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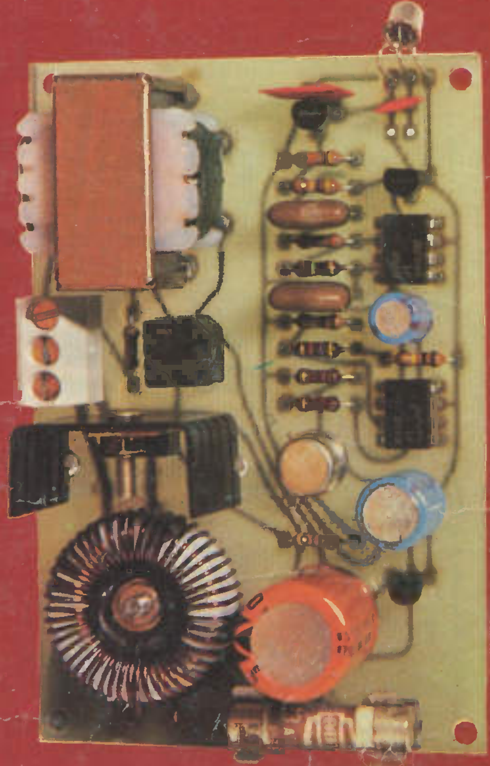

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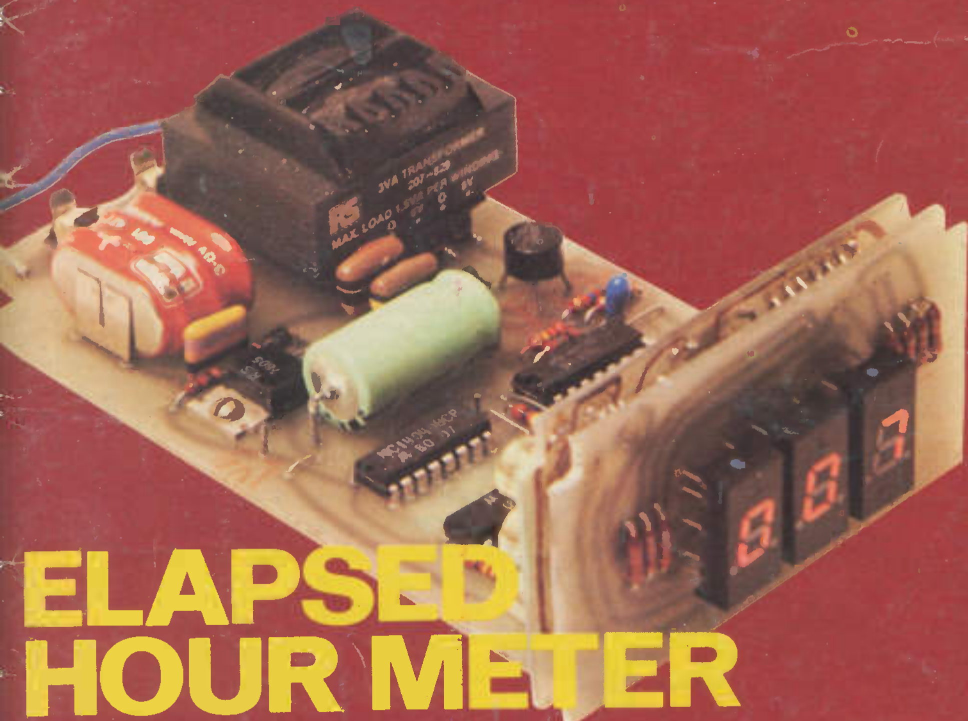

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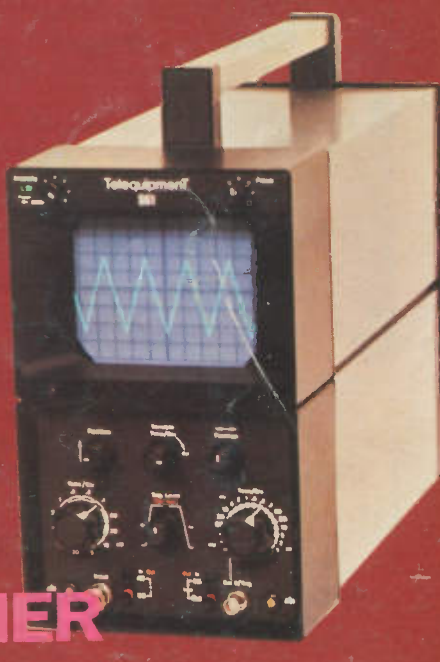

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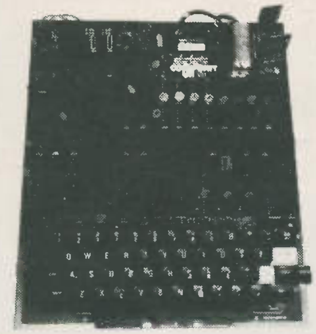

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PRACTICAL
ELECTRONICS

VOLUME 17 No. 2 FEBRUARY 1981

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR MARCH ISSUE WILL BE ON SALE FRIDAY, 13 FEBRUARY 1981
(for details of contents see page 31)

Market Place

Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by David Shortland and Jasper Scott

A CASE OF PROTECTION

A "brief case" for electronics engineers from Nefab in steel reinforced plywood is designed to protect fragile electronics components or instruments and is claimed to be unbreakable in normal use, yet is exceptionally lightweight.

The tough 4mm surfaces in natural wood finish are as durable as twice the thickness of softwood. They are further bonded by self-rivetting galvanized steel plate that gives four times the strength of conventionally rivetted steel. Double treated with thermoset resin, all surfaces are rust proof, anti-static, and resistant to flame, weather, alcohol and most solvents.

Weighing only 4¾lbs (2·2kg), the case has a carrying handle, two catches and can be readily locked for greater security. Measuring 17″×13½″×4″ (420×340×95mm), the Nefab all-weather safety case should look equally in place in the office or workshop. Priced at £25 including VAT, postage and packing, it is available from:

Nefab Ltd, 6 Osyth Close, Brackmills, Northampton NN4 ODZ. (0582 22943)

Q AND A ANSWERPHONE

Ansamatic Limited have just launched a sophisticated telephone answering system which acts as a message taker, information giver, dictation/transcription unit and recording machine. The new model combines the functions of two or three conventional systems, and adds a new dimension to telephone answering by leading a caller through what might be a very complex message by asking questions and giving the caller time to reply before moving on.

This ability is of benefit to organisations which receive numerous telephone calls of a similar nature such as orders for goods, spare parts, etc or sales representatives' reports. On being connected, the caller hears a message of explanation recorded by the user before the unit moves into its QA mode, asking questions (eg customer number, address, goods required, date required by, etc) and waiting for replies to be completed. The machine moves onto the next question when a gap of four seconds occurs in the caller's speech.

One major advantage of the system is that information is presented to the user in a standard format thus making the job of processing telephone messages considerably more efficient. It also ensures that the caller imparts all the information necessary for his or her call to be dealt with properly.

If the line of questioning on the user's cassette does not coincide with a caller's reasons for telephoning, that caller can still leave a message in the normal way.

Apart from its "QA" capability, the Doro 721 QA provides a range of other facilities. It can be used as a standard telephone answering machine, with variable announcement messages up to 15 minutes long.

In addition, the unit will record two-way telephone conversations and features a switch to screen the incoming call. As a dictation machine the unit features both mini and standard cassettes, an electret condenser microphone, one-hand control for dictate, stop, playback and unlimited backspace, slider controls for tone, volume and playback either through the microphone or speaker.

The 721 QA also acts as a transcription unit, using either mini or standard cassettes, and featuring rotary speed control, fingertip control to automatic rewind and fast erase (with automatic shut-off at the end of either function on a standard cassette), adjustable automatic backspace for up to seven words, and adjustable lightweight headset and sturdy foot pedal.

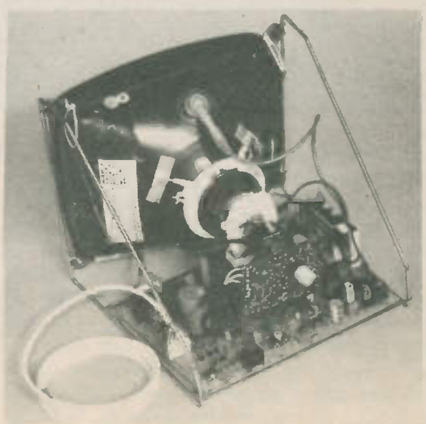
The Doro 721 QA is available from Ansamatic Limited either on a rental basis or at a purchase price of £575·00 (ex. VAT).

Ansamatic Limited, Viatron House, 928 High Street, Finchley, London N12 9SL

LCCD

A new idea in visual display has been developed by Microvitec Limited. At the heart of their design is a LCCD* (Low Complexity Colour Display), which has a direct digital interface for video data.

Currently, most manufacturers of small computer, Viewdata and video game systems requiring a colour display use standard or specially modified domestic television receivers. This often restricts the overall performance because such receivers are designed to operate from a broadcast standard signal where colour information is encoded on a composite video waveform and modulated onto an r.f. carrier. This creates various subsystems and each processing stage introduces distortion, noise and bandwidth limitations.



The LCCD dispenses with all these sub-systems. It has a separate input for each of the red, blue and green channels. This offers the advantages of low complexity with high technical performance and direct compatability via the logic interface with computer or alpha/graphic systems.

Because of the wide bandwidth of the LCCD it can display up to 80 characters per line on a 20″ screen. For graphical displays resolutions of 492(H) × 585(V) are obtained. This makes it ideally suitable for small computer systems and information displays such as Prestel (UK Viewdata system).

Power consumption by the LCCD is low at around 50W. This has been achieved by using an efficient switch mode power supply which gives a high order of stabilisation against mains and load variations together with a 4kV isolation barrier.

The LCCD is offered with a 14 inch (72 characters per line) or 20 inch screen. It is despatched either as a complete boxed item for desk top use, or in a nickel plated steel frame, which can easily be built into one off systems. The same electronics are used for both the 14 and 20 inch models.

The price of the monitors start at £185·00 excluding VAT. **Microvitec Ltd, PO Box 188, Bradford BD8 9HH**

BOOK CATALOGUE

Babani Books have just published their latest catalogue of radio, electronic and computer books. The catalogue covers just under one hundred titles with a brief synopsis of each book.

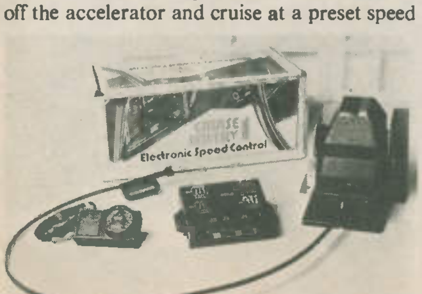
The catalogue is available free of charge by enclosing a SAE to **Bernard Babani Ltd., The Grampians, Shepherds Bush Road, London W6 7NF**

DIY CRUISE CONTROL

Traditional electronic cruise controls, achieve throttle control by means of a vacuum servo unit, which means that the installer has to cut into the vacuum line. Furthermore this system requires adaptor kits depending on the vehicle and has to be fine-tuned during a test ride following installation and whenever the vacuum in the manifold changes.

Cruise Sentry employs a small electric servo unit to accurately control the throttle, which does away with the need to cut into the vacuum line, while speed related pulses can be simply derived from the coil, whether the vehicle has standard or automatic transmission, 4–6–8 cylinder engine, standard or electronic ignition. The unit is universal for most vehicles, does not require fine-tuning, is virtually maintenance free and can be installed in 2 hours.

With Cruise Sentry the driver can take his off the accelerator and cruise at a preset speed



to maintain safe, legal speeds, save fuel and reduce driver fatigue.

The preset cruising speed can be modified at any time, without the need to disengage the system. Cruise Sentry can be overridden by depressing the accelerator and will automatically resume the preset speed. The system can be disengaged by any one of 3 ways for driver safety, e.g. depress the brake pedal, "push-in" the speed dial or by the special inertia switch mounted to the firewall, which is activated when the vehicle is braked.

The unit is priced at £78·50 plus VAT and p&p. **Enviro Systems Ltd, Hampsfell Road, Grange-over-Sands, Cumbria LA11 6BE**

VIDEO CARE

Bib, well known for their wide range of hi-fi accessories have now come up with two useful products for the steadily increasing home video market.

The Bib Video Tape Eraser (pictured below) is able to erase both visual and audio signals from either VMS or Betamax cassette tapes. Bib point out that many machines do not erase tapes sufficiently, resulting in poor image quality and background noise. The Bib eraser has a powerful 2420 Gauss magnetic field to ensure that erased tapes are completely signal free.

The Bib VHS Taper Cleaner incorporates a specially formulated cleaning tape in a standard VHS cassette. To clean the heads on your recorder the cassette should be "played" for abut 15 seconds. There is enough tape in the cassette for at least 20 cleaning operations, which would give about 2 years service with normal use.

Available from good video retailers, the Tape Eraser is priced at £20·70 and the VHS Tape Head Cleaner at £9·98. Both prices include VAT.

DIY CLOSED CIRCUIT

Photo-Scan of Sunbury—specialist CCTV manufacturers and designers of professional surveillance systems for retail, commercial and industrial security—are offering special low cost CCTV packages to amateur enthusiasts.

The packages, based on workshop reconditioned 1″ cameras and 17″ monitors, are available on a low cost, ex-works, install-it-yourself basis.

A 'one camera' package comprises 1″ vidicon camera, 25mm F1·9 lens, 17″ monitor plus camera fixing bracket for £187 excluding VAT.

A similar 'two camera' package complete with video switcher is priced at £329. Photo-Scan will also supply economy co-ax cable supplied to length and fitted with connectors at a cost of £17 per 100 metres.

Photo-Scan say they will guarantee the equipment for replacement of faulty parts—and if the system is installed by themselves (charged extra on a time and materials basis), the guarantee includes labour.

Further information is available from: **Photo-Scan Limited, Dolphin Estate, Windmill Road, Sunbury-on-Thames, Middx. (09327 89741)**

TOUCH TESTER

A new test instrument from Non Linear Systems measures 10 parameters and 20 functions using 44 ranges.

The Touch Tpst 20 is a $3\frac{1}{2}$ digit multimeter with 0·55″ l.e.d. display and front panel touch keyboard for selection of function and range. On selecting the desired function the least sensitive range is automatically displayed and the optimum display reading is obtained by touching the decade touch pads. The selection of function and range is indicated by an audible tone and illuminated l.e.d. at each pad.

In addition to the usual multimeter functions, the TT20 measures capacitance (1pF–200µF); temperature (−40 to +150°C); conductance (0·01nS–1·999nSiemens); diode test and audible continuity test.

Voltage ranges are 10µV–1kV d.c. (0·2%); 10µV – 750V r.m.s. Current 0·01µA – 10A d.c. and 10µA – 10A a.c.

Resistance 10mohms – 20 Mohms.

The TT20 is available as mains only or rechargeable battery/mains, it is priced at £195·00 or £215·00 with batteries and charger.

Lawtronics Limited, 139 High Street, Edenbridge, Kent TN8 5AX (0732 865191)

Elapsed HOUR Meter

CHRIS LARE

IT is instructive, and often necessary to produce a logbook for types of equipment where regular servicing or replacement parts are required. In order for such a log to be meaningful the entries need to be accompanied by the total equipment usage time, rather than the date as is often used.

To enable such times to be measured an accumulative hour counter which increments when the equipment is in use is required. It is also obvious that the counter should not have to be read after every use, thereby defeating the object of such a counter, and so the counter must retain the current count from one usage to the next. Such a counter is called an elapsed hour meter. The design here is for a counter to measure up to 9990 hours (416 days continuous use); the current time being displayed on a 3 digit display in ten hour steps.

The prototype was developed to measure the failure rate of KT66 valves in a stereo amplifier, another has since found use in a transmitter.

DESIGN PHILOSOPHY

Although the easiest way to measure long periods of time is to use a slow running oscillator the problems of stability over a minimum 10,000 hours are considerable. To avoid these problems the count is derived from the 50Hz mains, which over a long time is accurate.

The meter requires that the current count is stored while the equipment it is monitoring is switched off. It would be possible to arrange a separate supply to power the counter but this was rejected for two reasons:

(a) Safety.

(b) The chance of a mains failure in 10,000 hours is almost a certainty.

Accordingly a small nickle cadmium battery is used to maintain power to the counter when the mains is removed. The battery is trickle charged when the mains is connected. The use of a battery back up implies the quiescent current must be very low, hence CMOS technology. Several timers and clocks do exist in single i.c. form, but all have a high quiescent current and cannot be used, thus discrete CMOS circuits from the standard logic family are employed.

No reset switches or fast count facility are provided external to the cabinet. These functions are obtained by shorting links on the p.c.b. since it is unlikely that they will be used much. There is no reason why they should not be connected to switches if required.

THE CIRCUIT

The circuit consists of three parts:

(1) Power supply, 50Hz generator, and display blanking detector.

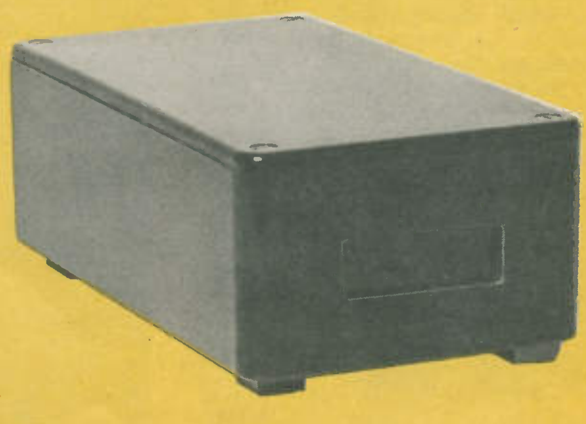
(2) Divider chain.

(3) '999' clock and display.

The power supply consists of a 3VA p.c.b. mounting transformer followed by a small bridge rectifier. The rectifier a.c. gives rise to 8 volts across C1, as well as driving the blank display detector. The detector consists of IC2 (a,b) together with C5 and R3. The time constant of C5 and R3 is fairly short and so the voltage on C3 tends to follow the presence of mains. IC2 (a,b) forms a simple Schmitt trigger to generate a clean edge from this voltage. Accordingly, the output of IC2b is high when mains is present and low if it is not.

The 8 volts on C1 is regulated to 5 volts, and then fed to the nickle cadmium battery via D2 and R1 so as to trickle charge the battery. Diode D2 prevents the battery discharging into the regulator when the mains is removed. The chosen battery has a 90 milliamp/hour capacity and should keep the data intact for 37 days without use. The battery is used to power all the CMOS except for the display driver, which takes a 5 volt supply direct from the regulator.

A 50Hz square wave is generated by IC2 (c,d) which is also connected as a Schmitt trigger, fed from the unrectified a.c. direct from one arm of the transformer.



Perspective on unit showing display window

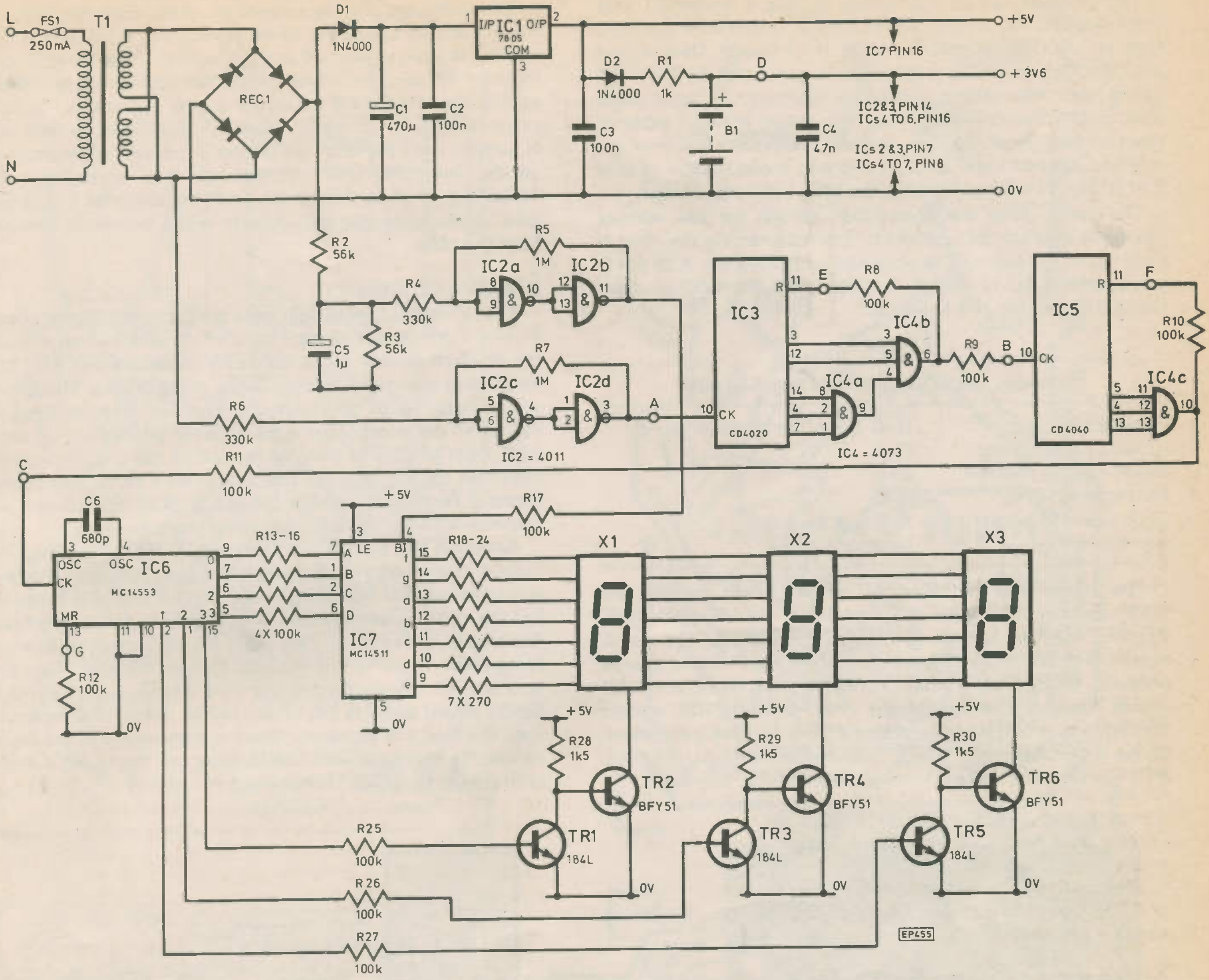


Fig. 1. Circuit diagram

COMPONENTS . . .

Resistors

R1	1k (100 required initially)
R2, R3	56k (2 off)
R4, R6	330k (2 off)
R5, R7	1M (2 off)
R8–17, R25–27	100k (13 off)
R18–24	270 (7 off)
R28–30	1k5 (3 off)

All $\frac{1}{4}$ watt carbon

Capacitors

C1	470μ 25 volt electrolytic
C2, C3	100μ polyester C280 (2 off)
C4	47n polyester C280
C5	1μ tant
C6	680p polystyrene

Semiconductors

D1, D2	1N4000 (2 off)
TR1, TR3, TR5	BC184L (3 off)
TR2, TR4, TR6	BFY50 (3 off)
IC1	7805
IC2	4011
IC3	4020
IC4	4073
IC5	4040
IC6	4553
IC7	4511
X1-3	DL704 (3 off)
REC1	REC70 or any 1 amp bridge

Miscellaneous

Battery p.c.b. type 90mA/hr, 3·6V (R.S. 591–477)
Transformer 3VA p.c.b. type, 6V c.t. (R.S. 207–829)
Fuse 250mA A/S type and two p.c.b. fuse clips
Box ABS 150×50×80mm
Mains cable and grommet
Display filter material
P.c.b. pins.

The 50Hz is fed to IC3 which divides it by 9,000, and from there to IC5 which divides it by a further 200 (giving a total of 1,800,000 or 50Hz pulses in 10 hours). The dividers are arranged so that a reset pulse is generated by the AND gates when the correct number is reached; the reset pulse also clocks the following stage. In order that an external reset or fast count may be applied 100kilohm resistors are inserted in each reset lead. In this way a connection to pins E or B (Fig. 1) will not damage the previous output stage.

The table gives the connection details for the various functions that can be realised by interconnecting the pins. A slow count for example is obtained by joining pin A to pin B which injects 50Hz directly into the divide by 200 counter, giving a clock rate of 4 seconds.

Table 1

Functions available by interconnecting pins

Reset 999 counter	D–G Note that displays blank
Reset ÷200 counter	D–F
Reset ÷9000 counter	D–E
Fast count (50Hz)	A–C
Slow count (4 secs)	A–B
Normal use	No connections

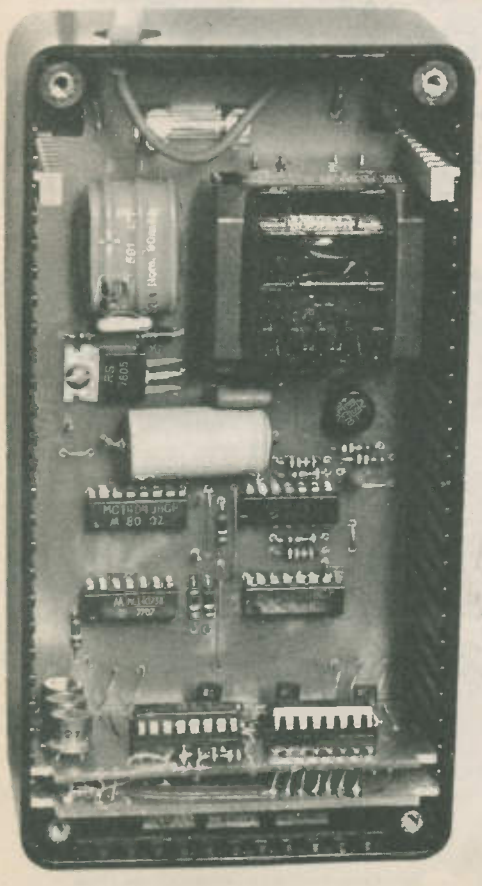
The pulses obtained every 10 hours is used to clock the '999' counter. This uses a 3 digit b.c.d. counter with multiplexed outputs, which minimises complexity. The b.c.d. output is decoded by IC7, which feature high current source outputs, which are in turn connected to three common anode displays. The multiplexer in the counter, IC6, selects the digits in turn by means of the 3 pairs of drive transistors. These invert the digit select from the counter as required. R18–24 limit the current through each display segment.

Obviously the display cannot be used when the mains is not on, and so the power down signal from the power supply section is used to turn off the display using the blank display input of the decoder/driver. This is not apparently necessary, as the displays go off when the supply is removed anyway since they are powered directly from the 5 volt rail. However, with the displays off the 5 volt rail fall much more gently, lessening the problem of data corruption. The 100kilohm resistors in series with the decoder inputs prevent damage to the gate inputs when power is removed from the chip.

CONSTRUCTION

The prototypes were built onto three printed circuit boards to give a compact system. This method of assembly allowed the finished boards to be housed in a fairly small ABS box, employing the layout shown in the photographs. The boards were designed to minimise the number of flying leads—indeed all the interconnections between boards can be made with short lengths of bare wires, and all the components are mounted on the boards. The actual 999 clock and display forms a very small module (65mm x 40mm x 20mm) and use may well be found for it in other projects.

Although the boards are fairly small they were produced quite successfully with an etch resist pen. During assembly it is suggested that sockets be used for IC6 and IC7, these being the most expensive and most likely to fail respectively. The displays were mounted 6mm proud from their board to bring them close to the outside wall of the box. Note that two pins of the display are cut off—do check very carefully before doing so. It is important not to solder the battery in until the board is complete. Once the battery is in the power cannot be removed, and CMOS does not like being inserted with power supplied. Do not short the battery.



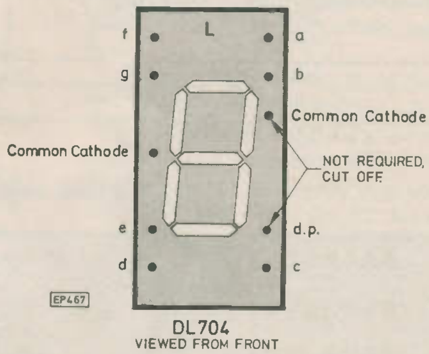
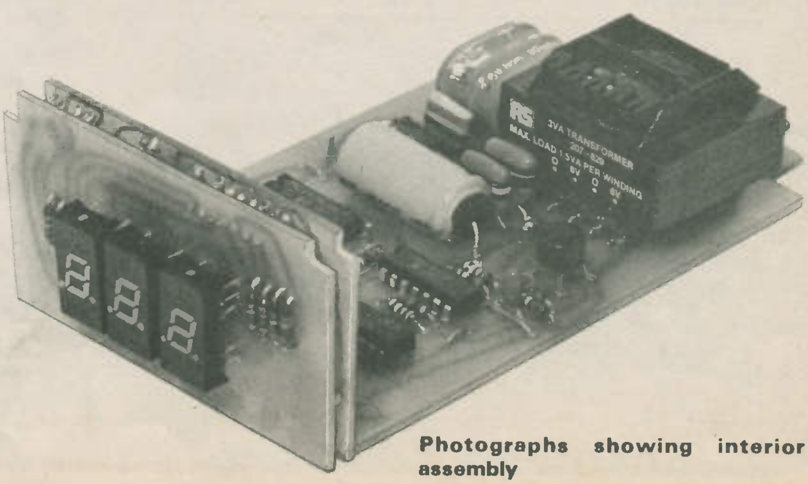


Fig. 2. Display pinout details



Photographs showing interior assembly

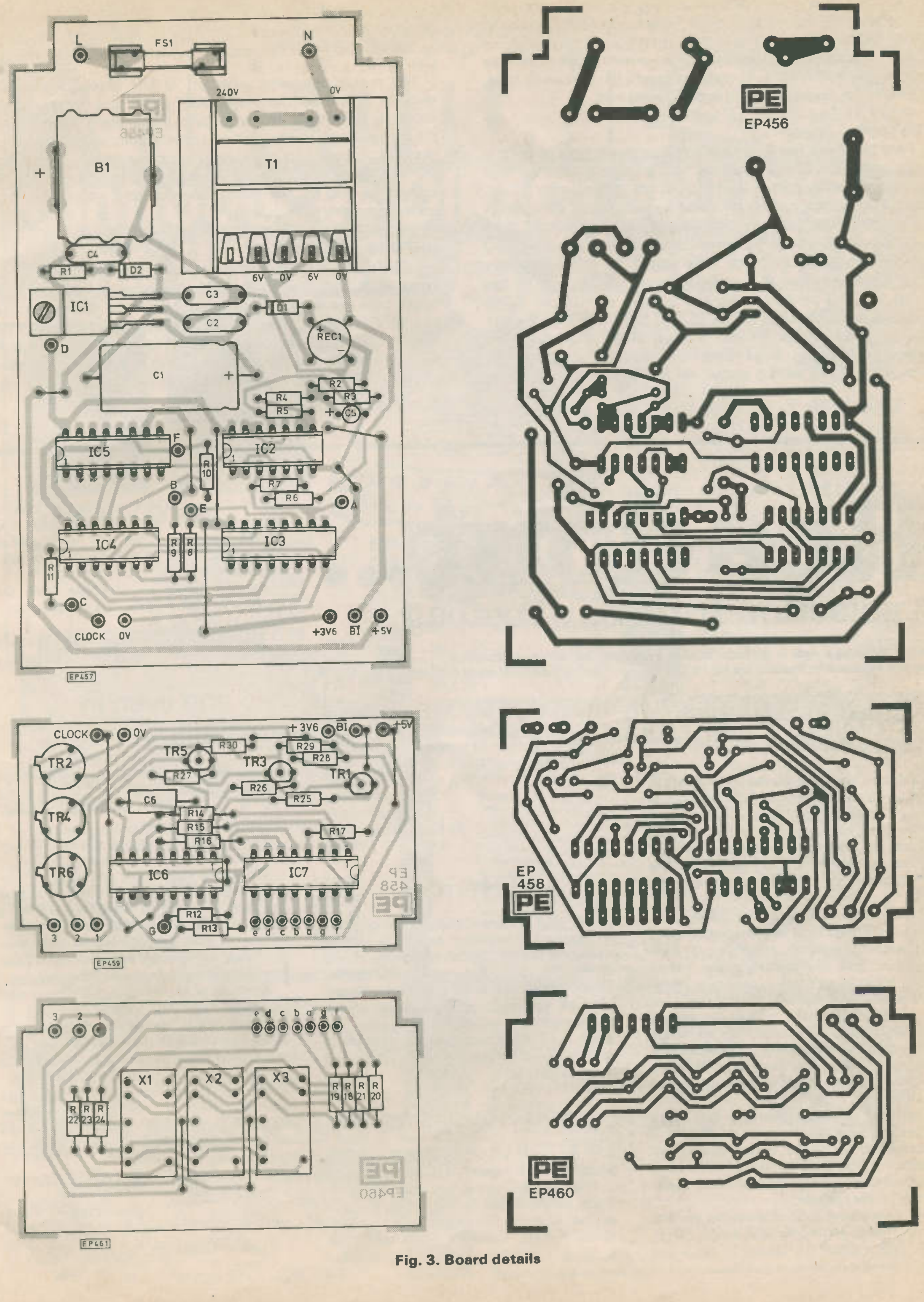


Fig. 3. Board details

To aid debugging it is suggested that the boards are interconnected with long flying leads initially, thus giving access to both sides of all the boards.

Before connecting the unit to the mains, cover the fuse and mains terminals with several layers of insulating tape. The need for care cannot be over emphasised.

TESTING

Plug in. Check the 5 volt rail and that the output of IC2d is high, and if a scope is available that a 50Hz square wave is present on the output of IC2b. Reset the 999 counter (D–G). Clock the counter quickly by using the fast count connection (A–C), and check all the segment drives. A count of 500 should be observed in 10 seconds. Check the divide by 200 counter by connecting for slow count (A–B), the display should increment at 4 second intervals. Finally, check the divide by 900 by measuring the voltage on IC5 pin 9. No connection is normally made to this pin since it is the Q1 output. The voltage should change every 3 minutes indicating a leading edge from the previous stage. When debugging, even with a scope, do not expect to be able to see the reset pulses—they happen very quickly, within the propagation delay time of the i.c.'s.

CASING

The prototypes were mounted in ABS boxes, a window was cut in one end for the display, and a hole for the mains cable in the other. No mounting holes were used in the p.c.b.s because of the slotted construction of the box. Any method of mounting is suitable, but if the display is required on a front panel, remote from the power board, it is suggested that the 999 count board is also mounted on the panel since this saves wiring.

BEFORE USE

Once the unit is installed and their is no risk of accidently shorting the battery it should be fully charged. Nickel Cadmium cells are supplied nearly discharged for this reason. To charge the battery, connect a 100 ohm resistor across R1 and leave the unit on for 24 hours. If for any reason the battery is ever completely discharged it may refuse to take charge, in this case replacement is the only solution. ★

Readout...

A selection from our Postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

A Computer Club in London

Sir—Since Computerclub was formed back in July, we have been delighted with the progress we have made. We could not, of course, have known quite what to expect and so we can't say that our expectations have been exceeded! We can say that we are very pleased to have been evidently accurate in assessing a market need.

Membership is approaching 1500, companies are writing to us with unsolicited offers to members, special offers have been negotiated and Computerclub has gained almost universal welcome.

Members get discounts. Participating outlets are increasing sales without the cost of sale promotion and manufacturers are selling just as much—perhaps even more because of lower costs expanding markets. All round, everyone seems to be happy and that can't be bad.

You may be interested to learn that a high proportion of Computerclub members are occasional, if not regular, readers of *Practical Electronics*—we hope to be able to be more specific following the production of our Membership profile analysis.

We have almost finished producing our first Computerclub Newsletter and would like to offer your readers the chance to get a free copy by writing to the address below enclosing a 12p stamped addressed envelope large enough to take our 16 page A4 Newsletter, or if they prefer, two 12p stamps and their name and address.

Roger Frampton,
Computerclub,
42 Great Windmill St.,
London W1V 7PA.

. . . and Harrow

Sir—The Harrow Computer Group meets on alternate Wednesdays at 7pm in Harrow College of Higher Education or, when closed, in the "Plough", Kenton. Details: 01-950 7068. Features are: lectures, magazine library, program exchange, demonstrations, advice, hardware & software debugging, nascom user group. Established two years ago, member of Association of London Computer Clubs, and free membership.

. . . and Southampton

Sir—We would like to publicise details of the Southampton Amateur Computer Club.

From October through to June we meet at 8 p.m. on the second Tuesday of each month, at the Medical Sciences Building, Bassett Crescent East, Southampton. Annual Subscription is £3.00, or £2.00 for students and Senior Citizens. There are Special Interest groups for Z80 including Nascoms and Z8000, and for 9900. We also publish "Benchman"—the Club Newsletter, in conjunction with the Thames Valley A.C.C.

Further details are available from the Secretary, Andy Low, on Southampton (0703) 555605 ext. 34.

P. D. Maddison
Southampton University

. . . and even in Australia

Sir—I wish to advise *Practical Electronics* and its large readership of a new user group that is "AUSTRALASIA ZX80 USERS' GROUP".

The user group aims to promote the use and growth of the Sinclair ZX80.

The user group will be producing a newsletter which will contain listings of original programs submitted by members and friends, handy subroutines and other useful programming aids. Also included will be reviews on purchased software and hardware and a guide to where some may be purchased.

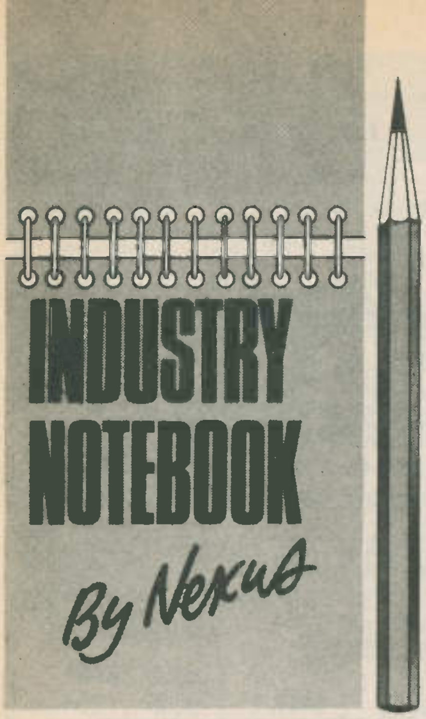
Anything of interest to the ZX80 user that comes to hand will be published and the newsletter will be stressing the harmful effect of software piracy on the industry.

It's good to see your magazine leading the way and giving a listing for the ZX80 user.

We would appreciate it if you could give our user-group a small mention in your magazine as we would like to correspond and obtain ideas and original software from as large a source as possible.

Anyone interested in the ZX80 may contact me as follows:—

Tony Mowbray,
87 Murphys Avenue,
Keiraville, NSW 2500,
Australia.



Retrospect

Few industralists will regret the passing of 1980. The recession was sharper and deeper than predicted in manufacturing industry and from mid-year onward it became increasingly clear that the economic strategy of the Government was not only painful in its immediate consequences but was also painfully slow in achieving results. The one heartening indicator was the reduction in the inflation rate which dropped ahead of target.

Everyone suffered from the squeeze but the electronics companies coped far better than most with some entering 1981 with a good year of trading behind and record order books for the years ahead. An exception was the volatile consumer goods sector where fierce competition from overseas coupled with reduced consumer demand compounded the problems.

The collapse of the Rank Toshiba joint TV manufacturing venture is one side of the coin although Toshiba will still produce in the UK with a greatly reduced labour force. The other side is the boldly conceived Ferguson TX range of TVs from the Thorn stable, launched with a massive publicity campaign. In the low-cost monochrome market Fidelity Radio was able to resume a five-day working week with the August-launched portable described as a resounding success. The ups and downs of consumer electronics are not confined to the UK. Even Phillips at Eindhoven, pioneers in cradle-to-the-grave paternalism, had to make people redundant during 1980.

Britain's capital goods electronics and aerospace industries achieved a sparkling performance in spite of the difficulties at home and uncertainties in overseas markets.

The year was dominated by the debate on the economy. Former hot topics like the impact of the 'chip' and the energy crisis were all but forgotten. Even the loss to the West of oil supplies from Iran and Iraq, almost unthinkable a couple of years ago, seemed remote and insignificant.

On the international political scene there was a general swing to the right culminating in the predicted but nonetheless dramatic election of Governor Reagan to the US Presidency. What effect the rightward swing will have is by no means apparent but it should, on the whole, prove beneficial for international trade.

The year ahead will be no less difficult than 1980 although there is a consensus that an upturn in business may be expected by the mid-year, assisted by falling inflation and interest rates.

Plessey

A useful illustration of what is happening to industry in general is the progress of Plessey over the past four years. Plessey is a British-based multinational with worldwide trade. It was huge and sprawling and very respectable. But not very profitable and frequently tipped as ripe for takeover by the much smaller, tighter run and aggressive Racal Group.

Something needed to be done and a new strategy started taking shape in 1975 with the establishment of a Chief Executive Office which would lead the company into a new style of management, particularly in marketing skills and planning. Along this road were painful decisions, including major surgery to rid the company of the cancer of loss-making subsidiaries, accompanied by strenuous efforts to improve productivity by the potentially profitable residue.

Inevitably there have been massive redundancies. The workforce of 48,000 last June was 5,000 less than in June 1979 and not much over half of that employed five years ago. Far fewer people, for example, are required to manufacture electronic telephone exchanges than the old labour-intensive electro-mechanical systems. But there have been other staff economies, too.

The broad result is that Plessey is breaking record after record with sales now running at £800 million p.a. and profit last year of £60 million. The forward order book which stood at £500 million in 1976 is now £1·2 billion.

Worker performance is also newly impressive. In 1976 each person employed represented, on average, sales of £7,374 and contributed £524 profit. In 1979-80 the figures were £14,180 and £1,135 respectively. After taking inflation into account there is still a marked gain in productivity and profitability and worth a self-congratulatory pat on the back.

Plessey's task, however, is by no means over. They are only a little over halfway there. For Plessey's major international competitors are claimed to be achieving £25,000 of sales and £2,000 of profit per employee.

As well as the struggle for productivity there is the struggle to keep abreast, preferably ahead, in technology and new products. In 1979-80 R & D in Plessey amounted to over £135 million, some 18 per cent of turnover, but much of this funded by customers.

From Plessey whole-year profits Government gained £19 million in taxati enough to keep the National Health Ser financed for about 20 hours or Bri Leyland alive for another few weeks.

The drive for productivity and efficien exemplified by Plessey is spread throughout all manufacturing industri There appears no practical alternative ev though the social cost is so high.

Technology

Two of the important technologic breakthroughs are fibre optics and th Josephson computer. The first is alread with us though not yet exploited on massive scale. The second is still on th horizon and remains problematical.

At the Sixth European Conference o Optical Communications at York no les than 270 papers were submitted fo presentation. The Programme Committ selected 84 for the four-day sessions atten ded by more than 800 delegates. Severa practical systems are undergoing field trial in many parts of the world. At the sam time there is frantic work in laboratorie which may yet influence future application and technical standards. Most observer expect operational systems in service b the mid-80s. Early systems will need to b flexible in order to take advantage of last minute advances in the technology. But nobody doubts that fibre optic communications will be a business bonanza in the years ahead.

In the early '60s one of the big technical topics was superconductivity achieved through low temperature engineering. In 1962 Brian Josephson discovered a switching effect in insulating materials cooled to near absolute zero temperature.

US and Japanese scientists have been building on Josephson's discovery with computing applications in mind. The objective is much faster operating speed, exceptionally low power consumption and very small size. A Josephson-type mainframe computer, according to one assessment, could do the job of an IBM 370/168 twenty times faster and be packaged in a 15cm cube taking only 7W of power. Such a computer could be with us in ten years time. It is difficult to believe that superconducting switches might replace silicon semiconductors. But twenty years ago it was hard to believe that the transistor could ever replace the valve. The Josephson computer would, indeed, be a comparable leap in the technology.

There have to be snags. First the problem of fabricating the equivalent of 'chips' to accuracies of a few tens of atoms. Not so difficult is the cryostat to house the 'mainframe' and cool it to four degrees Kelvin. But assuming all goes well with the 'mainframe', no exisiting or projected peripherals operating at ordinary room temperature could operate at anywhere near the speed of the computer itself. Experience teaches us, however, that nothing is impossible—it just takes a little longer to achieve.

SPECIAL OFFER!

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PE has arranged this offer exclusively for readers, we believe it represents excellent value for money. Since there is only a limited supply of available units orders will be processed on a first come, first served basis, if we run out your money will be refunded.

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Please note: Although Carston Electronics specialize in supplying second user equipment the Telequipment S61s are brand new and supplied in the manufacturer's packing—probes are not provided, but are available as an extra from Carston.

SLAVE LIGHT DIMMER

GILBERT DAVIES

THIS slave unit has been designed to follow a master triac controlled dimmer system. No electrical connection to the master is required provided each unit is supplied with the same electrical phase.

The dimmer which can be made to control full colour lighting by the use of filters receives light from the master (triac controlled). The signal is processed to derive trigger pulses, in coincidence with the master, triggering the slave triac (TR1) and controlling the lamp irrespective of both the ambient light and the illuminance from the master dimmer.

PRINCIPLE OF OPERATION

The voltage waveform applied to a filament lamp is integrated by the lamp. If the received light from the master is differentiated the waveform driving the lamp can be reconstructed. This waveform enables timing pulses to be generated in the slave unit to trigger the slave triac and control the lamp.

CIRCUIT DESCRIPTION

The circuit diagram of the Slave Lighting Dimmer is shown in Fig. 1.

The photo-transistor (TR1) receives light from the master triac controlled lamp. The photo transistor achieves optimum bias via the constant voltage source formed by TR2, TR3, R1 and R2 over a wide range of lighting conditions by mainta ing the output of the emitter of TR1 at around half the supp voltage.

The received signal is differentiated by IC1, R3, R4 an C1 and the integrating effect of the filament lamp is com pensated for.

The output of IC1 is fed through C2 to the comparator ci cuit which consists of IC2, R5, R6, R7 and C3. The resisto chain selects the comparator level at approximately 300m The inverting input of IC2 is a.c. coupled to ground by C and the positive transition from the output of IC1 passe through C2 forcing the non-inverting input of IC2 high cau ing its output to go positive switching TR4 on via the poten tial divider R8, R9. The drive pulses from TR4 are fed to t triac via resistor R11. The inductor L1 acts as a radio inte ference suppressor.

The resistor R10 acts as an interference rejection filte with IC3 stabilizing the supply voltage to 12V d.c. Th capacitors C6 and C7 provide filtering of noise and inter ference.

CONSTRUCTION

The complete unit is mounted on a p.c.b. The design the board is shown in Fig. 2. with the component layout Fig. 3. Before soldering the inductor L1, make sure th

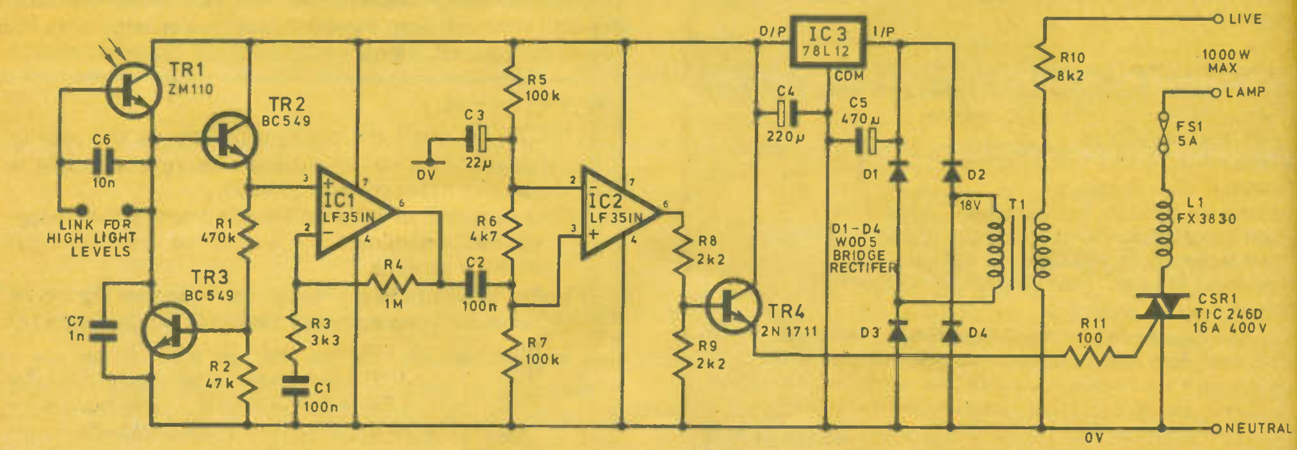


Fig. 1. Circuit diagram for the Slave Lighting Dimmer.

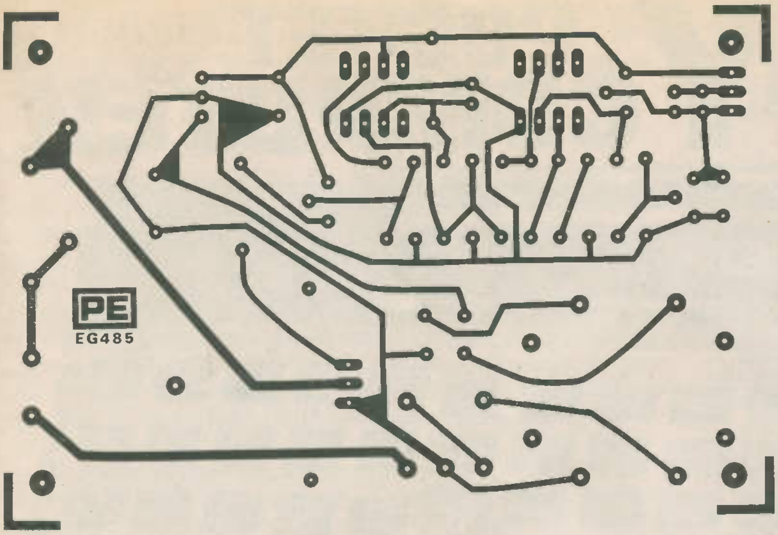


Fig. 2. The p.c.b. design.

COMPONENTS . . .

Resistors

R1	470k
R2	47k
R3	3k3
R4	1M
R5, R7	100k (2 off)
R6	4k7
R8, R9	2k2 (2 off)
R10	8k2
R11	100

All resistors ¼W 5% carbon

Capacitors

C1, C2	100n 250V polyester (2 off)
C3	22µ 16V elect.
C4	220µ 16V elect.
C5	470µ 16V elect.
C6	10n 50V ceramic
C7	1n 50V ceramic

Semiconductors

D1–D4	1A 50V bridge (W005)
TR1	ZM110
TR2, TR3	BC549 (2 off)
TR4	2N1711
CSR1	TIC246D 16A 400V triac.
IC1, IC2	LF351N (2 off)
IC3	78L12

Miscellaneous

T1	Mains transformer 50mA 18V sec.
L1	FX3830 bobbin with 40 turns of 22 s.w.g.
Case	ABS 115 × 95 × 45mm
FS1	5A fuse
Fuse holder	p.c.b. type
Terminal block	3 way
Heatsink	(RS type 401–863)
p.c.b.	

Constructor's Note

A complete kit of parts for the Slave Light Dimmer is available from **GJD Electronics, 105 Harper Fold Road, Radcliffe, Manchester, M26 0RQ.**

APPLICATIONS

(1) To control additional triac controlled lighting.

(2) Light reinforcement for stage work—by filtering the photo-transistor tracking of different coloured lamps can be obtained.

(3) Low power master lamps can be used to control the slaves to reduce size and power of stage lighting consoles.

(4) To switch additional lamps from non-dimming mains lamps.

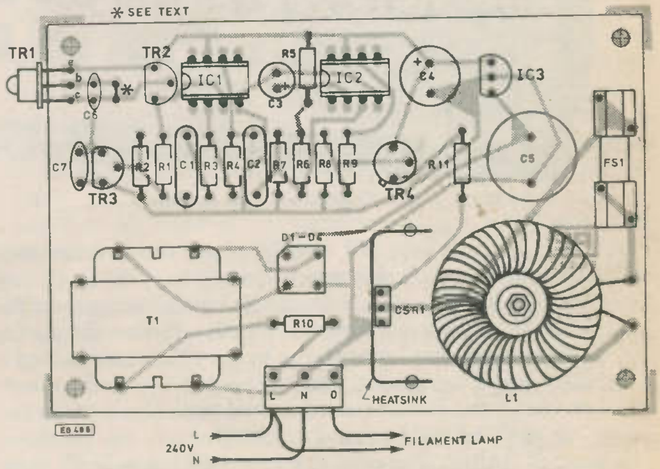


Fig. 3. Component layout.

enamel is removed from both ends for approximately 10mm. The photo-transistor should be mounted 10mm off the board to enable it's final position to be adjusted when the board is fitted into the case. After all the components have been soldered and checked the p.c.b. can be mounted into the case and the two case holes drilled: one for the mains lead and filament lamp lead, the other for the photo-transistor.

Although the unit does not rely on the wattage of the master lamp, lamps over 150W may cause sufficient 'lag' to cause incorrect unit operation.

Daylight being 'steady' light will not cause the unit to operate although light received from the master lamp must exceed ambient daylight.

INSTALLATION

(1) Try to point the photo-transistor at the master lamp being controlled although reflected light is sufficient for correct operation.

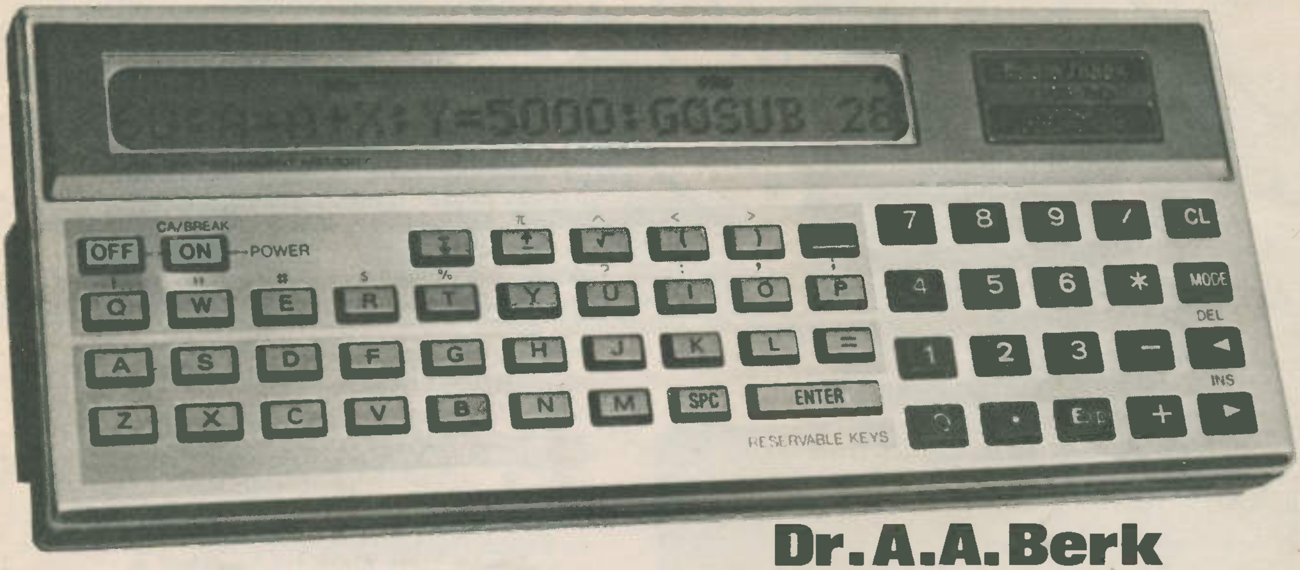
(2) A deep red or infrared filter in front of the photo-transistor eliminates activating the unit from light from TV screens.

(3) Try to point the photo-transistor so that light from the slave lamp does not exceed light received from the master to prevent interaction effects.

(4) If the photo-transistor receives too much light the unit will turn the slave lamp off, if this occurs insert the link as shown in the circuit diagram.

★

TANDY POCKET COMPUTER



Dr. A.A. Berk

AT last, the calculator and computer have met in a compact and versatile little unit which is truly hand held. As you read through the following, just cogitate on the immense confusion with which your non-technical friends will view this device in the light of the usual question as to the difference between a calculator and a computer. In the last year or two we have seen bottom-end of the market micros ascend from Hex-keypad and digit "things" to VDU and QWERTY keyboard machines "speaking" BASIC. The computer described below is the same size as one of the Sharp calculator ranges, but has a full QWERTY keyboard, floating point BASIC with full scientific functions, 24-character alphanumeric display (l.c.d.), cassette storage as well as full calculator functions and 100 per cent retained memory upon switch-off (which it does automatically after seven minutes if not in use). The total amount of spare memory available at any time is shown by the MEM function. After "NEW" there are 1424 steps of BASIC memory or 178 memories (variables) in a common memory format.

The cost of this machine is £119, and the cassette interface a further £17·95. These prices include VAT. It should be pointed out, however, that the apparently identical machine can be purchased from Sharp, the manufacturers presumably, for slightly less cost. Perhaps the TRS80 version is superior in some way—unfortunately, a Sharp version was not to hand at the time of writing.

HARDWARE AND ACCESSORIES

As can be imagined, the amount of hardware crammed into this machine is quite remarkable. Several VLSI chips with very large numbers of pins are soldered to two p.c.b.s. One of the largest components visible within the box is not the battery, but a sound transducer to produce a "beep". The batteries used are four "button" mercury cells giving 5·4 volts. Three hundred hours of operation are claimed from this source, and the operational power is stated as 0·011 watts. When the power is off, the batteries are probably limited largely by shelf-life, though all memory is maintained while the batteries are present. 1·9K of memory is available in a format which is common to both programming and variable storage. This will be explained below.

On one of the p.c.b.s within the machine, there is a RESET switch which is accessed through a hole in the back of the case. This is presumably to release the computer from any spurious states or loops which it may encounter at any time. It has the effect of completely clearing memory of both programs and data, if the machine is on at the time—if off, no harm to stored information is sustained.

The keys are excellent, soft to touch and definite, and their spacing does not feel too closely packed—despite the full alphanumeric capability. There is no key-rollover at all, indicating, as one would expect, that the device is designed for single finger use.

The display is composed of 24 five-by-seven dot-matrix characters. Their readability is excellent under normal daylight conditions, but the display is a little too inset into the machine for comfortable reading under a reading lamp—a shadow is cast over the display which is vaguely irritating, and, of course, angle of view is important as with any l.c.d. display.

At one end of the case, which is almost entirely metallic and quite robust, there is a 9-pin female connector designed to accept a plug located on the cassette interface housing. This is described later.

The machine is supplied with a Manual, quick reference card and two keyboard overlays for labelling user-defined keys. The soft black case for the machine is well padded and protects against most normal knocks and scratches.

MANUAL AND SOFTWARE PROVIDED

The Manual is not meant for beginners to BASIC, and it is highly recommended that a book such as the TRS 80 Level I Manual be read before attempting to program this machine if you are just starting. However, the doyen will find the book concise, informative and well written. There is a good index and an excellent reference summary.

There are some simple programs in the back of the book for experience in handling the machine, and the list includes the inevitable Biorythm and Guess-Number programs. Normal Distribution, Days Between Dates and Impedance in an a.c. series circuit also appear.

Tandy advertise quite a few tapes of software from about £9, and these include such headings as Personal Finance. Unfortunately, I was unable to find any of these tapes and cannot comment on their usefulness.

MODES AND CALCULATOR FUNCTION

The machine has four modes of operation, which are indicated at the top of the display. They are DEF, RUN, PRO, RESERVE. In the PRO mode, a BASIC program with line numbers may be written. In RUN, any stored program may be run, or the machine may be used as a calculator utilising all the BASIC scientific functions. RESERVE and DEF are used to personalize the lower two rows of alphanumeric keys (18 in all).

In the RUN mode, calculations are performed immediately by simply typing in the calculation, with functions and brackets etc., and pressing ENTER. The 10-digit answer, with two-digit ten's exponent, if necessary, appears automatically on the right of the display. The value of any variable may be examined simply by typing its label (A, B, C—A(1), A(2) etc.) and pressing ENTER.

Normally, on a BASIC computer, when an "immediate" mode calculation has been performed, the line of source data is lost and must be retyped. On this computer, the left and right arrow keys allow the line to be examined and amended or added to at will. If an error has been signalled, during execution, the line may be recalled to discover that the cursor is "sitting" on top of the faulty element of the calculation—a very useful function for long expressions. All the usual BASIC functions are included as well as full inverse trig. functions and logs to base 10 and e. The usual relations (<, > etc.) may be used as normal.

In the RESERVE mode, any function, expression or portion of a BASIC program may be reserved, to act upon a single key stroke. The total size of this reserve memory is 48 steps. For instance RUN 130 or COS may be programmed into the "A" key. In the RUN mode, SHIFT (A) would act as RUN 130 or COS—the latter requiring an argument to be typed in. In the PRO mode, the reserved data may be taken straight from the reserved keys. Thus, for instance, RUN 130 may be added into the program simply by pressing SHIFT (A).

The DEF mode allows each of several programs and/or routines within a program to be executed by a single stroke. Single-letter labels are allowed in this version of BASIC, and the routine starting at label C, for instance, is executed by SHIFT (C) in the DEF mode. In this manner, any number of programs may be stored in memory and executed by single keys.

SPECIAL FUNCTIONS

When output is required to be displayed, the PRINT statement is used as is normal in BASIC. The difference is that the program stops after printing each output and waits for the user to press ENTER to signify that the display has been read. A PAUSE function is also available to exhibit the output for about 0·85 second instead. A PRINT USING type function may be used to format the display to some extent when printing variable numbers of characters in a field.

In the DEF mode, a special method of entering data is available. If the function AREAD is included in the first line of the program, any display contents present when the routine is started are immediately transferred into any variable following AREAD. This provides a method of transferring data from routine to machine through the display. It is this type of function which provides a real hybridisation of the calculator and computer.

Other useful functions of the BASIC include a BEEP function to produce any number of beeps from the machine, and a MEM command to view the amount of memory remaining (in STEPS and in VARIABLES). Three different angle representations are allowed: DEGREES, RADIANS and GRAD. These are accessed by commands which change the machine's mode. Just as with memory, the angle mode and machine status mode are remembered when the machine is switched off.

It should be noted that variables on the machine take up eight times as much space as BASIC steps. Memory is flexible and may be used for either. However, there are 26 fixed memories which are referred to as A, B, C----Z. These are reserved as numeric and string variables only. String variables may store up to seven characters—A$, as usual, is a string. To contact the rest of the variables, A(n) format or A$(n) must be used. If n is less than 26, however, the variable assumed is just one of the alphabetic ones, e.g.:— A$(4) = D$.

The INPUT statement is available, in the usual manner, for allowing an operator to input data from the keyboard during program execution. As can be appreciated, the BASIC offered by this machine is by no means of a minimal variety, but it is rather slow. For instance, it takes 6 seconds to count up to 20 in the FOR loop:—

```
10 FOR I = 1 to 20: NEXT I
```

and 20 seconds to execute:

```
10 FOR I = 1 TO 20: F = 45*SIN (12·356): NEXT I
```

Just the same, the package has plenty of facilities. FOR statements may use the STEP function, and may be nested up to four levels. STOP, CONTINUE, CLEAR, multiple line statements, etc. all exist. LET is optional except after IF, END is only used to separate different programs stored in memory for the DEF function, for instance. Numeric valued expressions are allowed in most statements where a number is normally required. These facilities all make program writing easy and sophisticated.

DEBUGGING AND TROUBLESHOOTING

Much thought has been given to program development in a machine with just 24 characters as output. Such features as recallable text in immediate "RUN" mode for editing have been mentioned.

Listing is a particular problem with just one short line of text. The manufacturers have thus included two special keys to allow the operator to list the text in either direction line by line. The LIST command, followed by a line-number, recalls the given line, and use of the up or down arrow keys steps up or down the program at will. The left and right arrow keys allow viewing of text which disappears off the screen, as well as insertions and deletions of characters in a line.

A most useful feature for troubleshooting is the DEBUG function. Very similar to a TRACE, DEBUG is typed in RUN mode, and from then on running a program is performed by typing a RUN followed by the down arrow key. Each pressing of the down-arrow causes the next line-number in the sequence to be displayed and its contents executed. Pressing the up-arrow causes the current line contents to be displayed.

To further aid debugging, six error codes are offered. If one is signalled during a RUN, the exact position on the line at which the mistake is located may be discovered by pressing the 'up' arrow. The cursor will be positioned next to the error.

CASSETTE STORAGE

The cassette interface unit is a separate case into which the computer is plugged. The unit is powered by three penlight cells. The interface plugs into MIC, EAR and REMOTE for complete control. I found the cassette facility refreshingly impervious to temperament, and unaffected by vast changes in the volume setting. The only trouble I encountered was in recording a program with both MIC and EAR connected—excessive noise appeared on the tape until the EAR connection was removed. However, I am willing to concede that it may have been a peculiarity of my particular machine (not the Tandy one shown). Apart from that, recording and playback appeared faultless. CSAVE and CLOAD are used as normal for the TRS80, and named files are compulsory. The beeper is used to allow the operator to hear data being recorded and played back as a monitor on correct operation—a most desirable feature. PRINT # and INPUT # are both allowed for the storage and retrieval of data involving cassette.

Two other functions are also included for cassette use. The familiar CLOAD? function allows a program recorded on tape to be compared with the one in memory for checking purposes. A new type of function "CHAIN" followed by a file name may be included within a program. When encountered during execution, the file named is searched for on tape, transferred to memory and executed automatically. If a line-number also follows "CHAIN", the file is loaded as before and then executed from that line number. This is a clever and complex statement which allows a chain of routines on tape, too long in toto for storage in memory, to be executed one after the other.

CONCLUSIONS

The computer is very compact, and is a triumph for "state-of-the-art" electronics. Its memory is quite small but used in a very efficient manner. The execution is slow, but it can be left to cogitate on its own for as long as you like, produce an answer in a set of variables and then switch itself off, retaining program and solution for your later perusal. The cassette is slow but untemperamental and will allow a very long program to be executed in sections.

All in all, the computer is much more than a toy, though I suspect that its latter attraction will be its major selling point. As a means of storing data and supplying answers to calculative problems straight from the pocket, it is unparalleled. Uses could include the storage of data and common routines which an investor, engineer or scientist is forced to use and refer to continually in the field from day to day. It could be adapted to being a diary, a data storage unit, a super calculator all rolled into one. The major limitation, once again, is its comparatively small memory—looking at the inside, it would appear that expansion of this feature is not possible.

This is a remarkable little machine, and perhaps one should be more forgiving of the limitations given the present level of technology. However, I should be most interested to discover at which market segment this machine is aimed—or should one accept the design as yet another offering on the altar of Progress and Fashion?

POINTS ARISING

INTERFACING COMPUKIT 1
PE January 1981

Unfortunately, due to production difficulties some errors crept into Part 1, and for this we apologise.

The second line under "Capacitors" in the component list should read: C2, C5, C8–C13 100n (8 off).

Items six and seven under "Miscellaneous" should read: 1—2 × 22 pin 0·1in. edge connector, and 1—2 × 25 pin 0·1in. edge connector.

In Table 1.2, the polled keyboard is addressed incorrectly and should read: DF00, and similarly the ACIA port should read: F000–F0FF. In Table 1.7, pin 24 goes to $\overline{W10}$. Pin 14 goes to $\overline{R5}$, and pin 13 goes to $\overline{R4}$.

The following applies to Table 1.8. Pin 3 connects to $\overline{IRQ}$, pin 5 to BDIR, pin 12—$\overline{W9}$, pin 20—BL3, pin 21—BL4, pin 22—$\overline{R3}$, pin 23—$\overline{R2}$, pin 24—$\overline{BL7}$, and pin 25—$\overline{NMI}$.

On the lower side of the latter three pins the BL signals should also be NOT.

Table 1.9. Address 61317 (audio) is R5 to SK6.

In the photograph of the Decoder Module, the left-hand edge connector is for SK6.

PE DMM *(July 1980)*

In Fig. 2 the top of R31 should connect to the junction of C2, R15, R16 as shown in Fig. 5.

125W AMPLIFIER *(PE October 1980)*

We have been asked to correct any impression given that the 125W Amplifier project published in our October issue was in any way connected with Bi-Pak Semiconductors.

Bi-Pak of Ware, Hertfordshire, have been selling an AL250 module for the past five years, although our 125W Amplifier appears similar to the AL250 there was no collaboration or connection with Bi-Pak in the production of the article and our project was in no way a kit version of the AL250.

BOOK REVIEWS

TOWERS' MICROPROCESSOR SELECTOR
By T. D. Towers
Published by W. Foulsham & Co. Ltd., 120p. 10in × 7in. Price £14·95.

This new selector in what has proved a popular series covers specifications of the basic family of central microprocessor units and LSI central circuits such as RAMs, ROMs, PROMs, interface units etc.

In the detailed data table of the selector the descriptions of the microprocessors and related microcircuits are set out on a separate lines arranged in alphanumeric order.

The tabulations with related appendices cover the applications and family relations of chips together with manufactures, package and lead-out identification and possible second source suppliers.

In addition the appendices provide information on MPU training and development systems and manufacturers' house code numbering systems together with a bibliography on MPU subjects.

G.G.

NEXT MONTH

27-28 MHz CONVERTER

Listen in with our converter.

Add this unit to your car radio and it becomes capable of receiving transmissions in the 27 and 28MHz bands.

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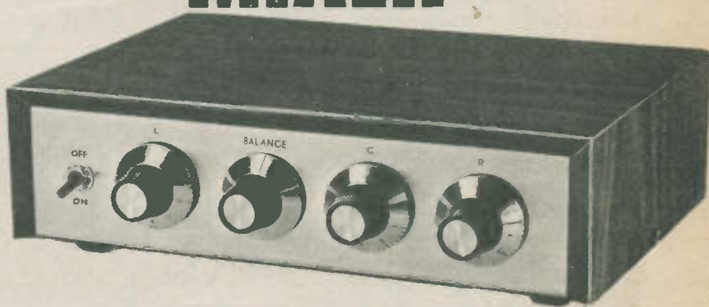
MICROPHONE MIXER



A simple mixer designed for using three microphones when making stereo recordings. Signals from the centre microphone are mixed into the left and right channels avoiding the "hole in the middle" effect.

PERIOD POWER TESTER

Designed to provide a stringent test on electronic equipment by continually switching the mains supply on and off at short intervals. This unit is particularly useful for testing equipment used for public demonstrations or performances.

PRACTICAL
ELECTRONICS

OUR MARCH ISSUE WILL BE ON SALE FRIDAY 13 FEBRUARY 1981

Digital COUNTER/TIMER

PART 1

Dr. MARK SAWIKI and ALEX KOWALEWSKI B.Sc.

THIS ARTICLE describes the design and construction of a universal low-cost digital counter-timer which can provide a simple and quite efficient solution to a whole range of frequency and time measurements, which with this instrument can be achieved quickly and conveniently. A fully integrated digital counter with a high stability quartz crystal stabilised high frequency oscillator (temperature stability defined over a −20°C to 70°C range), permits the frequency, period, frequency ratio A/B, time interval (A/B) and unit totalising counter, to be measured and monitored with greater accuracy than in most low-cost constructions.

The heart of the instrument is the 8 digit Universal Counter (Intersil ICM 7216 A) i.c., and a 10MHz crystal is used to guarantee a 0·1 microsecond resolution. For operational convenience and simplicity the instrument circuit is designed to display time in microseconds and frequency in kHz. The intention was to produce a design enabling precise frequency measurements up to 10MHz, at a relatively low cost, however, the use of a simple pre-scaler technique may easily extend the frequency measurement capability up to 100MHz if required.

The Universal Digital Counter-Timer has a pair of high impedance separate input channels with a full range voltage coverage for most applications. Three ranges (on both channels) can be selected, i.e. 3V, 30V, 300V—protected up to standard UK mains voltage level.

For increased versatility of the instrument, an independent internal SQUARE WAVE test oscillator is also provided with an output capability of ±0·6V with reasonable freedom from amplitude bounce. The frequency coverage of 80Hz to 800kHz is divided into four sub-bands, the one required being selected by means of a frequency selector switch and with a fine rotary control potentiometer for precise tuning. The test oscillator output is short circuit protected, and the maximum frequency level can be easily extended up to about 1·2MHz if necessary.

PRINCIPLES OF OPERATION

A block diagram of the Universal Counter-Timer is shown in Fig. 1. The complete system can be divided into the following eight sections:

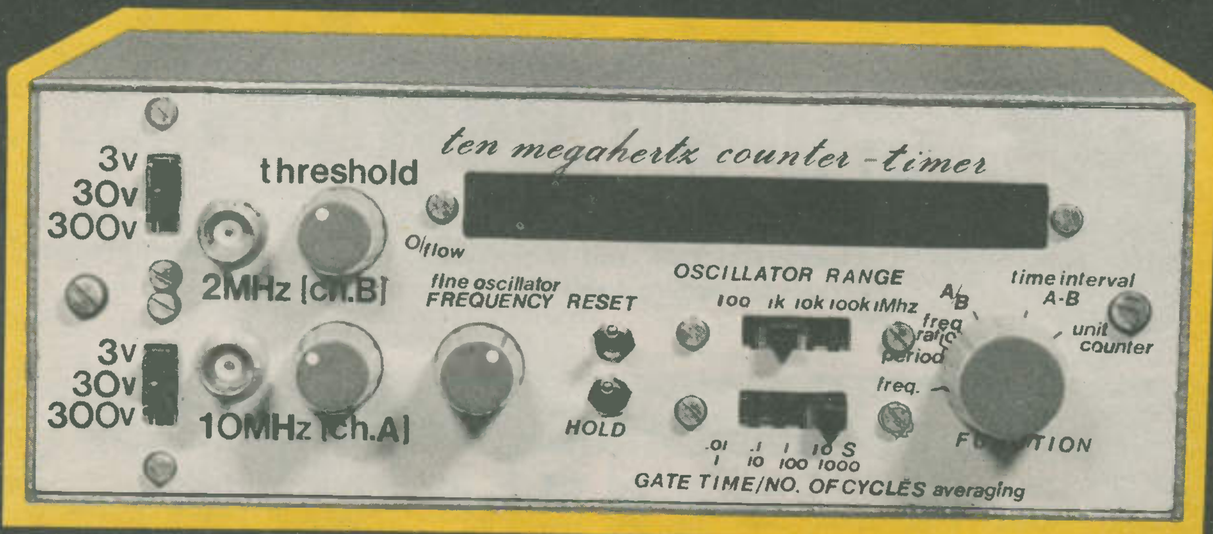
Attenuator Block (input A)
Attenuator Block (input B)
Pre-amp Block (input A)
Pre-amp Block (input B)
Counter-Timer Block
Internal Oscillator Block
8 Digit Display Board
Regulated Power Supply

Constructionally, the whole Counter-Timer circuitry is planned into the three p.c.b.s, i.e.

Main Board
Display Board
Power Supply Board.

Both channels A and B attentuator components are soldered directly onto the respective input selector switches, also three timing capacitors are placed outside the oscillator circuit on the Main Board.

The Display Board houses all eight 7-segment displays, as well as an "overflow" l.e.d. indicator. The Display Board



SPECIFICATION

PRE-AMPLIFIERS A & B

Performance	Frequency range: 7Hz–8MHz. Ref. 3dB point or better Maximum Sensitivity: 30mV r.m.s. Ref. 1kHz Maximum Input Level: Mains (240V r.m.s.) Input Voltage Ranges: Nominally 3V; 30V; 300V; protected up to mains voltage. Input Impedance: 1MΩ in parallel with approx. 20pF
Controls	1) Individual Range Selector Switch 2) Individual Threshold/Trigger Level controls
Inputs	Pair of 75 Ohms—BNC series sockets on both channels. Recommended coupling: 75 Ohms low-loss Coax cable and BNC series plugs

INDEPENDENT INTERNAL TEST OSCILLATOR

Performance	Nominal Output Level: ±0·6V (1·2V Peak to Peak) Output Form: Square wave Frequency Range: Better than 80Hz–800kHz (with 10 volts supply goes up 1·2MHz)
Controls	1) Coarse Frequency selector switch calibrated at: 100Hz–1kHz 1kHz–10kHz 10kHz–100kHz 100kHz–1MHz 2) Fine Frequency Rotary Control (1–10 variation)
Output	Single BNC series socket (75 ohms)—short circuit protection.

NOTE:
Oscillator spec. depends on accuracy of resistors and capacitors used for v.c.o. Prototype instrument uses: 5% tolerance resistors and 10% tolerance capacitors. For high performance 1% tolerance resistors and 5% tolerance capacitors are required. Mainly because of variation of v.c.o. chip (±15% frequency), therefore some trimming of values will be required.

COUNTER TIMER SECTION

Performance	Frequency Range, Channel A: d.c. to 10MHz (Frequency Mode) Frequency Range, Channel B: d.c. to 2MHz (ratio, time interval modes) Period Range: 0·5µsec to 10 secs. Period/Time Interval Resolution: 0·1µsec. Ref. 10MHz timebase Accuracy (Frequency Mode): 0·1Hz in the least significant digit. Ref. 10 sec. accumulation time. Gate Times (Accumulation times): 0·01 sec; 0·1 sec; 1 sec; 10 sec. Ref. Frequency counter mode. Number of Cycles, averaging: 1 cycle; 10 cycles; 100 cycles; 1000 cycles. Ref. period/frequency/Ratio and time interval Modes. Display: 8 digit (7 segment l.e.d.s) with automatically positioned decimal point) multiplexed common anode display (13 x 9mm) Overflow: $\frac{1}{4}$in. red l.e.d. indicator
Controls	1) Function rotary selector switch i.e. Frequency; Period; Frequency Ratio: $\frac{A}{B}$, Time Interval (A–B); Unit Counter 2) Gate Time/Number of cycles Selector Switch 3) Reset Switch (Zero's Display in all modes) 4) Hold switch (holds count in unit counter mode) Hold–same as Reset in all other modes)

POWER SUPPLY UNIT

	Regulated 2 x LM309K (5 volts/1·2A) dual. Rail supply: +5V; 0V; −5V: Internal foldback, overload and short circuit protection. Complete unit consumes approx. 150mA @ 5 volts per rail
Mains input Requirements	220–240 volts 50/60Hz
Fuse	500mA—Antisurge (20mm)
Physical Dimensions	91 x 204 x 153mm
Weight	Approx. 2,185 grams

p.c.b. will accept both types of displays, i.e. with RH and LH decimals. For simple wiring conversion see relevant note in Fig. 1.

Both input A and B Attenuator/Pre-amplifier circuit diagrams are identical and corresponding schematic diagrams are presented in combined form in Fig. 2. The input attenuator circuit is extremely simple with voltage dividing network and three-position voltage selector switch calibrated at 3V, 30V, 300V. The output signal from the channel attenuator feeds directly into the relevant pre-amplifier section, which then can be divided, because of its functional role, into the following:

Input protection stage
Impedance buffer, and approx 20dB gain stage
and high speed TTL (Schottky) compatible comparator.

The protection at this stage consists of a high resistance/voltage breakdown series resistor of 1M parallel with 47nF/400V capacitance, followed by a combination of four clamping diodes, i.e. a pair of 1N914s and Zener BZX 83C2·7.

The high voltage breakdown 1M/0·5W resistor can be obtained from Maplin, as standard high-stab carbon resistors are not recommended for this work, because of insufficient high voltage breakdown parameters.

Turning to the impedance buffer stage, the main design objectives are:

High input impedance
High gain (20dB)
Output impedance must be low enough to drive NE529 comparator
Must work from 5V supply

Finally, the network frequency response is maximised (maximum gain-bandwidth product). Use of a pair of f.e.t.s (2N5245) seems to be a reasonable answer.

Now a little field effect transistor theory. A practical small

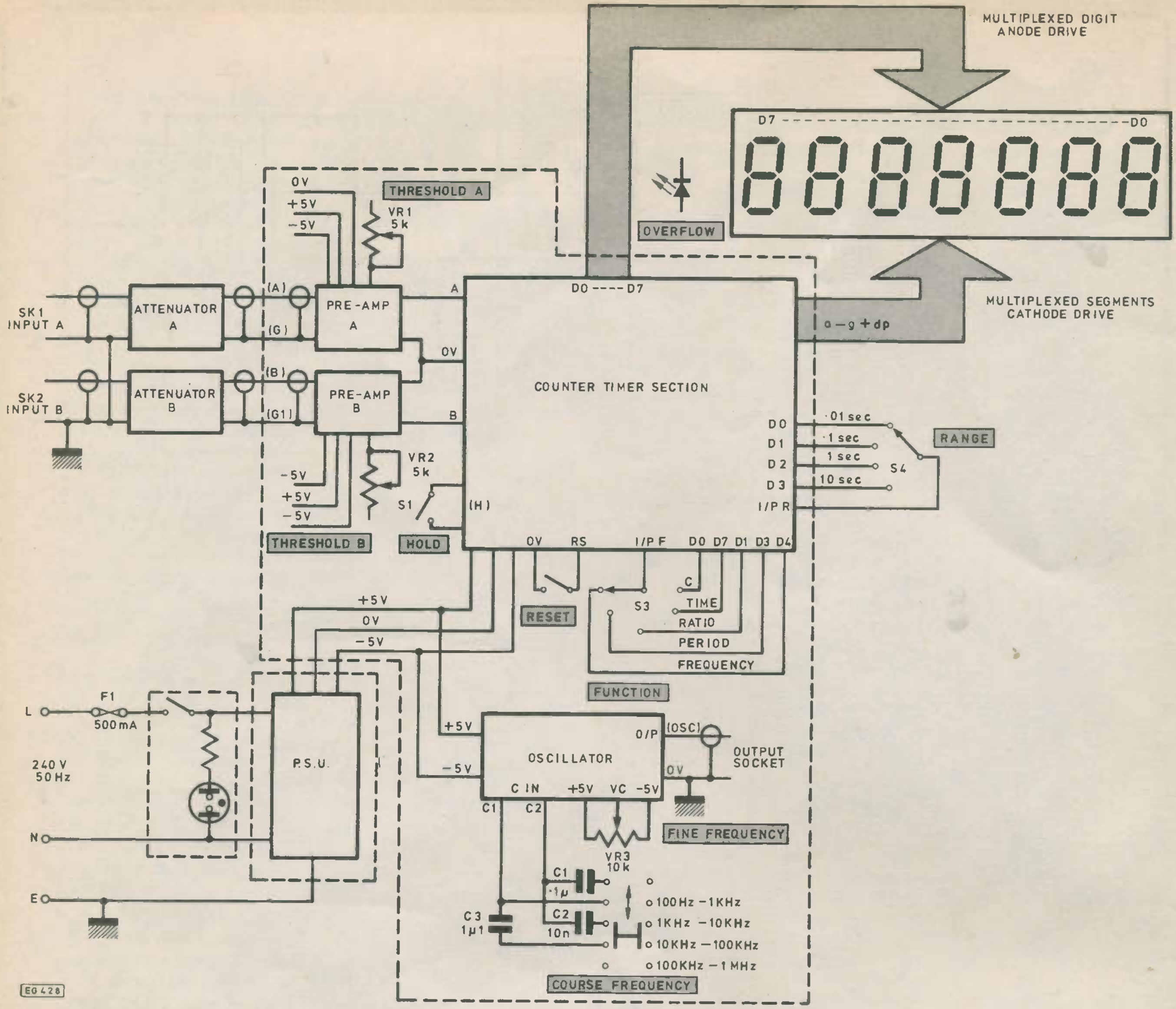


Fig. 1. Block diagram. Note on Overflow l.e.d. indicator. (a) For RH decimals: cathode to d.p. segment drive rail, and anode to D7. (b) for LH decimals: anode to D6. Do not connect decimals on D7 and D6

signal model of an f.e.t. is shown in Fig. 3.

Our impedance buffer stage employs a pair of such devices connected in series, i.e. as presented in Fig. 4.

The operational extrinsic elements we shall consider now, are those under d.c. and a.c. work conditions. From the simplified diagram (Fig. 4), you can see that under normal d.c. conditions transistor TR1 acts as a source follower giving a stable quiescent voltage (V_{out}) of approx. 2·5V. Under a.c. conditions TR1 becomes a constant current source due to the presence of C10 capacitor, bootstrapping its gate voltage. Due to the high slope impedance, gain is high; this applies also to the large bandwidth which is maintained due to constant current drive. The obvious advantage of this type of configuration over a simple constant current source is the highly superior d.c. stability.

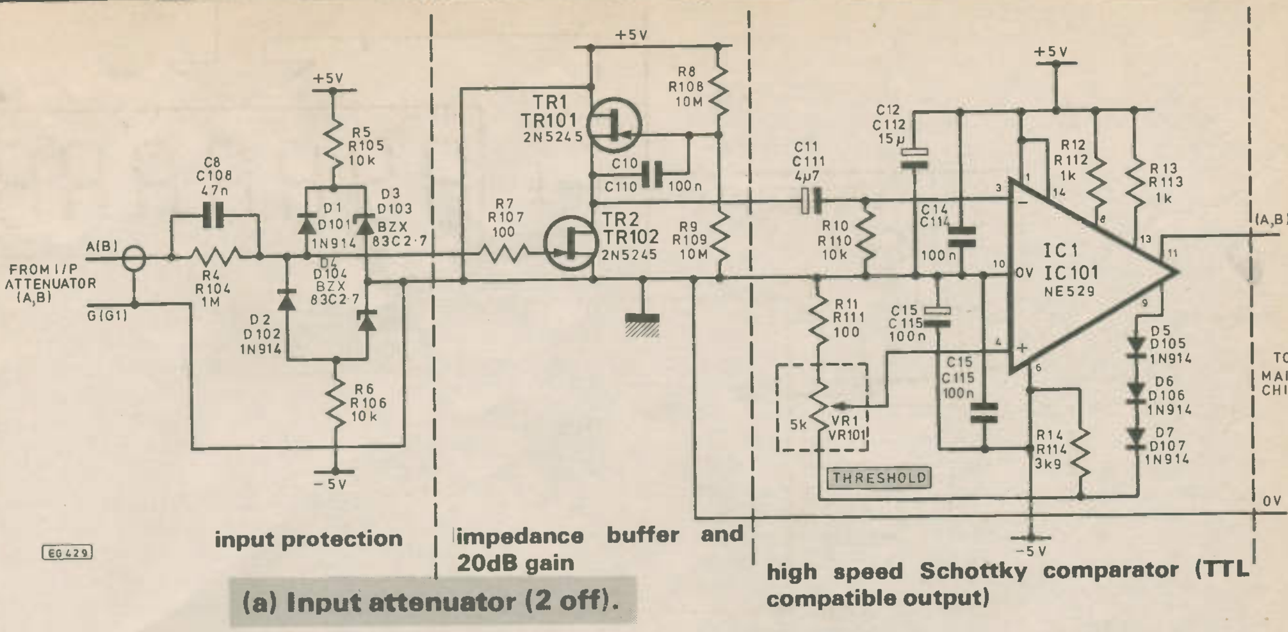
The 2N5245 f.e.t.s have been chosen because of their quite good performance combined with relatively low cost.

It might be worth noting that frequency response, including the input protection stage (maximum gain bandwidth product) is calculated using a computer model admittance analysis program, written specially for this project and run on a TRS 80 Tandy system, 16K BASIC level II. The source program occupies about 10K RAM and uses double precision (16 digit) for internal calculations.

Calculated gain is about 21dB at 10·9MHz and the corresponding frequency response characteristic is shown in Fig. 5.

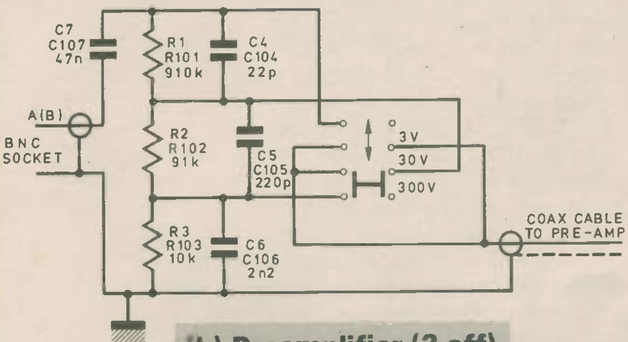
The last part of the pre-amp stage now is the Comparator Design is based on the application of a SE/NE 529 Analogue Voltage Comparator, being a high speed Schottky device. Among the many advanced features of this i.c., are the following:

10 nsec propagation delay.
complementary output gates.
TTL compatibility.
wide common mode and differential voltage range.

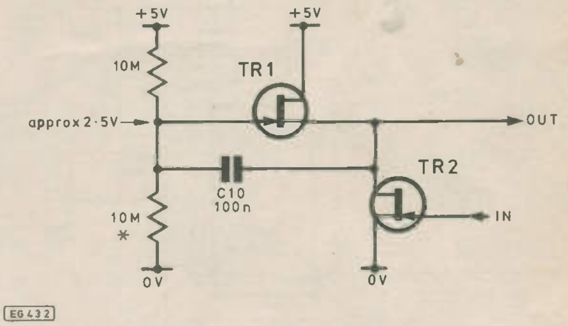


(a) Input attenuator (2 off).

Fig. 2. Input circuits.



(b) Preamplifier (2 off)



$$\text{Gain} \approx \frac{Y_{fs}}{2(Y_L + Y_{os})}$$

where Y_L = load admittance

$Y_L >> Yos$ ∴ Load defines gain

Since load is fixed, gain is stable

Fig. 4. Impedance Buffer and 20dB gain.
***Preserves high slope impedance**

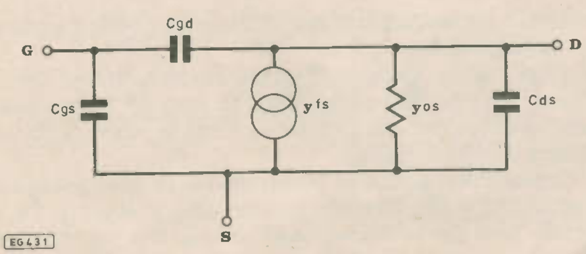


Fig. 3. Practical small signal model of single f.e.t. Note: Cds is usually negligible

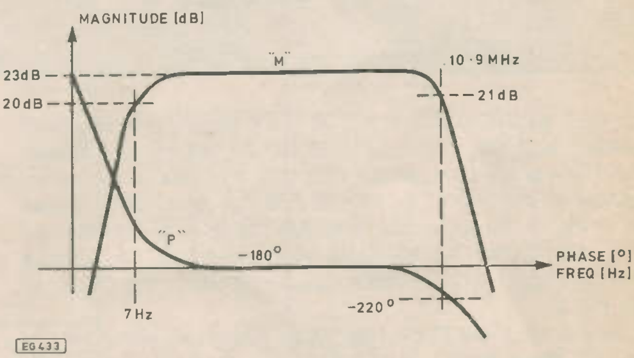


Fig. 5. Magnitude/phase/frequency relationship

COMPONENTS . . .

Resistors

R1, R101	910k (2 off)	pref. hi. stab. metallised 1%
R2, R102	91k (2 off)	
R3, R103	10k (2 off)	
R4, R104	1M, ½W 5% hi. stab. metallised (2 off)	
R5, R6, R10, R19-R23, R110	10k (11 off)	
R7, R11, R107, R111	100 (4 off)	
R8, R9, R108, R109	10M (4 off)	
R12, R13, R112, R113	1k (4 off)	
R14, R17, R114	3k9 (3 off)	
R15	200k	
R16	12k	
R18	4k7	
R24	4M7	
R25	8k2	Adjust to span 10:1 range in frequency for full Vc—control variation; 5% ⅛W hi. stab. metallised type
R26	130k	
R27	1k8	
R28, R29	1k ½W 5% hi. stab. metallised	

All resistors 5% ⅛W hi. stab. metallised unless otherwise stated.

Capacitors

C1	100n/160V polyester	
C2	10n/160V polyester	
C3	1µ1/160V polyester	
C4, C104	22p/400V ceramic (2 off)	10% tol.
C5, C105	220p/100V ceramic (2 off)	
C6, C106	2n2/100V ceramic (2 off)	
C7, C107	47n/400V polyester (2 off)	
C8, C108	47n/400V with high voltage breakdown (2 off) (Maplin)	
C9, C21, C109	2µ2/10V tant. bead (3 off)	
C10, C14, C15, C17, C110, C114, C115	100n/63V min. disc. cer. (7 off)	
C11, C111	4µ7/10V (2 off)	tant. bead
C12, C13, C23, C112, C113	15µ/10V (5 off)	
C14, C15	2n2 disc. cer. (2 off	
C16	33µ/10V tant. bead	
C18, C19	39p min. disc. cer. (2 off)	
C20	100p styroflex type	
C22	100n polyester	
C24, C25	2200µ/25V elect.	
C26, C27	220n polyester	
C28, C29	470n polyester	

Potentiometers

VR1, VR2	5k	1W rotary moulded carbon track + insulated spindle
VR3	10k	

Transistors and Diodes

TR1, TR2, TR101, TR102	2N5245 f.e.t. (4 off)
TR3	BC107
D1, D2, D5-D9, D101, D102, D105-D109	1N914 (14 off)
D3, D4, D103, D104	BZX83C 2V7 Zener
B1, B2	1A rectifier stack (RS 261-328) (2 off)

Integrated Circuits

IC1, IC101	NE529 Schottky comparitor (Signetics) (2 off)
IC2	CD4069B
IC3	ICM 7216A Intersil counter (see text)

Miscellaneous

S1, S2 SPST sub. min. rocker or push button switch, n.o. (2 off)
S3 1-pole 5-way rotary switch
S4, S5 2-pole 4-way slide switch min. (2 off) (S4 may be single pole)
SK1, SK2 75 Ohm BNC socket (2 off)
7-seg. 0·3in. com. anode displays with RH or LH decimals (see text)
example: RS586-526 (8 off)
l.e.d. overflow indicator (1 off)
Mains socket: 3-pin "Euroconnector"
20mm glass fuse + holder 500ma @ 240V
Neon illuminated mains on/off switch
Instrument case (see text) e.g. RS 509-901
Knobs, ribbon cable, nuts & bolts etc.
10MHz crystal (see text)
14-pin & 28-pin i.c. sockets for IC2 & IC3
Mains transformer: 240V/OV-6V + OV-6V @ 20VA (RS 207-138)
P.c.b.s & general hardware
NOTE: For RH and LH decimals see Fig. 1

In fact, SE/NE 529 will run at ± 5V supply and has both inverting and non-inverting outputs. As mentioned above, output levels are compatible with t.t.l. and this is necessary because of the use of an Interisl counter-timer chip. Referring to Fig. 2. the comparator circuit mode of operation employs differential inputs used with feedback to form a Schmidt trigger with variable hysteresis about the 0V level. (See Fig. 6.)

Since output has TTL levels, while hysteresis about zero is required, three diodes (3×1N914) are used as a level shifter. Finally, 5 kohm potentiometers are used as Threshold level controls, mounted individually in Channel A and B on the instrument front panel.

To conclude both input attenuator and pre-amplifier stages, a word about input protection—a practical feature not always respected in amateur constructions. The most important protection features of this part of the instrument can be listed as follows:

1) High series resistance (1Mohm) effectively limiting current, with parallel capacitance to stop h.f. losses due to resistive character, still sufficiently small to pass only 0·5mA if mains (50Hz) is applied.

2) Combination circuit of clamp diodes to limit voltage applied to TR2 (Field Effect Transistor) gate to about ± 3V, especially with Zener diodes used to keep the pair of diodes normally *reverse biased.* This protection network still works with the power off—so the instrument is *always* safe.!!

3) Resistance of 100 ohms limits current through gate of junction TR2, to approx 30mA (50mA is max level for 2N5245). This resistor value is kept small to maintain high frequency response.

Last but not least, the SE/NE 529 Analogue Voltage Comparator is a Signetics device and its pin configuration is shown in Fig. 7.

Coming to Fig. 8, we find the Counter-Timer section, and associated small additional circuit acting as induced delay (this will be explained later on). As mentioned earlier, the heart of the PE Universal Counter is the ICM 7216A Intersil i.c. and its internal block diagram as well as pin configuration is presented in Fig. 9.

The ICM 7216A Universal Counter integrated circuit is superbly documented by the manufacturer and therefore the necessary minimum information about the i.c. is included in this article.

As mentioned earlier, the circuit of our counter timer has provisions for two types of decimals (i.e. RH or LH) which do exist amongst commercially available 7-segment displays. The delay section of Fig. 8 provides this option, and if you use RH d.p. displays, you should use delayed output, i.e. marked (*) on Fig. 8, or directly pin 4 output (on 7216 chip) for RH decimals. The delay section circuit is very straightforward, using a single 14-pin CMOS Hex Inverter—CD4069B, working at a positive 5V rail and ground (0V), buffered by *single n.p.n.* transistor.

At this point, we shall turn for a moment to all the 7216A external components and controls as shown on both Fig. 1 and Fig. 8. The Hold switch or push-button which works as in most commercial counters, is connected between the +5V rail and pin 27, marked Hold (H) on Fig. 8. Reset switch or push-button is grounding pin 13 on the 7216A chip marked Reset (RS) on Fig. 1 and Fig. 8. Function rotary selector switch has its Common connected via a 10k resistor to pin 3 on the 7216A chip and the functional positions are as follows:

Frequency	connected to D3	as illustrated in Fig. 1 and Fig. 8.
Period	connected to D4	
Frequency Ratio	connected to D1	
Time Interval	connected to D7	
Unit Counter	connected to D0	

Range selector switch has its Common connected again via 10k resistor to pin 14 on 7216A chip and the range operational positions are as follows:

0·01 sec	connected to D0	as explained on Fig. 1 and Fig. 2
0·1 sec	connected to D1	
1 sec	connected to D2	
10 sec	connected to D3	

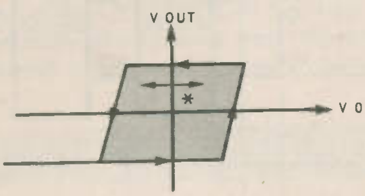


Fig. 6. Variable hysteresis. *Set by threshold control

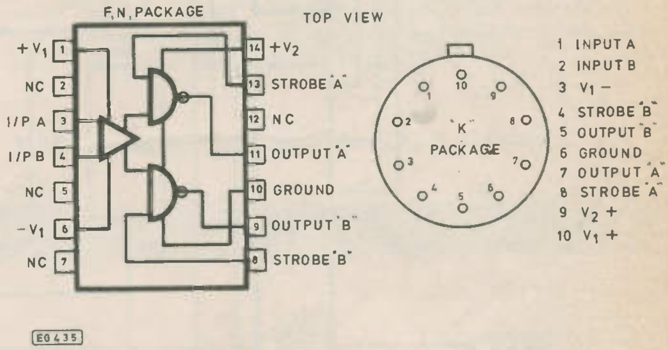


Fig. 7. The SE/NE 529 Comparator. The d.i.l. package is used on the prototype

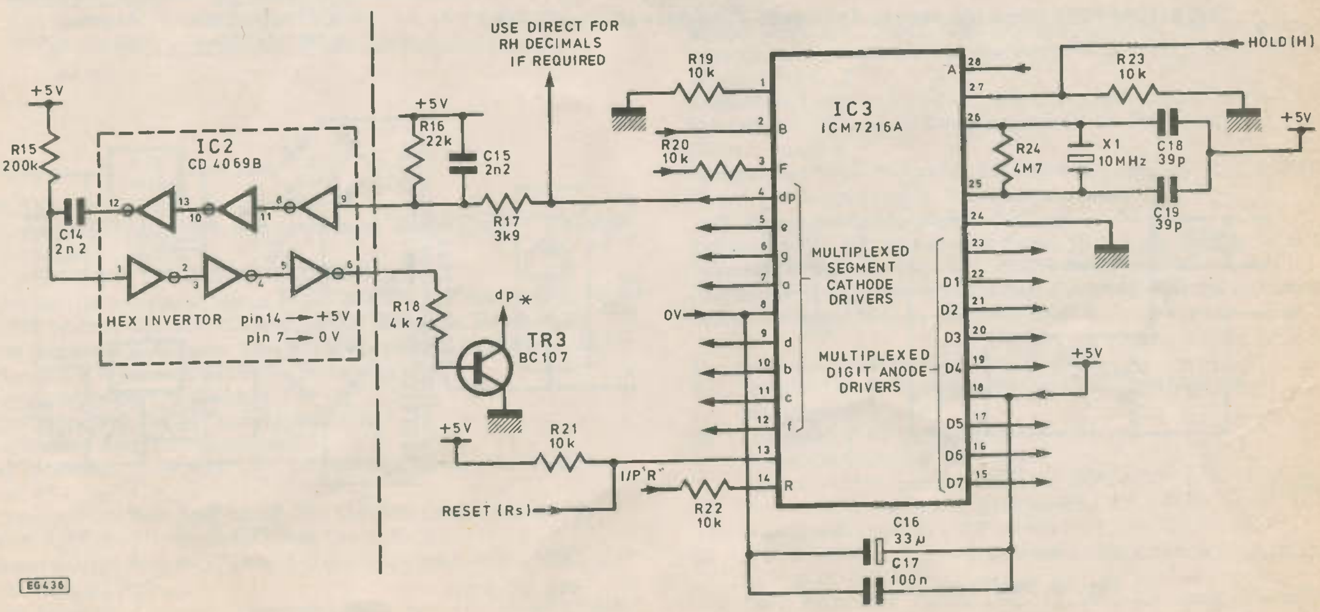


Fig. 8. Counter/timer section

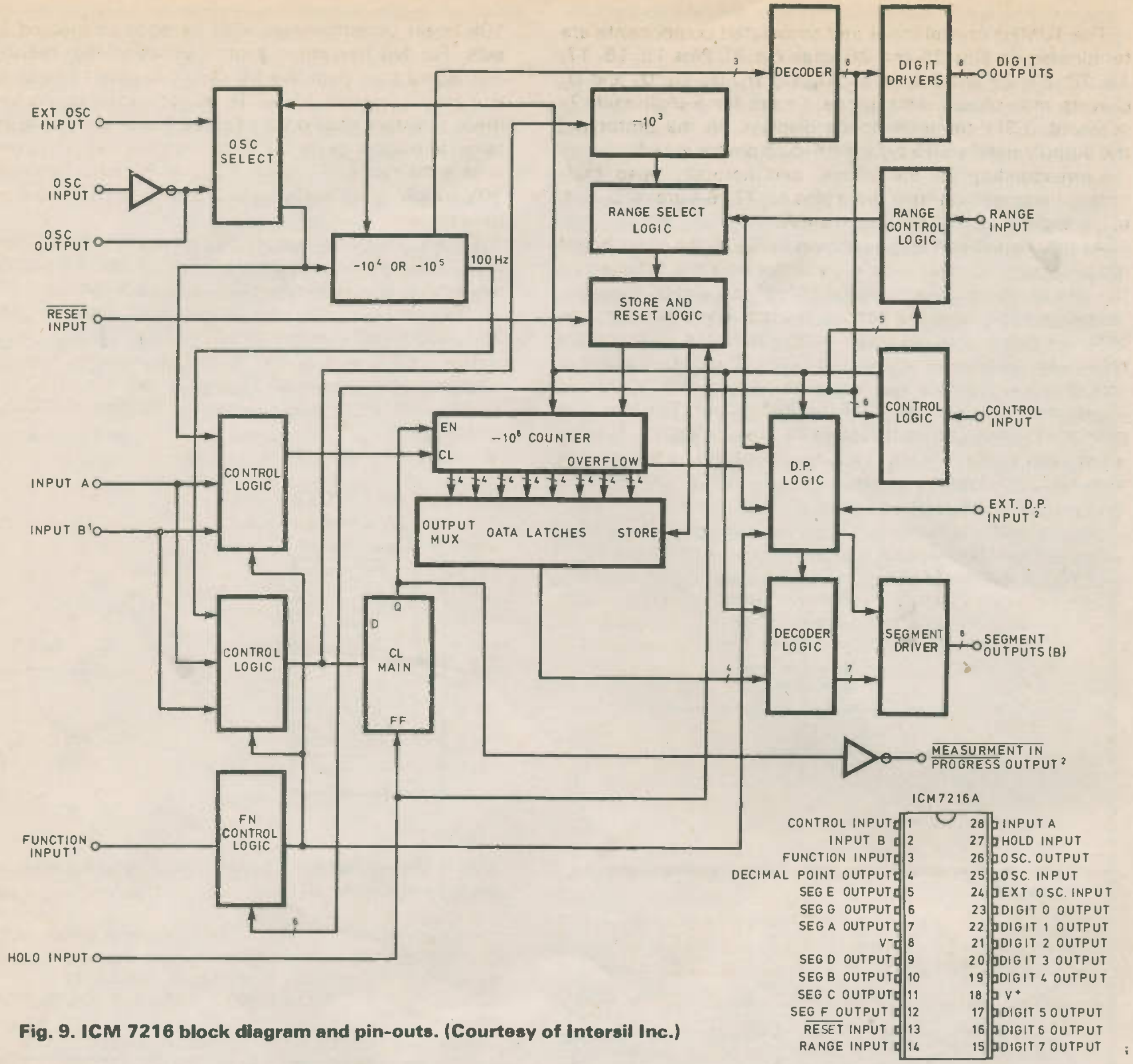


Fig. 9. ICM 7216 block diagram and pin-outs. (Courtesy of Intersil Inc.)

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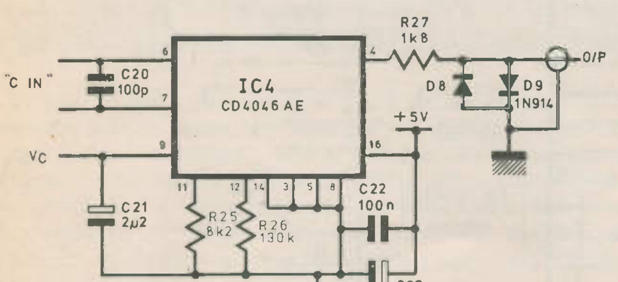

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Fig. 10. Oscillator

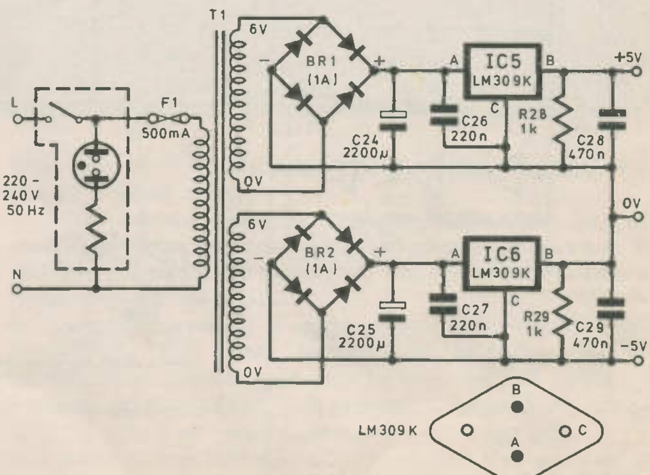


Fig. 11. PSU

The 10MHz crystal input and associated components are terminated on pins 25 and 26. (See Fig. 8). Pins 15, 16, 17, 19, 20, 21, 22 and 23, i.e. D_7, D_6, D_5, D_4, D_3, D_2, D_7 and D_0 provide multiplexed digit anode drivers for 8-digit-each 7-segment 0·3in common anode displays. In the prototype, the authors used an RS type: 586–526 device in red.

Corresponding to the above, and naturally, also multiplexed sigment cathode drive pins on 7216A are: a, b, c, d, e, f, g and d.p. (pin 4) discussed earlier.

As mentioned earlier, and shown in Fig. 1, the Main Board p.c.b. containing independent oscillator network is based on the use of the popular CD 4046AE phase locked loop i.c., where only the oscillator section is used. The oscillator uses both positive and negative 5V supply rails and its complete schematic diagram is shown in Fig. 10. The output signal is connected via a 1k8 resistor directly to the BNC socket provided on the rear panel of the instrument. The circuit is simple and well known, therefore its description is limited to a few points. The Course Frequency control has 4 positions selecting the following bands:

100Hz–1kHz
1kHz–10kHz
10kHz–100kHz
100kHz–1MHz

The timing capacitors are soldered directly to the switch and a pair of leads (marked C1 and C2 on Fig. 1 (or C IN on Fig. 10) should be made of two wires from ribbon cable to make a quasi-balanced pair. The fine frequency control uses 10k linear potentiometer with its ends connected to ±5V rails. For full frequency control variation two resistors are connected from negative 5V supply to pins 11 (approx. 8k2) and pin 12 (approx. 130k). To be more precise, the values of these resistors should be adjusted individually to span 10:1 range in frequency for full Vc control variation. This oscillator covers the range of approx. 80Hz to 800kHz; however, with 10V supply, goes easily up to 1·2MHz as checked during experiments.

Finally, the power supply unit (shown in Fig. 11) providing stabilised ±5V obtained from a pair of ubiquous 309K type regulators. The instrument consumes approximately 150mA at 5V per rail, and the transformer used is RS type: 207–138, rated at approximately 20VA.

The rectification is not critical as regards type, and the prototype uses a pair of 1A bridge rectifiers (RS261–328), where their outputs are smoothed by pair of 2200μF/25V electrolytics.

IMPORTANT NOTE

A pair of capacitors i.e. 33μF/10V tantalum type, and small ceramic 100μF capacitors are soldered onto the copper side of the main board as close as possible to the relevant pins (8 and 18) on the 7216A chip. ★

NEXT MONTH: *Construction and p.c.b. assembly.*

Countdown

Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below.

BEX Feb 4–5. Pavilion, Bournemouth. **K**
Microsystems (exhibition and conference) March 11–13. Wembley Conf. Centre, London. **ZI**
INSPEX March 16–20. NEC, Birmingham. **ZI**
Seminex (seminars only) March 23–27. Imperial College, London. **HI**
BEX (Business Equipment) March 25–26. Metropole, Brighton. **K**
The Northern Electronic Test & Measurement Exhibition March 31–April 2. Wythenshawe Forum, Manchester. **T**
Laboratory April 1–2. Glasgow. **I**
BEX April 8–9. Centre Hotel, Liverpool. **K**
Laboratory April 8–9. Manchester. **I**
All Electronics Show April 22–24. Grosvenor House, Park Lane, London. **FI**
Computer Graphics April 28–30. The Barbican Centre, London. **O**
BEX April 29–30. Dragonara Hotel, Leeds. **K**
Entertainment May 9–17 (weekday mornings trade only). NEC, Birmingham. **B2**
The European Consumer Electronics Show May 10–13. Nuremberg, West Germany. **I**
The European Consumer Electronics Show May 10–13. Nuremberg Fair Centre, W. Germany. (Trade) **I**
BEX Train May 11–22. Calling at: Cambridge, Norwich, Leicester, Sheffield, Newcastle, Middlesbrough, Hull, Nottingham, Reading and Portsmouth. **K**
Defence Components Expo May 12–14. Brighton Metropole. **I**
East Suffolk Wireless Revival May 24. Sports ground of Ipswich Civil Service Sports Association, Straight Road, Ipswich. **VI**
Scotelex June 2–4. Royal Highland Exhibition Hall, Ingliston, Edinburgh. **AI**
Semlab June 2–5, Grand Hall, Olympia, London. The international scientific, educational, medical and industrial laboratory equipment exhibition. (Trade). **I**
Transducer Tempcon June 9–11. Wembley Conf. Centre, London. **T**
Components (Electronics Components Industry Fair) June 9–12. Earls Court, London. **I**
International Word Processing Exhibition & Conf. June 23–26. Wembley Conf. Centre, London. **Z**
Solar Energy Exhibition Aug. 23–28, Brighton. **M**
Laboratory Sept 8–10. Grosvenor House, Park Lane, London. **I**
International Business Show Oct. 20–29. NEC, Birmingham. **A2**
Electronics 82 (Sub-titles International Electronics Control and Instruments Exhibition) May 24–28, 1982. NEC. **I**

I Industrial Trade Fairs. ✆ 021-705 6707
K Douglas Temple Studios, 1046 Old Christchurch Road, Bournemouth
M Montbuild. ✆ 01-486 1951
O Online Conference. ✆ 0895 39262
T Trident International Exhibitions. ✆ 0822 4671
AI Institute of Electronics. ✆ 0706 43661
VI Jack Tootill, Ipswich. ✆ 0473 44047
ZI IPC Exhibitions Ltd., 40 Bowling Green Lane, London EC1R 0NE. ✆ 01-837 3636
A2 Hart Browne & Curtis Ltd., 29 Sackville Street, Piccadilly, London W1X 1DR. ✆ 01-439 8556
B2 Brintex Exhibitions Ltd., 178–202 Great Portland Street, London W1N 6NH. ✆ 01-637 2400

Semiconductor UPDATE...

FEATURING AM 2960 HLMP31XX HMP 36XX

R.W. Coles

RAM SUCCESS

As readers of this column will be aware, semiconductor random access memory devices are getting smaller (in size), bigger (in capacity), less demanding (of power supplies), faster, cheaper and generally easier to use. All of these improvements have been made possible by advancements in semiconductor technology which have resulted in even smaller device geometries and associated interconnection line widths.

The thing to remember is that for every microprocessor sold, there are associated orders for numerous other components—especially RAM chips. This fact almost makes the microprocessor devices "loss-leaders", a necessary inconvenience needed before reluctant customers will buy all those memory parts which are actually much better for company profits! The importance of the RAM chip cannot be overestimated. Industry demand for these devices is increasing exponentially, and the memory size of a typical computer system, be it micro, mini or mainforce is zooming up to make room for even more sophisticated tools such as language compilers and operating systems. Cheap RAM memory is not only used by "ordinary" computer either. The availability of cheap storage has made possible a new breed of image processing systems which store and manipulate video pictures as huge arrays of binary numbers where each picture point has an associated storage word of "n" bits to code colour and intensity information. Applications for these new tools are growing and currently include such bizarre extremes as the image enchancement of Voyager pictures from Saturn, and the special effects to be seen on "Top of the Pops".

. . . AND FAILURE

Unfortunately, there is a sting in the tail of this RAM success story. As memories get larger and larger, the chances of memory errors also increase, and as every microcomputer owner knows, memory errors, even one bit errors, can create havoc with otherwise "tame" programs.

Memory errors, like other forms of Black Magic, come in two varieties—hard and soft. Hard errors are usually "stuck" memory cells caused by the random malfunction of on-chip devices, due to a latent manufacturing defect for example. Soft errors come and go, and often cannot be duplicated. They can be due to a variety of phenomena notably "pattern sensitivity" wherin a particular memory cell malfunctions only when surrounding cells contain a specific unfavourable bit pattern, and more recently (and as a direct result of shrinking device geometries) the dreaded Alpha particle induced errors caused by the decay of slight traces of a radio active isotape in the ceramic package material or even by background cosmic radiation.

Whatever the cause, these errors are not tolerable in many computer systems, and AMD for one has decided to do something about it. The spearhead of their attack on RAM errors is the AM 2960 Error Detection and Correction Unit, a very fast bipolar LSI device which can offer a dramatic improvement in memory reliability in the face of both hard and soft errors.

The principles of data protection have been known for a long time. The trick is to store not only the data bits but also an associated group of check bits generated using a version of the Hamming code. When the data bits are read back from the memory these check bits are regenerated and compared with the stored check bits. If the two sets of check bits match the stored data is correct, if not the differences are used to generate information on the type of error and its location so that corrections can be made. The problem in the past has been that microprocessors and computer CPUs cannot afford to wait for long while the checking and correcting process goes on, and the large conglomeration of TTL logic required for the checking and correcting process would have added unacceptable delays to every memory cycle.

The AMD 2960 solves this problem by putting all the logic on one very fast chip so that a sixteen bit word can be checked and corrected as it is read from the memory, for a time penalty of only about 50n/s. To protect a memory based on 16 bit words, 6 check bits must be added but the new AMD chip will detect single or multi bit errors which occur in either the data or the check bits, and will correct any single bit data errors.

With memory devices becoming so cheap and so large, it will soon be standard practice to protect all memories in this way.

LED NEWS

L.e.d. lamps have been with us for many years now, and it seems difficult to imagine what life was like without them. Apart from the revolution they caused when first introduced, there have been few surprises and today we have a "mature" technology supplying "jelly bean" parts.

There have been developments, particularly in packaging techniques and in increasing apparent light output by the use of reflectors and improved chip design, but the main improvement has been in price as more and more manufacturers have entered the market. With this sort of foundation already established, there are incentives to "make a better l.e.d.", and this month I can report on two such developments which should make life easier for us users before long.

From Hewlett Packard comes a nifty new l.e.d. series which does away with the need for an external current limiting resistor and reverse protection diode. Reverse protection diodes, by the way, are needed when an l.e.d. is powered from an a.c. source of more than a few volts. Although the l.e.d. can act as its own rectifier diode its reverse blocking voltage is so low that nasty things can happen when an a.c. supply is used, unless a diode with a higher breakdown rating is used in series. In effect, the incorporation of the resistor and the diode gives a device with characteristics similar to an incandescent lamp, making them easy to use but less flexible in that each lamp now has a rated operating voltage.

The new devices come in two series, the HLMP 31XX series of standard brightness units, and the HMP 36XX series of high efficiency types which are more expensive. All three standard l.e.d. colours (red yellow, green) are available, and 5 volt and 12 volt operating types cover the most popular supply voltages. All l.e.d. lamps in these series come in the popular panel mounting T1$\frac{3}{4}$ package.

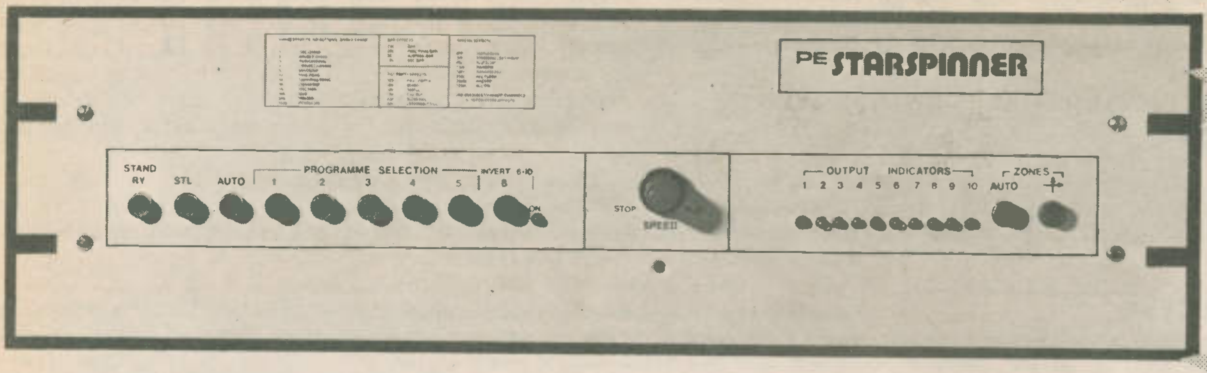
BRIGHT FUTURE

From Japan comes news of a breakthrough in l.e.d. efficiency and brightness. The Matsushita Electronics Corporation is about to introduce a new range of l.e.d. lamps with a light output more than ten times that of standard devices, and anyone who has looked in vain for a glimmer of light from their l.e.d. on a bright sunny day, will appreciate *that* development.

The secret of the new devices is a swop from the standard Gallium Phosphide semiconductor material to Gallium Aluminium Arsenide which gives a better current/light-output relationship and higher efficiency.

The only snag is that it seems likely that you will be able to have any colour so long as it's red!

Part 2



PE STARSPINNER

THE circuit diagram for the output and matrix/zone selection is shown in Fig. 2.1. The signal from each channel is taken to a pair of opto-isolators. These are the darlington type providing good current transfer. Since the active signal is a '0' the signals are taken to the cathodes. The anodes of the twenty opto-isolators are commoned together and taken to the phase control/zero switching circuit described in the power supply section. The anodes receive from this section of the circuit a short pulse every half cycle of the mains supply. This would normally be immediately after the zero voltage crossover point but provision is made for the unit to be operated into inductive loads such as pinspots, and therefore the point of appearance of the firing pulse can be altered.

From the cathode of each opto-isolator is also taken a 270 ohm resistor. The other sides of these resistors are commoned in groups of ten, one group being for those opto-isolators controlling the live rail and the other for those controlling the neutral rail. Each common line is clamped to the zero voltage line (all opto-isolator anodes) to prevent interaction between channels. These two commoned lines are taken to the collectors of a pair of BC172 transistors (TR8, 9) whose bases are driven via 1k resistors from the J and K outputs of a JK flip-flop (IC37) and also directly from the manual matrix/zone selection button. In the manual mode the manual/auto button delivers 5 volts to the selected 1k base feed resistor, but in the automatic mode, the 5 volts is diverted to pin 4 of IC37 enabling it to respond to the trigger pulse from the main clock. Accordingly, either one or the other sets of opto-isolators are over-ridden thus deciding the choice of matrix/zone in use.

An unregulated supply is provided for each mains rail and the opto-isolator transistors are used as emitter followers to drive the triacs through 22 ohm resistors. Each triac has a 'snubber'

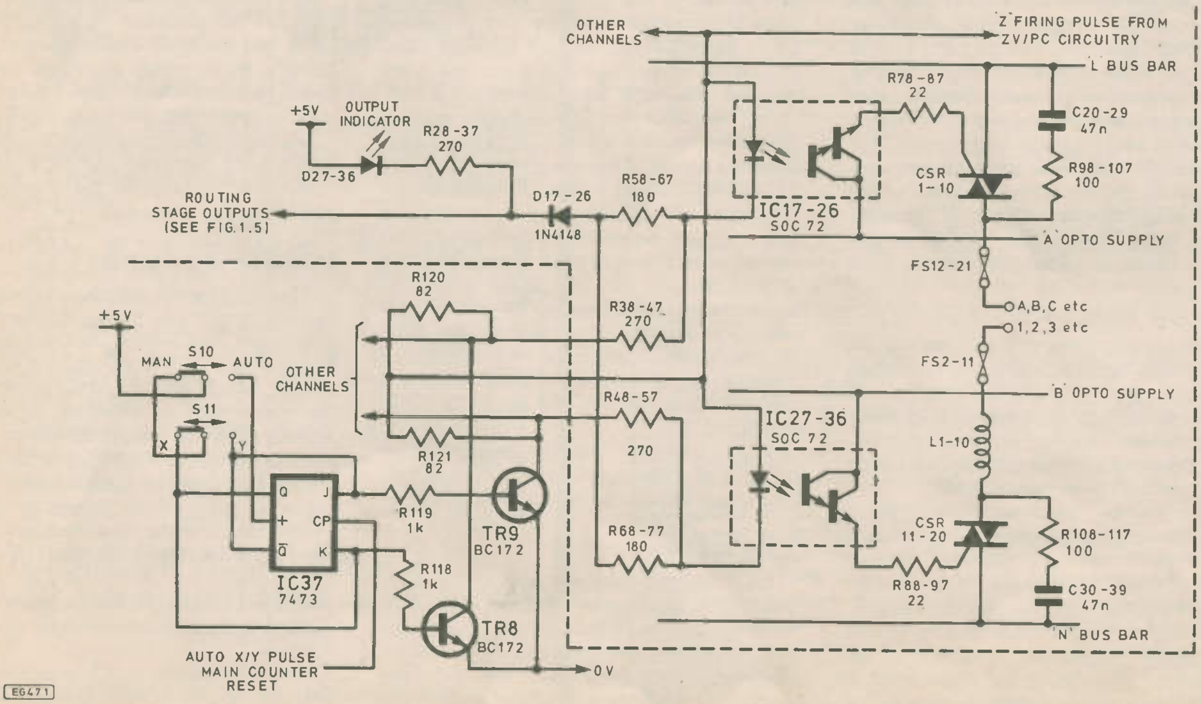


Fig. 2.1. Output and Matric/Zone selection circuit.

network connected across it. The resistance value is higher and the capacitor value lower than might be expected. This is because, when using inductive loads, the use of normal values such as, say, 33 ohms and 100n can result in sufficient ringing taking place to lock the triacs 'on'.

POWER SUPPLY AND PHASE CONTROL/ZERO SWITCHING

The p.s.u. circuit diagram is shown in Fig. 2.2. The very nature of the unit necessitates four separate supply sections; two provide isolated and unregulated d.c. for the output stage at a nominal 4 volts. Regulation is unnecessary since the actual power used is negligible due to the short length of firing pulse. Thus each supply consists of a full wave bridge and a 330μ reservoir capacitor. The third supply consists of a bridge rectifier, 1,000μ reservoir capacitor and LM309 regulator. The output of this regulator supplies all the TTL, the clock and also +5V to pin 24 of the EPROM.

The fourth supply consists of a 24 volt a.c. centre tapped winding with a bridge rectifier producing a smoothed nominal ±12 to 15 volts for the 741 op-amp (IC2) +14 to 16 volts for pin 19 of the EPROM (IC6) and, via a combination of a 220 ohm 1W resistor and 4·7 volt Zener diode, −5 volts for pin 21 of the EPROM. Although the EPROM requires three separate supply voltages it can be seen that, with the requirements of the 741, there is little problem, especially since the EPROM is extremely tolerant as far as variations in the 12 volt requirement are concerned. No attempt is made on the unit to switch the main power supply, because of the high currents involved. Instead, the unit has a 'standby' button which simply switches supply to the mains transformer.

To meet the requirements for interference suppression the unit features zero-voltage switching. However, in order that the unit may be used on inductive loads where the zero voltage crossing point does not coincide with zero current, the circuit allows for delay of the firing pulse. The output of the bridge rectifier on the 24 volt centre tapped winding is blocked by a 1N4001 diode before the reservoir capacitor. This does not affect the d.c. supplies obtained from this section of the supply but does allow a 100Hz signal to be taken to a limiter stage where it produces a 100Hz square wave with a large mark-space ratio (Fig. 2.3.). The collector of TR1 is only positive whilst the level of the 100Hz input to the base is less than 0·5 volts. This corresponds to a mains voltage of about 5 volts peak which may be con-

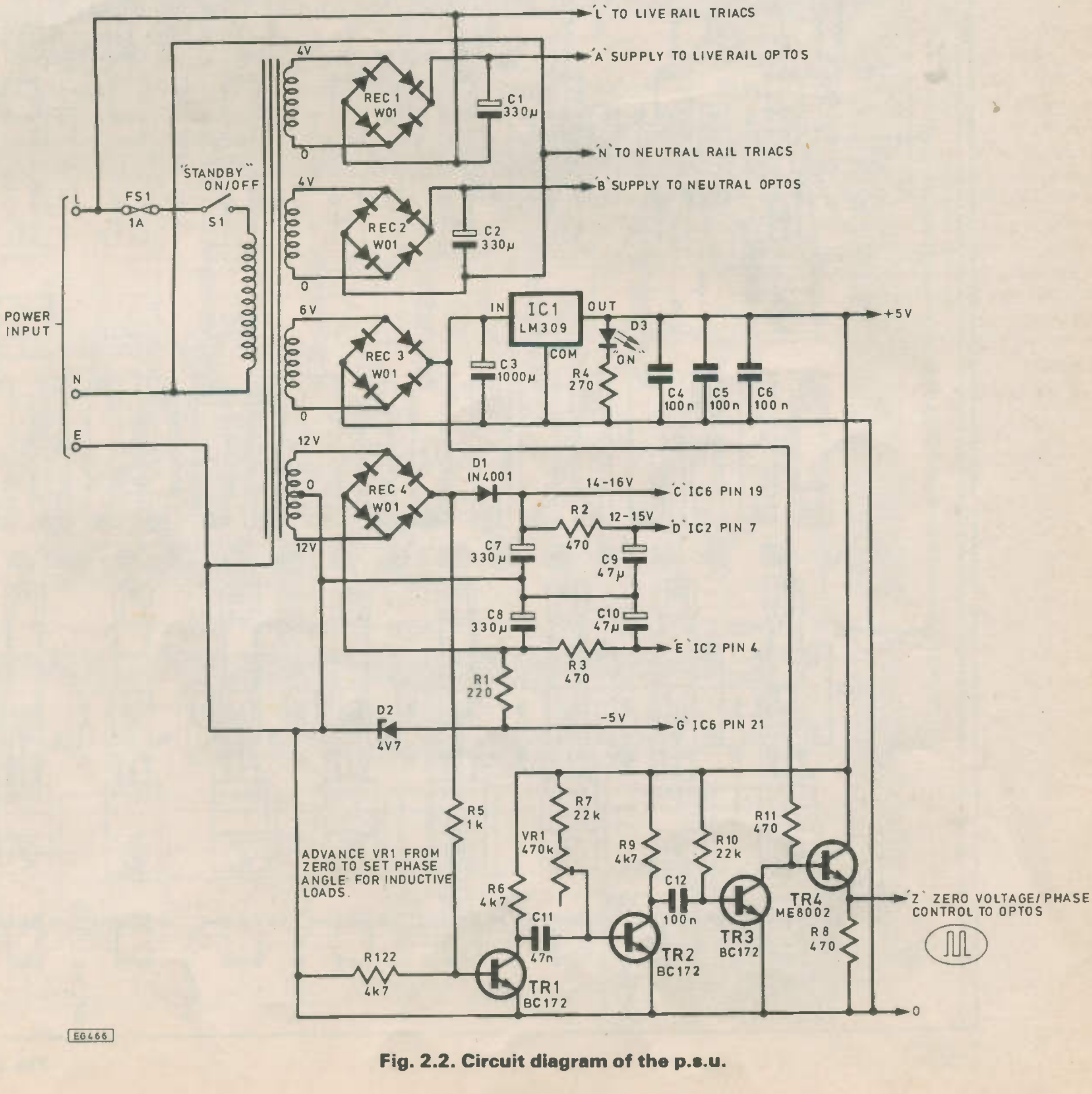


Fig. 2.2. Circuit diagram of the p.s.u.

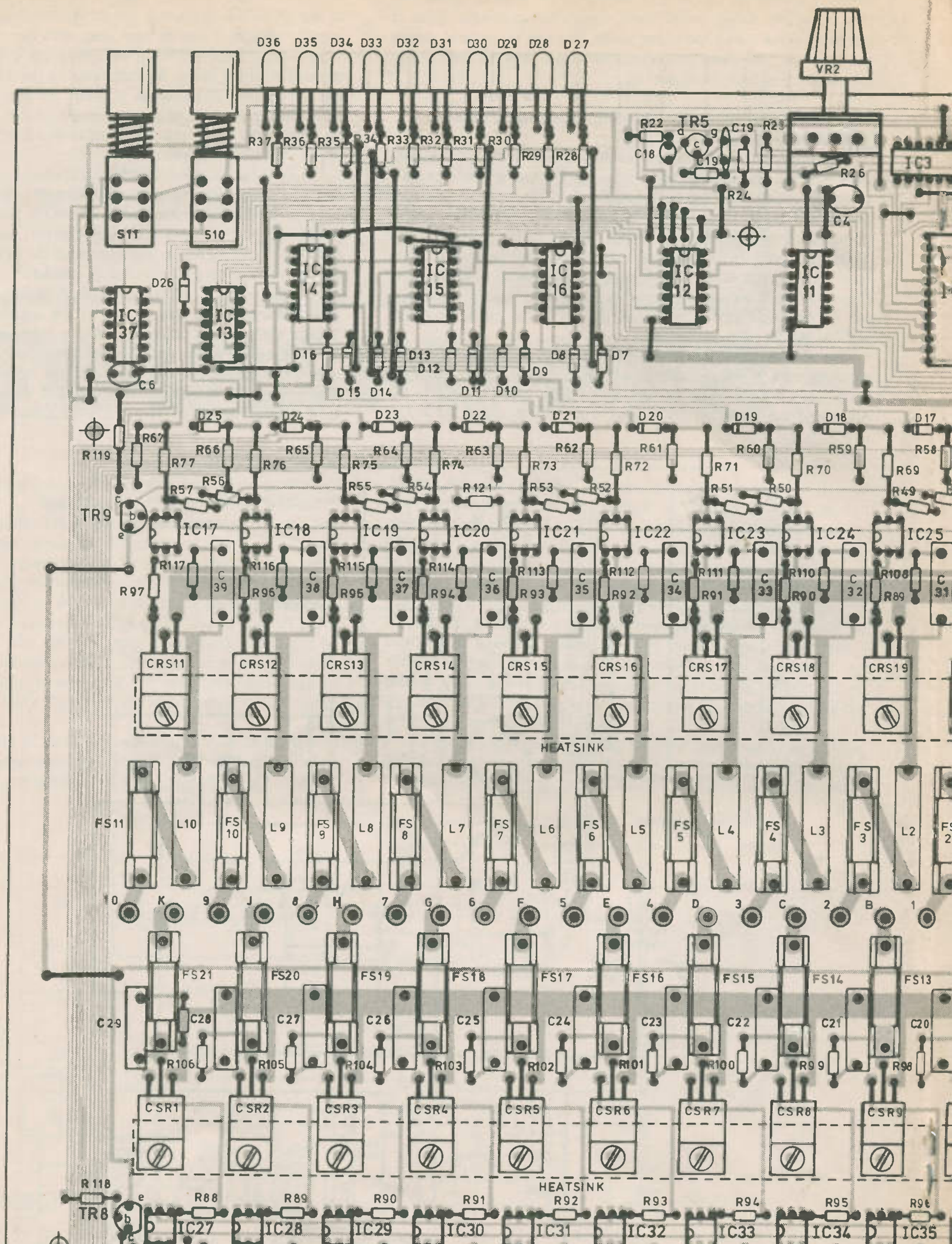
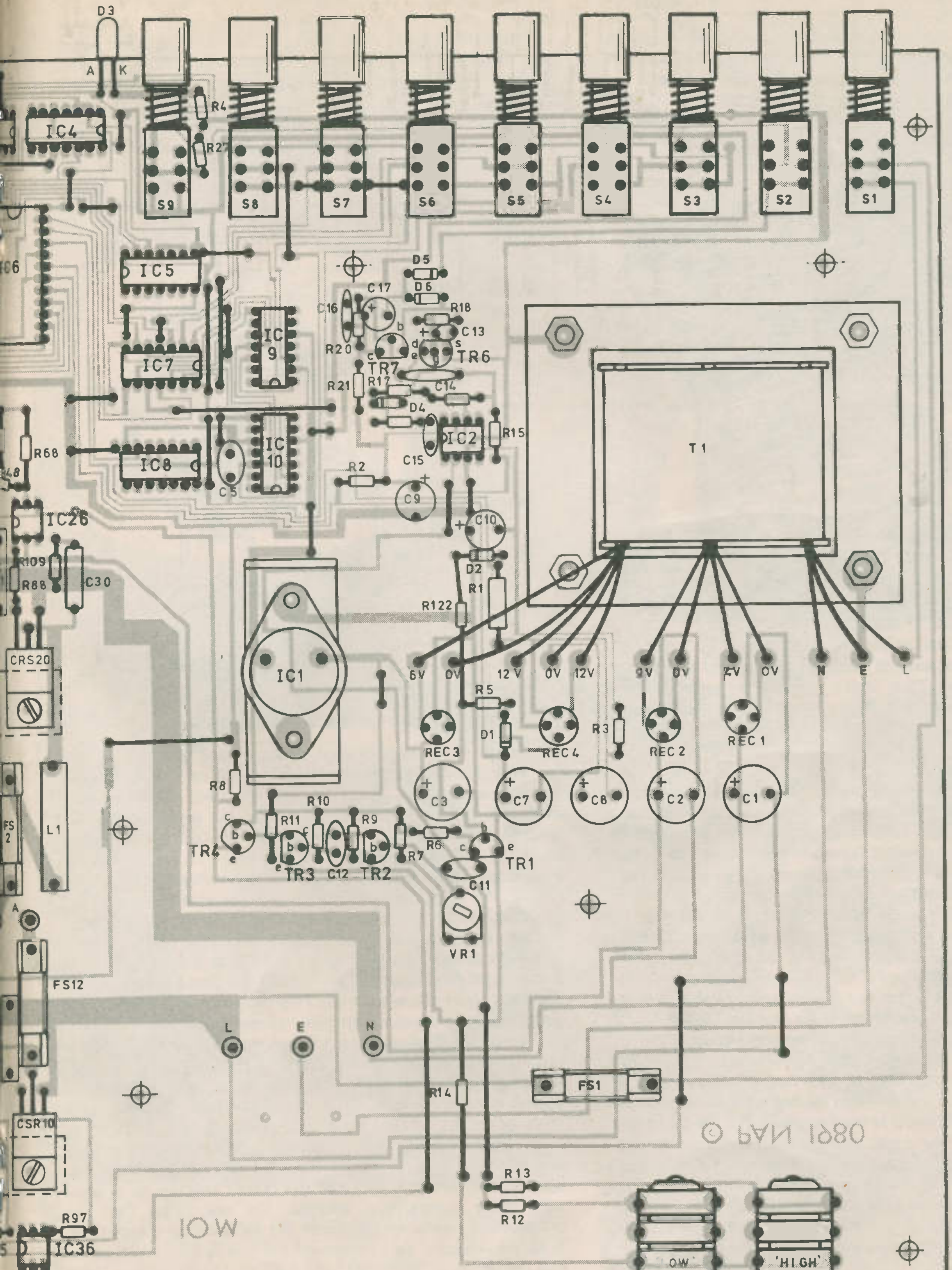
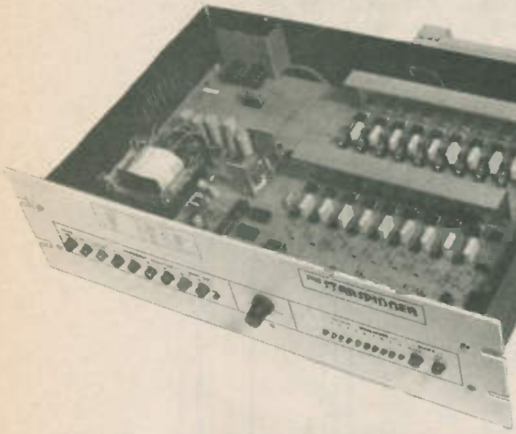


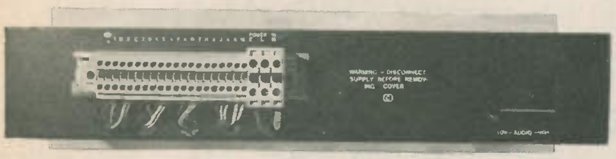
Fig. 2.4. Component lay



layout for the p.c.b.

sidered to be zero for all intents and purposes. The 47n coupling capacitor charges quickly through the collector load of TR1 and the base emitter junction of TR2. As TR1 switches off TR2 base is reversed biased and remains so until the charge on the capacitor has leaked away through the combination of preset VR1 and series resistor R7. The resultant signal at the collector of TR2 is a square wave of variable mark space ratio, with the positive going edge at zero voltage and the negative going edge decided by the time constant of the RC combination. This circuit is repeated with fixed component values to give a short pulse





located at the position of the negative going edge (Fig. 2.3.).

The pulse at the collector of TR3 is then delivered to the base of an emitter follower TR4, which supplies the opto-isolators commoned anodes. Note that the collector load of TR3 goes to IC1 input in order to give sufficient drive to TR4.

CONSTRUCTION

The EPROM should be left in its conductive foam until the rest of the board has been assembled and soldered. The unit, with the exception of final terminations, is mounted on one p.c.b. Fig. 2.4. shows the component layout of the board. The power and output terminations on the original unit were via DIN type rail equipment. The triacs are mounted on brackets made from $\frac{1}{8}$" (3mm) aluminium. The top of the bracket is turned over 1" and the cover of the unit, made from 14 s.w.g. aluminium is screwed onto these brackets as well as to the case proper. This fulfils two requirements. Firstly, using silicon compound to ensure good thermal connection, the lid acts as a heatsink. Secondly, the ridigity of this form of assembly stops the whole board rocking on the stand-offs when the buttons are operated.

The triacs used in this project have insulated tabs. Should different devices be used check that they have insulated tabs. If they do not, insulating washers and bushes must be used and a megger or flashtester should be used to check that the triacs are truly isolated from the case. So often, it is forgotten that although such a piece of equipment is designed for entertainment purposes, it is still deadly if not treated with respect. In particular do not forget to take an earth wire directly from the incoming earth terminal to the mounting rail or other part of the chassis. Also take the transformer screw wire to a tag under one of the mounting screws.

TESTING

There is no reason at all why the unit may not be tested initially without lamps connected. The advantage in this case is that there will then only be the incoming power leads and the sound to light signal, and twisting and turning of the board to find faults, should you be so unfortunate to have any, that is, will be easier without an extra twenty wires attached. Before turning on, use a meter set to the lowest ohms range to check the power lines for shorts. Reference to Fig. 2.4. shows the location of supply lines and the voltages to be expected once the unit has been turned on.

Remember, before you turn on, that although most of the circuitry is at ground potential, the mains wiring occupies a large

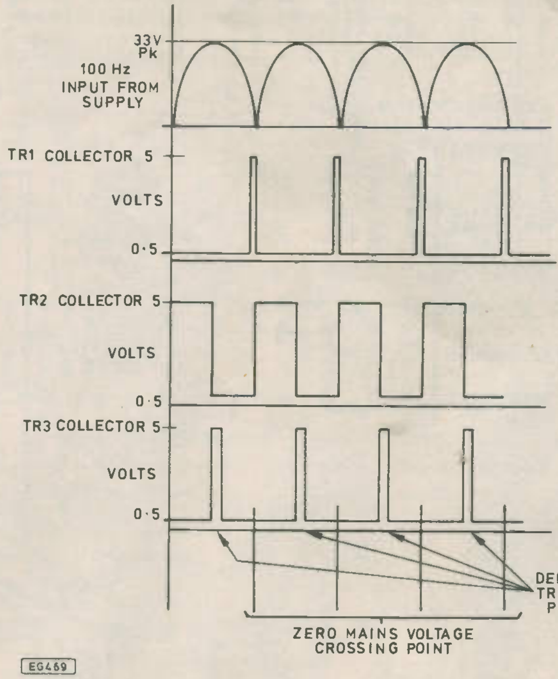


Fig. 2.3. Zero voltage switching waveforms

proportion of the board's area. Make a habit of attaching one test lead with the supply disconnected and using one hand to make measurements. When the unit has been turned on, immediately check the TTL 5 volt supply, the supply to pins 19 (+15V), 21 (−5V) and 24 (+5V) of the EPROM, the smoothed supply to the 741 op-amp (IC2) +12 and −12 volts. With the exception of the +5 and −5 volt rails, the voltages are far from critical. All being well you should now be able to operate the program buttons and speed control to get a display on the mimic indicators. Connect an audio signal to one of the inputs (200mV to 5 volts to that input terminated in 100k or 2 volts to 50 volts to that input terminated in 1M), operate the sound to light button and thus check the correct working of the audio section. If the audio lead is reversed, i.e. amplifier output 'live' going to unit input 'earth' the audio section will not work. However R14 prevents shorting of the amplifier output.

Before connecting up your lights to the unit, the preset phase control must be set: to zero (full anticlockwise) for non-inductive loads or at the correct phase angle for inductive loads. If an oscilloscope is available this may be coupled, via a potential divider network across a triac, the unit set to static display (buttons 1–5 in, button 6 out) and the matrix selection to manual with either matrix/zone selected. Do not forget that the oscilloscope should be connected via an isolation transformer. With an inductive load connected the unit is then switched on and the preset adjusted until the triac switches properly. Then run a dynamic rather than static program and check that the control is not too far advanced or the triacs locking on.

Having done all this the complete set of lamps may be connected and the unit checked through all its functions. ★

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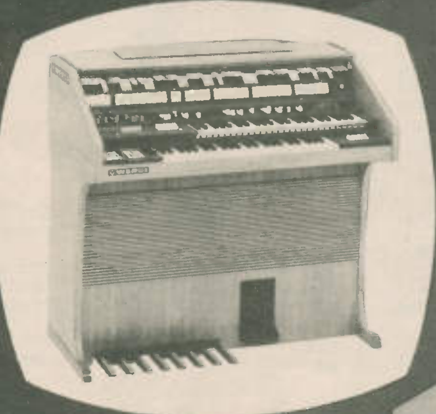

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PE2

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus presents ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data. The most original ideas often come from readers working on their own systems; payment will be made for any contribution featured.

THIS MONTH'S Micro-Bus contains an assortment of topics for the MK14, Acorn System One, and Sinclair ZX80.

TELEPHONE CALL-COST CALCULATOR

If you have been dismayed by the size of your telephone bill lately, the following program for the MK14 might be the answer; it gives a continuous reminder of the cost of a call at any time of day, and to anywhere in the UK. The program was submitted by *Adrian Dickens*, whose Digital Capacitance Meter program was featured in *Micro-Bus* last June, and he explains its operation as follows:

"Having entered the program into the computer (remember to place it near to the telephone!) go to address OF32 and press GO. If the program has been entered correctly OF32 C4 will remain on the display. Now refer to the selector chart, Table 1, and decide which range to select. This will depend on the time of day, day of the week, and distance of the call. Remember this range, and dial the required telephone number; when the handset is lifted up at the other end press the correct range number, and you will be able to see your 3·5 pence units being spent. When you have finished your conversation, and have been suitably shocked by the price being displayed on the computer, press 0 and the computer will be ready for your next call."

Table 1. Range codes for the different times of day, and different distances.

	MONDAY-FRIDAY			WEEKENDS
	9am-1pm	8am-9am 1pm-6pm	6pm-8am	
LOCAL	1	4	7	7
up to 56km	2	5	4	4
over 56km	3	6	8	8

```
              ; TELEPHONE CALL-COST CALCULATOR
              ;
      FFFF    VAR      =       -1              ;VARIABLE VALUE
      0030    COST     =       0030            ;COST COUNTER
              ;
0000                   .=OF21
OF21 E8       DATA:    .BYTE   OE8,OFA,OFE,ODC
OF25 F7                .BYTE   OF7,OFD,O70,OF4
OF29                   .=OF32                  ;PROGRAM START
OF32 C4OF     START:   LDI     OF              ;SET POINTERS
OF34 36                XPAH    2
OF35 C400              LDI     O
OF37 C83B              ST      COUNT+1
OF39 32                XPAL    2               ;P2=OF00
OF3A C401              LDI     1
OF3C 37                XPAH    3
OF3D C484              LDI     084
OF3F 33                XPAL    3               ;P3=KYBD
OF40 3F       HOLD:    XPPC    3               ;EXECUTE KYBD
OF41 0808              NOP
OF42 08                NOP                     ;COMMAND RETURN
OF43 01                XAE                     ;NUMBER RETURN
OF44 98FA              JZ      HOLD            ;ILLEGAL RANGE
OF46 F420              ADI     DATA-1          ;GET RANGE DATA
OF48 C802              ST      RANGE+1         ;PUT IN DISP
OF4A C2FF     RANGE:   LD      VAR(2)          ;RANGE DATA
OF4C C815              ST      TIME+1          ;PUT IN COUNTER
OF4E C400              LDI     O
OF50 CA30              ST      COST(2)
OF52 CA31              ST      COST+1(2)       ;CLEAR COST
              ; MAIN LOOP
OF54 02       UPDATE:  CCL                     ;INCREMENT CALL
OF55 C230              LD      COST(2)         ;  COST BY
OF57 EC35              DAI     035             ;  3.5 PENCE.
OF59 CA30              ST      COST(2)
OF5B C231              LD      COST+1(2)
OF5D EC00              DAI     O               ;ADD CARRY
OF5F CA31              ST      COST+1(2)
OF61 C4FF     TIME:    LDI     VAR             ;LOAD COUNTER
OF63 C859              ST      WAIT+1
OF65 C40B              LDI     OB
OF67 33                XPAL    3               ;P3=SEGMENT CODES
OF68 C400     LOOP:    LDI     O
OF6A C906              ST      6(1)            ;SELECT ROW
OF6C C100              LD      (1)             ;ZERO KEY PRESS?
OF6E E47F              XRI     X'7F
OF70 98BF              JZ      START           ;IF YES, JUMP..
OF72 C4FF     COUNT:   LDI     VAR             ;COUNTER
OF74 F401              ADI     1
OF76 C8FC              ST      COUNT+1
OF78 9842              JZ      WAIT            ;LOOP COMPLETE
OF7A C230              LD      COST(2)
OF7C D40F              ANI     OF              ;LOWER DIGIT
OF7E 01                XAE                     ;PUT IN EXT
OF7F C380              LD      -128(3)         ;GET SEGMENT CODE
OF81 C901              ST      +1(1)           ;DISPLAY DIGIT 1
OF83 C400              LDI     O
OF85 8F06              DLY     06              ;TIMING DELAY
OF87 C230              LD      COST(2)
OF89 1C                SR
OF8A 1C                SR
OF8B 1C                SR
OF8C 1C                SR                      ;UPPER DIGIT
OF8D 01                XAE
OF8E C380              LD      -128(3)         ;GET SEGMENT CODE
OF90 C902              ST      +2(1)           ;DISPLAY DIGIT 2
OF92 C400              LDI     O
OF94 8F06              DLY     06              ;TIMING DELAY
OF96 C231              LD      COST+1(2)       ;UPPER BYTE
OF98 D40F              ANI     OF              ;LOWER DIGIT
OF9A 01                XAE
OF9B C380              LD      -128(3)         ;GET SEGMENT CODE
OF9D C903              ST      +3(1)           ;DISPLAY DIGIT 3
OF9F C400              LDI     O
OFA1 8F08              DLY     08              ;TIMING DELAY
OFA3 C480              LDI     080             ;DECIMAL POINT
OFA5 C904              ST      +4(1)           ;DISPLAY DIGIT 4
OFA7 C400              LDI     O
OFA9 8F09              DLY     09              ;TIMING DELAY
OFAB C231              LD      COST+1(2)       ;UPPER BYTE
OFAD 1C                SR
OFAE 1C                SR
OFAF 1C                SR
OFB0 1C                SR                      ;UPPER DIGIT
OFB1 01                XAE
OFB2 C380              LD      -128(3)         ;GET SEGMENT CODE
OFB4 C905              ST      +5(1)           ;DISPLAY DIGIT 5
OFB6 C400              LDI     O
OFB8 8F08              DLY     08              ;TIMING DELAY
OFBA 90AC              JMP     LOOP
OFBC C4FF     WAIT:    LDI     VAR             ;COUNTER
OFBE 02                CCL
OFBF F401              ADI     1               ;INCREMENT
OFC1 C8FB              ST      WAIT+1          ;STORE
OFC3 988F              JZ      UPDATE          ;ANOTHER UNIT
OFC5 90A1              JMP     LOOP            ;NO - CONTINUE
     0000              .END
```

Fig. 1. MK14 program displays the cost of a telephone call.

PROGRAM VARIABLES

The program follows the unusual practice of modifying instruction operands in the program, rather than accessing separate variables; these operands are denoted by VAR in the listing of Fig. 1. The data for each range is stored in the table DATA; each byte is the negative of the number of multiples of 5 seconds that constitute one unit of cost. Thus range 3, the most expensive rate, has a code of FE or −2, corresponding to a rate of 10 seconds for 3·5p. When the range key is pressed its value is used as an offset to pick up the corresponding DATA constant. This is stored at OF62, and for each unit being counted this constant is written to OFBD, where it is incremented once for every 256 executions of the main display loop. The main display loop, from LOOP to WAIT, displays the current value of COST as a number of pence, and uses DLY instructions to adjust the timing so that 256 executions take exactly 5 seconds. The cost per unit is set at 3·5 pence, but if the PO decides to increase its charges this can easily be updated by putting the new charges at OF58.

Note that since the program modifies its own instructions it cannot be put into ROM as it stands; it should be altered so that the instructions at OF4A, OF61, OF72, and OFBC use four RAM locations as variables.

MEMORY LISTER

The following memory lister should prove useful to owners of the 6502-based Acorn System One; it was submitted by *R. A. Austin* of Essex who explains:

"The memory lister can be used, having completed a program and wishing to write it down, rather than using the "up" key (which can lead to sore fingers with large programs), to run through each address and show the contents. This leaves both hands free to jot down the hex codes."

The program, shown in Fig. 2, should be executed from START, and it will display the contents of successive locations starting from the last address accessed with the Memory Modify function. The time for which each location is displayed can be altered by changing the value at OE91. The program resides in the RAM I/O chip at OE80, but can be relocated providing that the jump address at the end is altered accordingly.

KEYBOARD AUTO-REPEAT

The simple circuit of Fig. 3, submitted by *Nick Toop* of Cambridge, provides an auto-repeat function for a parallel keyboard. It connects in the strobe line from the keyboard and, when triggered by a strobe input, toggles the output after a preset delay. If a key is typed quickly, as in Fig. 4(a), the output simply follows the input. However, if the key is held down for longer, as in Fig. 4(b), the strobe output oscillates giving the same effect as repeatedly typing the key.

The circuit uses a single quad 2-input CMOS NOR-gate package; as it stands it is designed for keyboards with a negative strobe, but can be altered for a positive strobe by moving the inverter from the output to the input. The repeat rate is determined by the value of C1, and the delay by C2.

SELF-PROTECTING MEMORY CLEAR

Program development can be made easier by first zeroing all the memory locations, so that subsequent changes to memory show up more clearly. The following short program for the MK14, or any other SC/MP system, can be entered anywhere convenient in memory and will zero all locations except the program itself. It was sent in by *Alan Trevennor* of Stevenage.

Enter the program, shown in Fig. 5, and execute it from START; after a few instants press reset, and the program will have zeroed all RAM locations from 0000, the value of pointer 1 on reset, to OFFF. It cleverly avoids zeroing itself by testing to see if the protection byte, in front of the program, has been zeroed; if so, it replaces the protection byte and increments pointer 1 past the program. Note that the program does not clear any addresses greater than OFFF since no carry is provided on auto-increment from bit 11 to bit 12 of the pointer registers.

DRAUGHTS BOARD

The following program displays a draughts board and enables two players to move their pieces by entering moves at the keyboard. The program provides a second example of how the screen display can be read and changed by PEEKing and POKEing the display file. It was submitted by *A. D. Daniells* of Essex, and what follows is based on his description:

"The Draughts-Board program, Fig. 6, uses pound signs for white pieces and dollar signs for black pieces, see Fig. 7. The plus signs in

```
                    ;       MEMORY LISTER
                    ;
                    RDHEXD =$FE60              DISPLAY A
                    QHEXD1 =$FE64              DISPLAY X AND X+1
                    DISPLY =$FECO              DISPLAY ROUTINE
                    ;
                    MAP    =$OO                M ADDRESS PTR.
                    REPEAT =$OE                REPEAT FLAG
                    SPEED  =$20
                    ;
0000                       *=$OE80             RAM I/O CHIP
OE80  AO OO         START  LDY   £O            SET UP INDEX
OE82  A2 OO                LDX   £O              REGISTERS.
OE84  B1 OO                LDA   (MAP),Y       GET DATA IN A
OE86  20 60 FE             JSR   RDHEXD        DISPLAY IT
OE89  20 64 FE             JSR   QHEXD1        DISPLAY ADDRESS
OE8C  A9 1F                LDA   £$1F          SET DISPLAY FOR
OE8E  85 OE                STA   REPEAT          SINGLE SCAN.
OE90  A9 40                LDA   £$40          SET UP DELAY
OE92  85 20                STA   SPEED         AND STORE
OE94  20 OC FE      SHOW   JSR   DISPLY        DISPLAY IT
OE97  C6 20                DEC   SPEED
OE99  DO F9                BNE   SHOW          ALL DONE?
OE9B  A6 OO                LDX   MAP           LOW ADDRESS BYTE
OE9D  E8                   INX
OE9E  86 OO                STX   MAP           STORE IT
OEAO  A5 OO                LDA   MAP           IS IT ZERO?
OEA2  DO O2                BNE   NOC           IF SO...
OEA4  E6 O1                INC   MAP+1         INC HIGH BYTE
OEA6  4C 80 OE      NOC    JMP   START         CONTINUE.
                    ;
                           .END
```

Fig. 2. Program for the 6502-based Acorn System One steps through memory locations displaying their contents.

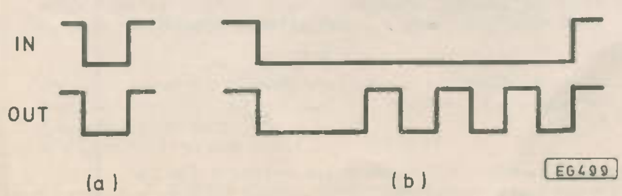


Fig. 4. Waveforms at input and output of auto-repeat circuit for (a) key typed rapidly, and (b) key held down.

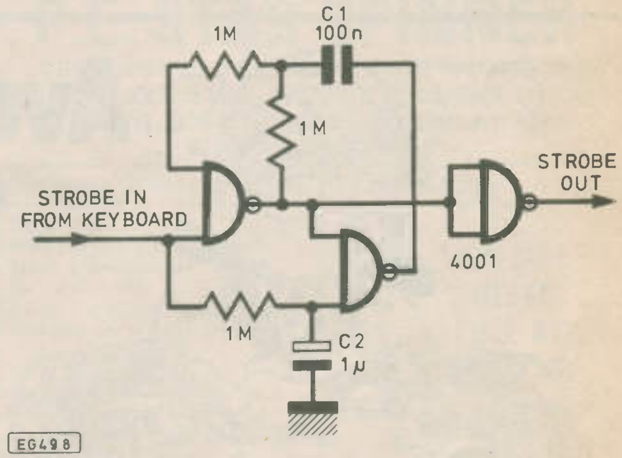


Fig. 3. Circuit adds auto-repeat function to a keyboard.

```
               ; MEMORY CLEAR
               ;
0000                     .=OF20                ;RELOCATABLE
OF20 FF        PBYTE:    .BYTE    OFF          ;PROTECTION BYTE
OF21 C400      START:    LDI      O
OF23 CD01                ST       @1(1)        ;ZERO LOCATION
OF25 COFA                LD       PBYTE
OF27 9CF8                JNZ      START        ;OK TO CONTINUE
OF29 C4FF      DONE:     LDI      OFF          ;HAVE REACHED
OF2B C8F4                ST       PBYTE        ;PUT PBYTE BACK
OF2D C510                LD       @16(1)       ;JUMP PROGRAM
OF2F 90FO                JMP      START        ;CARRY ON.
               ;
     0000                .END
```

Fig. 5. Program for the SC/MP micro zeroes all memory without destroying itself.

lines 50 and 60 of the program refer to the graphics character 'shift A' (grey square). The game is played by entering the coordinate of the piece to be moved, followed by one of the instructions 'UL', 'UR', 'DL', 'DR' (i.e. up left . . . down right), or 'H' (huff). For example, to move the piece in square (3,5) to (4,4) enter:

35 NEWLINE
UR NEWLINE

```
 10 REM DRAUGHTS-BOARD PROGRAM
 20 CLS
 30 PRINT "12345678"
 40 LET A=1
 50 PRINT "#+#+ +$+";A
 60 PRINT "+#+ +$+$";A+1
 70 LET A=A+2
 80 IF A<8 THEN GO TO 50
 90 INPUT N
100 IF N=0 THEN RUN
110 IF N=1 THEN LIST
120 LET A=N/10
130 LET B=N-A*10
140 LET M=B*10+A
150 INPUT A$
160 IF NOT (A$="UL" OR A$="UR"
OR A$="DL" OR A$="DR" OR A$="H")
 THEN GO TO 90
170 LET D=0
180 IF A$="UR" THEN LET D=-9
190 IF A$="DR" THEN LET D=11
200 IF A$="DL" THEN LET D=9
210 IF A$="UL" THEN LET D=-11
220 GO SUB 500
230 LET X=PEEK(F+M)
240 IF NOT A$="H" THEN GO TO 28
0
250 GO SUB 500
260 IF X=12 OR X=13 OR X=140 OR
 X=141 THEN POKE F+M,0
270 GO TO 90
280 GO SUB 500
290 LET Y=PEEK(F+M+D)
300 IF X=Y OR X=Y+128 OR Y=X+12
8 OR (X=12 AND TL$(A$)="L") OR (
X=13 AND TL$(A$)="R" OR NOT (X=1
2 OR X=13 OR X=140 OR X=141) THE
N GO TO 90
310 IF NOT Y=0 THEN GO TO 370
320 GO SUB 500
330 POKE F+M,0
340 POKE F+M+D,X
350 IF (X=13 AND A=2) OR (X=12
AND A=7) THEN POKE F+M+D,X+128
360 GO TO 90
370 GO SUB 500
380 IF NOT PEEK(F+M+D*2)=0 THEN
 GO TO 90
390 POKE F+M,0
400 POKE F+M+D,0
410 POKE F+M+D*2,X
420 IF (X=13 AND A=3) OR (X=12
AND A=6) THEN POKE F+M+D*2,X+128
430 GO TO 90
500 LET F=PEEK(16396)+PEEK(1639
7)*256
510 IF PEEK(F)=118 THEN RETURN
520 LET F=F+1
530 GO TO 510
```

Fig. 6. Draughts-Board program.

The program moves pieces on the screen by PEEKing and POKEing the display file, pointed to by the system variable D-FILE. Subroutine 500 finds the first end-of-line character (76 hex) after D-FILE, and the program works relative to this. Lines 290 and 310 determine whether there is an opponent's piece in the location chosen to be moved into; i.e. if the move is a capture. If a move is chosen lines 330 and 340 move the piece along the display file by displacement D. If a capture has been chosen lines 390 and 410 move the piece two places (2*D) and line 400 erases the captured piece.

"Lines 350 and 420 crown a piece as it reaches the other side of the board by inverting the graphics (adding 128 to the character code). Lines 160, 260, 300 and 380 reject any invalid move; e.g. taking your own piece, or moving backwards. When the game is over, entering a 0 will print a new board, or entering 1 will bring the ZX80 back to command mode.

"The program fits into the 1K unexpanded memory without any trouble, although a LIST instruction will only reveal three or four lines at a time because most of the memory is taken up."

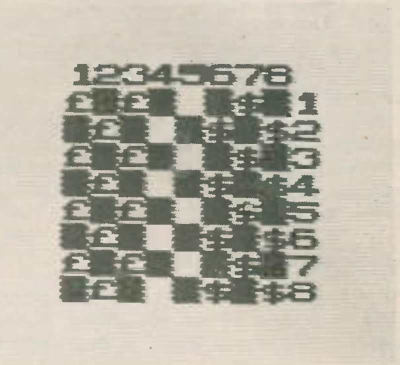


Fig. 7. Draughts-Board display.

PE MAGNUM MODIFICATIONS...

ANDY FLIND

SINCE the original Magnum design was published some worthwhile improvements and modifications have been carried out to the prototype, which constructors might like to incorporate into their own machines. This is also a good opportunity to answer a few of the more frequent queries regarding this design.

INSTABILITY

Some constructors have run into problems of instability, usually in the form of hunting around the threshold point. Despite its high gain and sensitivity the Magnum is an exceptionally stable circuit, so if you have a stability problem it follows that there must be a cause somewhere. A not too obvious cause of such a problem is the family telly, as the line timebase of a UHF TV is very close to the Magnum's search frequency. Depending on just how close your Magnum's oscillator is to the TV line output frequency the result can be anything from a mushy, imprecise threshold setting to a quavering effect or even a slow, regular drift, caused by the two frequencies beating together. Fortunately most actual search sites don't have TVs nearby, so most of the problems you'll encounter from this cause will be during indoor testing only. Another possible source of such trouble which needs only a brief mention is that the connection point for the separate 9V output battery positive was marked "+5V6" on both circuit and layout drawings in the original article. This has been mentioned in "Points Arising".

Another frequently raised point is that false signals can be produced by knocking the coil. On the prototype it takes quite a hard knock to do this, the false signal is easily recognisable as such and the continuous autotuning deals with it immediately. The cause of the signal is movement of the coil lead relative to the coil, so it can be minimised by taping the lower part of the lead to the stem to permit it as little free movement as possible.

Several constructors have complained that the meter isn't sensitive enough. This is easily cured; change R49 and R50 to 1k, D7 and D8 to 0A47, and VR6 to 4k7, then set up as before. This increases the meter sensitivity by about two or three times, which on the prototype proved to be just right.

ADD-ON BOARD

Now for a rather more complex modification. Reaching for the "Mode" switch every time an object was detected proved to be something of a chore, particularly as the free hand was likely to be holding a trowel and covered with mud, wet sand or whatever. It was therefore decided to incorporate a means of changing mode from the tuning button, and a small add-on circuit board has been designed to do this. This has been in use for some time now; it makes discriminating much easier and a great deal quicker.

The circuit of this modification appears in Fig. 1. The principle of operation is simple; every time the "Tune-Hold" button is pressed a half-second timer is started. If the button is released before the timer period is complete a mode-change is initiated. Thus a quick prod of the button changes mode, but normal operation simply holds the tuning as before. Three CMOS chips are used to achieve this, two 4011s and a 4016. Two gates of the first 4011, IC1a and IC1b, are connected to form a monostable with a period of about half a second. The second two gates on this chip are unused. The output from IC1a is normally low and goes high during the timing period, but so long as the button is kept pressed the output from R4 will be held low via D2. The signal for the tune-hold input on the main board is provided via D1.

The four gates of the second 4011 are connected to form a changeover switch which changes state every time its input is taken high briefly, and its complementary outputs are taken to the inputs of a 4016 quad switch. This gives two pairs of single-pole switches which open and close alternately, and these can be wired to provide the two changeover switches required for mode switching. Because it uses common CMOS chips this circuit is cheap to build and uses next to no additional power from the batteries.

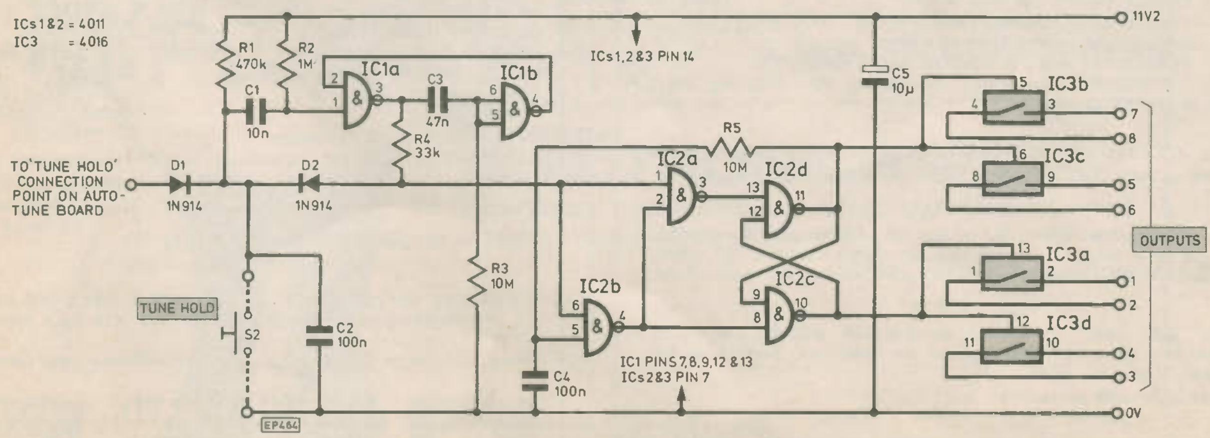


Fig. 1. Pushbutton mode change unit circuit

COMPONENTS . . .

Resistors	
R1	470k
R2	1M
R3, R5	10M (2 off)
R4	33k
Capacitors	
C1	10n polyester
C2, C4	100n polyester (2 off)
C3	47n polyester
C5	10μF 16V tantalum bead
Semiconductors	
IC1, IC2	4011B (2 off)
IC3	4016UBE
D1, D2	1N914 (2 off)

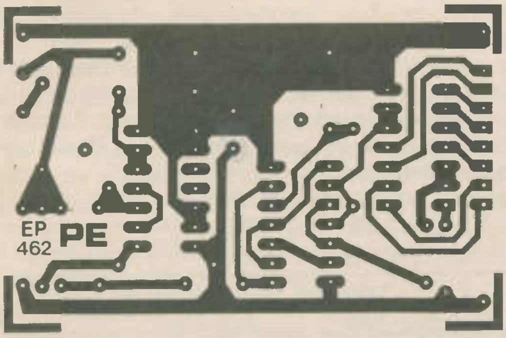


Fig. 2. Printed circuit (actual size)

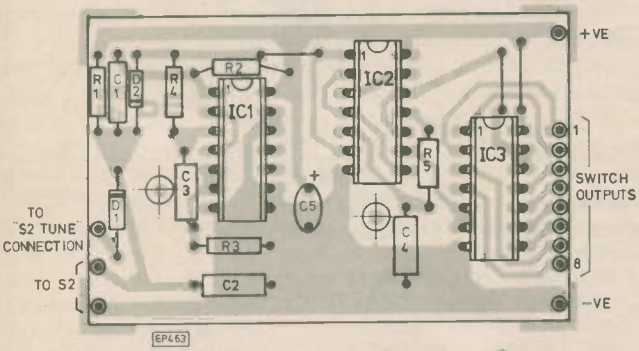


Fig. 3. Component layout

LAYOUT

The circuit has been designed on a small p.c.b. which mounts directly onto two of the lugs in the specified Vero case, next to the meter. Fig. 3. shows the layout of the components. Construction should be straighforward providing the usual CMOS precautions are observed; there is room for sockets for the three chips. Wire tails of suitable length should be attached to the unit before it is secured into the case with a couple of self tapping screws.

Connecting the unit into the main circuit is probably the most complicated part of this modification. Fig. 4. shows how the complete circuit is changed with this unit installed;

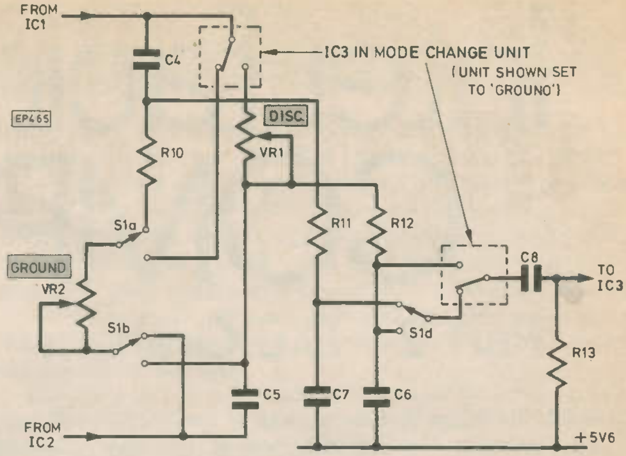


Fig. 4. Effect of adding mode change unit to main circuit

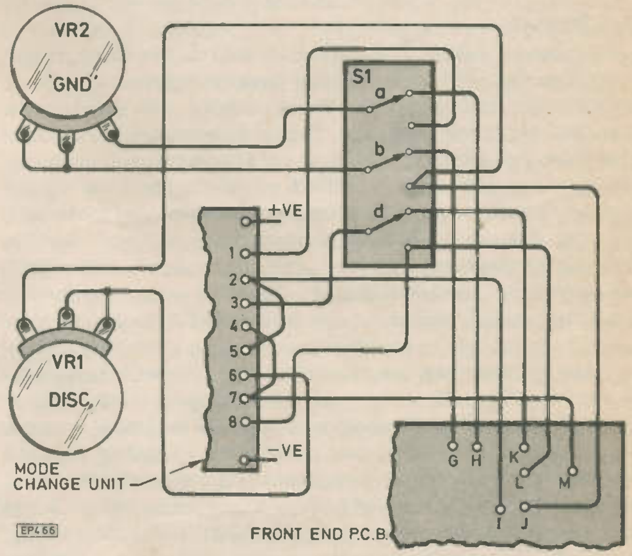


Fig. 5. Interconnections

note that S1, which was a 4-pole 3-way switch is now a 3-pole 2-way, with the two positions marked "Ground" and "Beach". It may be possible to use your existing switch; many rotary switches have an adjustable stop which can be used to limit the number of positions available. Fig. 5. shows how the actual interconnections are made. Not shown are the power supplies, which are taken from the 0V and +11V2 points on the power supply board, and the "Autotune" connections; button S2 connects straight into the new unit, and the single output lead from D1 goes to the old "S2" connection on the main board—the one going to TR3's gate. The other original S2 connection point is now unused.

There is, of course, no indication of which mode the unit is in when using this system. Actually this presents no problems, as when initially setting up it's in the mode whose control causes a meter deflection when moved. Once set up, there are two ways of telling. A mode-change causes an initial meter deflection before the autotune resets it; it will usualy jump one way on switching to "Discrim", and the other on going back to "Ground". Also of course, "Discrim" is the mode with the ground effect! In practice it takes no time at all to get used to the new way of changing mode and the increased speed and ease with which detected objects can be checked out should be greatly appreciated by all users. ★

Interfacing COMPUKIT

Part 2 D.E. Graham

THIS MONTH we discuss the use of the MC 6821 PIA on the Decoding Module, and look at the way in which digital data may be input to Compukit using both this, and sets of tristate buffers.

The 6821 PIA

Motorola's 6821 PIA provides two 8-bit input-output ports together with interrupt and peripheral control facilities. It achieves this through the operation of six internal registers; three for each port. One of these carries the actual data passing through the port, a second determines the direction in which data is carried, while the third is a control register largely associated with the generation of interrupts, and the operation of control lines to peripheral devices. Somewhat unusually, although the chip uses six registers, it occupies only four addresses, and as a consequence accessing its registers is not as straightforward as it might be.

It circumvents the problem by using bit 2 of each control register to determine whether the other two addresses refer to the data direction register or to the port data register. Table 2.1 gives the disposition of the six registers, and the four corresponding addresses used in the Decoding Module. Accessing the two control registers is quite straightforward. The command POKE 61341, W will place the value W into the control register of port A, while POKE 61343, W will do the same for port B. In order to access the data direction register, bit 2 of the control register must first be set to zero. POKE 61341, 0 will achieve this for port A. The command POKE 61340, Y will then configure port A for input if Y=0, or for output if Y=255. Bit 2 of the control register must then be set to 1 (eg. by POKE 61341, 255) to achieve access to the port itself, and this completes the initialisation procedure. PEEKing or POKEing to 61340 can now be used for input or output of data.

This is not really as difficult as it sounds, and Table 2.2 gives the four complete sets of commands for configuring either port for 8-bit input or output. Note that on Reset, or at switch-on, all registers are automatically zeroed, so that a number of commands in this table may be omitted in certain situations; and of course it is only usually necessary to configure the ports once at the beginning of a program, and all further Reads or Writes can be accomplished with a single PEEK or POKE.

In the examples discussed so far, the data direction register has been loaded with either a zero (for input) or 255 (for output). In practice each of the 8 bits of the two ports is individually controllable in this respect, with one binary digit of the data direction register controlling one bit of the corresponding port; a zero signifying input, and a 1 an output. Thus whilst placing 255 (11111111 binary) in the data direction register will configure all 8 bits for output, the number 15 (00001111 binary) would cause the top 4 bits to be set for input, and the lowest 4 for output, and so on.

Although the registers of ports A and B are addressed in an identical fashion, the two ports differ electrically in certain respects. Both have a drive capability of two TTL gates. But on input, the output circuitry of port B adopts a tristate condition, whereas that of port A does not. Port A's inputs are accordingly taken high by internal pull-up resistors, and require an effective resistance of 1k or less to earth in order to render them low. The voltage sensitivities of the two ports is also somewhat different. Port A takes voltage lower than about 1·4 as a logical zero, and higher than about 1·6 as a logical 1. whereas the two corresponding voltages for port B are about 0·7 and 3·0.

In a later article in this series we will look at the use of the peripheral control lines of the 6821. We now turn to the construction and testing of the Decoding Module.

Table 2.1. 6821 Registers

Address	Control Bit Reg A	Control Bit Reg B	Function	
61340	1	X	Port Data Register	
61340	0	X	Data Direction Register	Port A
61341	X	X	Control Flag Register	
61342	X	1	Port Data Register	
61342	X	0	Data Direction Register	Port B
61343	X	X	Control Flag Register	

Table 2.2

OUTPUT

For output on Port A P=61340	For output on Port B P=61342	Function
POKE P+1, 0	POKE P+1, 0	codes for data direction register
POKE P, 255	POKE P, 255	sets data direction to output
POKE P+1, 255	POKE P+1, 255	code for peripheral register

Further commands of *POKE P, W* will now place W on Port A or B

INPUT

For input on Port A P=61340	For input on Port B P=61342	Function
POKE P+1, 0	POKE P+1, 0	code for data direction register
POKE P, 0	POKE P, 0	sets data direction for input
POKE P+1, 255	POKE P+1, 255	code for peripheral register

calls of PEEK (P) will now return the data at port A or B

1 2 4 8

CIRCUIT OPERATION

A full circuit of the Decoding Module is given in Fig 1.5. Device IC1, a 13-input NAND gate, provides the complete decoding of the base address of the system. As the circuit stands, with a single inverter in address line A12, this is EF80 hex (61312 dec). It will be seen however, that a number of pads are provided to engage two further inverters in address lines A11 and A13. This allows the user, by cutting tracks and wiring between the pads on any of the three lines A11-A13 to set the base address at 7 other possible locations. The various permutations are given in Table 1.10. It should be noted that the top two of the 8 possible base addresses fall within the UK101's 2K monitor, and should therefore be avoided! The remaining 6 base addresses and accompanying blocks are unused by both the Compukit and the Superboard II. Since however, all software for the series will assume a base address of EF80, it may be simplest to leave all three sets of pads unaltered.

The output of IC1 is taken to IC2, a 74LS138 3-to-8 line decoder, which decodes address lines A4–A6 to produce eight 16-byte blocks (BL0–BL7). The decoding of these blocks has not been made conditional of Ø2 since they are generally intended for use with multi-register devices which often possess a separate master Enable pin, which when connected to Ø2 satisfies all timing requirements of the chip. Some devices, such as the 6522 VIA, require the chip select lines to settle before Ø2 goes high; so that if the output of IC2 had been made conditional on Ø2, no settling time would be given, and the device would not respond to the CPU's attempts to select it.

Device IC3, a 74LS154 4-to-16 line decoder, provides the sixteen address-decoded Write lines in response to BL0, R/W and Ø2. The outputs of both the 74138 and the 74154 are active-low, and a number of IC3's outputs have been inverted for convenience of subsequent use. Lines W5 and W6 have, in conjunction with R6, been further decoded to provide a pair of signals BDIR and BC1 for use with an AY-3-8910 or 8912 programmable sound generator. This decoding is all that the PSG requires to both write to, and read from its full complement of registers, and details of the use of these lines will be given later in the series.

IC4 (74LS138) decodes 8 Read lines in response to address lines A0–A3, $\overline{\text{BL0}}$. R/W and Ø2. The reason why 16 Write lines have been made available, and only 8 Read lines, is largely the additional Write requirement imposed by the use of 7-segment l.e.d. readouts, to be featured later. The addresses of these 24 lines are given in Table 1.9. As will be seen, a number of these have been ear-marked for particular projects in the series.

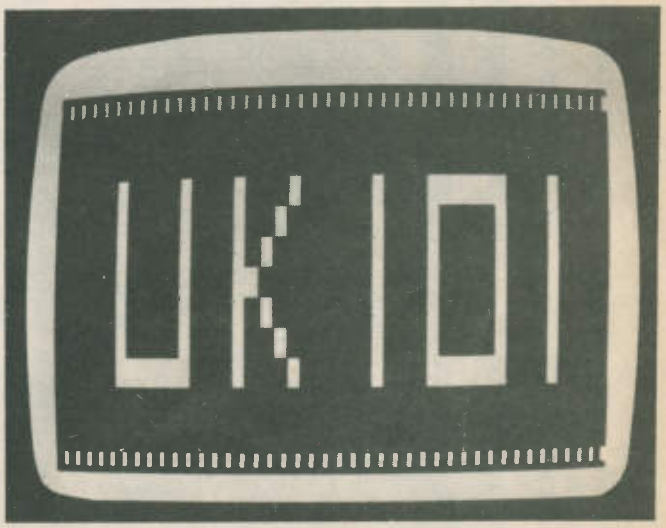
The NAND gate IC8A is used to produce the DD control signal. This is brought low when a Read is carried out at any of the addresses within the 128-byte block used by the module. The reason why it is not simply connected directly to the inverted R/W line is that this would cause the data bus of the CPU to receive extraneous noise from all interfaces during every memory Read cycle, whereas with the present circuit, interfaces are only given access to the CPU when the 128-byte block is called up.

As may be seen from Fig. 1.5, the 6821 PIA (IC9) is selected by the $\overline{\text{BL1}}$ line. Address lines A2 and A3 are wired to high-Enable Chip-Select pins 22 and 24, so placing the four addresses used by the PIA at the top of Block 1 (61340–61343 dec). Lines A0 and A1 are used internally by the PIA for decoding within the 4-byte block. Since block 1 is 16 bytes wide, there is clearly room for a further 3 PIAs to be located within it. This could be accomplished by wiring additional PIAs exactly as for IC9, but with inverters in either A2 or A3 or both; although it would probably be easier to locate them in one of the 6 unused blocks (BL2–BL7) whose signals appear on SK6.

The PIA's pin 25 is a master Enable against which all of its operations are timed. It is connected directly to the Ø2 clock. Pin 34 is a 6502-compatible $\overline{\text{RESET}}$ line. This has not been taken to the UK 101's Reset circuitry; one of the reasons for this being that the Compukit $\overline{\text{RESET}}$ signal does not actually appear at the expansion socket. Pin 34 is taken instead to a pair of pads intended for the connection of a pushbutton which may be used to simultaneously reset all devices wired to the Decoding Module. Capacitor C4 is used to give a power-on Reset. It does this by simply holding the $\overline{\text{RESET}}$ line low for a fraction of a second after power-up. A similar technique can be used on the Compukit itself: connecting 100 µF from pin 40 of the 6502 to earth will ensure that the D/C/W/M? message appears instantly at switch-on.

The Decoding Module power supply circuitry is quite straightforward, and employs a 7805 regulator to produce +5 volts at about 500 mA, and a zener stabiliser to give −5 volts at about 30 mA. The Module draws about 100 mA from the positive supply, leaving ample in reserve for driving external devices. The negative supply is generally intended for use with dual polarity analogue i.c.s that will be encountered in D/A and A/D conversion later in the series, and is not used by the Module itself.

The power supply requires a 9-0-9V a.c. transformer rated at 1A. It should be possible to tap Compukit's 3A transformer for this purpose providing it is not already heavily loaded.



Large characters produced by the joystic drawing routine

SK1 — TO COMPUKIT EXPANSION SOCKET — 1 off 2 × 22 pin edge connector
SK2 — 40 PIN DIL — ALLOWS FOR FURTHER EXPANSION OF COMPUKIT
SK3 & SK4 — 16 PIN DIL SOCKET — PORTS A & B OF PIA PIA
SK5 — 24 PIN DIL SOCKET — DECODING MODULE OUTPUT
SK6 — 1 OFF 2 × 25 PIN 0·1" EDGE CONNECTOR — DECODING MODULE OUTPUTS

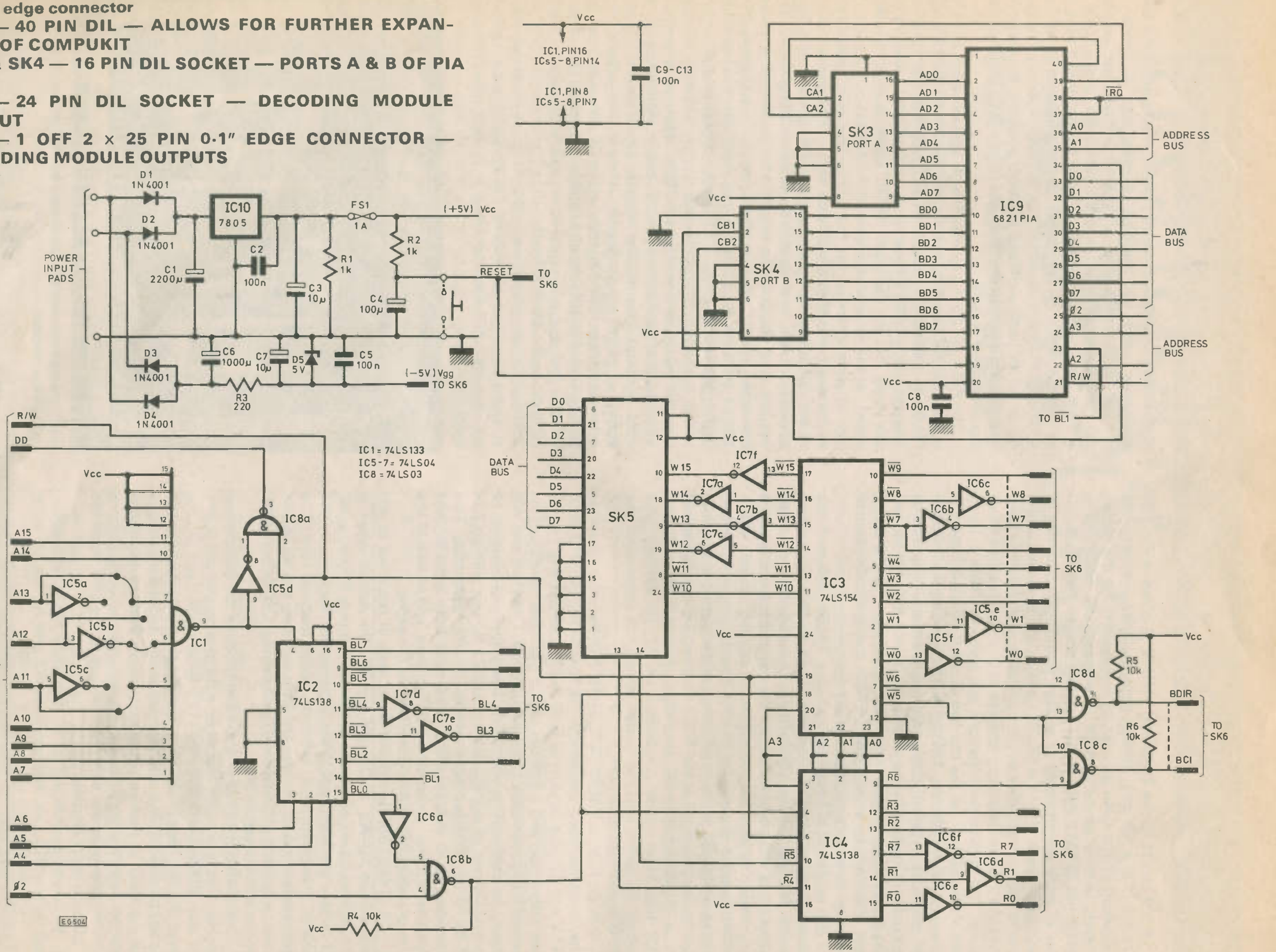


Fig. 2.1. Full circuit diagram. See Points Arising in this issue, concerning Part 1

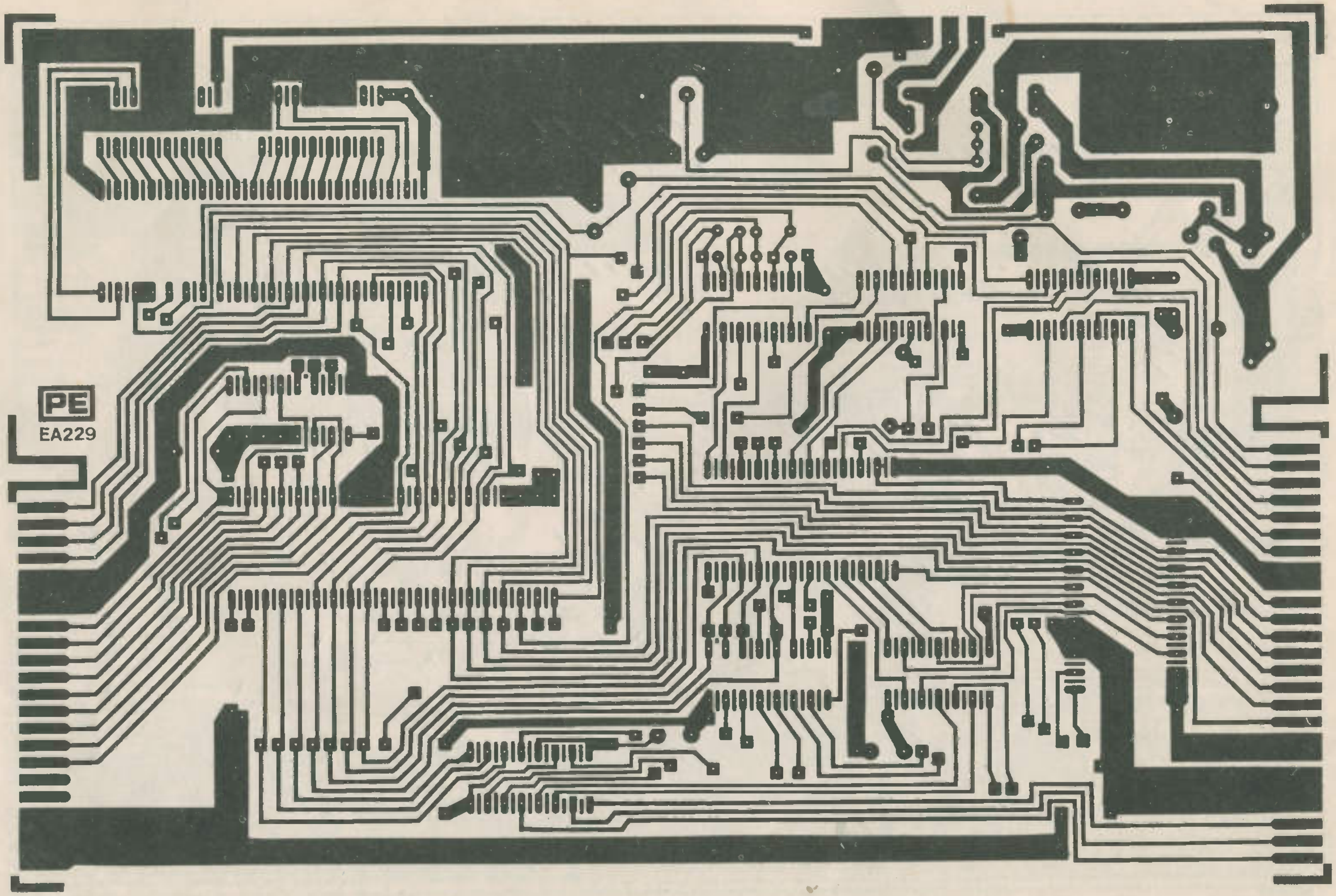


Fig. 2.2. Copper-side p.c.b. layout (actual size)

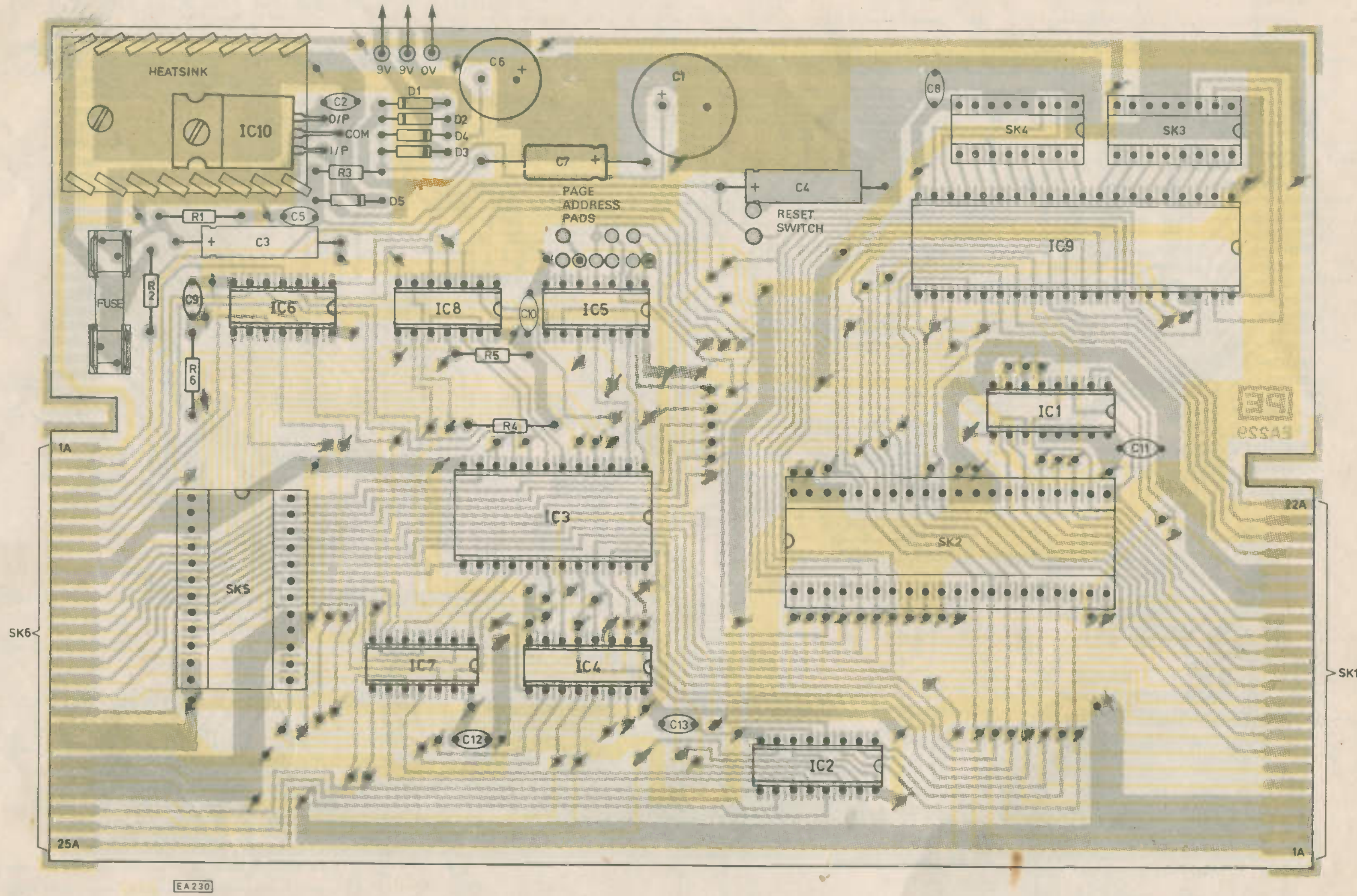


Fig. 2.4. Component layout. A complete kit of parts for the Decoding Module, including i.c.s, p.c.b., headers, edge connectors, ribbon cable etc., (but excluding transformer & 8T28s) is available from: Technomatic Ltd., 17 Burnley Road, London NW10. Price: £27.50 exc. VAT. Post free

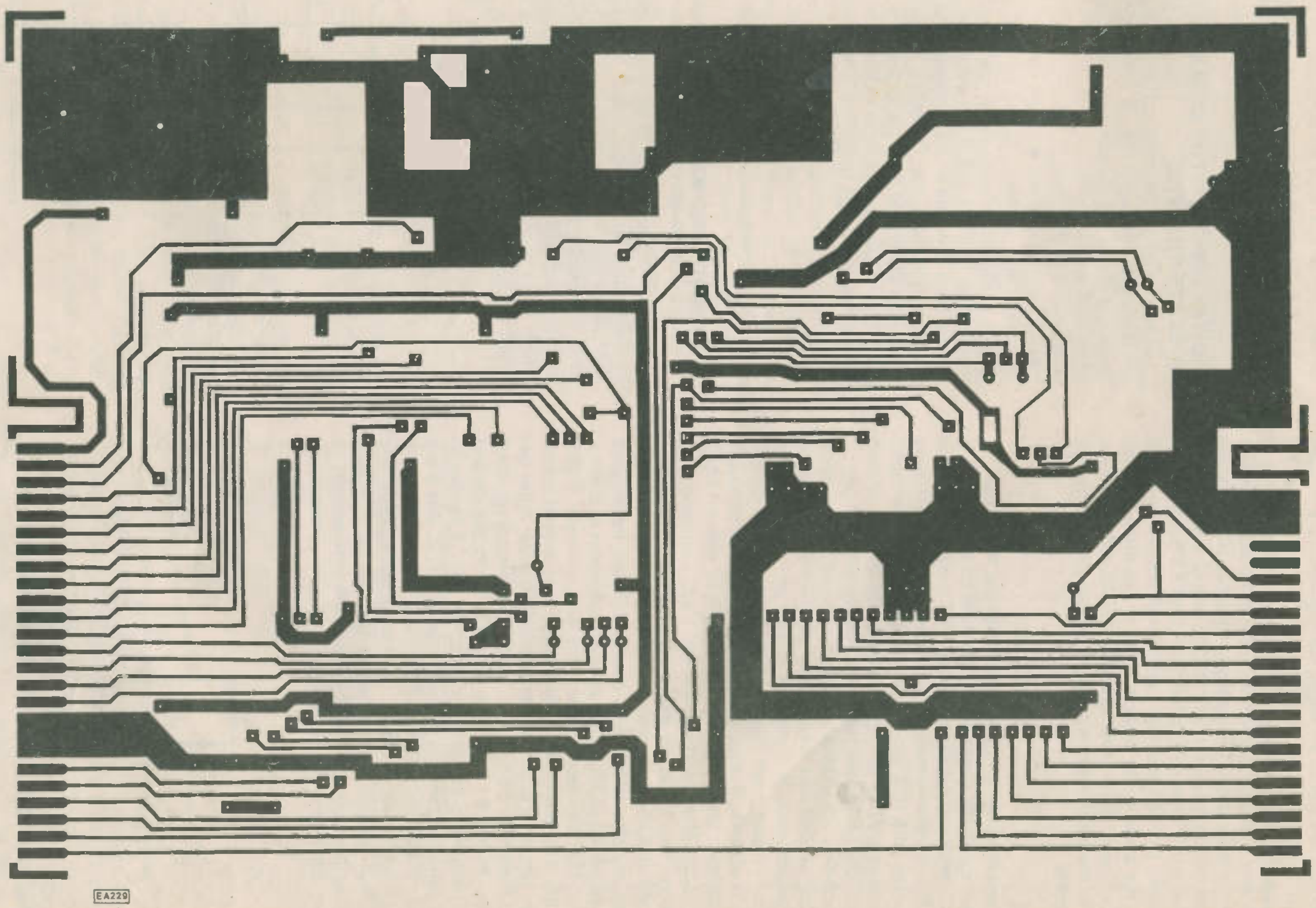


Fig. 2.3. Component-side p.c.b. layout (actual size)

CONSTRUCTION

Construction of the Decoding Module should pose no real difficulties to those experienced with soldering. It might be useful to put in all i.c. holders and other components before tackling the through-holes. The positions of these are indicated in the component overlay drawing, and may be identified in almost all cases as holes surrounded by a square rather than a round track on both sides of the board. All through-pins should be separately soldered on both sides of the board, and a check made that *both* joints are in tact at the end of the operation. The voltage regulator, IC10, should be mounted on the heat-sink with a 6BA bolt or similar.

Note that if it is intended to tap Compukit's PSU transformer to supply the Module, the connection should be made *directly* to the transformer tags, and *not* to the three pads on Compukit's board. This latter precaution will reduce mains hum due to the earth loop, keeping it within reasonably acceptable limits.

TESTING

After checking with an ohm-meter that the PSU lines are not shorted to earth, connect the Module to the 9–0–9 V supply with the fuse and all i.c.s except IC10 removed. If this produces 5 volts, the remaining i.c.s may be inserted, taking particular care with IC9, since this device may be damaged by high voltages. With all i.c.s. inserted, the Module should draw about 100mA (measured in series with the 1A fuse).

Next, connect the Module to Compukit's expansion socket. This should not cause any significant change in current consumption. If Compukit "locks up" at this point and refuses to Reset, then there is probably a short in the Ø2, R/W, data or address lines, or the DD line has been brought permanently low. Check for these possibilities with an ohm-meter (with the Module disconnected from Compukit and from its power supply), or by disconnecting the leads to SK1 one at a time until the fault clears.

When all appears to be well, connect a high impedance voltmeter to pin 16 of SK3. This should read about 4·5 volts. Ensure that IC6 has been reset, and then execute POKE 61340, 255. This sets port A to output, and should cause the voltage on pin 16 to drop to about 0·2 volts. Now execute POKE 61341, 255 (to call up the peripheral register) followed by POKE 61340, 255 (to put 1s in the output register). This should cause the voltage on pin 16 to rise to about 4·5 volts, and should indicate that ICs 1, 2, and 9 are operational. If pin 16 refuses to go high on resetting the 6821, this indicates a fault not associated with the decoding. If it is high, but failed to go low on POKEing 61340, then the fault could either be in the connections to the 6821 or a failure in the decoding.

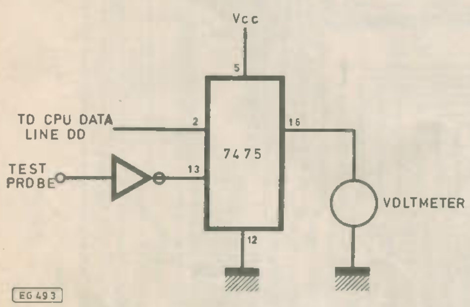
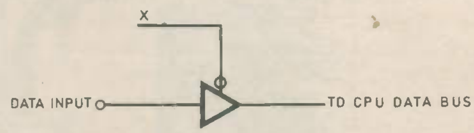


Fig. 2.5. 7475 Latch for testing the module

To check the decoding you will either need an extremely good oscilloscope, or a bistable latch. Fig. 2.5 shows a 74LS75 latch and inverter wired up for this purpose. The first point to check is the output of IC1. Connect this to the test probe, and POKE any address within the 128 byte block used (ie 61312–61439) with a 1 and then with a zero alternately. The voltmeter on the latch output should follow this, so verifying that IC1 is decoding the base address. The sixteen outputs of IC3 may also be tested with the probe. To test for the full operation of the Read circuitry a tristate buffer should be used (see below). Some indication as to the functioning of IC4 may be obtained by using the data latch of Fig. 2.5. This should read a '1' when connected to the outputs of IC4 when PEEK commands are executed at the appropriate address.

DIGITAL INPUT TO THE COMPUKIT TRISTATE BUFFERS

Digital data may be input to Compukit either directly using the Decoding Module's PIA, or indirectly through the use of tristate buffers. The function of the latter is simply to keep peripheral circuits isolated from the CPU data bus until the exact moment that data is required from it. Fig. 2.6 shows a tristate buffer buffering a single data line. With X high data will pass freely to the CPU, but when it goes low the buffer adopts a high impedance state. Eight such devices would be required to buffer a full 8-bit data bus, in which case the Enable lines X would all be connected to the same address-decoded line from the Decoding Module. A PEEK to the given address would then allow the CPU to read the data at the buffer inputs, and as soon as the Read was complete, the CPU would return the buffers to a high impedance state.



EG494 **Fig. 2.6. Tristate buffer on single data line**

The chief advantage of using this method over the PIA are its lower cost, and the fact that it does not require initialisation before use. This must of course be balanced against the extra complexity of wiring involved. There are also a number of more complex buffers on the market (eg the 74241) which are easier from the wiring point of view, but this is offset by their greater cost per bit.

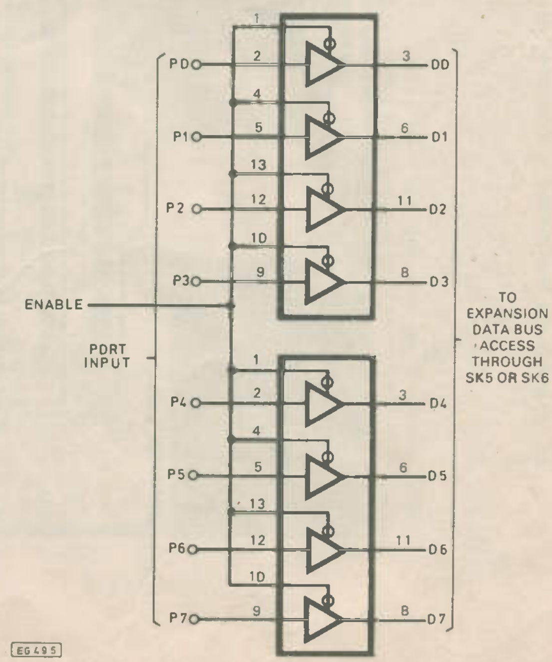


Fig. 2.7. 74LS125 8 bit port

In the event that more input ports are required than the Decoding Module PIA provides, Fig. 2.7 gives the circuit of a pair of 74LS125s wired as an 8-bit input port that may be used directly with the Module. The Enable, being active-low, is directly compatible with the Decoding Module's non-inverted Read lines.

SWITCHES AND JOYSTICKS

The 6821 and PIA or a 74125 port can be easily used for the input of information from switches or push-buttons. Fig. 2.8 shows one way in which this may be achieved. The resistor value of 1k used here is appropriate for either port of the PIA or for a 74125 port.

Interfacing a games joystick for digital operation is also easily accomplished (the more complex interfacing of joysticks for analogue control will be dealt with in a later article). The two-axis joystick consists of two linear potentiometers of about 100k mounted at right angles, and can be conveniently interfaced in a similar manner to the switches. Fig. 2.9 gives the circuit for a control box containing 4 push-buttons and a joystick. The 1k resistors may be mounted inside the box, and a single 10-strand ribbon lead used to connect this to the Decoding Module.

A truth table for the four least significant bits of this circuit is shown in Table 2,3. As may be seen, there are nine possible configurations, including the four diagonal directions. The great advantage which the use of switches and joysticks confers over the polled keyboard for games and other uses is that it is possible to activate any number of switches etc. simultaneously without blocking the input. In the case of the joystick alone this simply means that "diagonal" instructions can automatically be accepted as well as "vertical" or "horizontal" ones. But it also implies that any combination of the four push-buttons may be simultaneously acted upon.

It is also a simple matter to extract the relevant information from the binary data at the port. The easiest way to do this is to use the extremely useful AND operator in Compukit's BASIC. If this operator is used on decimal numbers rather than on expressions, it converts those numbers to binary, and behaves like a set of eight 2-input AND gates. Thus the instruction PRINT 13 AND 25 will give the result 9.

Converting 13 and 25 to binary and ANDing them we can see why.

```
13  00001101
25  00011001
 9  00001001
```

The only bits which are 1 in both numbers are the first and the fourth, which gives the binary representation of 9. This function makes decoding of the joysticks and other digital data an extremely easy matter.

To test whether the joystick is in the "up" position one can simply PEEK the corresponding port and AND the result with the binary number 00000010. Clearly, the result will only be non-zero if the second bit of the joystick data is also non-zero; ie if it is in the "up" position. Similar operations can be performed for the other three bits, and since each operates completely independently of the others, the diagonal positions will automatically be catered for. Thus the following four program lines could be used to move a cursor in eight different directions across Compukit's screen. X and Y are the horizontal and vertical screen positions, and A the address of the port.

```
100  IF(PEEK(A) AND 1)>0 THEN Y=Y+1
110  IF(PEEK(A) AND 2)>0 THEN Y=Y−1
120  IF(PEEK(A) AND 4)>0 THEN X=X−1
130  IF(PEEK(A) AND 8)>0 THEN X=X+1
```

In order to demonstrate these principles in action, a simple program is given for screen writing, using the joystick and push-button circuit of Fig. 2.9. The joystick is used to move a flashing cursor to any point on the screen, and the four buttons have the following functions: 1 (at bit 4) Draw, 2 Erase, 3 Change character, 4 Clear screen. The program, which is listed in Table 2.4 is extremely short, but allows intricate graphics work to be executed on the screen.

The techniques used here could obviously be implemented in a number of different ways for games purposes, and one could easily add a second joystick to allow for two-person games. In next month's issue, when we will be discussing digital output techniques, we will give circuitry and

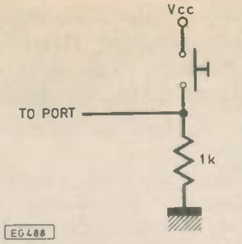


Fig. 2.8. (Left) push button inputs

Fig. 2.9. (Below) Joystick control box

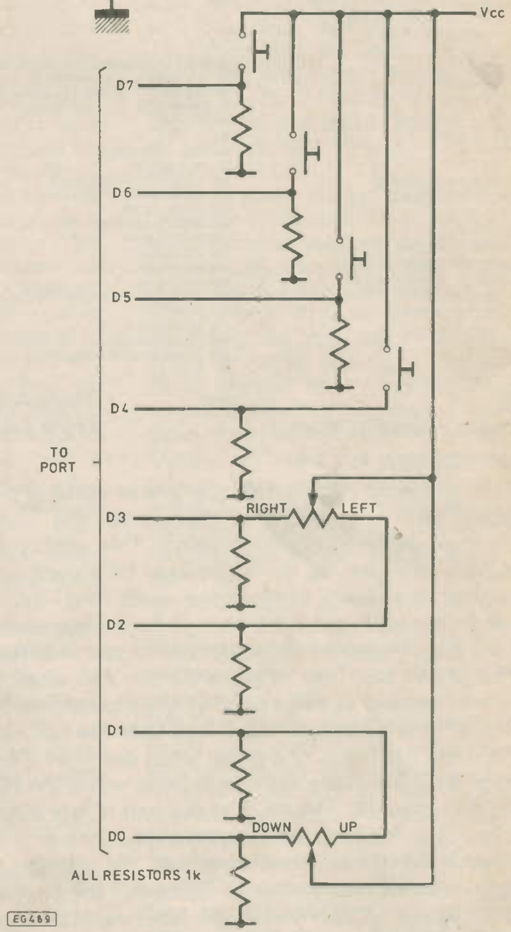


Table 2.3. Truth table for Joystick

Position of Joystick	P3	P2	P1	P0
	Four Least Significant Bits			
Centre	0	0	0	0
Down	0	0	0	1
Up	0	0	1	0
Left	0	1	0	0
Right	1	0	0	0
Down and Left	0	1	0	1
Down and Right	1	0	1	0
Up and Left	0	1	1	0
Up and Right	1	0	1	0

soft-ware for adding a 7-segment l.e.d. display to indicate the position of the cursor in the above program. This is a useful complement and enables the program to be used to set up graphics work for transferral of both BASIC and 6502 code programs.

```
OK
LIST
 80 REM P.E. INTERFACING UK101 PROG 2
 90 REM JOYSTICK DRAWING ROUTINE
 95 REM (WITHOUT LED DISPLAY)
 100 FORI=0TO15:PRINT:NEXT
 110 V=53260
 120 X=23:Y=8
 125 VP=V+X+64*Y
 130 P=61340
 140 C=161
 150 POKEP+1,0:POKEP,0
 160 POKEP+1,255
 170 Q=PEEK(P)
 180 IF(QAND64)=0THEN200
 184 C=C+1:IFC=191THENC=128
 186 POKEVP,C
 188 FORI=0TO300:NEXT
 200 IF(QAND1)>0ANDY<15THENY=Y+1
 210 IF(QAND2)>0ANDY>0THENY=Y-1
 220 IF(QAND4)>0ANDX>0THENX=X-1
 230 IF(QAND8)>0ANDX<47THENX=X+1
 240 IF(QAND128)>0THEN100
 250 VP=V+X+64*Y
 260 C1=PEEK(VP)
 265 POKEVP,35
 267 FORT=0TO100:NEXT
 270 POKEVP,C
 280 IF(QAND16)>0THEN170
 290 IF(QAND32)>0THENPOKEVP,32:GOTO170
 300 POKEVP,C1
 310 GOTO170
OK
LOAD
```

```
OK
LIST
 30 REM P.E. INTERFACING UK101 PROG 3
 40 REM UK101 LOGIC TESTER
 50 REM NOTE - RETURN KEY GIVES SCREEN
 55 REM RECORD OF LOGIC STATES
 60 V=54125
 70 P=61340
 80 POKEP+1,0:POKEP,0
 90 POKEP+1,255
 100 FORI=0TO15:PRINT:NEXT
 110 PRINTTAB(13);"UK101 LOGIC TESTER"
 115 PRINT:PRINT
 120 PRINTTAB(11);"D7 D6 D5 D4 D3 D2 D1 D0"
 130 PRINT:PRINT
 200 POKE530,0
 210 FORI=0TO7
 220 Q=PEEK(P)
 230 POKEV-3*I,((QAND(2↑I))/(2↑I))+48.1
 250 NEXT
 270 POKE530,1
 280 POKE57088,223
 290 IFPEEK(57088)=247THEN120
 300 GOTO200
OK
LOAD
```

Table 2.4. Left
Table 2.5. Above

LOGIC TESTER

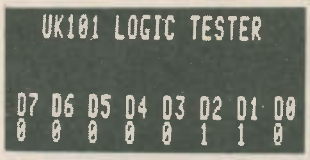
It is a very simple matter to use one or more of the ports developed with the Decoding Module for the purpose of testing logic state in digital circuitry. This simply involves connecting test clips to the eight lines of a particular port, and using these in conjunction with the appropriate software. Table 2.5 gives the listing of a program which displays the logic states of the eight lines of port A of the PIA. If 74125s are to be used in place of the PIA, then line 70 should be changed so as to set P to the appropriate address, and line 80 and 90 deleted. Line 230 uses the AND operator to determine the value of a given input line, and it performs this once for each of the eight data lines, using the FOR loop at program line 210. The 48·1 at the end of line 230 should really be 48·0. Its function is to convert a zero or 1 into the ASCII code for those characters, and the number 48 will normally achieve this; but since Compukit thinks that 2↑16 is 65536·2 (rather than 65536·0), 48·1 must be used so as to convert correctly.

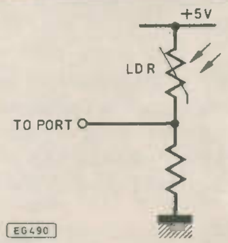
The photographs show Compukit's screen during the running of the program. Pressing Return at any time causes the current logic states to be printed as a record higher up the screen as may be seen. Note that since the program is written in BASIC, the response time is relatively slow.

OTHER INPUTS

There is of course no limit to the variety of devices that can be interfaced using the 6821 PIA or a 74125 port. In fact any device capable of producing a transition between about 0·5 and 3·5 volts (less for port A of the PIA) can be directly connected to them. We shall briefly look at the implementation of light and sound detectors, although here, as in many other cases, far greater information can be derived from such sources using analogue to digital conversion techniques, to be treated later in the series.

Light dependent resistors such as the ORP 12 are amongst the easiest light detectors to interface because their parameters change over many decades for relatively small changes in illumination. It is even possible to wire these directly to the port using a 1k resistor to ground as shown in Fig. 2.10. If it is required to detect lower levels of light than this circuit permits, a simple transistor amplifier may be used as in Fig. 2.11. With the high gain 2N2926G transistor this is capable of detecting very low levels of light. If desired, a potentiometer could be inserted in the base circuitry of the transistor so as to provide some degree of level control. The circuit of Fig. 2.11 differs from that of Fig. 2.10 in that it takes the port low when light is present. This effect can easily be reversed in software by subtracting the data read at the port from 255. This will cause each of the eight inputs of the port to be effectively active-low rather than active-high.





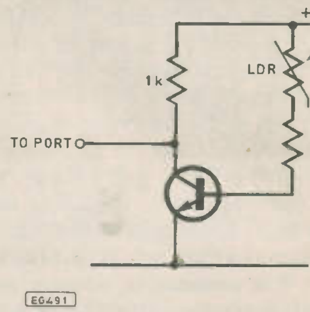
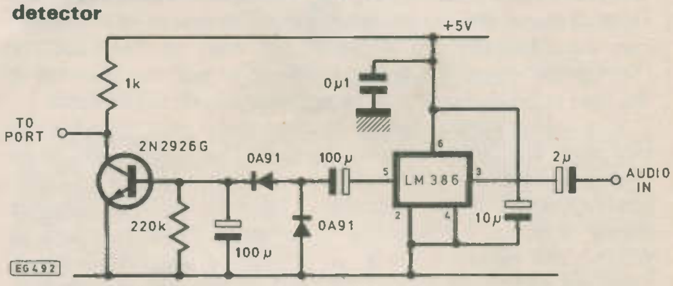
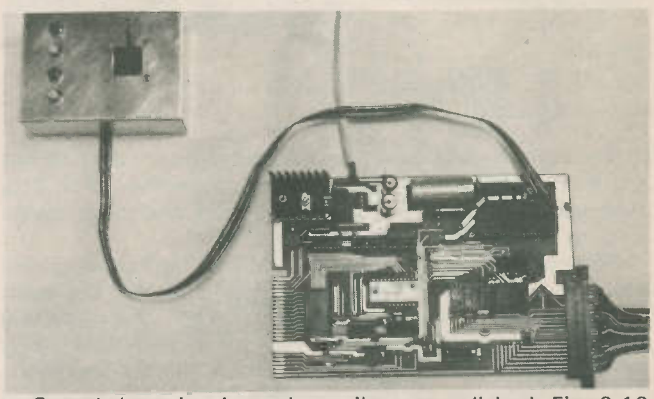


Fig. 2.10. (Above) LDR directly connected
Fig. 2.11. (Right) High Sensitivity light detector
Fig. 2.12. (Below) Audio detector





Sound detection is again easily accomplished. Fig. 2.12 gives the circuit of a simple audio detector using an LM386 audio amplifer, which will run happily at 5 volts. The amplifier is sufficiently sensitive for the circuit to operate with a high output dynamic microphone, but if greater sensitivity is required, a preamplifier should be used. In setting up this and other digital interfaces it will be found that the Logic Tester program of Table 2.5 can be used to provide a convenient way of monitoring the state of the port in use.

Next month we will look at the use of the PIA and data latches to output digital data from the Compukit, and will discuss various applications including an IC tester for devices of the 7400 series.

FRANK W. HYDE

THE SATELLITES OF SATURN

In the continuing saga of Saturn something old is proved and something new is seen. There are activities which confirm the Lagrange points which have so far been known only in connection with the Trojan asteroids. Comte Joseph Louis Lagrange studied the problem, often known as the Three Body Problem, because of the difficulty of separating or analysing the perturbations when a third body is introduced into a stable two body system. Lagrange held that it was possible to have a stable system with three bodies. if they were at the angles of an equilateral triangle. This would appear to be the case of the moons of Saturn.

The last issue of *Spacewatch* referred to the peculiar spoke like features that were seen from the distance of the first encounter. Also it was noted that although the speed of the inner and outer edges of the rings was different these features endured over a long period. At first it was thought that they were opaque and preventing light passing through. Yet another surprise was in store for these areas were not black apparently but clear when seen from the underside after the spacecraft had dipped down below them. This has raised many questions, for on the first thinking there are things happening which cannot readily be reconciled with our present system of physics.

As the spacecraft approached the planet at a speed of more than 9·57 miles a second, greater detail and more "structure" appeared. Hundreds of "ringlets" filled the spaces between the major rings. It had been thought that the satellites would cause divisions in the rings, but there are not enough satellites to cause so many divisions as have appeared. There are quite serious problems with the theories currently held about these features alone. It appears from the pictures returned, that the old theories about the rings may in some part be substantiated since there is evidence that they are made up the debris round the planet, dust, ice, etc. The close-up views were expected to show up the atmosphere of the satellite Titan, the largest in the Solar System, and possibly enable a glimpse of its surface. However this was not possible though it may be that later analysis and processing of the pictures will afford more detail.

It perhaps, is well to note that Saturn is twice as far away from the Sun as Jupiter. At this distance Saturn receives only a quarter of the light and energy from the Sun that Jupiter does. In fact Saturn radiates about 15 per cent more heat than it receives. This is some support for the theory that perhaps Saturn has a core about 20 times the mass of the Earth but about the same size, and made of rock. The atmosphere is banded like that of Jupiter but not so bright. It would seem however that the constituents of the atmosphere are similar. That is, that there are jet streams of ammonia and other compounds spinning round at different speeds according to latitude. The rotation period of the planet has been established at 10 hours 30 minutes. By reason of the fact that there are colder temperatures involved the clouds form at lower levels and the whole is overlaid by a haze. They are therefore not so bright as on Jupiter.

The itinerary of the new exciting period in the history of mankind, still continuing at the moment of writing has been so far:

November 6. Voyager photographs Saturn and its rings then the satellites Titan, Rhea, Dione, Mimas and Iapetus.

November 7. Pictures of Saturn and the rings were used to locate other possible satellites in addition to the 14 moons verified so far. Moon Rhea is photographed to see why it is bright on one side and dark on the other.

November 8. Photographs of the moon Tethys, Enceladus, Rhea and Dione in addition to more pictures of Saturn.

November 9. The Infrared scanner checked the "heat" level across the disc.

November 10. Studies of Titan's atmosphere and seeking for a glimpse of the surface. More than 400 pictures transmitted to Earth.

November 11. The close approach to Titan. The spacecraft measures Saturn's magnetic field and searches for high energy particles.

November 12. The spacecraft flew within 77,000 miles of the planet's cloud tops, past the South pole and then behind Saturn and then up through the ring plane. At this point the vehicle was travelling at about 19·25 miles per second. The closest approach to Saturn coincided with the close approach to Tethys (260,000 miles), Mimas (67,000 miles), Enceladus (126,000), Dione (100,600 miles), and Rhea (44,739).

November 13. Photographs from over Saturn's North pole. Observation of Aurora and lightning from dark side of the planet.

November 14. Closest approach to Iapetus (1,250,000 miles).

November 15–18. Further search for satellites.

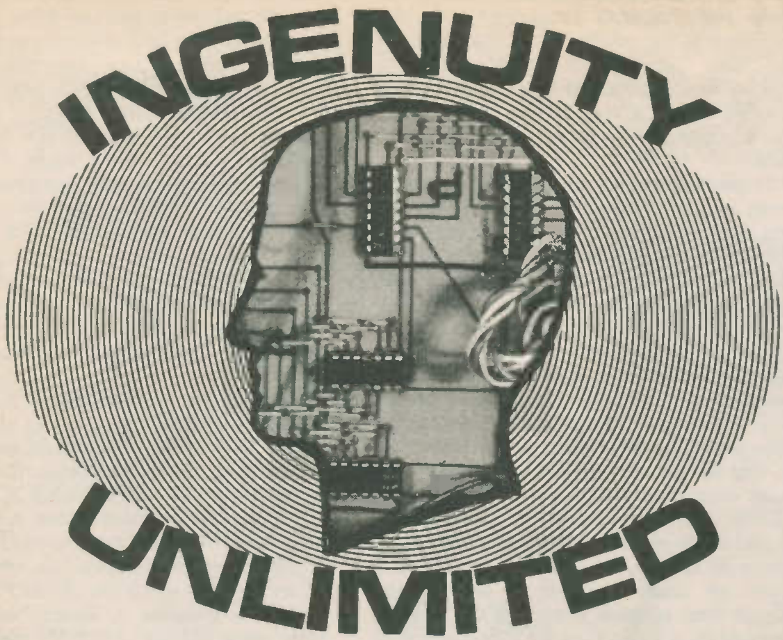
Now some more details. Observation of the satellites as the approach was made, white blobs dark streaks and blotches were seen on them. The photochemical smog layer of Methane Acetylene and Ethylene on Titan made it look like a cotton ball of orange colour. No opening in the smog gave any view of the surface. However some dark areas could be seen at the poles of the satellite and there appeared to be a difference between the northern and southern hemispheres. The southern hemisphere seemed brighter than that of the northern hemispheres.

Rhea has a white spot which shines in the way that a sheet of ice might do in the sunlight. Iapetus even with sunshine over the whole disc looks like an apple, all white except for a great black piece which looks rather as though a bite had been taken from it. A puzzle here is why does Iapetus have a surface that reflects light like the Earth's Moon on one part while another part reflects little or no light at all. Dark and light splotches can be seen on Dione.

The three new moons found by Voyager 2, designated by numbers are giving clues as to why the rings of the planet are separated. The most recently discovered moon, number 15, which was found on November 8, is about 100km across. It circles Saturn just outside the A ring. The other two moons discovered by the spacecraft cameras, numbers 13 and 14, are on either side of the narrow F ring. According to Bradford A. Smith and Edward Stone these moons could be regarded as "sheep dogs!" That is to say that they appear to keep order among the rings, involving a complicated change of energy. Studies from Earth have shown that dust and ice form the particles of which the rings are made. These appear to move out of the plane of the rings due to the fact that the orbits vary as they move from the inside to the outside of a ring. For example, if a particle is regarded as a "dusty snowball" and moves out of the A ring into the slower orbit of moon number 15 outside the A ring, the "snowball" is slowed down by the moon and falls back into the lower orbit. The two other moons, numbers 13 and 14, on either side of the F ring do the same thing. Similarly the mechanism that operates with two other moons appears to work as follows: The moons S-10 and S-11 whose orbits are only 50 kilometres apart could be expected at least to make a disastrous approach to each other, but they do not. The two moons move in the same direction but the one nearer the parent body moves faster than the other one 50 kilometres further out. As the moons come together the inner one will be pulled into a higher orbit and will slow down, the slower moving moon will fall to a lower orbit and speed up, thus the two moons do not collide but transfer from one orbit in exchange. Surely this must be unique in discoveries of science.

From Earth there are three broad rings visible in the telescopes. These are the innermost C-ring then the B-ring, the A-ring with a narrow F-ring. There is an additional ring which cannot even be seen on the Voyager pictures.

The broad rings are found to consist of more than 100 smaller rings. These are the puzzles. What keeps the rings apart? Why are the outer tenuous rings intertwined like a rope? The Casini division which looks black is not filled with dark matter, but with a number of thin rings. Photographs taken of the rings in ultra-violet light seem to indicate that the material is different for each ring, or, perhaps the material is the same but reactions we do not understand are taking place, maybe due to the effects of the high level magnetic field.



A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

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CAPACITIVE TOUCH SWITCH

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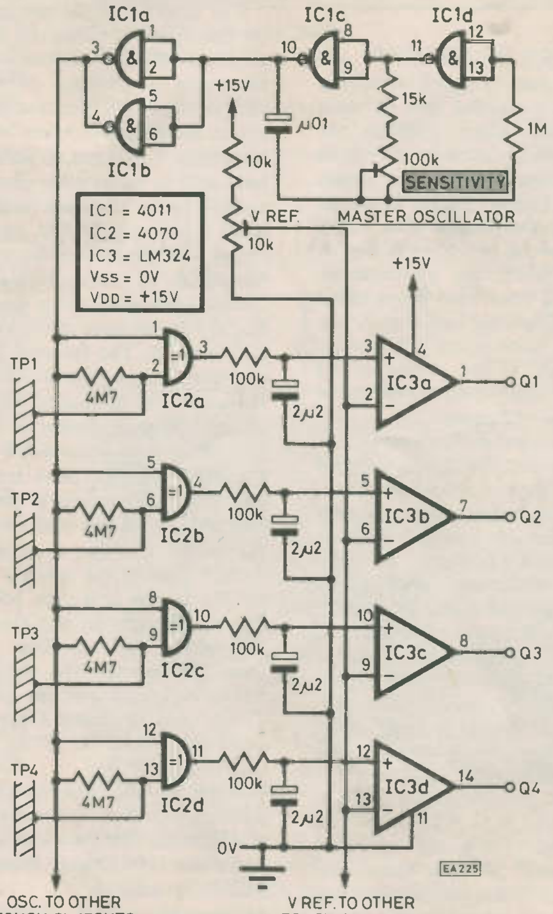
A circuit of such a switch for driving CMOS is shown. IC1 is used to provide a buffered oscillator circuit which drives a phase comparator circuit made up from IC2 an EX-OR device. The sensor plates TP1 to TP4 are connected to the oscillator output via a high value resistor. The phase between the touch plate signal and the oscillator output is measured by the EX-OR gates. As a finger is brought near to the plate the capacitance loading the plate to ground through the finger causes a phase lag of the plate signal. After passing through a low-pass filter this is seen as an increase in phase comparator output which is then detected by quad comparator IC3, causing the relevant Q output to go high.

The touch plates consist of one inch square copper pads on a $\frac{1}{16}$in printed circuit board. The blank side of this is painted and switch touch positions labelled with Letraset. Construction is critical and leads from the sensor plates must be kept below 1in to minimise stray capacitance. This is done by mounting boards containing 4070, LM324 devices on the back of the switch panel perpendicular to it. Veroboard is not recommended.



The circuit is set up by monitoring the voltage at one of the IC2 outputs. The sensitivity control is adjusted to give a mean level of about 1 volt at this pin. On bringing a finger up against the switching area a rise in the appropriate output should be noticed. The voltage reference should be set so that the comparator just triggers at this level. The zero voltage supply line should preferably be connected to the mains earth line.

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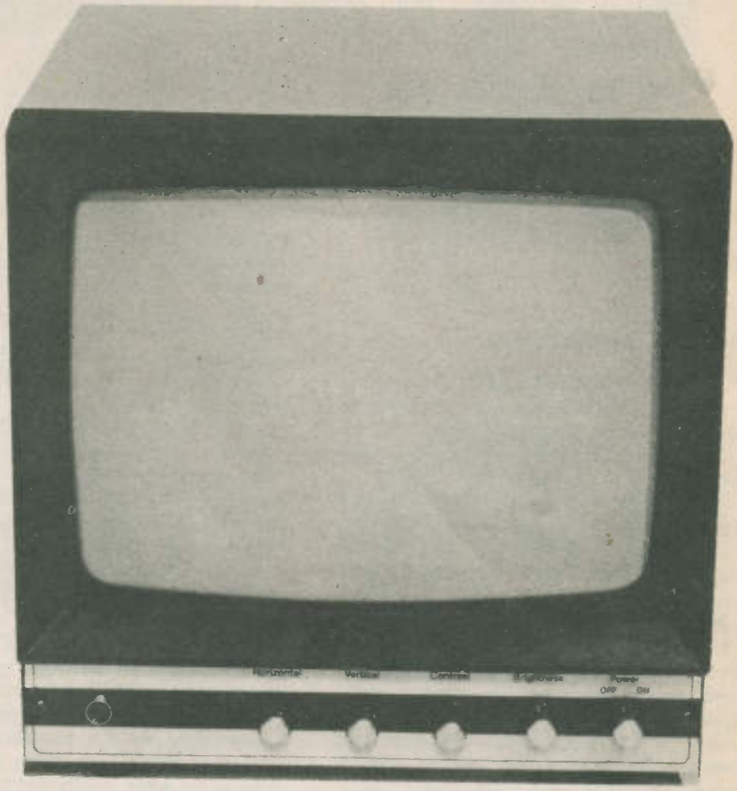

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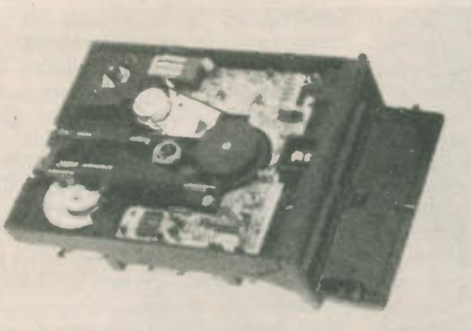

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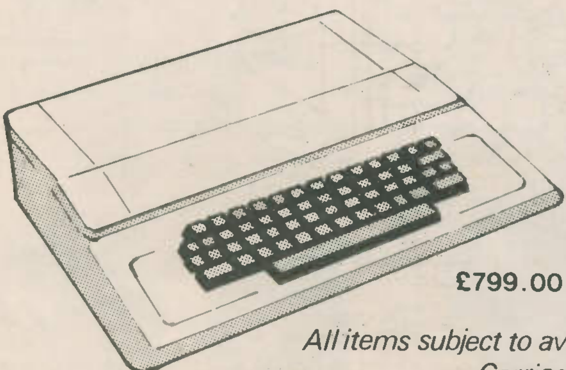

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PATENTS REVIEW...

HEALTH MONITORS

Two patent applications published recently in the UK describe devices intended to safeguard the health of the wearer, for instance anyone undertaking strenuous exercise.

British patent application 2 032 764 dates from October 1978 and was filed by Carlos Biset of Argentina. This patent merits only brief mention because the idea is speculative—i.e. the inventor has come up with more of a problem than a solution.

The aim is to provide a device like a wrist watch which automatically reveals data on a wearer who collapses. The idea is to use a miniature tape player which will reproduce sound from a tape when triggered into operation by an impact switch. Fig. 1 shows the switch. Arm 18 is spring biased into latching slot 25, but when jolted (for instance when the wearer takes a fall) the arm jumps temporarily out of the notch and is forced against slide switch 8 to close contacts 26, 27. This completes the circuit for the mini-tape announcer. Although potentially valuable (the device could save a life if it announced blood group, name, address and phone number at a crucial moment) the patent is silent on the real design problems e.g. how to provide a tape player of sufficiently small size to be incorporated in a bracelet. Hobbyists may like to address themselves to this problem. As a challenge it is worth noting that at the recent Photokina exhibition in Cologne, Sony of Japan demonstrated a video camera no larger or heavier than a Super 8 sound film camera, which incorporates a mini-cassette recorder capable of recording not only sound but colour video as well. The Sony recorder module is in fact nothing more than a very cleverly scaled down version of a current Sony Betamax recorder.

British patent application 2 039 364 dates from December 1978 and comes from the Hughes Aircraft Company of California, the aerospace giant started by the late Howard Hughes.

For some time it has been known that the human pulse rate can be read optically, by sensing light pulses reflected from a finger. The tiny blood vessels or capillaries change in size as the heart beats, and this, varies their reflectance (the blood capillaries dilate when the systolic pressure wave arrives and the reflectance drops). Attempts at obtaining a direct pulse readout have so far been bedevilled by the confusing effect of ambient light, especially when it is pulsed at mains frequency. Feedback bias control has been used to distinguish between ambient and system light, but the circuits take 20 or 30 seconds to stabilise and draws more power than a bracelet can provide from batteries.

Hughes describes circuitry which is claimed to stabilise in 2 or 3 seconds, and can be worn like a watch calculator by athletes. In Fig. 2 an l.e.d. 10 produces infra-red light and detector 12 picks up reflections from the finger surface. The l.e.d. is driven with constant current pulses at a fixed rate which is chosen to distinguish clearly from local mains frequency and its harmonics—e.g. 73Hz for US standard 60Hz mains. Generator 16 provides a 31 microsecond pulse of 2mA to the base of drive transistor Q1 every 13·67 microseconds, to give the necessary 73Hz rate. The output of photodiode sensor 12 is routed to conditioning section 24 where ambient light and any steady state component of the diode signal are removed by cancellation. The heart pressure wave, represented as the envelope of the remaining signal, is bandpass filtered at 26 and fed to discriminator 28 which triggers on signals which exceed a threshold VR5. The pulsed output is timed at 18 and the heart rate displayed at 30. The lengthy patent contains full details of the techniques used to cancel spurious signals created by ambient noise or finger movement.

Fig. 1

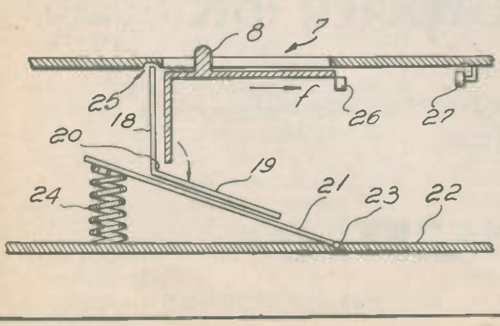
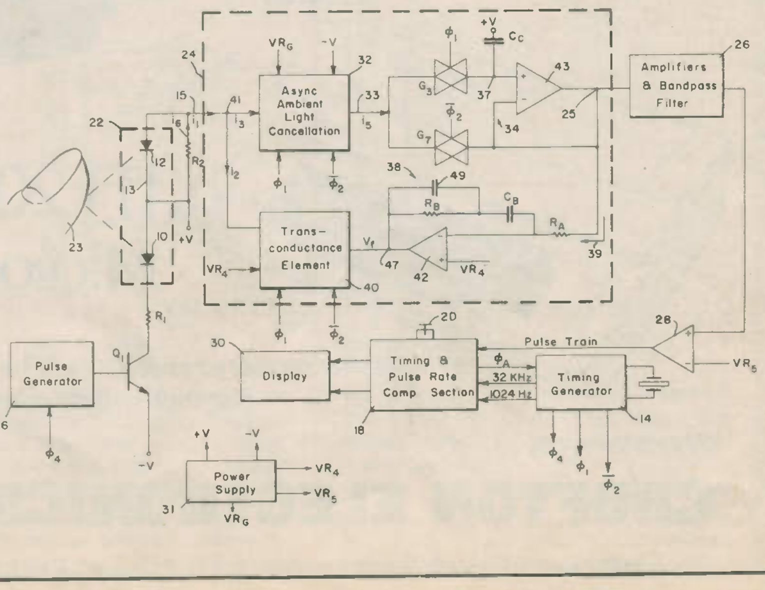


Fig. 2



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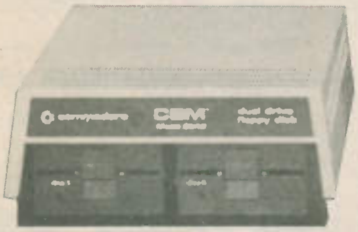

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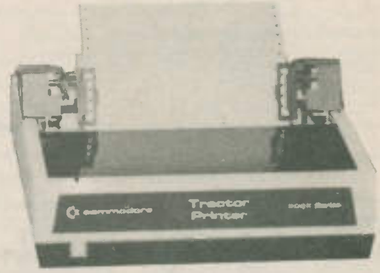

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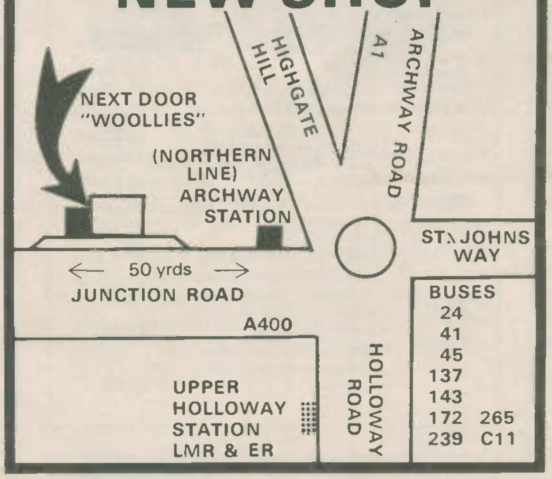

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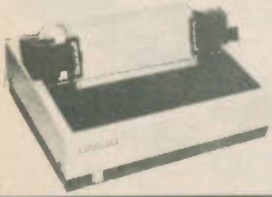

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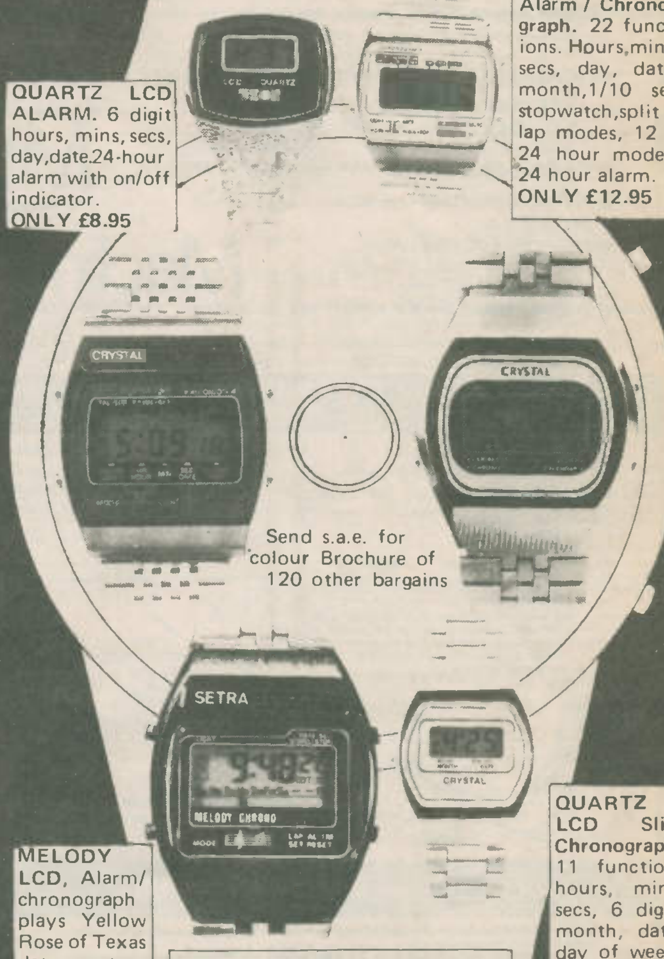

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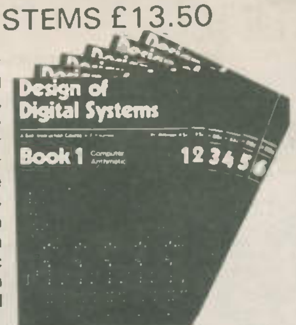

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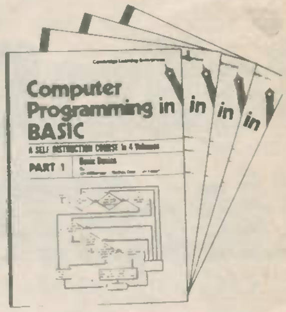

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Why the Sinclair ZX80 is Britain's best-selling

Built: £99.95

Including VAT, post and packing, free course in computing, free mains adaptor.

Kit: £79.95

Including VAT, post and packing, free course in computing.

This is the ZX80. A really powerful, full-facility computer, matching or surpassing other personal computers at several times the price. 'Personal Computer World' gave it 5 stars for 'excellent value'. Benchmark tests say it's faster than all previous personal computers.

Programmed in BASIC – the world's most popular language – the ZX80 is suitable for beginners and experts alike. And response from enthusiasts has been tremendous – over 20,000 ZX80s have been sold so far!

Powerful ROM and BASIC interpreter

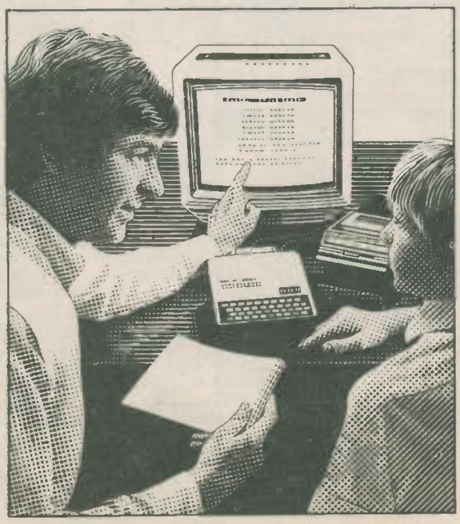
The 4K BASIC ROM offers remarkable programming advantages:

* Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.
* Unique syntax check. A cursor identifies errors immediately.
* Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison).
* Up to 26 single dimension arrays.
* FOR/NEXT loops nested up to 26.
* Variable names of any length.
* BASIC language also handles full Boolean arithmetic, condition expressions, etc.
* Randomise function, useful for games and secret codes, as well as more serious applications.
* Timer under program control.
* PEEK and POKE enable entry of machine code instructions.
* High-resolution graphics.
* Lines of unlimited length.

Unique RAM

The ZX80's 1K-BYTE RAM is the equivalent of up to 4K BYTES in a conventional computer – typically storing 100 lines of BASIC.

No other personal computer offers this unique combination of high capability and low price.



The ZX80 as a family learning aid. Children of 10 years and upwards are quick to understand the principles of computing – and enjoy their personal computer.

The Sinclair teach-yourself BASIC manual

If the specifications of the Sinclair ZX80 mean little to you – don't worry. They're all explained in the specially-written 128-page book (free with every ZX80). The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs.

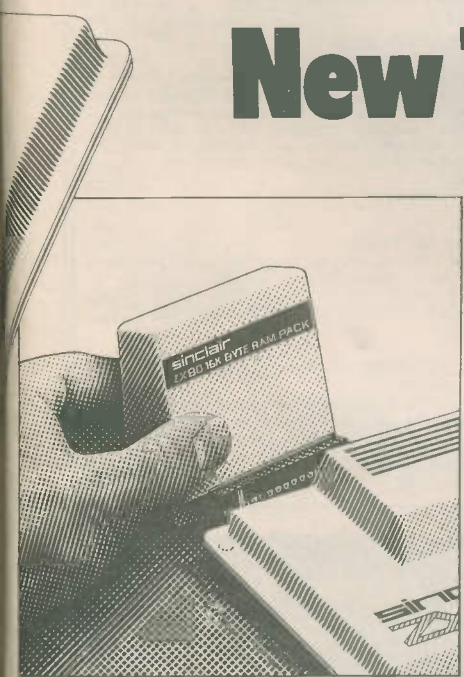
Kit or built – it's up to you

In kit form, the ZX80 is pleasantly easy to assemble, using a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9V DC nominal unregulated. If not, see the coupon.

Both kit and built versions come complete with all necessary leads to connect to your TV (colour or black and white) and cassette recorder. Plug in and you're ready to go. (Built versions come with mains adaptor.)

personal computer.

Now available for the ZX80... New 16K-BYTE RAM pack



Massive add-on memory. Only £49.95.
The new 16K-BYTE RAM pack is a complete module designed to provide you – and your Sinclair ZX80 – with massive add-on memory. You can use it for those really long and complex programs – or as a personal database. (Yet it can cost as little as half the price of competitive add-on memory for other computers.)

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Or you can store a mass of data – perhaps in a fairly simple program – such as a name and address list, or a telephone directory.

And by linking a number of separate programs together into one giant, but modular, program, you can achieve the same effect as loading several programs at once.

We're also confident that it won't be long before you can buy cassette-based software using the full 16K-BYTE RAM. So keep an eye on the personal computer magazines – and brush up your chess perhaps!

The RAM pack simply plugs into the existing expansion port on the rear of the ZX80. No wires, no soldering. It's a matter of seconds and you don't need another power supply. You can only add one RAM pack to your ZX80 – but with 16K-BYTES who could want more!

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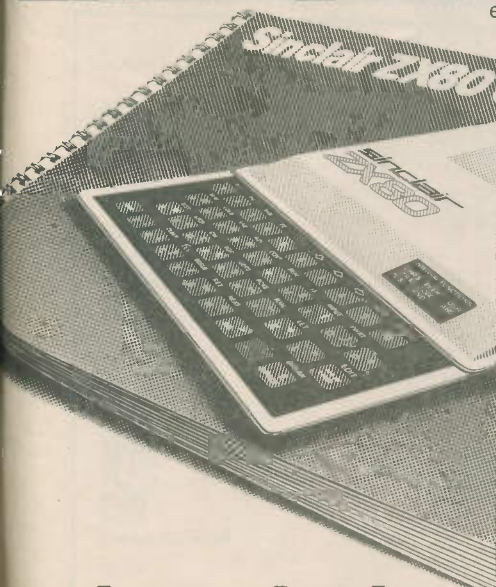

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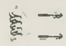

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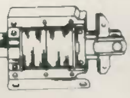

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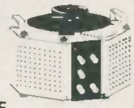

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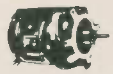

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