supply. What quantity of heat is generated per minute?

$$\text{The current flowing } I = \frac{V}{R} = \frac{200}{25} = 8\text{A}$$

Then we may use either $W = IVt$ or I^2Rt

Using the first of these we get $W = 8 \times 200 \times 60$

$= 96{,}000\text{J}$ or **96kJ**

Check on this result by using the second formula.

POWER

Power is the *rate of doing work*: a powerful electric motor will do a given amount of work a lot quicker than a less powerful motor. So time enters into things and we have:

$$\text{Power } P = \frac{\text{work done (J)}}{\text{time taken (t)}} \text{ J/s or } \textbf{Watts}$$

So the power of a system is 1 watt if work is done at the rate of 1J per second. Another name for the joule is the **watt-second**.

Using our two formulae for work done above, we get

$$P = \frac{IVt}{t} = \textbf{IV watts}$$

or

$$P = \frac{I^2Rt}{t} = \textbf{I}^2\textbf{R watts}$$

In many electronic systems the watt is a large unit, so the usual sub-units are introduced:

$$1 \text{ milliwatt (mW)} = \frac{1}{1{,}000{,}000}\text{ W} = 0{\cdot}001\text{W} = 10^{-3}\text{ W}$$

$$1 \text{ microwatt } (\mu\text{W}) = \frac{1}{0{\cdot}0000001}\text{ W} = 0{\cdot}001\text{W} = 10^{-6}\text{ W}$$

while for other purposes, like the disco hall, there is the kilowatt (kW) = 1,000 or 10^3W.

POWER RATINGS

Power in resistors is dissipated as heat and, unless we are deliberately generating heat, this is wasted power. In electronics, the power rating of resistors (quite distinct from their ohmic values) must always be selected to suit the expected power dissipation, otherwise the resistor will burn out or, at best, probably malfunction. It is *not* good practice to work at the extremes of the rating; always allow a rating margin which is at least one-and-a-half to twice the calculated dissipation.

It is time now to demonstrate a few worked examples on the topics so far discussed.

2. A 240V lamp has a hot resistance of 520Ω. What current is taken and what is the power rating of the lamp?

$$\text{Current } I = \frac{V}{R} = \frac{240}{520} = 0{\cdot}46\text{A}$$

$$\text{Power } P = VI = 240 \times 0{\cdot}46 = \mathbf{110W}$$

3. A 5·6kΩ resistor carries a current of 15mA. What power rating would you choose for this component?

Here $R = 5{,}600\Omega$ and $I = 0{\cdot}015\text{A}$

Then using $P = I^2R$ watts we have

$$P = (0{\cdot}015)^2 \times 5{,}600 = \mathbf{1{\cdot}26W}$$

The choice here would be a resistor of 2W rating.

4. A battery of e.m.f. 13·7V and internal resistance 0·18Ω is connected to a load resistance of 15Ω. What power is wasted *in* the battery?

Here the total circuit resistance = 15 + 0·18 = 15·18Ω

$$\therefore \text{ the circuit current } = \frac{13{\cdot}7}{15{\cdot}18} = 0{\cdot}9\text{A}$$

and the power dissipated in the battery = I^2 × (internal resistance)

$$= (0{\cdot}9)^2 \times 0{\cdot}18 = 0{\cdot}146\text{W or } \mathbf{146mW}$$

5. Two resistors of 10Ω and 20Ω are connected first in series and then in parallel across a 9V supply. Find the power dissipated in each case.

Firstly, in series, the total resistance = 30Ω

$$\therefore \text{ circuit current } I = \frac{V}{R} = \frac{9}{30} = 0{\cdot}3\text{A}$$

Then the power dissipated = V × I = 9 × 0·3 = **2·7W**

Notice that this result is the *total* power dissipated by both resistors. Each resistor here dissipates a different power; we can find these powers by using I^2R; the current of 0·3A is the same through each resistor so the individual power dissipations are:

For the 10Ω resistor $P = (0{\cdot}3)^2 \times 10 = \mathbf{0{\cdot}9W}$
For the 20Ω resistor $P = (0{\cdot}3)^2 \times 20 = \mathbf{1{\cdot}8W}$

These powers, of course, add up to the total power of 2·7W.

When the resistors are parallelled we have a total resistance of 6·67Ω (verify this for yourself), hence I = 9/6·67 = 1·35A and the *total* power dissipation P = V × I = 9 × 1·35 = **12·15W**.

To find the individual powers this time we could first find the current division between the two branches and use the I^2R formula. But it is easier to find a third expression for power by substituting Ohm's law form of I = V/R into W = V × I from which we get

$$P = V \times \frac{V}{R} = \frac{V^2}{R} \text{ watts}$$

Then for the 10Ω resistor $P = \frac{9^2}{10} = 8{\cdot}1\text{W}$

and for the 20Ω resistor $P = \frac{9^2}{20} = 4{\cdot}05\text{W}$

Again, these sum to the total power of 12·15W.

We summarise the three important formulae for power:

$$P = V \times I \qquad P = I^2R \qquad P = \frac{V^2}{R}$$

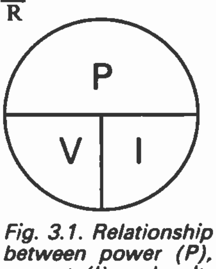


Fig. 3.1. Relationship between power (P), current (I) and voltage (V).

Remember how to *derive* the second two of these from the first. This way is a lot better than trying to memorise the whole string of formulae. There is a diagram, shown in Fig. 3.1, which is supposed to show the relationship between power, current and voltage. By covering the quantity you want with a finger tip, the position of the other two will tell you which calculation to carry out, i.e. P = VI, V = P/I or I = P/V. I never advocate the use of such diagrams (there is a similar one for Ohm's Law); what do you do if you know I and R or V and R, for instance? R doesn't appear on the diagram. All right, remember the P = VI relationship, then make the Ohm's law substitutions for the other forms of power formula as we did above.

RESISTOR COMBINATIONS

The last worked example above has shown us that if we connect two *unequal* resistors in series or in parallel for the purpose, perhaps, of making up a required single value of resistance that is not a preferred value, the power dissipation is *not* equally distributed between the resistors. By calculating the individual powers in the way illustrated, the resistor ratings can be selected to suit the situation.

If *equal* valued resistors are used the problem is eased slightly. The required power ratings are the same and the total power dissipation is simply the sum of the individual ratings: For example, two 0·5W resistors in series *or* in parallel will produce an equivalent resistance of 1W rating. So if you want, say, a 10kΩ resistor rated at 2W, two 5·1kΩ resistors rated 1W wired in series will do the job.

Now here are two more worked examples before you are flung into the deep end on your own:

6. A model motor draws 200mA at 6V. If it is to be operated from a 9V battery, what series resistor will be required and what power will be dissipated in this resistor?

We need to drop (or "loose") 3V at a current of 200mA (0·2A)

The required resistance then is $R = \frac{V}{I} = \frac{3}{0{\cdot}2} = \mathbf{15\Omega}$

The power dissipated in this resistance $P = I^2R = (0{\cdot}2)^2 \times 15 = \mathbf{0{\cdot}6W}$

A 1W rated resistor would be used for this job.

7. Two p.c.b. drilling motors are connected in parallel and take a total current of 0·85A from an 18V supply. The power expended in one of the motors is 8·2W. What power is expended in the other? What is the effective resistance of each motor?

As 0·85A is flowing at 18V, the total power expended is V × I = 0·85 × 18 = 15·3W. hence if one motor expends 8·2W the other expends (15·3 − 8·2) = **7·1W**.

Knowing the power expended by each motor and the voltage across them, the resistance of each can be found from

$$P = \frac{V^2}{R} \quad \text{or, rearranging, } R = \frac{V^2}{P}$$

So for the 8·2W motor $R = \frac{18^2}{8{\cdot}2} = \mathbf{39{\cdot}5\Omega}$

and for the 7·1W motor $R = \frac{18^2}{7{\cdot}1} = \mathbf{45{\cdot}6\Omega}$

There is one final important point about power which should be borne in mind at all times. There is a tendency to treat I^2R as representing heat; this is quite wrong. I^2R represents the *rate* at which heat and light energy are produced in a lamp or the *rate* at which mechanical energy is turned out by a motor.

Now here are this month's self-assessment problems, followed by last month's answers.

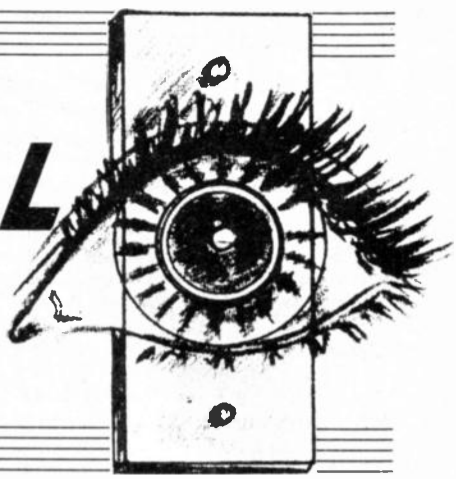
1. A current of 47mA flows through a 270Ω resistor. What power is dissipated and what power rating would you choose for this resistor?
2. When a p.d. of 2·8V exists across a certain resistor, the power dissipated is 0·4W. What is the value of the resistor?
3. Another name for the Watt is the joule-second. True or false?
4. Deduce that a kilowatt-hour is equivalent to $3{\cdot}6 \times 10^6$J.
5. A cell has an e.m.f. of 2V and an internal resistance of 0·1Ω. Find (a) the current flowing in a 5Ω external load, (b) the terminal p.d. of the cell, (c) the energy wasted in the cell when it operates for ½-hour.
6. A 12V, 15W soldering iron is fed from a 12·5V battery through a pair of leads which each have a resistance of 0·7Ω. What is the voltage acting at the terminals of the iron? What power is lost in the connecting wires?
7. Two lamps, (A) 6V, 1·8W, and (B) 6V, 7·2W, are wired in series across a 12V battery. What current will flow through the lamps? Explain why the lamps are not working under their proper conditions with this arrangement. What resistance would you parallel with lamp (A) so that each lamp gets its correct working current and what power is dissipated by this resistor?
9. Three resistors are wired in parallel across a 6V supply. One resistor dissipates 3W and the second 4·5W. The total energy used by the whole circuit in 10 minutes is 9kJ. What is the resistance of the third resistor and what current flows in each branch?

Last month's answers: 1. 5·14Ω; 2. 37·5Ω, 5·4V; 4. 20Ω; 5. Five; 6. True; 7. 4·6V; 8. 30Ω; 9. 30Ω, 0·08A in 30Ω, 0·12A in 20Ω, 0·2A in 18Ω; 10. 1·31V, 3·75Ω.

FREE WALL CHART

This issue carries the first of two wall charts designed to back up *Calculation Corner* and provide an instant reference to a wide range of electronics formulae. We can supply extra charts for schools, colleges etc – contact the editorial office. – See Editorial page.

Constructional Project



VISUAL DOORBELL INDICATOR

ANDY FLIND

An easy-to-build answer to alert people with hearing difficulties that callers are at the door. Will drive up to five 100W light bulbs

THIS project arose when the author was asked by a colleague to complete a half-finished device intended for his mother, a lady somewhat hard-of-hearing. Apparently she often failed to hear callers at her door, so the project's originator had come up with the idea of strategically-placed flashing lights, activated with the bell, to alert the lady visually.

Unfortunately the original designer had moved on before the project was complete, so the author was handed a plastic case and components including two standard 555 timers and a relay, with some scribbled notes. From these it appeared that the circuit was to be powered by a PP3 battery. The expected life of this, supplying two 555's and a relay, wasn't specified!

A fresh start seemed the best option. Mains power, rather than batteries, was the obvious choice for a continuously operating circuit, and substitution of a triac in place of the relay would eliminate possible contact problems. A further improvement, enabled by the use of the triac, was "zero-crossing" switching action to extend the life of the lamps connected to the unit and reduce the generation of interference. With these points in mind, the new design took shape.

HOW IT WORKS

Before a full description of the circuit is given, a simplified drawing of part of it should make it easier to follow. Fig. 1 shows a simple oscillator built from two inverting gates, an arrangement often used where an a.c. signal is required and a couple of spare inverters are available.

The output of the first inverter is connected to the input of the second, so for a given input both inverted and non-inverted outputs are present. The positive feedback applied through capacitor C1 and negative feedback through resistor R2 turns the circuit into an oscillator having a squarewave output, with frequency determined mainly by the capacitor and resistor.

The function of resistor R1 may not be obvious. With each change of state, the input to the first gate is driven beyond the appropriate supply rail voltage, according to the direction of the change. Most CMOS logic gates have inbuilt protection in the form of diodes between the input and supply pins which conduct if the input exceeds the supply voltages. This could adversely affect the performance of this oscillator, but the inclusion of the series resistance in the input circuit virtually eliminates the problem.

Wired as shown, the two inverters form a circuit with one input and two outputs. These can be replaced by the "Data", "$\overline{Q}$" and "Q" connections of a CMOS 4013B "D-type" flip-flop, as shown in Fig. 2. However, the output from this can only change state with positive edges of a signal applied to the "clock" input, allowing the changes of state to coincide with those of another frequency.

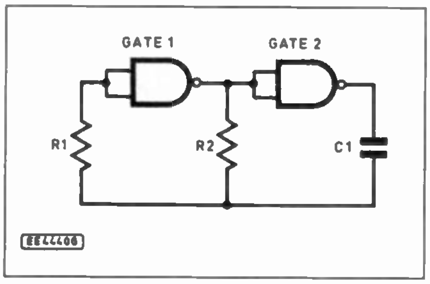


Fig. 1. Simplified oscillator circuit.

In this case it is synchronised to the zero-crossing points of the a.c. mains supply, because switching the lamps on and off at these points eliminates the generation of mains-borne interference noise. It also helps to prolong the life of the lamps used, and the "reset" input of the flip-flop can be used to start and stop the oscillator.

CIRCUIT DESCRIPTION

In the full circuit diagram shown in Fig. 3, low voltage d.c. power for the electronics is obtained from the mains with a "capacitive dropper" circuit. Current taken directly from the mains is limited to about 35mA by capacitor C1, half-wave rectified by diodes D1 and D2 and smoothed by capacitor C3.

The output voltage is limited by Zener D4 to 12 volts. In this circuit it is arranged to be negative of the neutral rail, because the output is required to drive a triac (CSR1), and the particular triac used has been found to operate more satisfactorily when driven by negative gate current.

Resistors R2 and R3 discharge capacitor C1 when power is disconnected, removing the possibility of an unpleasant shock from stored charge in this capacitor. Resistor R1 limits the destructive instantaneous surge current that would result if the circuit were switched on at the peak of the supply voltage waveform. VDR1 is a voltage limiting device which clips high voltage spikes from the mains supply to protect C1 and the triac. Capacitive supply voltage droppers of this type are cheaper and more compact than transformer circuits and do not generate heat or hum.

Current flowing through the capacitor but not actually used by the circuit is "reactive", leading the mains voltage by ninety degrees, and as such does not register on the electricity meter or the bill. However, the low voltage side must be treated as ***"live" and hazardous at all times***, which can complicate testing and external connections.

The "clock" signal to synchronise oscillator switching with zero-crossings is obtained from the live rail with resistors R5 and R6 and clamping diodes D5 and D6. The output from this resembles a 12 volts peak-to-peak squarewave, synchronised with the mains, which is applied to both "clock" inputs of IC2.

The two resistors R5 and R6 are used because the mains voltage exceeds the rating for a single resistor. Suitably rated single components are harder to obtain and are larger and more expensive than two

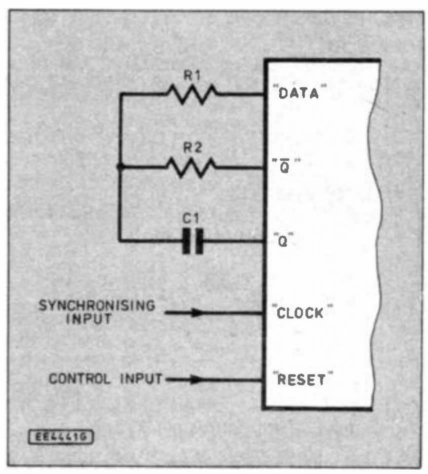


Fig. 2. Oscillator circuit using one half of a 4013B D-type flip-flop.

standard components. The same reasoning applies to R2 and R3.

FLASH RATE

The 4013 integrated circuit, IC2, contains two "D-type" flip-flops, the first of which generates the flashing function. When the doorbell is operated, the voltage applied to it is also connected to the l.e.d. input of the opto-isolator IC1. Both a.c. and d.c. bell supplies may be used, as a.c. will be half-wave rectified by diode D3.

When the l.e.d. is energised it turns on the transistor in IC1, which discharges capacitor C6. This takes the "reset" input of IC2 low, allowing oscillation to start. The oscillator is formed from C4, R8 and R7, and operates in the way shown in the simplified circuit of Fig. 2.

So long as the input voltage from the bell is present, it will continue running. When the input is removed capacitor C6 will receive a charging current from diode D7 and resistor R9 each time $\overline{Q}$ goes positive. After a dozen or so cycles the voltage across this capacitor becomes high enough to operate "reset", and oscillation stops with $\overline{Q}$ high and Q low. This arrangement provides a reasonable period of lamp flashing even if the bell is pressed only briefly.

COMPONENTS

Resistors

- R1 100
- R2, R3, R5, R6, R9 470k (5 off)
- R4 470
- R7 330k
- R8 1M
- R10 10k
- R11 1k5
- R12 2k2

All 0·6W 1% metal film

See SHOP TALK Page

Capacitors

- C1 470n/250V, interference suppression type. (Suitable for direct connection across Mains voltage)
- C2, C5 100n polyester layer (2 off)
- C3 470µ radial elect. 16V
- C4 1µ polyester layer
- C6 10µ radial elect. 50V

Semiconductors

- D1, D2, D3 1N4007 1A 1000V rec. diode (3 off)
- D4 BZY88C12 12V 1·3W Zener diode
- D5, D6, D7 1N4148 signal diode (3 off)
- CSR1 C206D 4A 400V triac
- IC1, IC3 opto-isolator (2 off)
- IC2 CMOS 4013B dual D-type filp-flop

Miscellaneous

- VDR1 transient suppressor for 250V operation
- TB1 to TB4 p.c.b. screw terminal blocks, 2-way 10mm spacing (4 off)

Printed circuit board available from the *EPE PCB Service*, code 863; ABS plastic box, size 130mm x 68mm x 46mm; 8-pin i.c. socket (2 off); 14-pin i.c. socket; connecting wire; solder etc.

Approx cost guidance only **£12**

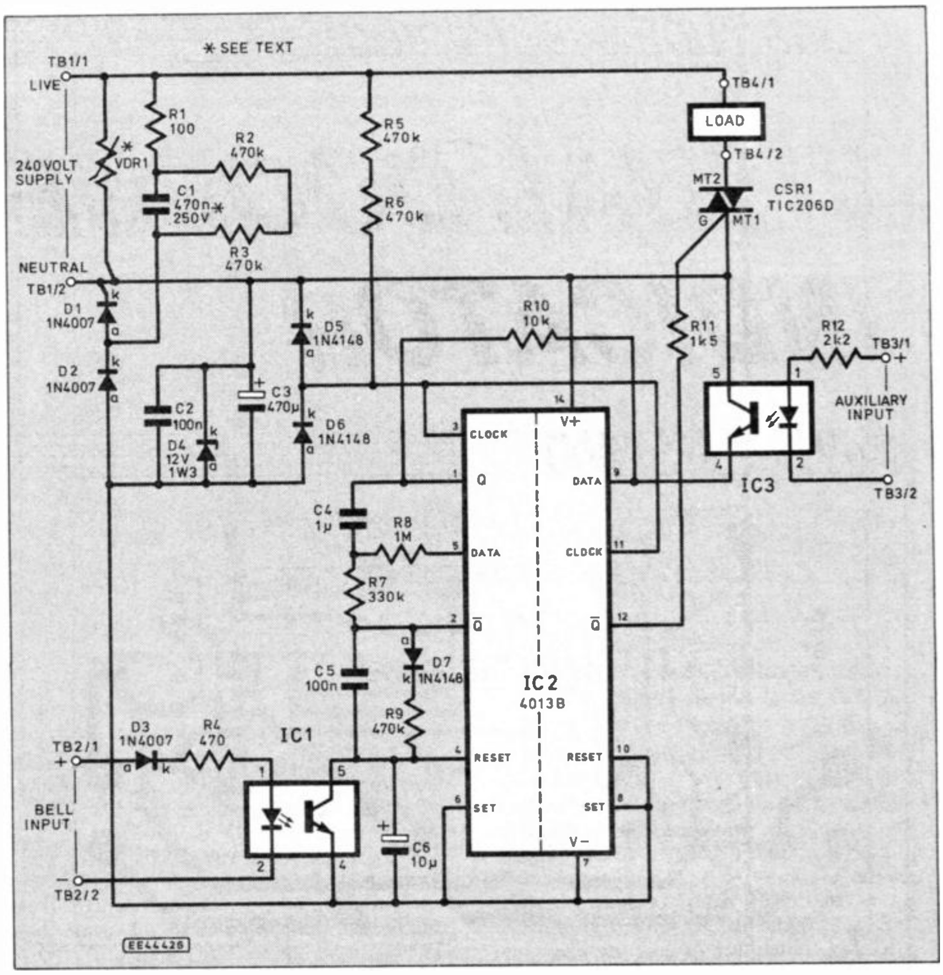


Fig. 3. Complete circuit diagram for the Visual Doorbell Indicator.

The oscillator output is connected to the "data" input of the second flip-flop. When it is high, the next clock positive edge causes $\overline{Q}$ of this stage to go low, turning the triac on. When it is low, the next positive edge removes the triac gate current. When the first stage reset is high, it's low Q output ensures the triac remains turned off.

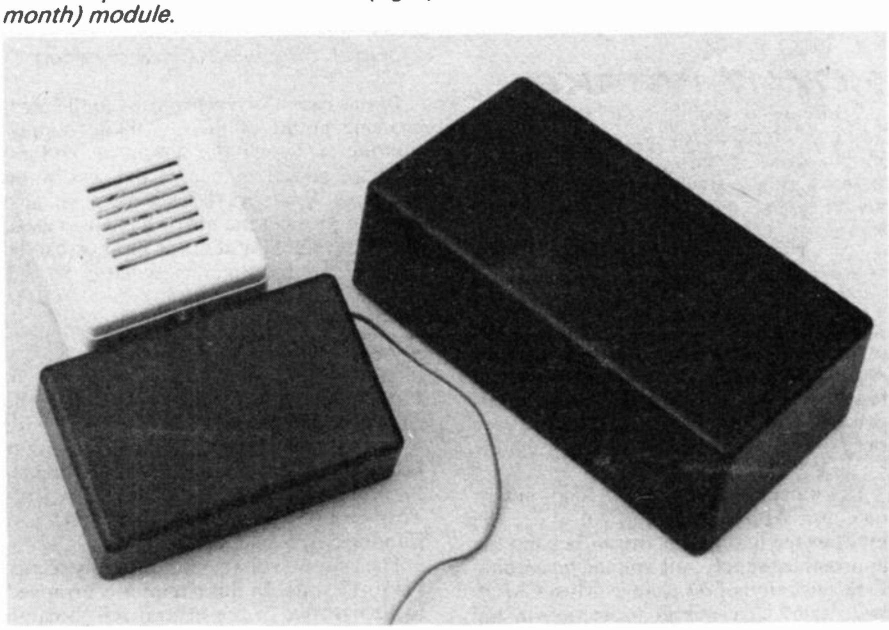
AUXILIARY INPUT

Resistor R10 in the path from the oscillator output allows the input to the second flip-flop to be forced high by the transistor in the second opto-isolator IC3, overriding the normal input signal. Other signals can then be applied via this auxiliary input.

The lights will follow the pattern of such signals, making it particularly suitable for use with the "burr-burr" pattern of a ringing telephone. This is not as daft as it sounds, as nowadays a range of specialised telephones are available for the hard-of-hearing.

These range from amplified handsets and inductive couplers for hearing aids, to an audio-coupled device with keyboard

The completed Visual Doorbell (right) and the telephone ring detector (next month) module.



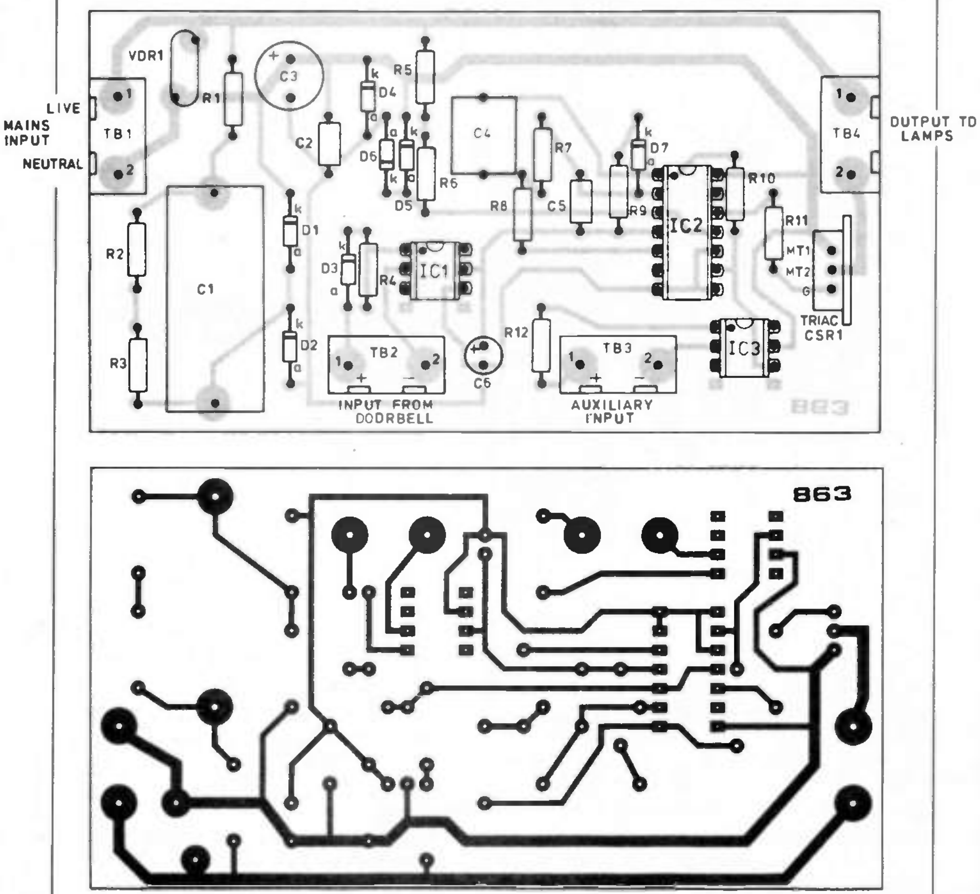


Fig. 4. Printed circuit board component layout and full size underside copper foil master pattern.

and alphanumeric display for visual communication between totally deaf users. As technology is continually advancing, the availability of devices like these can be expected to increase.

SAFETY FIRST

Extreme care must be taken when building this project as mains voltages are present on some of the underside copper tracks of the circuit board. It is recommended that the published p.c.b. design is adhered to.

The components of this project are all mounted on a single p.c.b. with a fairly widely spaced layout, as shown in Fig. 4. The reason for this is the need to maintain adequate spacing between "live" and "safe" areas of track on the board, but it also makes for easy construction.

It could be just built and tried, but most constructors will probably prefer to test in stages as construction proceeds. As stated previously, a problem with a circuit supplied by a capacitive voltage dropper is that everything has to be treated as "*live*", so testing of this circuit *MUST* be carried out with due care and precautions for safety.

In most cases, it is best to connect the test meter to the appropriate points with the *mains* supply *disconnected*, then power up to take the reading and switch off again *before* removing the test connections.

One hazard that may not be immediately apparent arises from the metal tab on the triac CSR1. When the output is connected to the load but not energised, this will be at mains "live" voltage potential.

CONSTRUCTION

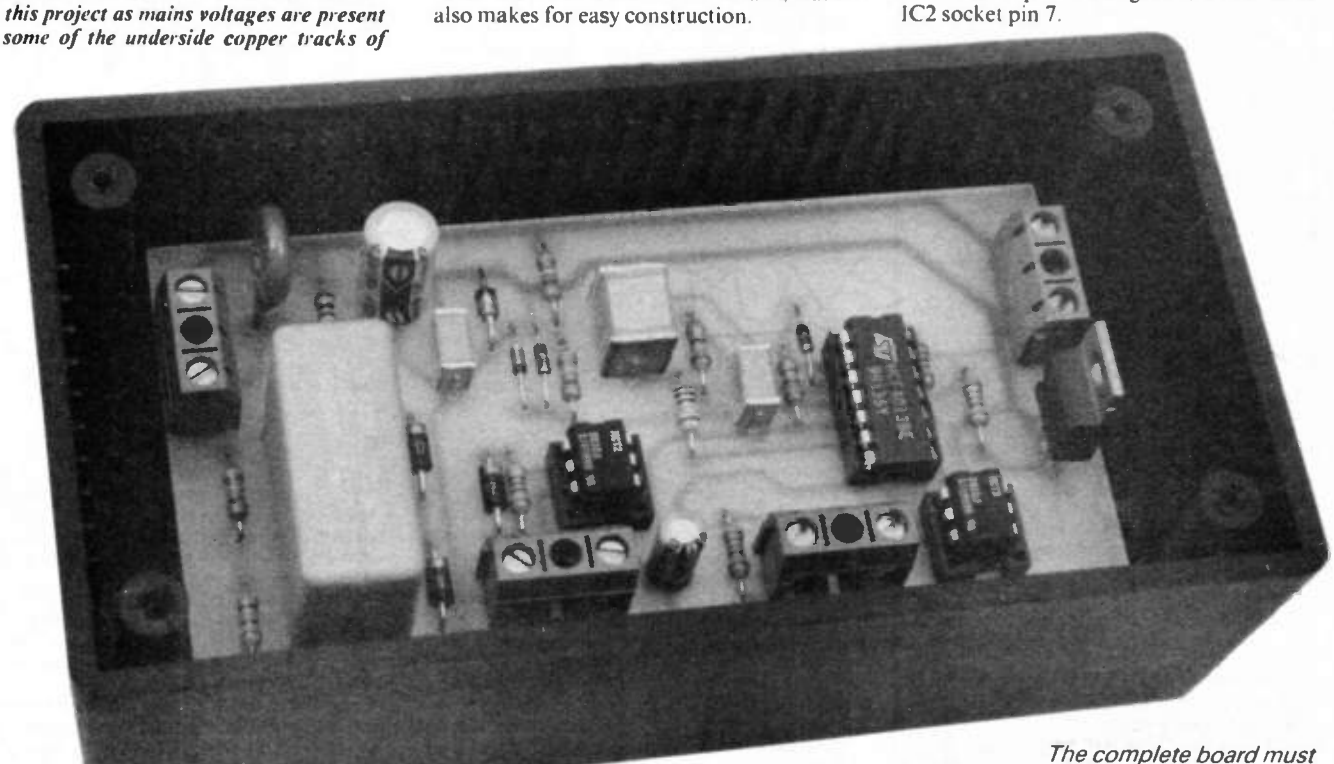
The printed circuit board (p.c.b.) topside component layout and full size underside copper foil master pattern is shown in Fig. 4. This board is available from the *EPE PCB Service*, code 863.

Construction should commence with the fitting of all components except the three i.c.s. Sockets are recommended for these as they simplify testing and trouble-shooting later. If the auxiliary input is not required, resistor R12 and IC3 could be omitted, but if the resistor and a socket are fitted then future upgrading will require only the insertion of the i.c.

The first test is of the low-voltage supply. A d.c. meter should be connected across pins 7 (negative) and 14 (positive) of the socket for IC2, the board can then be powered and presence of the 12-volt supply checked.

Next, an a.c. voltmeter can be used to look for the presence of the "clock" signal at pin 3 of IC2 socket. This should be around 7V, though the actual reading will depend to some extent on the loading imposed by the meter and it's response to the shape of the waveform. Most DVM's should give a fairly accurate indication.

The average d.c. level at the same point should be about 6V. Both these readings are with respect to negative, taken from IC2 socket pin 7.



The complete board must be enclosed in a plastic case.

Following this, the i.c.s can be fitted and a mains lamp and power connected. Note the position of IC1 and IC3 in their sockets, these are six-pin chips, but eight-pin sockets have been used as six-pin types are difficult to find.

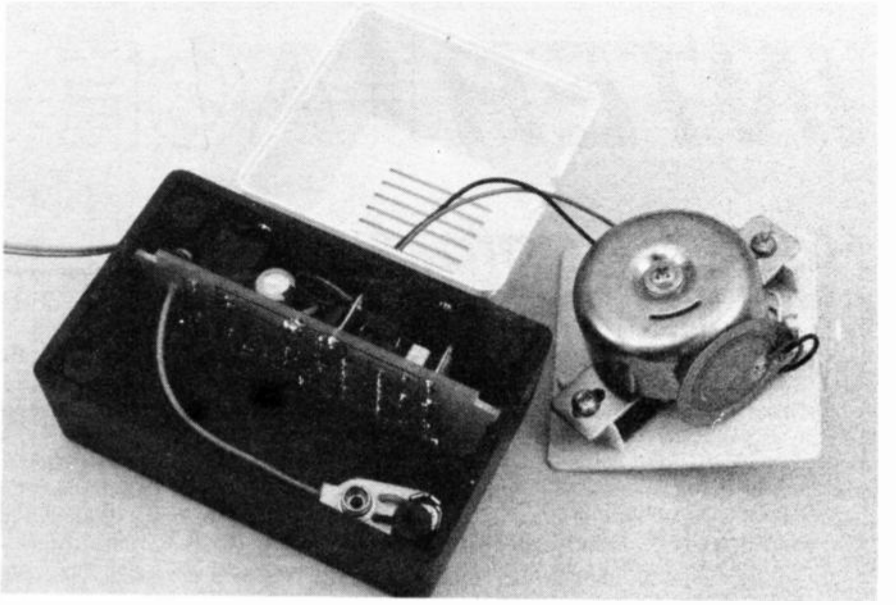
When first powered, the lamp will probably flash as capacitor C6 charges. Whether this happens on subsequent power-ups depends on whether C6 has had time to discharge, or if an applied input has discharged it.

With the unit connected, a 9V supply of correct polarity connected across the input should start the lamp flashing action. A momentary application of the input should produce ten to twelve flashes. If IC3 is fitted, the same voltage applied to the auxiliary input, again observing correct polarity, should turn the lamp on continuously for as long as it is applied.

CASE

The completed unit must be housed in an insulated enclosure such as an ABS plastics box. Although a fuse is not fitted to the prototype, for installations where the circuit is not protected by a low-value plug fuse a fuseholder should be fitted to the box.

For simplicity, connections to the board are made with screw terminals (TB1 to TB4). It is suggested that the unit be mounted somewhere close to the lamp(s) to be driven, as the doorbell can be connected to it with cheap and inconspicuous wire such as bell flex. Connections to both



inputs are *isolated* by the opto-couplers and are therefore quite safe to handle, and may be connected to their sources with low-voltage cable.

The output power is limited mainly by the lack of a heatsink for the triac CSR1. The unit can quite safely drive up to five 100-watt light bulbs, which can be strategically placed so that they will be very difficult to miss when all flashing together. □

NEXT MONTH: An additional circuit – see above – will be described for operating this unit *legally* from a BT telephone ringing signal, to extend it's usefulness. For increased versatility this will also be able to operate other devices, such as extension bells, by itself.

SHOP TALK
with David Barrington

CCD TV Camera

It seems only yesterday that we carried a news items on a Philips camera that used a new "image sensor" device, type FT800P. Now, thanks to the efforts of John Becker, we are able to offer a closed-circuit, black and white, *CCD TV Camera* constructional project, using this "state-of-the-art" chip, which can be used with a TV or linked to your computer.

Using a "Frame Grab" circuit card, to be described next month, you can capture the "live" pictures and feed them to the computer, where it can be displayed, modified, coloured, stored on disc or even printed to paper.

Obviously, with a project like this some components are special and not generally available. As the article explains two versions of the image sensor chip are available and this is reflected in the price of the project.

However, a kit of all electronic components for the camera including hardware, but excluding cables, p.c.b.s and sensor chip, is available from the author for the sum of £77. The image sensor is only available as a separate item in two versions: sub-spec FT800P (as used by the author) for the sum of £25 and a "full-spec" version of the FT800P will cost £97. **John Becker, Dept. EPE, 8 Finucane Drive, Orpington, Kent, BR5 4ED.**

It was decided that with a project of this quality and nature, that for the most consistent results we should make the Control printed circuit board, and the future Frame Grab board, a "plated-through-hole" double-sided job. The Control board is available from the *EPE PCB Service*, code 845 (see page 243).

The camera lens will have to come from an old discarded camera (see article) or purchased from a photographic store.

Smart-Key Immobiliser

Having just read of the power contained in a car battery in the *Safety First* feature in this issue, caution and only use the specified parts is the byword when constructing the *Smart-Key Immobiliser* project.

It is imperative that an in-line fuseholder and fuse be installed as indicated and that auto-type cable be used on the relay contacts. The heavy duty 12V 30A relays used in the model were purchased from a motor spares garage/shop. Some of our advertisers list an auto type relay, but most of these seem to be rated at 16A and have not been tried in the model.

The choice and size of small box for the dashboard key and flashing l.e.d. is left to the individual. The rest of the components are standard off-the-shelf items.

Visual Doorbell Indicator

Most of the comments reserved for the *Visual Doorbell Indicator* concern the actual choice of components. Most parts are readily available from advertisers, but they must be rated as specified in the "comps list".

The "mains dropper capacitor" used in the prototype is a Siemens item, but most advertisers will be able to offer an interference suppression type capable of ***direct*** connection across the mains. The voltage dependent resistor, also directly across the mains, should be a stock item but if difficulties do arise it is stocked by **Maplin**, code HW13P.

When ordering the screw-terminal blocks be sure to quote the 10mm spacing types. The small printed circuit board is available from the *EPE PCB Service*, code 863.

Finally, you must be careful when testing this project as mains voltages appear on some tracks of the p.c.b. Beware of the metal tab on the triac as this is "live" also.

Audio/R.F. Monitor

Only two problems seem likely to cause concern and prompt further comment when checking the list for the *Audio/R.F. Monitor*.

The first item is the 2-pole 5-way rotary switch. A 5-way type seems non-existent and you will have to purchase a 2-pole 6-way type and set the stop for 5 positions.

The only listing we have found for the BAR28 Schottky diode is from **Maplin** (☎ ***0702 554161***), code QQ13P.

Three-Phase Generator

We cannot foresee any component buying problems arising for anyone building the *Three-Phase Generator*. The glass-encapsulated bead thermistor rated as 5k at 20°C, or one with almost identical ratings, should be carried by stockists like **Greenweld, Cirkit, Electrovalue, Bull Electrical, Maplin, Cricklewood** and many others.

The printed circuit board is available from the *EPE PCB Service*, code 861 (page 243).

Circuit Surgery

This month's *Circuit Surgery* is straightforward with the exception of the *Mains Lamp Dimmer* project. This is rated at up to 1,000 watts (1kW) and is definitely not intended for beginners.

The circuit diagram is very simple, and as always it is left to the constructor to use his own initiative to assemble the project, working from the circuit and information given as a guide.

You require at least a 6A phase controlled, a.c. mains power regulator i.c. to control a 1kW lamp. The mounting tab of the regulator i.c. is electrically isolated and requires fixing to a suitable heatsink rated at about 7° to 8°C/W. Most of our advertisers should be able to offer a heatsink to meet these requirements.

The fully integrated power controller i.c. was supplied by **Electromail** (☎ ***0536 204555***), code 300-344. Apart from a Farnell device, we were unable to find an alternative source of supply.

You must heed the author's warning: The circuit must be soundly constructed with suitably-rated mains cable, all solder joints be fully insulated with sleeving and the case ***must be Earthed*** to protect users.

INTERFACE

Robert Penfold

CONTINUING our look at EPROM programming, Fig.1 shows the circuit diagram for a d.c. to d.c. converter that will provide a 12·5 volt programming voltage from a standard five volt supply. A circuit of this type is essential if you wish to power the EPROM programmer from the host computer rather than using a separate mains power supply.

The five volt supply must be stepped-up by a factor of 2·5, and an output current of about 50 milliamps is required. This requires the use of a proper switch mode circuit, and this one is based on the TL497 integrated circuit. This is a fairly basic switch mode device, but it is inexpensive, quite efficient, and perfectly adequate for this application.

Stepping Up

The TL497 can operate in three modes, which are the step-down, step-up, and negative supply generator modes. In this case it is used in a straightforward step-up mode circuit. Operation of the circuit is dependent on inductor L1 providing the voltage boost. First the right hand end of this component is connected to the negative supply, and L1 is then (more or less) connected across the input supply. This produces a strong current flow and a magnetic field is generated around L1.

Next the right hand end of L1 is connected to the output of the supply. L1 is now de-energised, and as the magnetic field around it collapses a high reverse voltage is generated. This process is repeated at high speed under the control of a clock oscillator, generating a series of high reverse voltage pulses.

These reverse voltage pulses are added to the 5 volt input, giving a greatly boosted output voltage. However, IC1 includes a regulator circuit which is used to limit the output voltage to the required figure of 12·5 volts.

Resistors R2, R3, and preset VR1 are the negative feedback network in the regulator circuit. VR1 is adjusted to give an output potential of precisely 12·5 volts. The output potential (in volts) is approximately equal to the total resistance (in kilohms) through the feedback circuit. The output from IC1 is a pulsed signal, but it is smoothed to a reasonably ripple-free d.c. signal by C4 and C5.

Resistor R1 is part of the current limiting circuit at the input of IC1. This protects IC1 by limiting the input current to no more than about 500 milliamps. C3 is the timing capacitor for the oscillator which controls the built-in electronic switch. C1 and C2 are decoupling capacitors.

The output current to the EPROM is about 50 milliamps, but due to the voltage step-up the input current is much higher than this. With 100 per cent efficiency the output input current would be about 125 milliamps. In practice the circuit is likely to achieve no more than about 70 per cent efficiency, which means that the input current will be something approaching 200 milliamps.

21V EPROMs

EPROMs that require a 21 volt programming voltage are now obsolete, but if you should wish to program some of these the circuit is quite capable of producing a 21 volt output at about 50 milliamps. It is merely necessary to increase the value of R3 to 15k, and adjust VR1 for an output potential of 21 volts. Note that this higher output voltage will produce a correspondingly higher input current. The actual figure will be about 350 milliamps or so with the output loaded at 50 milliamps.

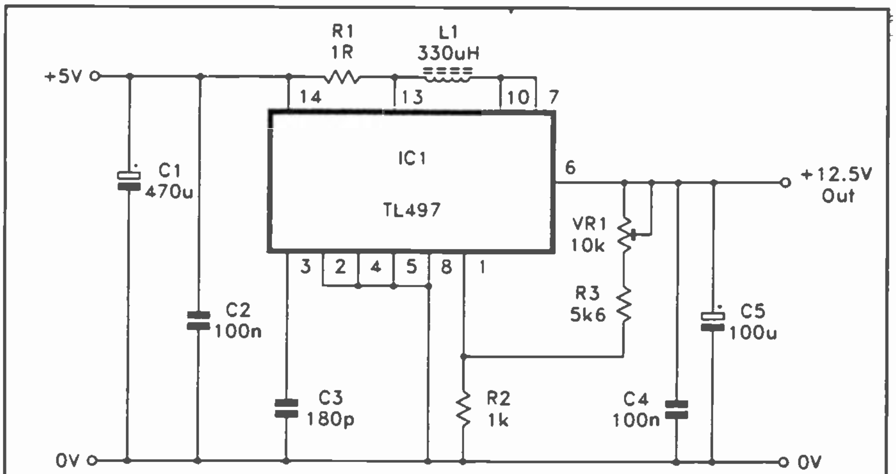


Fig. 1. Circuit diagram for a 5V to 12·5V d.c. to d.c. converter using the TL497 switch mode control i.c.

A very important point to note is that L1 must be an inductor which is intended for operation at low frequencies, and it ***must not be* a simple r.f. choke.** Also, it must have a reasonably low coil resistance (around one ohm or less), and be capable of handling the input currents involved here. At one time an inductor of this type had to be home-wound on a pot-core assembly. This is not particularly difficult, but tends to be quite expensive.

These days there are plenty of ready-made low frequency inductors available at comparatively low prices. Probably the cheapest type that will give good results in this circuit is the Maplin 330µH miniature radial lead inductor (order code AH35Q). Any inductor having similar characteristics should work just as well here, but I have only tested the circuit using this particular component.

Next month we will continue our look at EPROM programming with a step-by-step description of the programming process, verification, etc.

Impulse Buy

I have received various pieces of PC software for review in the last 12 months, and most of these have been printed circuit design programs. One exception is the "IMP" demonstration program. The "IMP" name is derived from the purpose of this software, which is Impulse response Measurement and Processing.

The demonstration program has some facilities disabled, but it is supplied with some sample data files which can be loaded and processed. The real program is used with a fair amount of hardware, and its purpose is testing the frequency response of loudspeakers. It can also provide other information such as phase responses.

Systems for automatically testing the frequency responses of loudspeakers have been around for many years, and they were originally based on audio sweep oscillators. More recent systems have used pulse analysis techniques. The basic setup is to feed a short pulse to the loudspeaker via a power amplifier.

The pulse of sound from the loudspeaker is picked up by a high quality microphone which feeds into a 12-bit digitiser. The samples from the digitiser are stored in the PCs memory, and then analysed by the program which uses some advanced number crunching.

Although one might expect this method to produce only some rather approximate results, it can apparently produce very accurate and detailed frequency response measurements, plus other useful information. The sample data provided with the "IMP" demonstration program certainly produces some intricate frequency response charts.

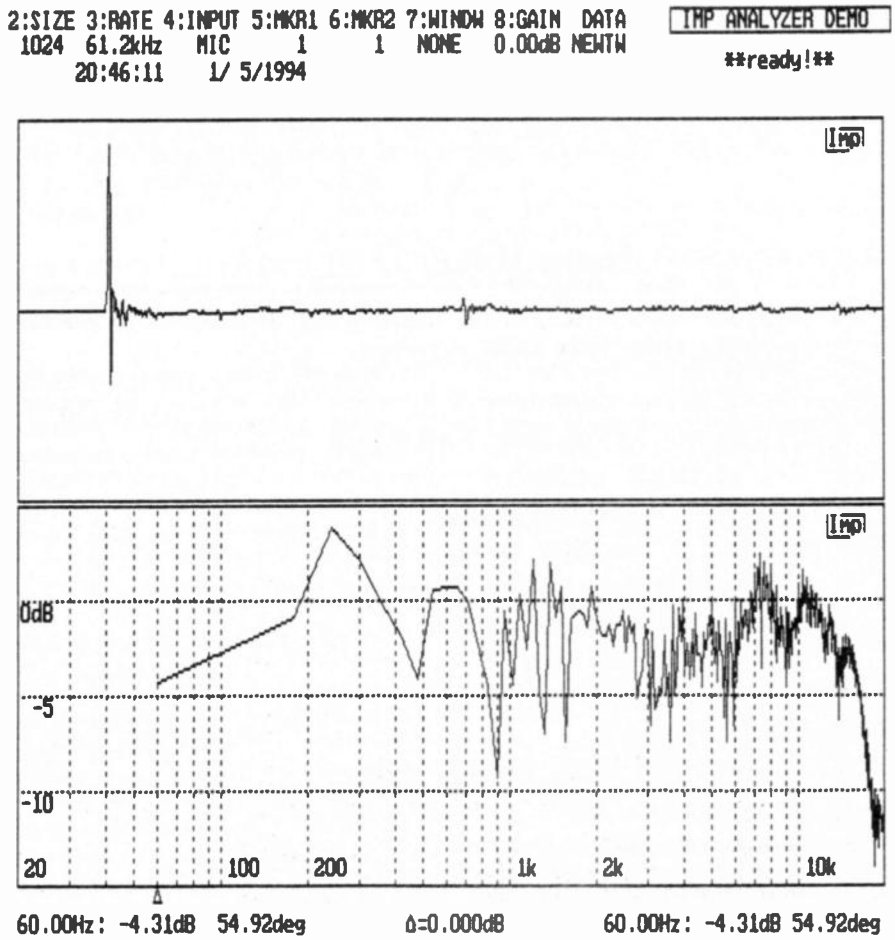
The program is quite easy to use, and it does not require a particularly advanced PC. Virtually any PC with 640K of RAM and running MSDOS 3.1 or higher will suffice. However, an E.G.A., V.G.A., or Hercules display is required (C.G.A. displays are not supported). Some aspects of the program seem to require a fair amount of specialist knowledge, but it is quite easy to produce basic response charts if that is all you need.

Full Program

The fully working program costs £47-70 including VAT and postage, but a substantial amount of hardware is needed in order to use it. A hardware kit of parts plus the software has a fully inclusive price of £192, but this does not include the amplifier, microphone, case, power supply, or minor odds and ends such as nuts and bolts. The system is probably too expensive for most amateur audio enthusiasts, but for those who really need a system of this type it offers a relatively low cost approach.

I must point out that I have not tested a fully working system, and cannot vouch for the accuracy of a complete "IMP" setup. If you need a system of this type though, the "IMP" system would certainly seem to be worth further investigation. The demonstration program is on a high density 3·5 inch disk and costs £2-35 plus 38p postage.

For further details contact **Falcon Acoustics Ltd.**, Dept EPE, Tabor House, Norwich Road, Mulbarton, Norwich, Norfolk, NR14 8JT (Tel. 0508 78272, Fax 0508 70986).



IMP sample printout (300 d.p.i. laser). The top trace is the digitised pulse, the lower one is the calculated frequency response.

VIDEOS ON ELECTRONICS

A range of videos designed to provide instruction on electronics theory. Each video gives a sound introduction and grounding in a specialised area of the subject. The tapes make learning both easier and more enjoyable than pure textbook or magazine study. They should prove particularly useful in schools, colleges, training departments and electronics clubs as well as to general hobbyists and those following distance learning courses etc.

VT201 to VT206 is a basic electronics course and is designed to be used as a complete series, if required.

VT201 54 minutes. Part one; D.C. Circuits. This video is an absolute must for the beginner. Series circuits, parallel circuits, Ohms law, how to use the digital multimeter and much more. **Order Code VT201**

VT202 62 minutes. Part two; A.C. Circuits. This is your next step in understanding the basics of electronics. You will learn about how coils, transformers, capacitors, etc are used in common circuits. **Order Code VT202**

VT203 57 minutes. Part three; Semiconductors. Gives you an exciting look into the world of semiconductors. With basic semiconductor theory. Plus 15 different semiconductor devices explained. **Order Code VT203**

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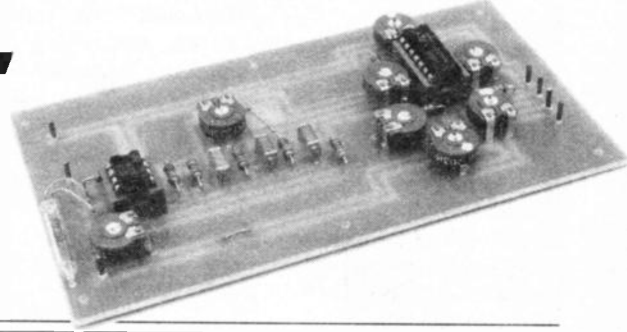
Constructional Project

THREE-PHASE GENERATOR



R. T. IRISH

A simple circuit that can be used with power amplifiers to drive many items of three-phase equipment, including aircraft equipment.

THE USE of three-phase supplies to run induction motors and other apparatus is well established. Unfortunately, the man in the street does not have general access to such supplies and therefore has to forego the advantages which they offer.

Instructional establishments also often experience some difficulty in obtaining suitable three-phase supplies for demonstrations and experiments. This design enables a low-power consumption, accurate, three-phase supply to be generated at any frequency from a circuit consisting of just two i.c.s and a few discrete components.

PRINCIPLE OF OPERATION

The design uses the familiar *3-CR* oscillator, stabilised by a thermistor. It is well known that the equal *C*, equal *R* circuit produces phase shifts within it which are far from the 120 degrees required. This design uses equal valued capacitors but differing valued resistors – as indicated in Fig. 1.

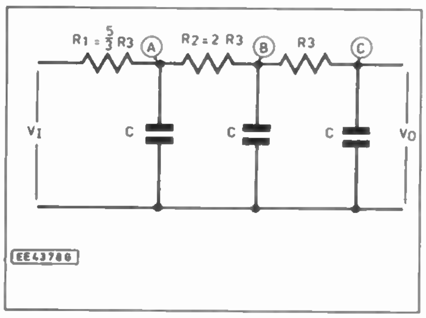


Fig. 1. The 3-CR circuit for three phase generation.

Careful analysis of this circuit shows that the output voltage (V_O) is in antiphase with the input voltage (V_I) at an operating frequency of

$$f = \frac{\sqrt{3}}{2\pi CR_3} \quad \ldots\ldots\ldots 1$$

At this frequency, the voltages at *A*, *B* and *C* are each at 60 degrees to each other. It is only necessary to invert the voltage at *B* to achieve the appropriate 120 degrees between each voltage.

Under these conditions the voltages in the circuit are:

$V_I = 35V_O$, $V_A = 10V_O$ and $V_B = 2V_O$.

CIRCUIT DETAILS

As may be seen from the circuit diagram of the complete generator (Fig. 2) it consists of two parts, each associated with separate functions. IC1 is the 3-CR oscillator and IC1b provides the principal gain element, giving a voltage gain of −17·8. IC1a gives a nominal gain of 2, but its principal action is to stabilise the amplitude of the oscillations using the thermistor (TH1) in its feedback path.

The voltages at *A* and *C* are already at 120 degrees to each other and IC2a and IC2d simply amplify them both to a level equal to the output from IC1b. Op.amp IC2b buffers the voltage at *B* so that the subsequent processing does not effect the frequency, and IC2c inverts it, now making it at 120 degrees to both the voltages at *A* and at *C* and brings it up to the voltage level of the output from IC1b.

The potentiometers VR5, VR6 and VR7 are included across the outputs from each phase op.amp to provide an adjustment of the amplitudes fed to the "drive".

CIRCUIT DESIGN PROCEDURE

The calculation of the necessary values for *C* (C1 to C3), R1, R2 and R3 is quite straightforward and the simple example below should clarify any possible problems:

Design for a three-phase, 400Hz generator (to run aircraft equipment):

i) Select *C*. Initially chosen as 0·047µ (47n)

ii) Calculate R3 from equation 1:
$R3 = \sqrt{3}/(2\pi Cf) = \sqrt{3}/(2.\pi.0{\cdot}047.10^{-6}.400) = 14{\cdot}66k\Omega$
If R3 is lower than about 10 kilohms, it is recommended that the value of *C* should be reduced to the next lower preferred value until R3 does lie above this value.

iii) Calculate R2 = 2.R3 = 29·32kΩ

iv) Calculate R1 = 5.R3/3 = 24·44kΩ

Usually, a small tolerance in the actual frequency is acceptable and it is therefore recommended that resistor R1 is made equal to the nearest preferred value – in this case 24 kilohms.

Recalculation of R2 and R3 and f give:

R2 = 28·8kΩ
R3 = 14·4kΩ

and f = 407Hz (less than two per cent error).

Resistor R2 hence consists of a 27kΩ resistor in series with a 2·2kΩ or a 4·7kΩ preset trimmer and resistor R3 consists of a 13kΩ resistor in series with a 2·2kΩ preset trimmer.

COMPONENTS

Resistors

R1	24k	SEE TEXT
R2	28k8	SEE TEXT
R3	14k4	SEE TEXT
R4	10k	
R5	5k6	
R6	100k	
R7, R8, R9	82k (3 off)	

All 0·6W 1% metal film

See SHOP TALK Page

Potentiometers

VR1, VR3, VR5 to VR7	10k sub-min. enclosed carbon preset, lin. (5 off)
VR2	100k sub-min. enclosed carbon preset, lin.
VR4	5k sub-min. enclosed carbon preset, lin.

Capacitors

C1 to C3	47n polyester layer (3 off)

Semiconductors

IC1	TL082 dual j-f.e.t. op.amp
IC2	TL084 quad j-f.e.t. op.amp

Miscellaneous

TH1	RA53 glass bead thermistor, (res. 5k @ 20°C, min. res 80Ω)

Printed circuit board available from *EPE PCB Service*, code 861; 8-pin d.i.l. socket; 14-pin d.i.l. socket; solder terminal pins; wire links; solder, etc.

Approx cost guidance only **£12**

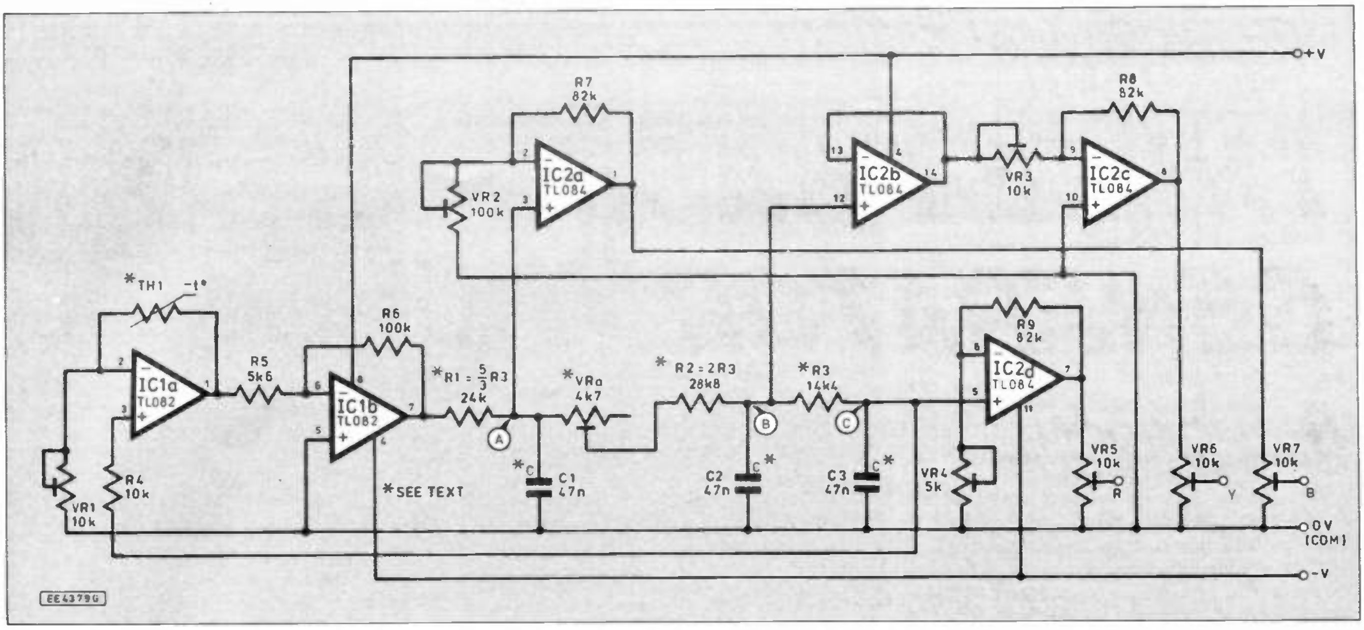


Fig. 2. Complete circuit diagram of the Three-Phase Generator.

CONSTRUCTION

The circuit is best built on the printed circuit board designed for it, although several successful generators such as this have been built on stripboard and matrix board bases. The printed circuit board component layout and underside full size copper foil master pattern is shown in Fig. 3. This board is available from the *EPE PCB Service*, code 861.

No particular difficulties should be experienced constructing the circuit, but it is recommended that sockets should be used for the i.c.s. Three holes have been incorporated in the printed circuit board for each of the *RC* network capacitors to facilitate the use of components with differing pin spacings. All of the fixed resistors are 0·6W, metal film types.

Small-valued potentiometers (VRa, VRb) are included in series with resistors R2 and R3 to facilitate the accurate realisation of the total resistance needed in these positions. They should be set up, using the most accurate ohmmeter available, with the integrated circuits removed from their sockets. Happily, the circuit is quite tolerant of any small errors in setting these and, if high accuracy is not required, they may be omitted (if this is done, they must be "short circuited" on the p.c.b. with wire links, as shown for VRb).

SETTING UP THE CIRCUIT

The circuit is very straightforward to set up. Connect the d.c. voltages to the unit – these may lie anywhere between +2V and +18V but either +10 or +12V is recommended. Too low a supply voltage will limit the maximum amplitude of the output voltage available.

Monitor the output of IC1b and adjust preset VR1 until the circuit just oscillates. Then advance its setting a little so that changes in the ambient temperature do not affect the thermistor (TH1) so much that oscillations stop – a particularly important point if the generator is to be included in a case with a power amplifier.

Note the amplitude of the wave at the output of IC1b and adjust presets VR2, VR3 and VR4 so that the outputs from IC2a, IC2c and IC2d are all equal and slightly less in amplitude than the output from IC1b.

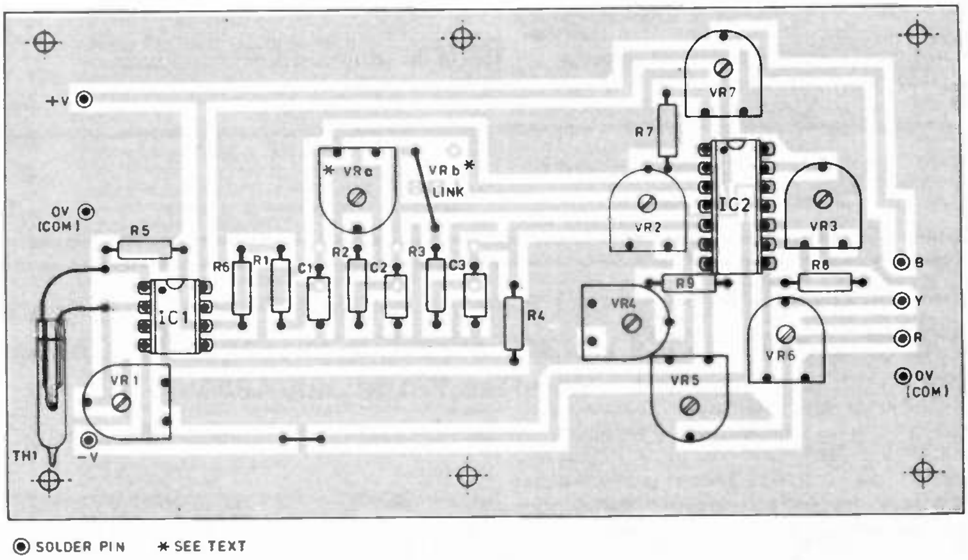
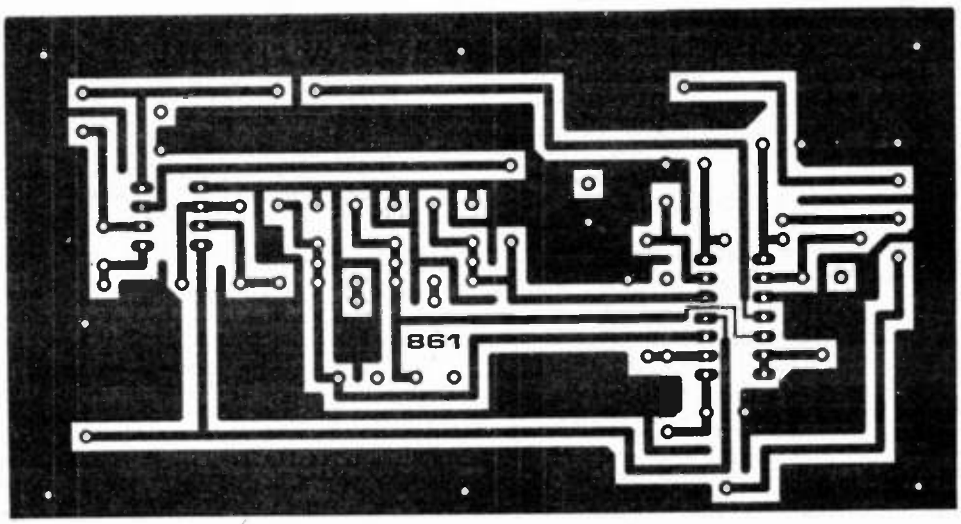


Fig. 3. P.C.B. for the Three Phase Generator.



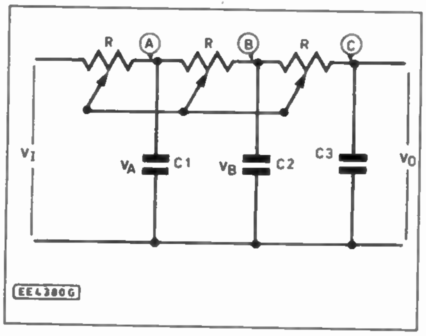
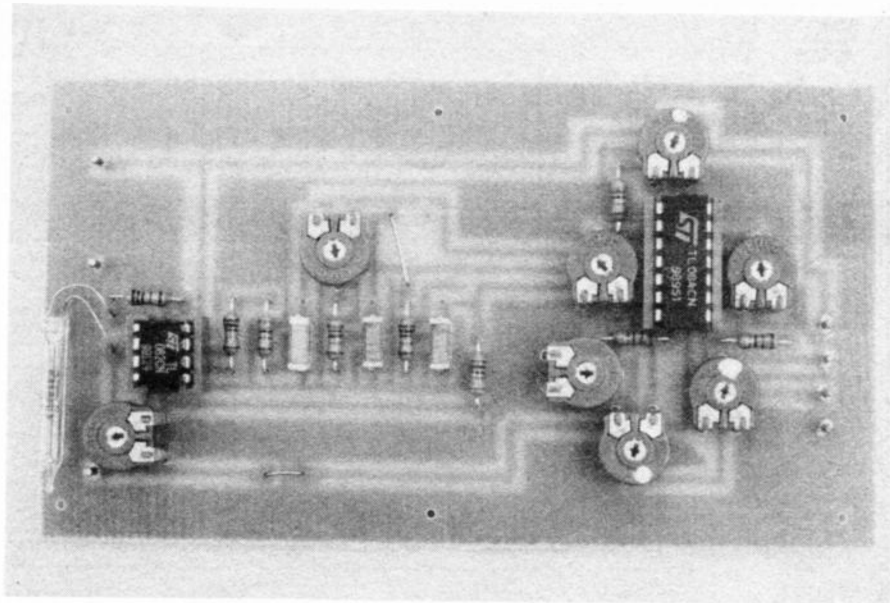


Fig. 4. Modification to provide variable frequency generation.



APPLICATION OF THE CIRCUIT

This circuit has been used very successfully to generate a wide range of frequencies and has usually been employed in conjunction with three power amplifiers to drive the equipment concerned. The Maplin range of power amplifiers, from 1W output power to 150W (or even 1kW!) are particularly suitable.

The 150W MOSFET power amplifiers will run appropriate motors up to ½ horsepower well. If a 240V (phase) supply is required, then the outputs from the power amplifiers may be stepped up using appropriate transformers.

Three-phase motors, gyroscopes and a wide range of other equipment have been easily driven using three power amplifiers, fed directly from this three-phase generator. Note:– The specification of three-phase equipment always quotes the LINE voltage. To obtain the appropriate PHASE voltage necessary from the amplifiers' outputs, this should be divided by $\sqrt{3}$. For example, a three-phase motor, rated at 200 volts should be driven with the amplifiers' outputs set to $200/\sqrt{3}\ V = 115V$.

A further, interesting application would be to extend the circuit to form a variable-frequency, three-phase generator. This is readily achieved by making the three resistors in the frequency-determining network equal and variable (mechanically ganged (linked) linear slider resistors could be used). A diagram showing this arrangement is given in Fig. 4.

Under these conditions the relevant equations are:

$$f = \frac{\sqrt{3}}{2\pi C_3 R}$$

$$V_I = 26\ V_O,\ V_A = 7V_O \text{ and } V_B = 2V_O$$

$$\text{with } C_1 = 12.C_3/7$$

$$\text{and } C_2 = 3.C_3/2$$

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Techniques

ACTUALLY DOING IT!

by Robert Penfold

IT IS some time since the all-important topic of soldering was covered in this feature. I think it is fair to say that soldering is something which puts off a number of would-be electronic project builders. This is a pity, because soldering is not really that difficult, and it is a skill that virtually anyone can master.

You are unlikely to produce really neat and professional looking soldered joints right from the start. Indeed, you may never produce really neat looking results.

Being practical about matters though, it does not really matter whether or not a finished project is built to professional standards. Provided the joints are mechanically and electrically sound, the project will work, which is all that really counts. If you progress to the point where you produce really professional looking results, so much the better.

TOOL FOR THE JOB

Some of the tools needed for electronic project construction are to be found in many household tool chests. However, suitable soldering equipment is something that you will almost certainly have to buy specially. There are plenty of very expensive soldering iron stations available, offering variable temperature control, thermostatic control, etc., etc.

Fortunately, for project construction a basic iron costing about ten pounds is perfectly adequate. I have used irons of this type to build what must be in excess of a thousand projects, and have never found the need for anything a bit more up-market.

On the other hand, I could not recommend very cheap soldering irons. These might not be particularly long lived, and in my experience they usually produce too little heat. If you try to complete several joints in rapid succession the bit soon "freezes" to one of the joints. Some of these irons barely reach a high enough temperature to melt solder!

Modern project building tends to involve large numbers of very small soldered joints, and for this type of thing an iron having a rating of about 15 to 18 watts is ideal. The Antex model C and CS irons are available from most component retailers, and either of these should give many years of trouble-free use. The two Antex irons I currently use were bought so long ago that I could only guess at their ages!

BIT SIZE

Small electric soldering irons are normally supplied with a bit of about 2·3 millimetres in diameter. This is suitable for most project building, but when working on intricate circuit boards you might find it easier to use a bit having a diameter of only about one millimetre.

Spare bits of various sizes and shapes are readily available for the popular soldering irons, and changing the bit is a very simple task. Note that over a period of time the end of the bit will corrode away, and a new bit will eventually have to be fitted.

A matching soldering iron stand is an *essential* piece of equipment, and it should only cost a few pounds. These usually consist of a plastic base section on which a sort of large metal spring is mounted. The bit and shaft of the iron fit into the spring, which provides a safe resting place for the hot iron, as well as helping to remove excess heat from the bit and element when the iron is not in use.

The base section of the stand is usually fitted with a sponge which can be used to clean the bit of the iron. The bit should only be cleaned on the sponge if the latter is moist. Otherwise the hot bit will simply burn the sponge, and the bit will probably end up dirtier rather than cleaner.

I have never found the sponge to be particularly useful for cleaning the bit. Cleaning blocks and other types of tip cleaner seem to be more efficient, and do not need to be kept wet.

STATE OF FLUX

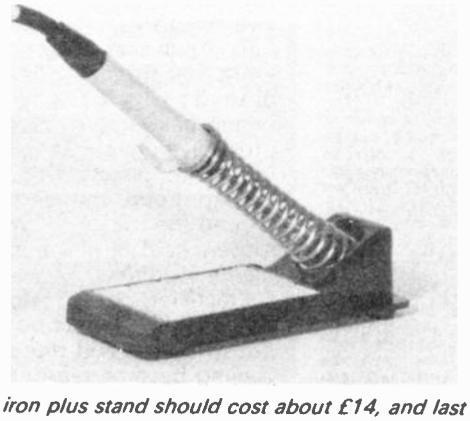
The correct solder for electronic work is a 60/40 tin/lead multi-core type. This type of solder should be available from any component retailer, and will probably be the only type of solder that they sell. It is normally available in two thicknesses – 22 s.w.g. (0·71mm) and 18 s.w.g. (1·22mm). 22 s.w.g. solder is the best choice for modern project construction, but it is useful to have a small amount of 18 s.w.g. solder for the odd occasion when some large joints must be tackled.

It is advisable to buy the 22 s.w.g. solder in one of the larger size packs, or even as a 500g reel. Buying solder in small amounts is likely to be very expensive, and you will probably keep running out with projects 90 percent finished!

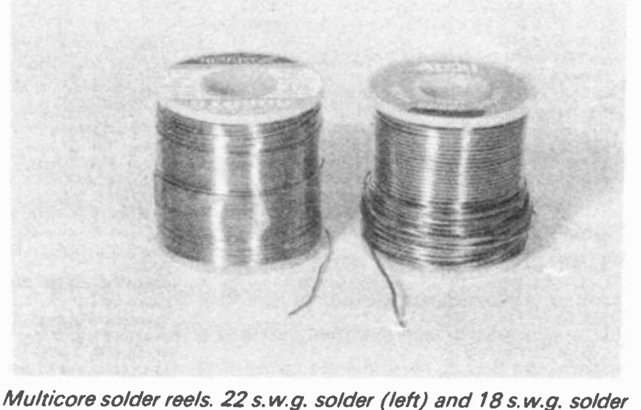
The cores in the solder are made of flux. This helps the solder to flow nicely over each joint. Flux also removes any slight corrosion or thin films of dirt on the surfaces to be joined. At one time dirt and corrosion on leads was a major problem, and it was necessary to clean the ends of leads before making each connection. Modern production line methods have lead to the development of improved solders and wires which make this practice unnecessary.

You may occasionally be faced with a component that has been in storage for some time, and which has dirty or corroded leadout wires or tags. With such a component it is definitely advisable to clean the leads or tags. This is easily done with something like a piece of fine grade sandpaper, or by scraping the affected areas using the small blade of a penknife.

Provided you are using some form of ready-made printed circuit board it is unlikely that there will be any problems



A 15 to 18 watt iron plus stand should cost about £14, and last many years.



Multicore solder reels. 22 s.w.g. solder (left) and 18 s.w.g. solder (right). 22 s.w.g. is best for most project building..

with dirt or corrosion on the copper side of the board. Virtually all ready-made boards are coated with a thin protective film which also acts as a flux. However, if there should be any signs of dirt or corrosion on a circuit board it is a good idea to thoroughly clean the entire copper side of the board.

Special printed circuit polishing blocks can be obtained, but wire-wool or a piece of scouring pad (such as "Brillo" pad) used *gently* will also do the job well. Home-made printed circuit boards should always be cleaned in this way prior to fitting the components.

WHILE THE IRON'S HOT

Do not worry if a new iron produces a certain amount of smoke when it is first switched on. There are usually protective coatings on the element and bit which will burn off as the iron heats up. There may also be a certain amount of dust on the element which will burn away.

Once the iron is hot enough it is important to "tin" the bit with a small amount of solder. In other words, simply melt a small amount of solder onto the tip of the bit, so that it is fully coated with solder.

It is important that the bit is "tinned" soon after it reaches a high enough temperature. Waiting too long can result in the bit failing to "tin" properly, with the solder simply falling off the bit. Once this happens, it seems to be almost impossible to get the bit into proper working order.

In use the tip of the bit should always have a thin coating of fresh solder. The bit will therefore need to be wiped clean periodically, and given a fresh "tinning". This ensures that there will be good thermal contact between the bit and the two pieces of metal that are being joined. This is an important factor, and good quality joints will only be produced if both pieces of metal are properly heated up.

SEQUENCE

When producing soldered joints the most important thing is to work through the sequence of events in the right order. When soldering components onto some form of printed circuit board this means fitting the first component in place, and then trimming the leads to length on the underside of the board. Use proper wire cutters for this, and leave about three millimetres of wiring protruding on the underside of the board.

Soldering is a two-handed job, so something must be used to hold the component in place while it is soldered to the board. Special printed circuit assembly frames are available, but some Bostik "Blue-Tack" provides a simple and inexpensive means of holding components in place.

Alternatively the component leads can be bent over slightly to hold the component, but this does make it more difficult to remove the component later if necessary. Most constructors soon devise their own pet ways of handling this problem.

Next the tip of the bit should be applied simultaneously to the copper pad and the end of the leadout wire. It is very important that the bit is applied *before* the solder, so that the surfaces to be joined have time to heat up before the solder is fed in. This helps to ensure that the solder will flow properly and produce a good joint. The wire and copper pad will heat up very rapidly when the iron is applied, so only wait about half a second before feeding in the solder.

ENOUGH SOLDER

Apply enough solder to give a good covering over the surfaces to be joined. A certain amount of smoke will be produced, but this is just the flux burning away. Do not make the classic beginners mistake of applying solder to the bit and then trying to pour this onto the joint.

If you do this the flux will largely burn away before the solder reaches the leadout wire and pad. Also, the solder will not flow properly onto the cold metal surfaces. The "pour it on" method more or less guarantees a high percentage of bad joints, or "dry" joints as they are usually termed.

If you get everything right, a completed joint should be volcano-shaped, with the end of the leadout wire protruding through the "crater". If the joint is obviously non-symmetrical, it is not necessarily a bad one, but this is not a good sign.

If the lopsidedness is due to a lack of solder, this should be fairly obvious, since parts of the wire and copper pad will still be visible. It is then just a matter of applying the iron and the solder again, to complete the joint.

If too much solder has been used, this should also be fairly obvious. In some cases the solder will flow across to another joint, producing a bridge of solder. In other cases there will be a large blob of solder extending upwards from the joint. In either event it is best to remove the solder and redo the join or joints.

The best low cost tool for removing solder is a desolder pump of the type which has a spring-loaded piston. These only cost a few pounds, but they are easy to use and very effective. These days, a desoldering tool is just as essential as a soldering iron and solder. However expert you become, you will still produce some solder bridges from time to time.

Occasionally the solder may not flow over the joint properly. This can give a joint which is quite strong physically, but which does not provide a proper electrical contact. There may be no immediately obvious signs that a "dry" joint has been produced, but in most cases there will be some outward signs of trouble.

A "dry" joint is often globular in appearance, and the surface of the solder tends to have a dull appearance instead of the normal shiny metallic finish. There may also be a lot of partially burnt flux on and around the joint.

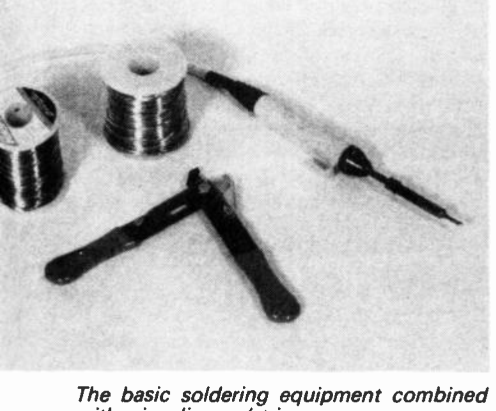
PRACTICE MAKES PERFECT

It would be unrealistic to expect perfect results the first time you try your hand at soldering. It is a good idea to practise soldering using a piece of stripboard, some wire, a few resistors, and a couple of d.i.l. integrated circuit holders. Start by soldering the resistors to the board, together with some link-wires.

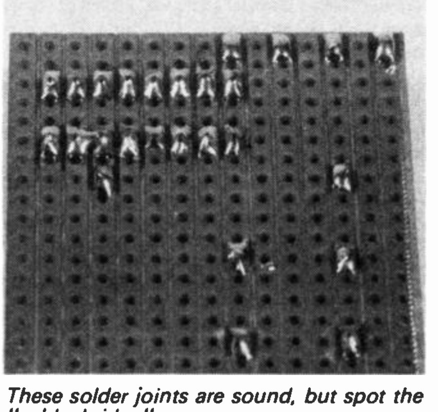
Once you have become reasonably proficient, try fitting the integrated circuit holders. These are slightly more difficult due to the rows of closely spaced connections. Try to avoid solder bridges, then deliberately produce a few so that you practise removing them.

Although most interconnections are carried via the circuit board, virtually all projects involve a certain amount of hard wiring (i.e. wires soldered between pairs of component tags or pins). You can practise this type of thing by fitting a few solder pins onto the piece of stripboard. Then try wiring pairs of pins together. There is probably no point in trying to produce ultra-neat results with this type of wiring. Loop the end of the wire around the top of the pin so that is it loosely held in place, and then apply plenty of solder.

Practising on a "dummy" circuit board might seem to be a bit wasteful, but it is time and money well spent. Having become reasonably proficient at soldering, your chances of success with your first project are very high.



The basic soldering equipment combined with wire clippers/strippers.



These solder joints are sound, but spot the "solder bridge".

FOX REPORT

by Barry Fox

KODAK PICTURE EXCHANGE

When visiting Eastman Kodak's Headquarters in Rochester, NY State recently, I got the chance to try KPX, the new Kodak Picture Exchange. Since the end of November 1993 this has been providing newspapers, magazines and TV stations a 24 hour a day, one stop access service to 17 of the world's leading stock picture agencies.

With KPX, picture editors need no longer phone round several agencies, searching for the right picture to illustrate an article. Instead they can use a personal computer and electronic mail modem to search through a master index of pictures from all agencies, digitally stored in the central Kodak database. The editor can then call up low resolution images of his likely choices before making a final selection.

Picture agencies stock up to 6 million pictures each, and currently charge between $75 and $150 to search out a selection of pictures to fit a client's order. They then charge $15 to send paper prints by courier for approval. Magazines pay a penalty of up to $1500 for any picture not returned. All this is before negotiating a copyright fee for any picture published. If an editor puts the same request to three agencies, the basic search cost is tripled.

"We are offering a brokerage service", says Roger Hansen, Marketing Manager for KPX. "We put people who want to buy images in contact with those who want to sell them".

Kodak uses a high resolution scanner to convert an agency's images into digital code and then store them on magnetic disc at its Rochester base. Each image is indexed, by key words, to describe the content. A magazine pays a one-off charge of $400 for software which lets a personal computer dial the KPX database at a fixed search rate of $1·42 a minute.

The searcher enters a string of key words and the screen displays a list of all pictures that fit the bill. I tried "trumpet" and "jazz" and got a long list. Refining the search to "Louis Armstrong" shortened the list to a few that looked hopeful. The KPX digital store then sends low resolution images of the short list down the telephone line, for display on the PC screen. These images show what the picture depicts (e.g. Louis on stage, in mug shot and at home) but are deliberately not of good enough resolution for the magazine to use.

On average it takes around 15 minutes of search time, costing $20, for a magazine picture editor to find an image that fits the bill. KPX levies a fee of $16 for each thumbnail image sent down the line. When the searcher makes a choice, the KPX alerts the agency which then phones to negotiate a fee and send a full resolution print by courier.

The original image is scanned into the KPX computer store using the same technology that Kodak uses to scan Photo CD images for storage on a compact disc. The print or transparency is scanned in a raster of 2048 x 3072 picture points or pixels, with red, green and blue colour content at each pixel converted into 12-bit digital code. This generates a data package of 27 Megabytes, which is compressed to around 4·5 Megabytes for storage. At this resolution, all the detail in the original picture is captured, making KPX futureproof.

It is not usually feasible to send full resolution images by phone line. A conventional line and EMAIL modem supports a data rate of only around 10 kilobits/second and a full resolution image requires at least 35 Megabits of data (4·5 Mbytes). So one picture would take an hour to send.

COPYRIGHT

Technology is not the only reason why the picture libraries still prefer to send out prints or transparencies. ISDN lines would speed delivery to a few minutes. "The agencies are nervous about copyright" explains Hansen. If KPX sends a full resolution image in digital code down a telephone line, anyone who receives that image is free to copy it as many times as they wish, as easily as copying computer text.

Kodak charges agencies between $2 and $5 per image scanned, depending on picture size, around $3 per image for indexing and a storage fee of $1 per image per year. But the agency will no longer have to publish expensive colour catalogues annually.

Already 17 international agencies including the Hulton-Deutsch Collection, Animals/Earth Scenes and EMPICS of Nottingham, have signed up and are storing images in the KPX. Access is so far avaiilable only in the US, but Kodak plans to offer the service in Europe during 1994.

The next generation of KPX technology will offer thumb nail movie sequences, so that TV and film producers can choose stock footage from film and video libraries. The MPEG compression system used to store Full Motion Video on a CD-I disc, needs a data stream of just over 1 Megabit/second for VHS quality video. Modern modems can support 15 or 20 kilobit/s, which should give picture quality good enough for film and TV producers to select stock sequences.

SHOCKING

My report on last year's Berlin Show mentions a nasty gadget which puts up to 175,000 volts through anyone unlucky enough to get in its way. Although ostensibly for self-defence, the opportunities it offers muggers are obvious. So, I should have thought, were the risks.

Anyone who has got a belt from the 25,000 volts or so on the sparking plug leads of a car will know how nasty high voltage shocks can be, even when the current flow is low. So I phoned the British Medical Association for some expert opinion.

The BMA does not itself give opinions, but has a database of experts who will. It took the BMA twenty-four hours, and a reminder, to come up with an expert on electric shock. He was a retired professor of medicine and after phoning him I began to understand why gadgetry like this can get onto the market. In the Professor's own words he wanted to "dissect the problem".

Was I an electrical engineer? Was I a doctor? So I was a journalist then? Yes.

He then explained to me what I had already explained to him, namely that the current flow would be low and depend on whether the electrodes were prodded against clothing, or bare skin, either wet or dry. In Berlin the demonstrator had boasted that the device would "work even through leather clothing".

My concern, I kept saying, is what might happen if someone used one of these devices against an elderly person with a weak heart, or a child.

"Well, it all depends," the Prof would then say and go off on yet another ramble and lecture.

"So are you prepared to say it is not dangerous?" I asked.

"Oh no, you are not going to catch me like that," he came back, and started off on another ramble.

Fortunately the BMA had given me two other names of doctors who specialised in electric shock. And both saw the risk immediately. Said Dr. Tar-Ching Aw of the Institute of Occupational Health in Birmingham. "I would most certainly worry about someone using 175,000 volts as a weapon, especially on someone with a weak heart or worse, a pacemaker."

Said Dr. Julian Kenyon of the Centre for the Study of Complementary Medicine in Southampton, "It sounds potentially lethal."

I was left uncharitably wondering how the retired professor will feel if he is one day mugged by someone with a 175 kilovolt shocker. I suspect he will very quickly stop wanting to dissect the problem and recognise the risk.

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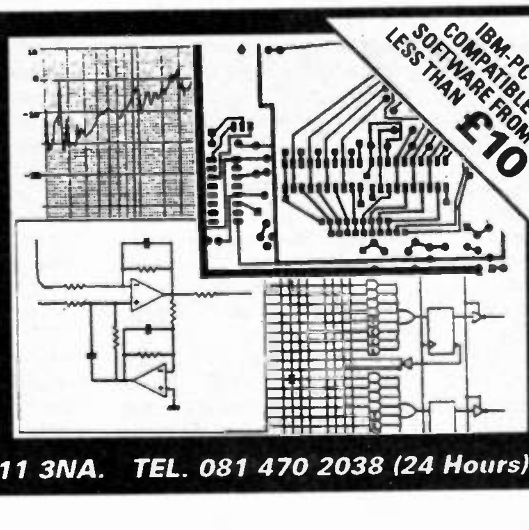

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Home Base

Jottings of an electronics hobbyist –Terry Pinnell

What do you Mean, Mean?

I wouldn't say I was penny-pinching (well, I wouldn't, would I?) In fact, if pressed (not very hard) I'd modestly admit to thinking of myself as a generous sort of chap. So why do I get so much pleasure out of making things from junk?

Saving money is part of it of course, but I think it's mainly about the creative spirit. Salvaging cast-off materials and turning them to good purpose appeals to the inventive streak in me. (By the way, searching just now for another word for "creative", the built-in thesaurus in my word processor, Microsoft's Works for Windows package, suggested the strange synonyms: lovely, poetic, elegant, artistic, beautiful, decorative and musical. It's normally pretty good, but it's way off target with all seven of those!)

Anyway, returning to my theme, I definitely get some satisfaction out of rescuing domestic flotsam and jetsam and putting it to good effect in my electronics.

Making the Case

Improvising cases for projects is a particularly fruitful area. There are so many common-or-garden items that can make useful housings for electronics gadgets. It helps to be a bit of a hoarder of course, a trait which I have admitted earlier in *Home Base*, because you then have a large potential source of raw materials. You don't necessarily have to save everything in sight. After a while you develop a sense of what is likely to be useful and what will for ever remain just junk – although on the evidence of my loft, this skill can take a decade or two to acquire!

Although there are nowadays (thankfully) a tiny fraction of the pipe-smokers around compared with when I started this hobby, it may well still be easy to get hold of empty tobacco tins. Having kicked the habit some years earlier, I wrote to a tobacco manufacturer and they kindly sent me a gross. (I suppose in these modern metricated times they would send a 100! Surely not 10?)

The two ounce tins make excellent cases for small projects, particularly small pieces of test equipment and such like. They are well-screened against r.f. interference (both incoming and outgoing) and are easy to finish smartly, readily taking spray-on cellulose or enamel paint or transfer lettering (or both).

You can also get a PP3 battery neatly inside, holding it tight with either a piece of sponge or a specially shaped tin or aluminium bracket. I've made a couple of dozen projects inside such tins, and a few others with "double-decker" versions, such as in my Electronic Mousetrap which I rambled on about in this column a few months ago.

Guttered

A less common source of cases is plastic guttering of the kind in the attached photograph. Actually, that Buzz-Bar project for a young relative illustrates a couple of other examples of improvising junk too. I see that an old coathanger from the local dry-cleaners was pressed into service in the star role of Bar, and a tubular piece of plastic from a pen formed the probe. Even the two chunky toggle switches were probably courtesy of some dark surplus components shop or mail-order outfit, for a few pence each.

But coming back to the square-section guttering itself, it has some nice advantages for cases. Apart from being strong and good looking and accepting transfers easily, it can be cut to any length, so you can tailor it for your particular project. It also holds a PP9 battery as if it was made for it, like a bullet in a rifle, and you can get easy access to that or the electronics via the push-fit end pieces. These also serve to raise the whole case above the surface, avoiding scratching and allowing self-tapping screws or nuts and bolts to be used if necessary on the bottom.

Marley certainly had no more intention of this purpose for their rain guttering than Benson & Hedges did for their tobacco tins, but they both do the job splendidly in the right circumstances.

Watch Out

The second photograph shows examples of two small cases made from other surplus items. Both are plastic presentation boxes of the sort that you normally either throw away as soon as you get the item home or else stick in a draw to await that unpredictable return-to-maker if something ever goes wrong.

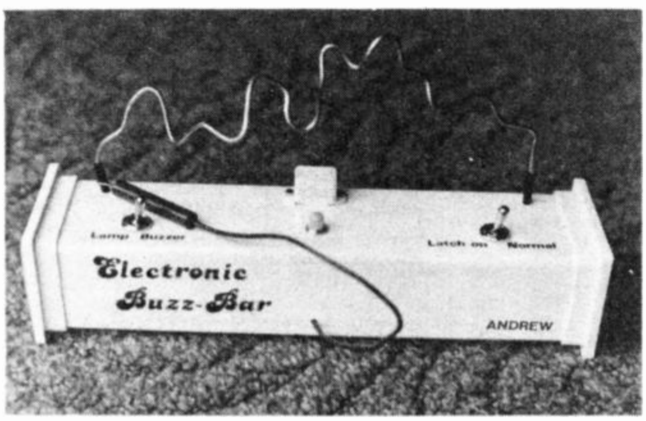
The flat rectangular one initially held a watch and proved ideal for a small metal detector. I recall that I was struck with a rare attack of d.i.y. but decided to first seek out safe bits of wall before launching out wildly with my Black & Decker.

Its radiating coil was mounted flushly at one end and the case just held a PP3 battery as well as the circuit board. It can't be seen too well in the photograph, but there is a small knob to adjust the circuit to equilibrium, so that the green l.e.d. is just off when there is no metal in the immediate vicinity, and it lights up as soon as the coil is about 100mm or less from metal (and that includes the copper of a mains wire of course). Despite having a strongly sprung lid (as is usually true with jewellery and watches) a single screw was used to keep it closed.

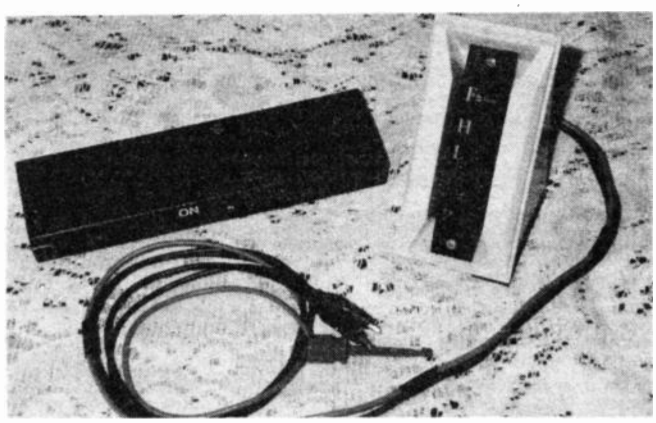
The light-coloured, wedge-shaped case also originally held a watch. With a bit of fiddling, removing unwanted innards, and the addition of a small strip of plastic, I made a useful logic probe from it. The power supply is taken from the CMOS circuit under test and the three l.e.d.s show High, Low or Pulses, with a "Floating" condition indicated when none of them are on. Because of its shape, the l.e.d.s are much easier to see than if a conventional flat case had been used.

One snag was that, being so light and having such a small base, it tended to slide around a bit. But a couple of strips of self-adhesive window draught excluder stopped that, and it has been in regular use on my bench for many years now.

Junk or a potential project? Hang onto it, just in case.



Buzz-Bar project housed in a section of plastic guttering.


A metal detector and a logic probe housed in different types of watch cases.

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The subjects covered in each chapter of the book are: Introduction and Power Supplies; Small Signal Amplifiers; Power Amplifiers; Oscillators; Logic Circuits; Timers; Radio; Power Control; Optoelectronics.
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TESTING, THEORY AND REFERENCE

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Ian Sinclair
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R. A. Penfold
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D. Weale

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The subjects covered include: PC overview; Memory upgrades; Adding a hard disk drive; Adding a floppy disk drive; Display adaptors and monitors; Fitting a maths co-processor; Keyboards; Ports; Mice and digitisers; Maintenance (including preventative maintenance) and Repairs, and the increasingly popular subject of d.i.y. PCs.

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R. A. & J. W. Penfold

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How to use Paintbursh and its tools to draw and edit drawings, and how to set up, sort and search a Cardfile database and exploit its autodial feature. How to use the Windows Calendar to enter appointments, add special times and alarms. How to use the Terminal accessory to connect to remote systems, specify terminal emulation preferences, communications setting, telephone number and prepare files for transfer. How to use the Notepad, Macro Recorder, PIF Editor and Calculator.

138 pages — **Order code BP325** — **£4.95**

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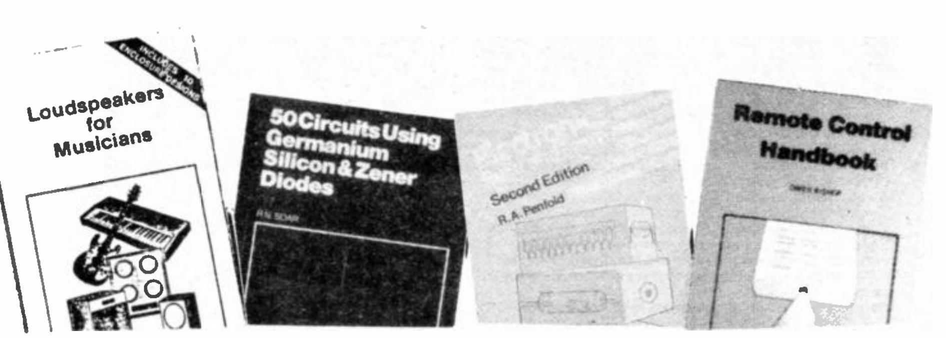

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R. A. Penfold

Getting started with logic circuits can be difficult, since many of the fundamental concepts of digital design tend to seem rather abstract, and remote from obviously useful applications. This book covers the basic theory of digital electronics and the use of CMOS integrated circuits, but does not lose sight of the fact that digital electronics has numerous "real world" applications.

The topics covered in this book include: the basic concepts of logic circuits; the functions of gates, inverters and other logic "building blocks"; CMOS logic i.c. characteristics, and their advantages in practical circuit design; oscillators and monostables (timers); flip/flops, binary dividers and binary counters; decode counters and display drivers.

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Waveform generator circuits may be built using transistors, op-amps, standard digital ICs, or dedicated waveform or "function" generator ICs.

The manual is divided into eleven chapters, and presents over 300 practical circuits, diagrams and tables. The subjects covered include: Basic principles; Sine wave generators; Square wave generators; Pulse generator circuits; "Timer IC" generator circuits; Triangle and sawtooth generators; Multi-waveform generation; Waveform synthesizer ICs; Special waveform generators; Phaselocked loop circuits; Miscellaneous "555" circuits.

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POPULAR ELECTRONIC PROJECTS
R. A. Penfold

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This book describes in detail how to construct some simple and inexpensive but extremely useful, pieces of test equipment. Stripboard layouts are provided for all designs, together with wiring diagrams where appropriate, plus notes on construction and use.

The following designs are included:–
AF Generator, Capacitance Meter, Test Bench Amplifier, AF Frequency Meter, Audio Millivoltmeter, Analogue Probe, High Resistance Voltmeter, CMOS Probe, Transistor Tester, TTL Probe.

The designs are suitable for both newcomers and more experienced hobbyists.

104 pages Order code BP248 **£2.95**

HOW TO DESIGN AND MAKE YOUR OWN P.C.B.s
R. A. Penfold

Deals with the simple methods of copying printed circuit board designs from magazines and books and covers all aspects of simple p.c.b. construction including photographic methods and designing your own p.c.b.s.

80 pages Order code BP121 **£2.50**

HOW TO GET YOUR ELECTRONIC PROJECTS WORKING
R. A. Penfold

We have all built projects only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

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R. A. Penfold

The purpose of this book is to provide the reader with a wide range of preamplifier and power amplifier designs that will, it is hoped, cover most normal requirements.

The preamplifier circuits include low noise microphone and RIAA types, a tape head preamplifier, a guitar preamplifier and various tone controls. The power amplifier designs range from low power battery operation to 100W MOSFET types and also include a 12 volt bridge amplifier capable of giving up to 18W output.

All the circuits are relatively easy to construct using the p.c.b. or stripboard designs given. Where necessary any setting-up procedures are described, but in most cases no setting-up or test gear is required in order to successfully complete the project.

100 pages Order code BP122 **£2.95**

BEGINNER'S GUIDE TO BUILDING ELECTRONICS PROJECTS
R. A. Penfold

Shows the complete beginner how to tackle the practical side of electronics, so that he or she can confidently build the electronic projects that are regularly featured in magazines and books. Also includes examples in the form of simple projects.

112 pages Order code 227 **£1.95**

AUDIO AND MUSIC

LOUDSPEAKERS FOR MUSICIANS
Vivian Capel

This book contains all that a working musician needs to know about loudspeakers; the different types, how they work, the most suitable for different instruments, for cabaret work, and for vocals. It gives tips on constructing cabinets, wiring up, when and where to use wadding, and when not to, what fittings are available, finishing, how to ensure they travel well, how to connect multi-speaker arrays and much more.

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REPORTING AMATEUR RADIO

Tony Smith G4FAI

MORSE SURVEY RESULTS

The results of the Radio Society of Great Britain's consultation exercise, on behalf of the Radiocommunications Agency, on the subject of a Morse-free licence for amateur radio operation below 30MHz, have been announced by the RSGB.

A total of 1499 replies were received, with 67·5 per cent voting "NO" to a code-free licence, and 32·5 per cent voting "YES". The report, published in *Radio Communication*, journal of the RSGB, comments "No doubt this topic should be reviewed by the RSGB Council from time to time to see if opinion changes."

Prepared by the RSGB's H.F. Committee, it stresses that the views expressed in the survey do not represent RSGB policy regarding a code-free H.F. licence. At the same time it mentions the recent decision of the IARU Region One Conference in favour of retaining the Morse requirement and states, "Council's current opinion is in agreement with the Region One decision but recognises that the situation may change in the next 5 to 10 years."

BAND PLAN CHANGES

The amateur H.F. band plans, designed to keep different operating modes apart, which might otherwise interfere with each other, were changed at the IARU Region One conference to allow more space for digital modes, now designated "Digimode". The revised frequencies for digimode are mainly shared with CW (Morse) and include, in some cases, international QRP (low power) and UK Novice frequencies; also some 'phone frequencies and frequencies used by the International Beacon Project.

The new "Digimode" sub-bands are: 1·838 to 1·842MHz; 3·580 to 3·620MHz; 7·035 to 7·045MHz; 10·140 to 10·150MHz; 14·070 to 14·112MHz; 18·101 to 18·109MHz; 21·080 to 21·120MHz; 24·920 to 24·929MHz; and 28·050 to 28·150MHz.

A typographical error in *Radio Communication*, indicating that in the 80m band the digimode section began at 3·560MHz (an international QRP frequency), nearly caused a revolution among QRP and Novice operators as such an allocation would have made the popular 80m frequencies frequented by these operators very difficult to use.

It was subsequently confirmed that the correct lower frequency is, in fact, 3·580MHz and not 3·560MHz. There is still concern, however, about the extension of digimode operation in other H.F. bands, sharing frequencies previously allocated for CW, including other QRP and Novice frequencies, but the possibility of mass resignations from the RSGB by QRP operators has probably now been averted.

PHASE 3 SATELLITES

Last month I described some of the new amateur satellites recently launched, also the work of AMSAT-UK in co-ordinating amateur satellite activity in the UK. Even more exciting, is the forthcoming 400kg *"Phase 3D"* satellite, which is possibly the most challenging project the international amateur radio community has ever attempted.

Phase 3 refers to the class of amateur satellites built to relay broad bands of amateur frequencies in real time from high elliptical orbits to provide worldwide coverage. Phase one satellites carried only beacons and were designed to last only a few weeks. Phase two satellites are built to last for a period of a year or more and, flying in a relatively low orbit, provide limited time access and restricted coverage.

The Phase 3 programme began in the 1970's and aimed to alleviate these limitations. The first Phase 3 craft was lost in an *Arianne* launch failure in 1980, but others followed.

The first successful one became *Oscar-10*, which still supports amateur communication, although now unable to provide optimum service due to onboard computer failure caused by radiation damage. A further Phase 3 satellite, *Oscar-13*, launched in 1988, is still working, but is slowly de-orbiting and is forecast to re-enter the earth's atmosphere in about four years' time.

The launch of the fourth Phase 3 satellite (*Phase 3D*) is expected to coincide with the demise of *Oscar-13*, but the new "bird" will be much more than a mere replacement for currently operating satellites. Its highly elliptical orbit will cause it to rise rapidly in the sky and appear to hang almost stationary for several hours at about the same time every other day and it will be possible to work through it with quite simple equipment.

Through a combination of higher power transmitters and higher gain receivers which, unlike *Oscar-10* and *Oscar-13*, will point earthward during the entire orbit, it will offer improved signal strengths on downlinks and require much less power on its uplinks. Designed to last for 10 to 15 years, and providing much longer operating periods, these features are specifically designed to bring satellite operation within the reach of many more amateurs around the world.

There is a worldwide fund-raising effort to meet the cost of building and launching Phase 3D, which even with volunteer labour is estimated to be about £3·25 million. In this country, donations will be gratefully received by AMSAT-UK, Dept EPE, 94 Herongate Road, London E12 5EQ. Cheques, etc, should be payable to AMSAT-UK, and crossed "A/C Payee Only". (Information from AMSAT-UK and other satellite groups, and the *W5YI Report*).

EUROPEAN DX COUNCIL

I often mention shortwave broadcast listening in this column as it can easily represent the first step towards taking up amateur radio. The serious listener obtains a good quality receiver, possibly of the worldband radio continuous coverage type, and this is soon found to be capable of picking up a lot more than broadcast stations from around the world. Amateur stations are heard, and the first glimmerings of interest are stirred!

With this as a background, I was interested to come across some information about the European DX Council (EDXC) recently. This is an umbrella organisation for DX clubs across Europe, representing over 30,000 listeners who are interested in many aspects of communication, including shortwave, medium wave, FM/VHF, TV DXing, satellite reception, amateur radio and computers.

A monthly magazine *Euro DX*, published by the EDXC, contains news from member clubs and from EDXC "observer" clubs in other parts of the world; news about international broadcasting; technological developments; previews of new receivers; publications, and so on.

Every year it holds a conference (with English as the working language) in a different European location. Over three days, broadcasters and listeners from around the world meet to discuss matters of mutual interest. Talks on many aspects of short wave listening are given and visits are made to places of local interest.

The next conference will be in Paris, France, on 20th to 23rd May 1994, and is open to anyone interested in attending. Details can be obtained from EDXC, address below.

Apart from *Euro DX*, EDXC has a number of publications available to assist SWLs in their hobby. Particularly useful is a *"Reporting Guide"* which offers useful advice on how to send reception reports to ensure a better than average chance of obtaining a QSL card or other acknowledgement, and includes a selection of appropriate phrases in various languages.

A "Radio Countries" list enables listeners to keep track of all countries heard; and an EDXC "Club List" gives details of listeners clubs around the world, with information about their publications, membership fees and activities.

A number of these clubs have their own programmes "on-the-air", in different languages, via the established DX programmes of HCJB Ecuador, Radio Prague, Radio Sweden, Radio Austria International, etc. Also, EDXC has its own monthly "European Report", in English, as part of the "DX Partyline" programme from HCJB, Ecuador.

There's a lot more than these brief notes can cover, and further information can be obtained by sending an s.a.e. to Michael Murray, Secretary-General EDXC, Dept EPE, PO Box 4, St Ives, Huntingdon, Cambs PE17 4FE.

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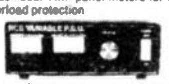

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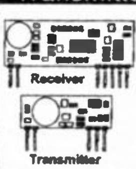

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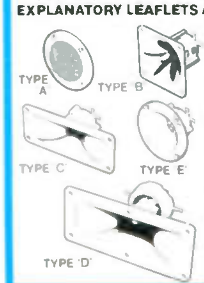

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