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see page 61 for details

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Monitor the revolution on a crystal clear customised counter

BASIC ELECTRONICS
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Here at Tandy we stock a large selection of parts for the hobbyist and professional alike. Whether you are repairing a computer or building your first electronic project your needs can be catered for all under the same roof.

Tandy has a range of lamps and assemblies; ICs, diodes, regulators, displays, transistors, relays, enclosures, power connectors, in fact anything and everything you could ever need for repairs and projects.

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So, whether you are building an alarm system, repairing a radio or just wiring a plug, Tandy is the place for parts!

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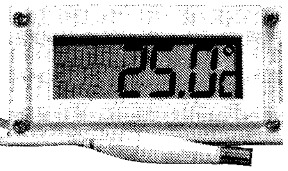

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Use "as-is", or add simple circuits to control an LED, fan, heater, buzzer. −40 to +50°C, −40 to +122°F range. Requires "AA" battery. With probe cord, data.
277-123 .... **£14.95**

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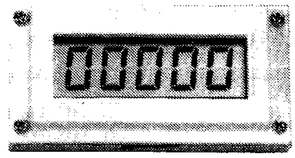

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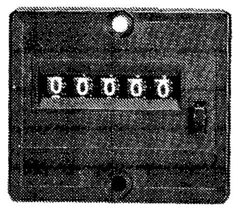
Counts up to 99,999. Advanced by external switch closure or digital circuit. Count rate up to 7 Hz. 12.7mm LCD display. Requires "AA" battery.
277-302 .... **£12.95**

MECHANICAL COUNTER



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Extra rugged device with many uses. Advances one count with a 12 VDC pulse. Manual pushbutton reset. With leads and data.
277-222 .... **£10.99**

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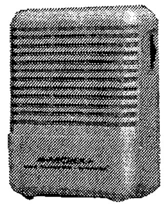

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High gain IC design, use as a test bench amplifier. Ideal for computer voice/music synthesis. On/off volume control. 3.5mm earphone and input sockets. Requires 9v battery. **277-1008** **£9.99**

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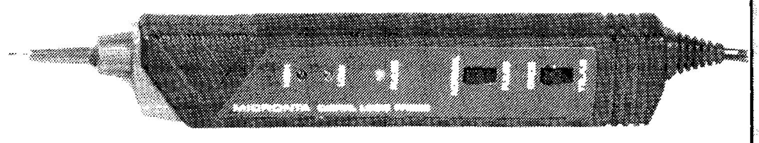

Colour-coded LEDs indicate high, low or pulsed logic states (up to 10 MHz). Simultaneous tone output frees your eyes for fast testing. Switches for pulse or normal modes. Input: 100K ohms. Minimum detectable pulse width: 50 ns. Operates from 4 to 15 VDC. Instructions included. With 91.4cm leads.
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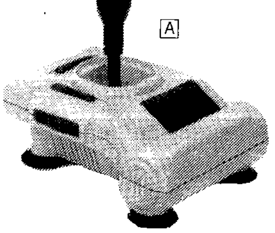
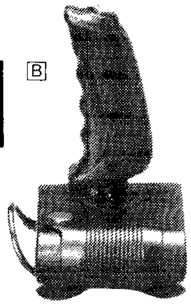


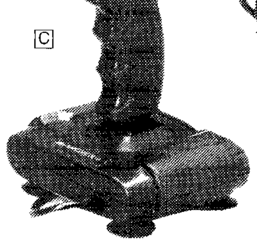
A

£16.95



B

£7.99



C

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B **Jet Fighter Style Competition Joystick.** Features two "fire" buttons plus auto-fire control.
270-1701 .... **£7.99**

C **Super-Deluxe Competition Joystick.** Features large contoured handle and two firing buttons. **270-1703** **£9.99**

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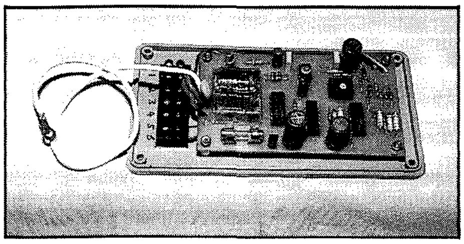
InterTAN U.K. Ltd., Tandy Centre, Leamore Lane, Walsall, West Midlands WS2 7EG. Telephone: 0922 710000



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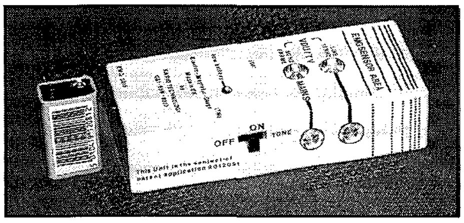

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British Telecom
Fibre to the Home

NEXT MONTH

POINTING THE WAY

Our main constructional project will show you how to use magnetic sensors to produce a digital electronic compass. It's microprocessor controlled and can be used independently or with an existing mechanical compass. We also explain how you can achieve synchronisation in circuits where accurate timing is of vital importance. Practical computer input-output interfacing will also be featured. (The Fault Finding article previously intended for this month is being rescheduled for a later issue).

And:

Watch out for our announcement about exciting new changes planned for PE March 1991!

★ DON'T MISS YOUR COPY OF OUR FEBRUARY 1991 ISSUE

★ ON SALE FROM THURSDAY JANUARY 4TH

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★ ★ ★

PRACTICAL ELECTRONICS

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Enter our monthly draw and you too could let us pay for your purchases............. 61

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Offers many of the facilities featured in top manufactured models and yet is easy to build and install with the minimum of wiring.

MICROCONTROLLING THE ROBOT CAR - PART TWO by Alan Pickard............27
Examining more of the hardware and software aspects, with suggestions for future developments, including infra-red links.

BIKE COMPUTER - PART THREE by John Becker 35
Final testing and mounting, answering a few queries, and on to using the main board as an independent 6502 microcontroller.

LCD REV COUNTER by John Becker 43
Designed as an answer to a reader's query, this counter has multiple input ratios and may be set for different sampling rates.

SPECIAL FEATURES

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The Senior Product Manager of Philips Communications and Security increases our awareness of a lesser known but vital communications system.

NICAM STEREO TV by Ian Poole..24
With tv stereo sound increasingly available nationwide, we explain how the signal is superimposed without overloading the transmission spectrum.

HOME-BASE by Ian Burley 32
Caller-ID announces itself to the UK and the Beeb reveals a technique that could offer near-HDTV quality without making your set obsolete.

LASERS - PART THREE by Mike Sanders...38
Concluding the series by examining the industrial applications for lasers, from holography to cutting and welding.

BASIC ELECTRONICS - PART THIRTEEN by Owen Bishop 48
Time is of the essence with this month's 'know-how' feature, particularly with regard to frequency in audio and other analogue circuits.

HISTORY OF TECHNOLOGY - AMBROSE FLEMING by Ian Poole 52
Arguably the father of modern electronics, Fleming invented the thermionic valve and made great advances in the efficiency of measuring instruments.

REGULAR FEATURES

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HOME CINEMA

Toshiba is involved in intensive promotional activity to support the launch of two new Nicam tvs with Dolby Surround. The two deluxe additions to Toshiba's TITAN range are the V66cm (28 inch) 2805DB (shown in the photo) and the V59cm (25 inch) 2505DB. The company believes that the sets are the first volume tv products on the UK market to feature Dolby Surround decoders as well as Nicam digital stereo.

At around £799 the 2805DB features Toshiba's new Super C3 screen, offering improved contrast levels and a special antistatic coating to reduce dust build-up on the tube face, ensuring a clearer picture. Other features include: computer controlled digital chassis; Teletext with Fastest; two 21-pin SCART sockets; no signal power off; on-screen display; on/off timer; selectable picture, blue back control and S-VHS input. (Also featured in the picture is Toshiba's V610B Nicam video recorder and the company's latest 15 inch portable.)

As part of the major promotional launch package Toshiba has produced a special demonstration video cassette, "Every Night at the Movies", presented by Channel 4's movie buff, Tony Slattery. The tape gives a lively explanation of Dolby Surround (the domestic version of cinematic Dolby Stereo). It uses scenes from hit films including Dirty Dancing and Buster to help dealers show how Dolby Surround can create 'cinema sound' at home.

TOP GEAR

A highlight of the Maplin 1991 catalogue is the new range of car radio/cassette players and in-car speakers. Flush mounting and superb styling combine with digital pll synthesiser tuning systems and 30-station automatic memory systems to make the Prosound range hard to beat for both quality and value.

Top of the range is the high-quality auto-reverse car stereo which incorporates a wide selection of features. A microprocessor controlled pll synthesised receiver provides 18 preset memories for fm band, and six each for mw and lw bands. A comprehensive lcd display shows tuned frequency, operating modes and a digital clock. The model will find and store the six strongest stations, and also features local/distant selection.

For more information on this model and others in the range see Maplin's 1991 catalogue, or contact any of Maplin's nationwide shops. Their head office is at PO Box 3, Rayleigh, Essex, SS6 8LR, tel 0702 554161.

CATALOGUE DATABASE

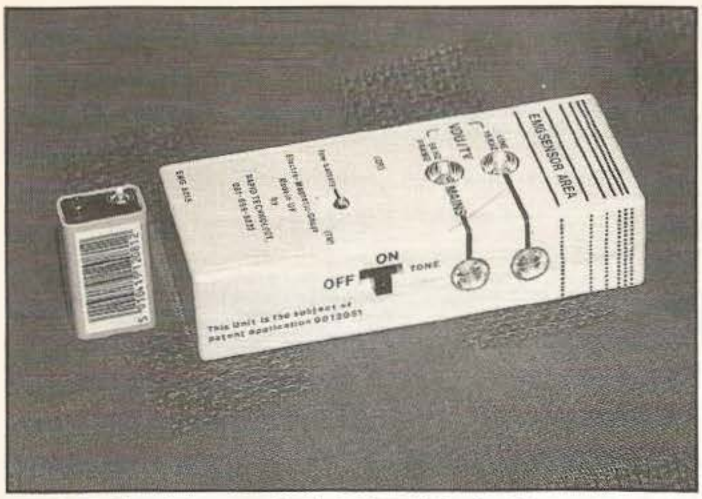
Our browse through recently received literature

Cirkit's Winter 1990/91 catalogue costs £1.60 and is worth every penny of it to anyone who has any interest in electronics, which of course you all have! There are nearly 200 A4 pages bound with a glossy cover. All categories are well illustrated and cover **practically every item you could need in pursuance of your hobby**, or even your trade for that matter. Amongst the categories are batteries, books, components, computers, crystals, filters, inductors (the latter is an exceptionally good range), kits, modules, semiconductors, test gear, tools, transformers, and much more besides. Of the many new items to found in this latest catalogue, the **full-spec battery powered scope stands out as a valuable asset** for many workshops, as do the low cost bench power supplies with lcd readouts. I know from personal experience what a good service Cirkit provide and recommend the company and their catalogue to you all. Cirkit Distribution, Park Lane, Broxbourne, Herts, EN10 7NQ. Tel 0992 444111.

JPR Electronics have introduced themselves to me by sending their 1990/91 electronic component distribution catalogue. There is an **amazingly full selection of most types of electronic products** packed into over 80 A4 pages. The ranges include batteries and boxes, connectors, pcb making equipment and materials, passive components such as capacitors and pots, active components from ics to transistors, plus test equipment and other such items of value to any hobbyist. **This catalogue will be of interest to those in education** as well since schools and colleges are offered automatic account facilities. The company also offer a trade counter service. **JPR Electronics**, Unit M, Kingsway Industrial estate, Kingsway, Luton, Beds, LU1 1LP. Tel 0582 410055.

Tandy, of course, are a household name and it is always interesting to browse through their latest catalogue. One of the great benefits that Tandy have to offer is that not only do they stock a range of electronic components of interest to the occasional constructor, but they also have **extensive ranges of consumer electronic products**. Tandy claim to be The Technology Store, and their unique range of audio, video and specialised electronic products and accessories certainly justifies their claim. And you probably don't need reminding that Tandy have their own **extensive line of PC compatible microcomputers**, from lap top to high powered business machines. Nip into you local **Tandy** store (there are over 500 around the country) and pick up your copy of their interesting catalogue.

NEWS



FIELD TESTING

You'll probably recall that in PE May 90 we highlighted the possible health problems that may arise from prolonged exposure to certain electromagnetic fields. Rapid Technology have told us that they have introduced their Electro Magnetic Gauge in response to public concern about the subject.

The company believes that this low cost product has a special 'quality of life' attribute and has environmental/social implications as a 'green' product. The device is the subject of a patent application.

Electro Magnetic Gauge 5015 has been produced in response to a need for a low cost, standardised device, capable of being used by non-technical people for measuring the low frequency electromagnetic radiation produced by most home, office, industrial equipment and wiring.

The unit is priced at £98.00 inclusive, though it may be hired at a rate of £28.00 for 30 days.

For more information contact Rapid Technology, 3 Tremaine Road, Anerley, London, SE20 7UA. Tel: 081-659 8220.

MICROWAVE SAFETY

INTEK
MICROWAVE LEAKAGE DETECTOR
OFF
TEST
ON
TEK 500

We receive a fair number of letters from people who are concerned about checking their microwave ovens for escaping radiation. Our basic advice is that if you believe you have a microwave safety problem then you should consult an expert. However, if you feel that you have the ability to assess the problem, then the new microwave leakage detector from Alpha could interest you.

Alpha say that the Intek model TEK 500 is simple to use and that it is supplied with detailed operating instructions. It meets BS5175 requirements relating to the Safety of Commercial Electrical Appliances using Microwave Energy for Heating Foodstuffs and is suitable for detecting exposure levels as specified by the NRPB (National Radiological Protection Board).

This new tester is a hand held battery operated device featuring both visual and audible warning devices and self test. Simple visual indication of Ready, Safe and Danger is via a series of coloured leds together with an audible warning when levels are above the safety limit. Measuring just 150 x 64 x 30mm, this neat compact unit is fully guaranteed and supplied ready for use. Detailed instructions for carrying out user-orientated microwave leakage tests are included. The price is £129.50 plus vat.

For more information contact Alpha Electronics Ltd, Unit 5, Linstock Trading Estate, Wigan Road, Atherton, Manchester, M29 0QA.

EVENTS DIARY

If you are organising any event to do with electronics, big or small, drop us a line,

Please note : Some events listed here may be trade or restricted category only. Also, we cannot guarantee information accuracy, so check details with the organisers before setting out.

Dec 9. SATRO (Science And Technology Regional Organisation) 4th annual show for computer and science enthusiasts. Aberdeen Music Hall. 0224 273161.

1991

Mar 19-21. Nepcon Europe and Electronics International (formerly British Electronics Week). NEC, Birmingham. 0799 26699.

April 17-18. Laboratory Manchester. Windsor Hall, G-Mex Centre, Manchester. 0799 26699.

May 15-16. Laboratory Scotland. Scottish Exhibition Centre, Glasgow. 0799 26699.

IEE FARADAY LECTURES 1990-91

Presented by the Universities of Bath and Sussex.

1990: Dec 4 Coventry. Dec 12 Ipswich.

1991: Jan 15 Exeter. Jan 22 Swansea. Jan 29 Southampton. Feb 5-7 London. Feb 12 Hanley, Stoke-on-Trent. Feb 27 Nottingham. Mar 6 Sheffield. Mar 13-14 Bath.

For free tickets and further information contact (enclosing SAE) The Faraday Officer, IEE, Michael Faraday House, Six Hills Way, Stevenage, Herts, SG1 2AY.

MICROPROCESSOR TRAINING COURSES

In conjunction with Colchester Institute, Flight Electronics is offering a range of intensive four-day microprocessor courses. Contact: Suzanne Kittow, Flight Electronics Ltd, Flight House, Ascupart Street, Southampton SO1 1LU. Tel: 0703 22721.

Newsworthy news of your new product could be on these pages – send us details and preferably a photograph.

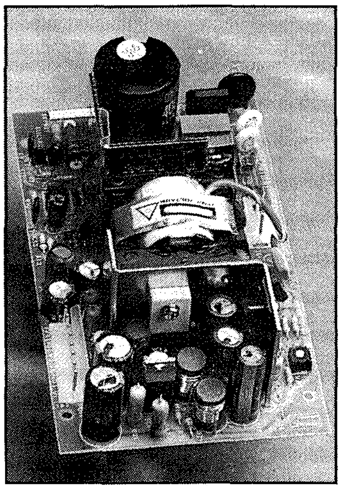
NEWS

LOW COST SM-PSUS

Skynet Electronic has announced the launch of the low cost, high quality, 65W, SNP316 series of switched mode power supplies for applications ranging from workstations and cad/cam equipment to videos, office automation and PCs.

The low noise, 100Vac to 260Vac psus incorporate overvoltage protection on output one as well as power foldback protection, rated at 150% load, on all outputs. Eight models comprise the range enabling users to specifically select output voltages from -5V to +24V over a range of rated current loads and output tolerances.

Skynet is a major manufacturer of switched mode power supplies and boasts the widest universal input psu selection available to industry. It also manufactures mosfet and magamp regulated designes and can customise to suit individual OEM specific requirements.



For more information contact Vicki Grummit at Skynet Electronic Co Ltd, 17c London Street, Basingstoke, Hants, RG21 1NT. Tel: 0256 810810.

PLASMA REVERSING

We were interested to receive the next news item, not because has any direct relevance for you as hobbyists are likely to want to use, but because it gives another insight into what goes in the world of semiconductor manufacturing.

The press release concerns plasma etching, and brought to our attention the EDPS 2000 machine.

Reactive Ian Etching (RIE) with plasma is one of the most widely used techniques in the manufacture of integrated circuits. It enables chip manufacturers to etch successive dielectric layers on ics with a high degree of accuracy.

But when it comes to reversing the process - to analyse decapsulated components for circuit failure or for reverse engineering - test laboratories run up against a major difficulty. There is no simple way of determining the exact thickness of the etched layer or the etching speed. Now the French company I.R.I.S. has developed an end-point detection system which allows the monitoring of the etching process for each layer with far greater precision than before. Based on the laser interferometry principle, the EDPS 2000 automatically halts the etching process as soon as a new layer is detected.

EDPS 2000's laser beam is adjusted so that the angle between the chip and the beam is maintained at a constant 90^ thereby reducing diffraction and reflection interference and improving the signal. The beam itself is extremely narrow (from 10 to 100 microns) and can be focussed on a very small area. The system also employs some sophisticated software routines which analyse the interferometric signal in terms of six different parameters.

Thanks to these techniques, the new machine gives the manufacturer precise etching control of decapsulated components with an 85% success rate.

For more information contact Veronique Lefevre, WTR UK, Colne House, Highbridge Estate, Oxford Road, Uxbridge, UB8 1UL. Tel: 0895 70646.

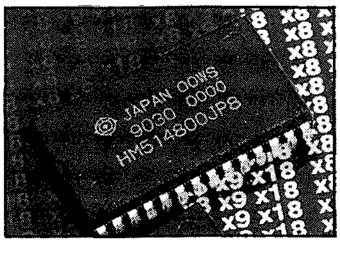
SURFACE MEMORY

Creating large capacity memory arrays in a small space has become even easier with the introduction by Impulse of drams at the 4-megabit level.

The HM514XXX series manufactured by Hitachi comprises versions organised as 512K x 8 bits, 512K x 9 bits, 256K x 16 bits and 256K x 18 bits. These organisations are designed to meet the requirements of microprocessor-based systems with the minimum of interface logic, the additional bits providing for parity.

Like other 4-megabit drams from Hitachi, this series is available in a number of speed options down to 70ns. Power is from a single standard 5V supply, and for the 7-ns parts, power requirements are modest at 605mW (active), reducing to only 11mW on standby.

For further information contact Roy Taylor at Impulse Electronics, Hammond House, Caterham, Surrey, CR3 6XG. Tel: 0883 346433.



CHIP COUNT

NEW VOLTAGE REFERENCES

Three new Advanced Linear voltage references from Texas Instruments have been designed to provide a versatile range of precision references to meet performance requirements at low power.

The LT1004 is an improved replacement to the popular LM185. Using a bandgap reference to provide high accuracy and excellent temperature stability, the 2.5V version is accurate to +-20mV, and the 1.2V version to +-4mV. The LT1004 also operates at only 10uA reference current, making an ideal choice for portable and battery powered applications, such as hand-held meters and test instruments.

The LT1009 is precision-trimmed 2.5V shunt regulator, accurate to +-5mV at 25 C. Although the device itself needs no adjustment, a third terminal is provided to allow for adjustment of up to +-5% to compensate for any system errors. It can operate over a wide range of reference currents from 400uA up to 20mA if necessary. The LT1009 can be used as a reference for an 8-bit adc or dac, or in test instruments and control systems.

The TL431A adjustable precision shunt regulator is an improved version of the TL431. It can be adjusted to provide an output voltage in the range 2.5V to 36V to an accuracy of 1%. The TL431A has a typical output impedance of 0.2 ohms, and an active output circuitry for a very fast turn-on characteristic. It is an excellent alternative to expensive zener diodes in many applications.

BIGGER RESISTOR NETWORKS

Beckman Industrial have introduced 18-pin and 20-pin dil thick-film resistor networks into their range. Models 888 and 887 respectively were developed to provide a standard package for speciality circuit applications using isolated, bussed or dual termination resistor configurations.

The standard resistance range is 22 ohms to 2M2, with a tolerance of 2% or 5% depending on the configuration, and the power rating per package is up to 2.5 watts.

Beckman are Britain's largest manufacturer of resistor networks. They also produce a wide range of capacitor, combined resistor/capacitor and diode networks in dil, sil and sm style packages.

FOUR NEW HCMOS

Four new types have been added to Philips' high speed cmos (HCMOS) range. The functions are: serial in-out, static shift register, crystal oscillator, and a buffer/line driver.

HCMOS devices bring together the features of earlier cmos devices with those of low power Schottky ttl. The result is a unique combination of low power consumption, high immunity to input noise, a wide operating temperature range, together with high speed and an excellent drive capability.

The 74HC/HCT595 is a tri-state 8-bit serial-in/serial-out shift register with output latches.

74HC/HCT7731 is functionally compatible with the HEF4731, though not pin-compatible. Its advantages are its greater speed and the fact that it can be switched in the circulation mode. Typical Applications include data storage and delay lines.

Crystal oscillator 74HC/HCT6323A features a built-in ripple counter. It is tri-state and is for use from 2 to 50MHz.

Octal buffer/line driver 74HC/HCT7245 is similar to the well known 74HC/HCT245 but features Schmitt trigger action on all inputs to maintain signal integrity.

SOURCE DATA

Beckman Industrial Ltd, Astec Building, High Street, Wollaston, Stourbridge, West Midlands, DY8 4PG. Tel: 0384 442393.

Philips Components Ltd, Mullard House, Torrington Place, London WC1E 7HD. Tel: 071-580 6633.

Texas Instruments, Manton Lane, Bedford, MK41 7PA. 0234 223000.

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AN5071	£1.20	M5218L	£1.90	STR58041	£5.00	TDA4600-2	£1.75	BU508DF	£1.25	2SC1106	£1.75
AN5150	£5.50	M50115	£2.50	TA7070	£1.15	TDA4600-3	£1.75	BU508AF	£1.10	2SC1115	£2.60
AN5256	£2.20	M50120	£7.00	TA7130	£0.70	TDA4610	£1.95	BUT11A	£0.70	2SC1170	£2.45
AN5510	£2.85	M51164	£2.00	TA7205	£0.89	TDA5630	£3.25	BUT12	£0.85	2SC1185	£3.00
AN5521	£2.20	M51172	£2.60	TA7282	£2.48	TDA5650	£4.10	TIP30	£0.25	2SC1342	£1.08
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AN5722	£1.60	M54886	£4.20	TBA120S	£0.40	TDA7231	£4.15	TIP31A	£0.22	2SC1429	£1.35
AN6135	£1.40	STA401	£3.00	TBA120P	£0.40	TDA7240	£2.90	TIP33	£0.50	2SC1445	£3.05
AN6248	£2.00	STA441	£2.25	TBA120U	£0.48	TDA8145	£1.05	TIP32B	£0.25	2SC1507	£1.30
AN6306	£8.17	STK0029	£4.00	TBA800	£0.45	TDA8153	£3.15	TIP32A	£0.23	2SC1577	£6.00
AN6360	£2.60	STK0040	£5.40	TBA520	£1.00	TDA8170	£3.00	TIP41	£0.20	2SC1678	£1.12
AN6673	£2.25	STK0049	£5.50	TBA540	£0.85	TDA8185	£4.80	TIP41A	£0.20	2SC1682	£1.45
AN6876	£1.50	STK0050	£4.50	TCA650	£2.85	TDA8190	£2.80	TIP41C	£0.22	2SC1760	£1.90
AN7120	£1.25	STK0060	£8.50	TCA830	£0.70	TDA8196	£1.50	TIP42	£0.20	2SC1875	£2.50
AN7140	£4.00	STK0080	£6.00	TCA900	£1.00	TDA9045	£3.10	TIP42C	£0.23	2SC1881	£2.00
AN7143	£2.45	STK043	£9.00	TDA440	£1.85	TDA9503	£2.21	TIP110	£0.45	2SC1913	£1.85
AN7168	£2.50	STK080	£6.20	TDA1002	£1.85	UPC554	£1.50	TIP120	£0.42	2SC1970	£1.90
AN7220	£2.85	STK082	£6.10	TDA1011	£1.00	UPC1023	£0.50	MJE340	£0.25	2SC2023	£1.60
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AN7320	£1.60	STK086	£9.00	TDA1010A	£1.00	UPC1377	£1.60	MJE521	£0.35	2SC2298	£1.15
AN7417	£2.38	STK435	£4.50	TDA1015	£1.05	UPC1382	£0.80	2N1893	£0.30	2SC2486	£2.10
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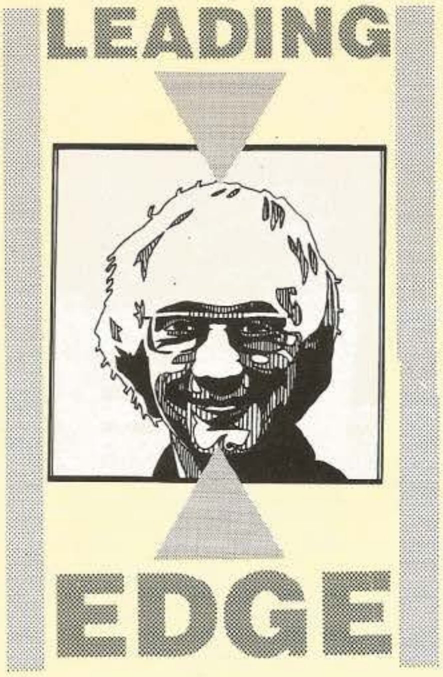

QUERYING PHONE BASE

BY BARRY FOX
Winner of the UK Technology Press Award

BT's Phone Base allows direct public access to directory data, but are the security measures hacker-proof?

I wrote recently about the mess that is British Telecom's Electronic Yellow Pages (PE Nov 90), how the EYP "Help Line" turned out to be an answering machine.

No-one ever got back on the message I left even after pieces I wrote had appeared in print. EYP looks effectively dead in the water and I can only hope that the consultants and staff who have now wasted several million pounds of BT shareholders money on this project are asked to explain themselves.

CHARGED ENQUIRES

In the meantime British Telecom has announced that in April it will reduce local telephone call charges by 4.5%, but pay for the cut by charging subscribers 43.5p whenever they use Directory Enquiries. We have known for a long time that this was coming, and that the announcement was waiting on the readiness of BT's plans to offer electronic versions of DQ (as it's known in the telecoms trade). One version is a telephone database, like EYP, the other a cd-rom. The DQ announcement was brought forward a week after press leaks embarrassed BT. Nimbus, who were pressing the cd-rom discs, had to rush through an order of 300 to meet the new deadline.

Phone Base gives direct access to BT's DQ database in Sheffield by telephone line and modem. Phone Disc stores all 17 million telephone numbers from 99 paper directories on a single 12cm disc which is searched by a Personal Computer equipped with suitable rom drive and software extensions to the operating system.

Both these electronic systems are very expensive. It costs around 26p in call charges to search a number by Phone Base. BT charges £2,200 for a year's supply of four updated cd-roms, even though it now costs less than £1 to press a cd. Also there are very real practical difficulties in setting up Phone Base to work with a conventional PC. The difficulties may deter all but skilled computer buffs.

RESTRICTED INFORMATION

At the official unveiling BT's management appeared badly informed on the technology. BT's man in charge of the new projects venture, Andy Green, General Manager Network Services, said the cd-rom could be placed on a "cd reader costing a couple of hundred pound". When I queried this, his staff corrected him; cd-rom drives cost around £500 or £600 pounds.

When asked, both Green and his boss, Mike Bett, BT's Vice Chairman and Managing Director, admitted they had never actually tried using Electronic Yellow Pages. "It's a different decision," they explained.

It really is very worrying to see the decision makers at the top of an organisation as big and powerful as BT so ignorant of the technology which pays their salaries. Apart from anything else it devalues the answers given to obvious questions, like why are the new electronic services so expensive.

Bett and Green say the very high cost pays for the security which BT has had to build in to guard against reverse searching eg to stop people getting an address and name from a telephone number or collating lists of telephone numbers for a whole village or city street. Reverse searching represents an intrusion on privacy and a security risk for terrorist targets.

A 12 cm cd-rom can hold 600 MBytes of data. BT's directory database contains 17 million names, addresses and telephone numbers, which in raw state represents 1.7 Gbytes. BT compresses the code by stripping out redundant data and at the same time encrypts it so that hackers cannot retrieve information from the disc without using BT's approved search software, which de-encrypts the numbers. This accounts for a short delay between the appearance of names and numbers. BT's software refuses to hunt for anything, unless a name is entered first. If too vague an address is entered in an attempt to trawl large volumes of numbers, the system stops searching.

BT believes that it would be easier for a hacker to key all 17 million entries from the paper directories into a PC database than de-encrypt the numbers from the cd-rom. The usual way to arrive at this conclusion is to offer hackers a prize if they can find a way to beat the system.

BT acknowledges that it will have to completely re-think the pricing structure for Phone Disc when Philips launches domestic CD-Interactive players which will cost only around £500 or £600 and will play cd-rom discs. This creates the possibility of selling directory discs direct to the public. And this would save BT the costs of printing paper directories, around £30 million year.

Until then BT suggests that people who search for between 20 and 300 numbers a week will find it cheapest to use the Phone Base system, with PC and modem. Reverse searching and trawling is also barred on Phone Base.

FLAWED

BT was forced to suspend Phone Base temporarily just three weeks after launching it as a trial service. The flaw in Phone Base was that BT's computer in Sheffield stores the full name and address of all ex-directory numbers. This meant that anyone knowing roughly where someone with an ex-directory number lives, could systematically key in the name of all streets in the area until the Phone Base computer matches names and street. Although Phone Base refused to give the telephone number, it displayed the ex-directory subscriber's address.

Now Phone Base is back in business, supposedly safer.

BT's admission that it let the Phone Base trials continue even after it knew of the security loophole inevitably calls into question the promised security of Phone Disc.

Les Macallister, Project Manager for Phone Disc, has previously refused to talk publicly about security measures. But under pressure from the Phone Base disclosure he now pledges that there is no ex-directory information on the disc. So not even the cleverest computer hacker can retrieve information from a disc if it has never been put on the disc.

Only time, and the inevitable attention of hackers, will tell whether this confidence is justified.

PRACTICAL
ELECTRONICS

BUILDING THE FUTURE

During its 26 years, PE has published many hundreds of projects, perhaps even thousands; I've never counted. They have come from many sources, from designers in industry, from advertiser's technical staff, from the staff of PE, and of course from readers.

Interestingly, as PE developed, a new breed of designers specialising in projects for hobbyist electronics magazines emerged. Many were keen amateurs who, encouraged by PE, found their expertise in both electronics and writing had developed to a point nearing professionalism. Several of our regular contributors started like this. PE always has been a breeding ground for tomorrow's electronic experts, who were inspired by having been encouraged to first build something electronic.

Yet, from time to time, I find that there are those who do not understand why anyone should want to construct electronic circuits on a hobbyist basis. Often the questioner believes that there are so many electronic products which one can cheaply buy ready made that there is no point in trying to make one's own. Whilst it's true you can often buy rather than build, those who question the validity of diy electronics miss the central points. The reasons for doing electronics on the diy level are for the satisfaction of achieving something for oneself, for the benefits of learning from it, and for encouraging an interest in electronics. Although I accept that hands-on experience is not the only cause for interest in electronics, it is a major factor in developing that interest further.

The projects we publish in PE serve these central roles. At the simplest level, readers can build a published design idea just as a project which performs its intended function. Many readers *do* build the project exactly as published, as the 1989 survey proved. That survey, though, also confirmed that many readers build variations of the project, modified to suit their own needs. Many, for example, ignore the published pcb and either design their own board or build the circuit on Veroboard. Other readers select specific parts from a variety of projects and combine them to produce something entirely different in nature. Others treat the projects as a source of inspiration, having their imagination fired by one author's solution to a problem and seeing if they can arrive at their own answer in another way. Some readers tell me they just enjoy reading circuit diagrams! But whatever your reasons, projects are a vital part of any diy electronics magazine's contents. Any such magazine which ignores the necessity for catering to the constructionally-minded reader is in peril of extinction.

Let me assure you, however, that although you will soon be seeing some exciting changes to PE, we shall continue to keep you well supplied with interesting, useful and original projects. Indeed, it's to this area that I shall be giving my future attention. I've decided to take a break from the day-to-day excitement of editing the entire contents of PE. So I'm stepping sideways and passing the editorial chair over to Kenn Garroch. He will have the overall responsibility and fun of entertaining and informing you, starting next month. But I'm not deserting you: I'm going to concentrate specifically on projects, as Projects Editor. Hopefully, I'll also find more time to do what I love best, experimenting with electronics.

Best wishes to all of you.

JOHN BECKER

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LOW-COST CAR ALARM

Kevin Browne's multiple circuitry offers increased security for any car. And it's easy to build and install.

This project is concerned with the construction, and fitting, of a reliable car alarm system. It offers many of the facilities of the top manufactured models - but, at less than a fifth of the cost. The alarm system is easy to install, with a minimum of additional wiring. It is suitable for any type of car.

FACILITIES

* Alarm detection, using existing interior light switches.

* Variable entry delay period.

* No minimum exit delay (system armed by closing last door)

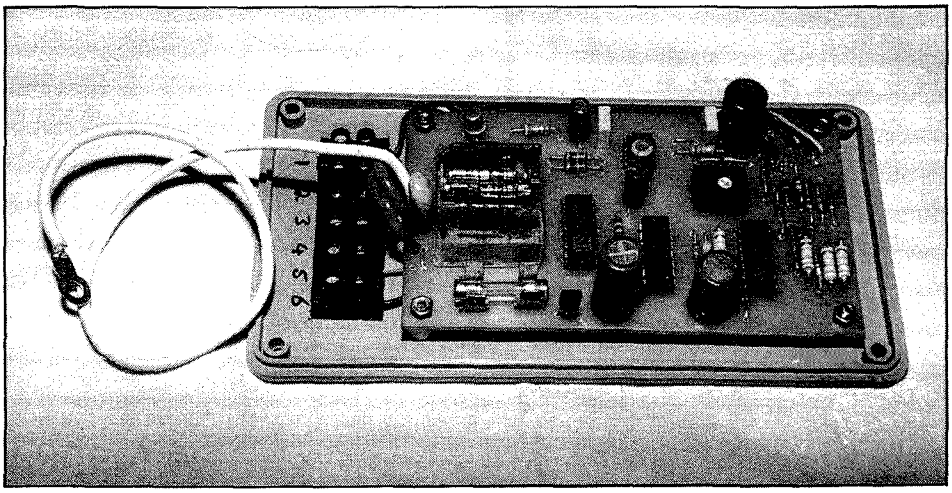
* Automatic timeout and resetting.

* Break glass detection.

* Addition of a visual deterrent.

* Alarm sensing, immune to wind or traffic vibration.

* Concealed switch or ignition key control.



The alarm controller main printed circuit board assembly.

SYSTEM DESCRIPTION

The full alarm system consists of three separate parts, the alarm control unit, the shock sensing unit and the visual deterrent. (See Fig.1). The function of each unit is outlined below:

Alarm control unit

As the name suggests, this unit is responsible for overall control of the alarm system. It detects the alarm conditions from either the car doors or the shock sensing unit, sounds the alarm and automatically resets it after a period of time. It also controls the entry and exit delay sequences. This unit may be fitted on its own to provide a basic alarm system, or with either, or both, of the following units to provide a full security system.

Shock sensing control

The unit is responsible for detecting a forced entry to the car, a smashed window, or a damaged lock for example. It works by detecting the shock vibrations which are set up in the metal shell of the car by any sudden or violent action. When a shock is detected, an alarm signal is sent to the control unit, to trigger the alarm.

Visual deterrent.

This part of the unit is provided more for its looks than its actions. It is designed to look like an expensive ultrasonic alarm unit, and a flashing led draws attention to it, especially at night. It should be mounted prominently, on the dashboard of the car - to maximise its effect.

CONTROL OPERATION

The operation of the alarm control unit is split into a number of different functions:

1. System on/off control

The alarm can be controlled either by the car ignition (allowing the system to be switched on automatically when ever the ignition key is removed) or by a small switch carefully concealed within the car.

Terminal number 5 in Fig.2 is the input for the former control method. This terminal requires 12 volts to be applied to it to inhibit the alarm system. R3 and D5 drop this voltage to 5 volts, which is then applied to the reset inputs of the two latches IC3a and IC3b preventing them changing from a reset state.

The second inhibit input (terminal 6) requires a zero volts condition to inhibit the alarm. This input is inverted by IC1a, again to provide a 5 volt logic signal to the reset inputs.

2. Alarm detection

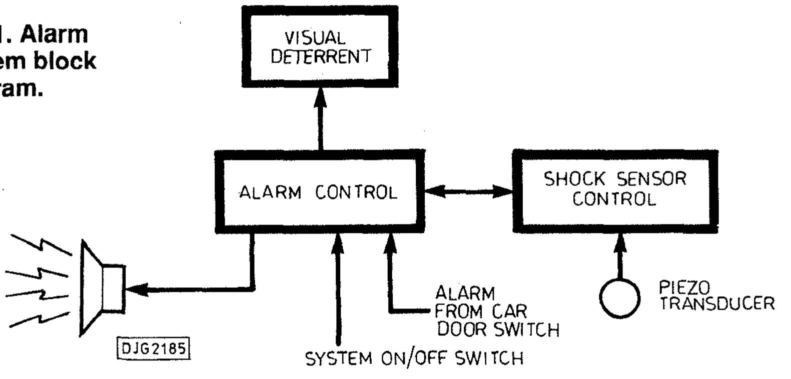
Two alarm detection inputs are provided to the alarm control unit. One of the inputs (terminal 1) requires a 0V condition to trigger the alarm. This input will be wired to the courtesy light door switches of the car, to trigger the alarm whenever a door is opened. The second alarm input (terminal 2) is normally connected to 0V. It is the removal of this condition which triggers the alarm. This terminal will be wired to the alarm output of the shock sensing unit.

The presence of an alarm condition (0V) at terminal 1 will cause the output of IC2c to go high. This will set the alarm latch (IC3b), subsequently sounding the alarm. If the circuit is triggered from the second alarm input (terminal 2), the removal of the 0V condition allows R2 to pull up the input of IC1b, the output of which, via D7, applies a 0V condition to the alarm lead. This will set the alarm latch (IC3b) via Ic2c.

3. Enabling the alarm system

The sequence for enabling the car alarm is as follows: First, open the car door, then, switch on the alarm system. Get out of the car and finally, close the doors. The action of closing the last door enables the alarm system. Should any door be opened again, the alarm will be triggered (after the entry delay period has expired).

Fig. 1. Alarm system block diagram.



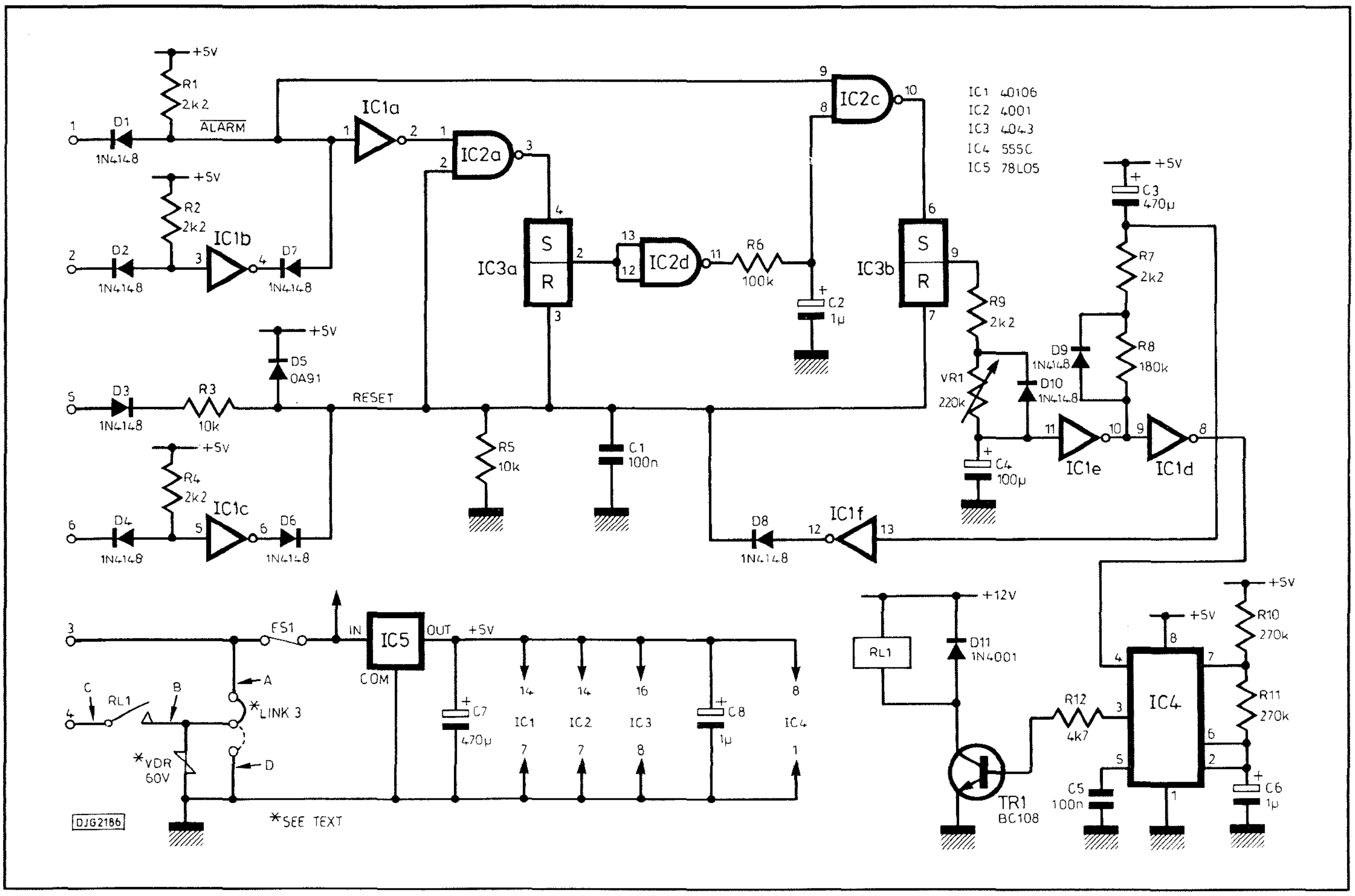
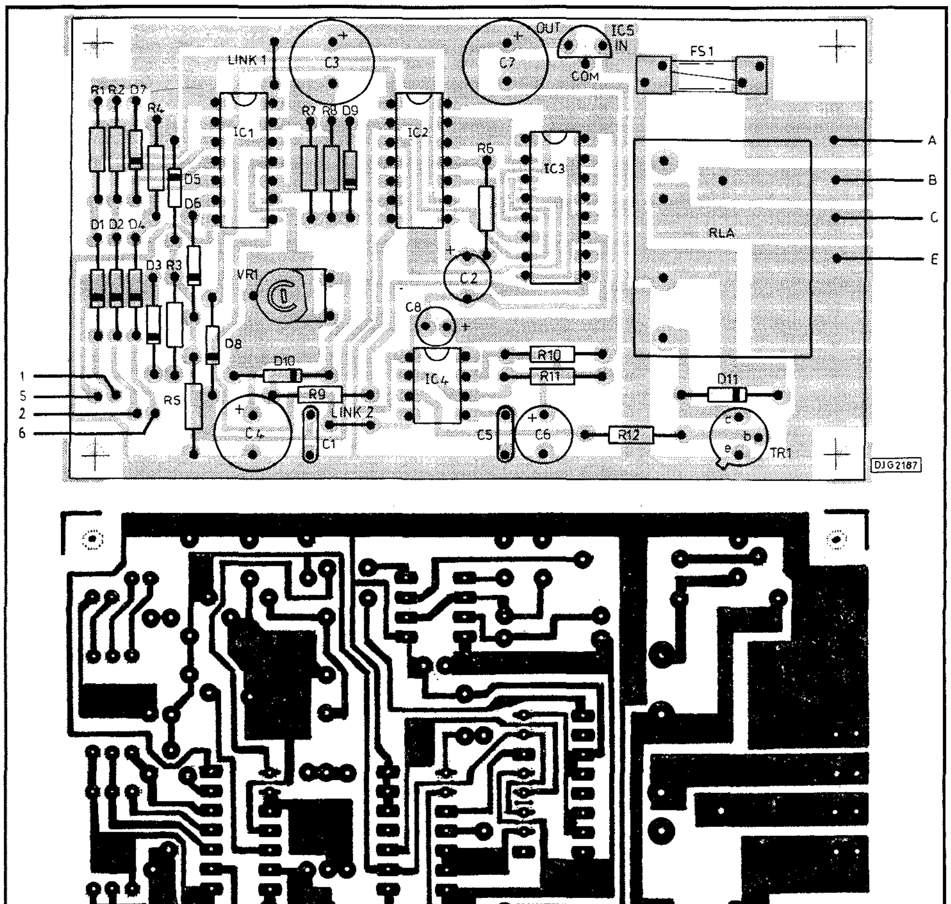

+5V
R1
2k2
D1
1N4148
ALARM
IC1a
IC2a
IC2b
R2
2k2
IC1b
D2
1N4148
D7
1N4148
IC3a
S
R
13
12
IC2d
R6
100k
C2
1μ
IC2c
IC3b
IC1 40106
IC2 4001
IC3 4043
IC4 555C
IC5 78L05
C3
470μ
R7
2k2
R9
2k2
R8
180k
D9
1N4148
D10
1N4148
VR1
220k
D5
OA91
D3
1N4148
R3
10k
RESET
R5
10k
C1
100n
C4
100μ
IC1e
IC1d
R4
2k2
IC1c
D4
1N4148
D6
1N4148
D8
1N4148
IC1f
+12V
RL1
D11
1N4001
FS1
IN
IC5
OUT
COM
C7
470μ
C8
1μ
14
IC1
7
14
IC2
7
16
IC3
8
IC4
1
A
*LINK 3
D
C
RL1
B
*VDR
60V
DJG2186
*SEE TEXT
R12
4k7
TR1
BC108
C5
100n
IC4
R10
270k
R11
270k
C6
1μ

Fig. 2. Circuit diagram of the alarm controller.

Below: Figs. 3 and 4. Component and track layouts for the alarm controller pcb


LINK 1
C3
C7
OUT
IC5
IN
COM
FS1
R1 R2 D7
R4
IC1
R7 R8 D9
IC2
R6
IC3
D5
D6
D1 D2 D4
D3 R3
VR1
C2
C8
RLA
A
B
C
E
D8
D10
R10
R11
IC4
D11
R9
R5
LINK 2
C4
C1
C5
C6
R12
TR1
1
5
2
6
DJG2187

The action of opening the car door applies an alarm condition to terminal 1 of the alarm control, since at this stage the system is still inhibited, with a logic 1 on the reset lead. Latches IC3a and IC3b remain reset. When the alarm system is switched on, the logic 1 is removed from the reset lead.. This has no effect at this stage. Closing the last car door removes the alarm condition from terminal 1. This allows the latch IC3a to set (from the output of IC2a). C2, via R6, slowly discharges. This holds one input of IC2c high for approximately 500ms after the car door has been closed in order to prevent any contact bounce in the door switches from setting the latch IC3b prematurely. The alarm system is now armed.

4. Triggering the alarm

An alarm condition subsequently being detected from either terminal 1 or terminal 2 will (via IC2c) set latch IC3b, the output of which will slowly charge C4 by way of R9 and VR1. This provides for an entry delay period, variable between one and 20 seconds (set by VR1). At the end of this period the output of IC1e goes low, causing the output of IC1d to go high. This removes the reset condition from the timer (IC4) allowing it to oscillate at approximately 1Hz. This, in turn, operates the relay, sounding the car horn in short bursts.

5. Alarm timing and auto reset

As soon as the alarm starts to sound, C3 (via R7 and R8) slowly discharges. This takes approximately 100 seconds. At the end of this period the output of IC1f will go high, applying a 5 volt reset level to both latches (IC3a and IC3b), silencing the alarm.

If an alarm condition is still present at this stage, IC2a will prevent latch IC3a from being set. The circuit will remain in this 'lockout' state until the alarm condition is removed.

When the alarm condition is removed, IC2a will set latch IC3a, returning the circuit to its original pre-alarm state. Any further alarm conditions will retrigger the circuit as normal.

6. Disarming the alarm

Switching the alarm system off at any stage will apply a logic 1 to the reset lead, and this will clear both latches and disable the alarm.

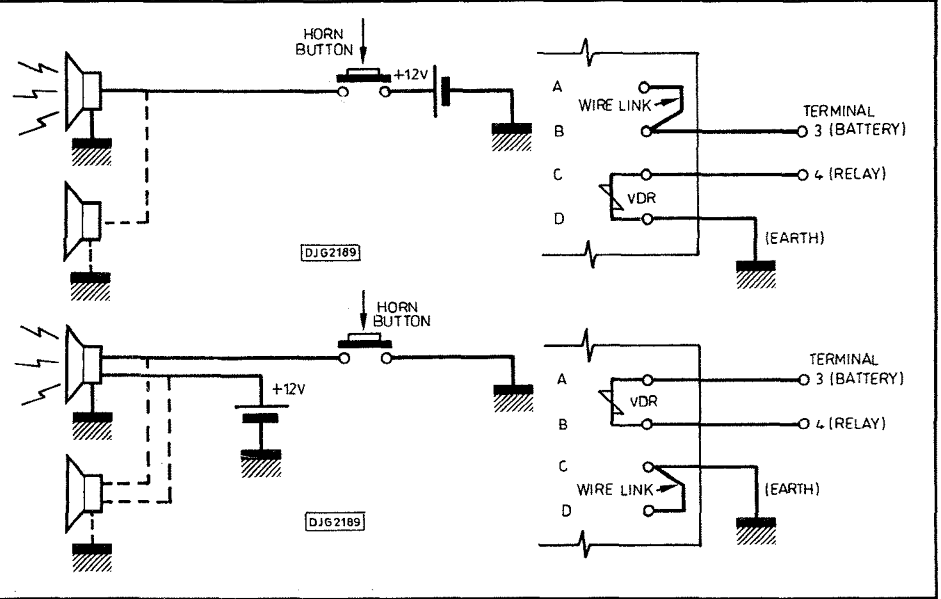


Fig. 5 (Top). Earth wired horn system.
Fig. 6. Battery wired horn system.

CONTROL UNIT CONSTRUCTION

The assembly of the main control pcb (Figs. 3 and 4) presents no real problems. The smaller components should be fitted first, however, leaving until last the ics. It is recommended that these are soldered direct to the pcb, as the alarm unit can be subjected to severe vibration when fitted to the car and it is possible that the ics may become dislodged from the sockets. Great care should be exercised to use the minimum of heat, and a soldering iron with an earthed tip should be used, as all the chips are cmos and subject to possible static damage.

Four lengths of stranded wire should be soldered to points 1,2,5 and 6 for connection to the terminal strip. The connections to points A,B,C and D (Figs. 5 and 6) and the fitting of the delay are dependent upon the type of car horn fitted to your car. Most cars are fitted with a single wire horn system which uses the car body as a common return. The connections to A,B,C and D for this type of horn circuit are shown in Fig.5. Some cars, on the other hand, have a two wire horn system, with a permanent battery connected to one side of the horn(s). In this case use the connections as shown in Fig.6. In both cases, the wire used to connect the battery supply and the relay contact to the terminal strip, and also the earth wire to the pcb, should be of sufficiently heavy duty to carry around 10 amps.

The pcb should be loosely mounted inside the lid of the box as shown in Fig.7, using four 6BA nuts and bolts with 0.25 inch spacers. The terminal strip is mounted as shown, and is best held in place with suitable glue. Connect the wiring between the pcb and the terminal strip as shown in Fig.8.

ALARM CONTROL

RESISTORS	
R1,R2,R4,R7,R9	2k2 (5 off)
R3,R5	10k (2 off)
R6	100k
R8	180k
R10,R11	270k (2 off)
R12	4k7
VR1	220k sub-miniature preset
SEMICONDUCTORS	
D1-D4,D6-D10	1N914 or 1N4148 (9 off)
D5	OA91
D11	1N4001
TR1	BC108
IC1	40106 hex schmitt trigger
IC2	4001 quad 2 i/p NOR gate.
IC3	4043 quad NOR r/s latch.
IC4	TLC555C cmos timer
IC5	uA78L05 +5V 100mA regulator
CAPACITORS	
C1,C5	100n disc ceramic (2 off)
C2,C6,C8	1µ 100V electrolytic (3 off)
C3,C7	470µ 35V electrolytic (2 off)
C4	100µ 25V electrolytic

MISCELLANEOUS

Relay flat 12V (eg, Maplin HY20W), fuse 20mm 100mA. fuse clips (2 off), voltage dependent resistor (VDR) 60V (eg, Electrovalue S07K60), box to suit, 2 amp connector (6-way), 0.25 inch spacers (4 off), 6BA nuts and bolts, (4 off), rubber grommet 0.5 inch, spst subminiature toggle switch, connecting wire and connectors, (car accessory shops).

MAIN CONTROL TESTING

With the aid of a bench power supply, set to 12 volts, connect up the battery and earth supplies of the alarm unit. Also connect terminal 2 to 0V. Set VR1 to minimum, and switch on the power. In its quiescent state the circuit should only take two to three milliamps. If the relay starts to operate tap a 0V condition briefly to terminal 6 to reset the circuit.

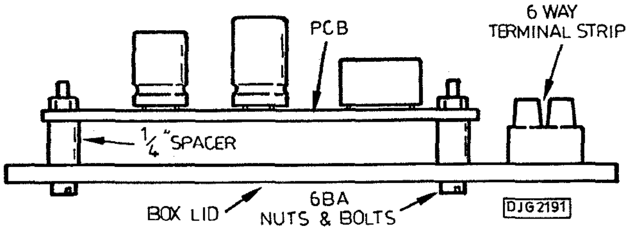


Fig. 7. Alarm control pcb mounting.

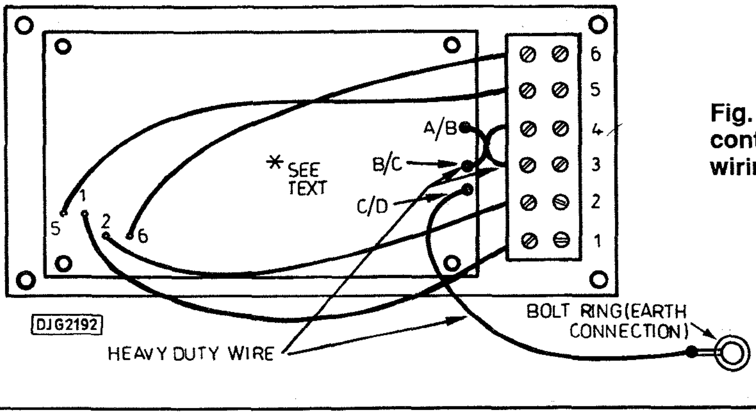
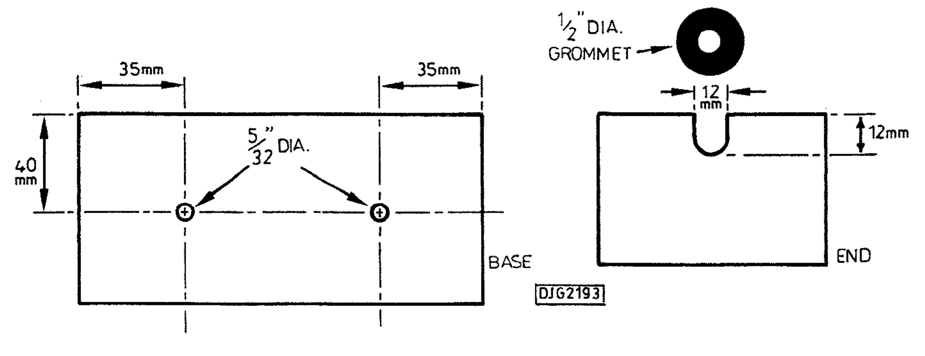


Fig. 8. Alarm control pcb wiring.

Fig. 9. Alarm control box.



First, with a meter, check the 5 volt supply from the regulator (IC5). Next, with a short length of wire apply a 0V condition briefly to terminal 1. Almost immediately the relay should start to operate and release at approximately 1 Hz. A quick tap with a 0V condition to terminal 6 should reset the circuit. Again trigger the alarm from terminal 1, this time apply a +12V reset pulse to terminal 5. The circuit should again reset. Trigger the alarm for a third time, but leave the alarm condition on. Don't reset the circuit, but leave it for approximately 100 seconds, after which the circuit should automatically reset. Now remove the alarm condition. As a final check, repeat each of the above tests, but this time trigger the alarm with a brief disconnection of terminal 2.

If desired at this stage, the alarm delay (set by VR1) may be given a rough setting. A delay of around 10 seconds between triggering an alarm and the relay first operating is usually sufficient, but this can be finally set after installation in the car.

MAIN CONTROL FINAL ASSEMBLY

Once the circuit has been tested and is working satisfactorily, the pcb should be removed from the mountings and give a coat of (non-conducting) lacquer or varnish on both sides, to provide protection against damp. When the pcb is dry, re-mount and tighten the screws, using either locktight or shakeproof washers to ensure that they remain secure.

Cut a slot in one end of the base of the box as shown in Fig.9 to accommodate a large rubber grommet. Also drill two holes in the base, to allow the box to be secured to the car with self tapping screws.

SHOCK SENSING OPERATION

When a window in a car is broken, or when a lock is forced, a series of shock waves are set up in the shell of the car. These waves can be detected by a piezo transducer attached firmly to any part of the car's shell. The resulting signal is amplified by TR1 and TR2, (Fig.10) with VR1 setting the overall gain, and thus the sensitivity of the circuit. This signal is then rectified by TR3 and presented to one input of IC1d. The combination of IC1d, IC1c and C3 acts as a pulse stretching circuit, lengthening the very short pulses produced by TR3 into pulses of approximately 500ms duration. The second input of IC1c is used as an inhibit, preventing any output pulses being generated when held low.

Terminal 4 of the shock sensing unit is an inhibit input and is wired to the car door switches. This is to allow the shock of closing a door to dissipate before activating the detection circuit. The delay period is produced by the slow discharge of C4 via R11 and R12. This takes about two seconds.

The alarm output of the unit is from TR4, which is normally in the 'on' state. Terminal 5 of the unit is therefore at 0 volts. When an alarm condition is detected, TR4 is turned off momentarily. This is detected by the alarm control unit, and acted on accordingly.

LED1 is provided as a testing aid for setting up the shock sensing unit.

SHOCK SENSOR CONSTRUCTION

The assembly of this pcb (Figs. 11 and 12) presents no problems, I again soldered IC1 directly to the pcb, but use a socket if you'd prefer, since this unit will be mounted inside the car. Connect short lengths of stranded wire to the six points on the pcb for connection to the terminal strip. Mount the pcb inside the box, along with the terminal strip. Solder a length of screened wire to the piezo transducer; about a yard is sufficient. The central conductor should be soldered to the central electrode of the transducer and the screen of the cable (suitably sleeved) to the brass base (see Fig.13). Caution should be exercised to use the minimum of heat necessary for the shortest possible time otherwise the silvered coating of the piezo's electrodes will be permanently damaged.

Drill two holes in the side of the box, large enough to accommodate two small rubber grommets - one for entry of the screened transducer cable and one for the connecting cable to the main alarm control unit.

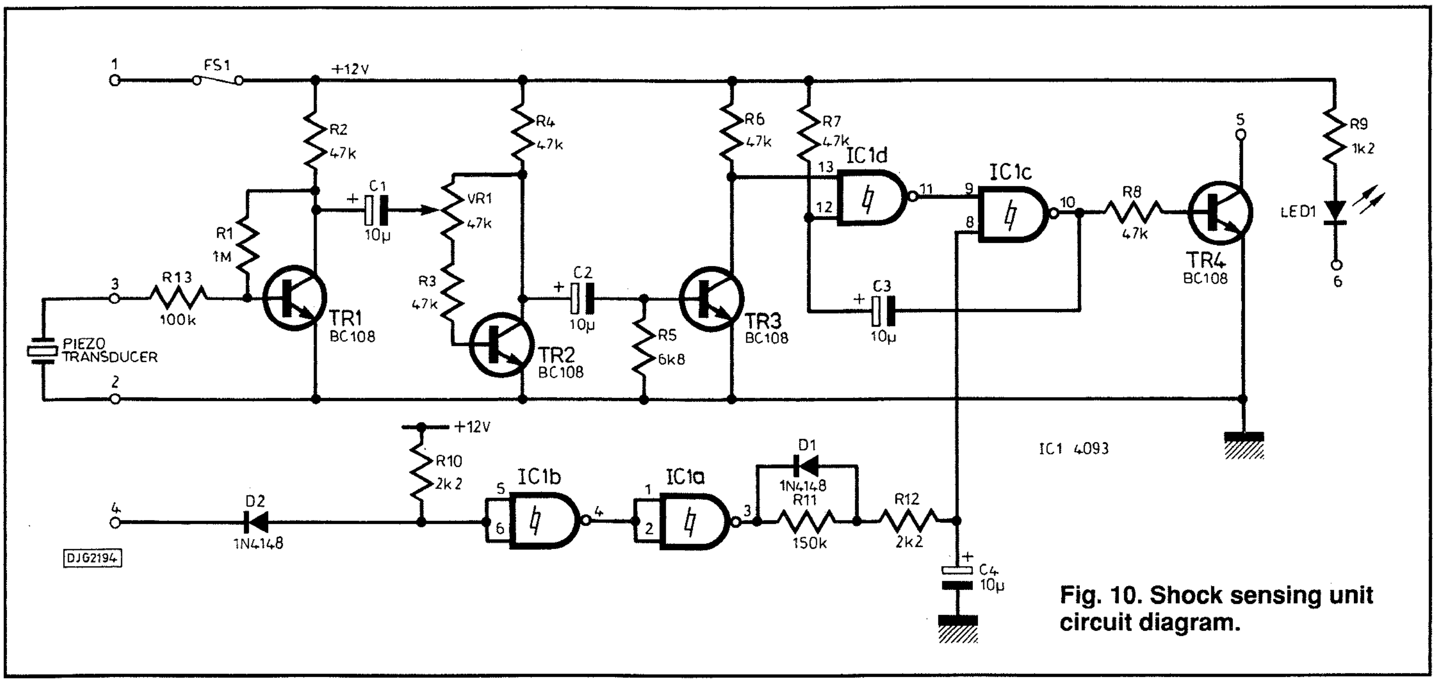
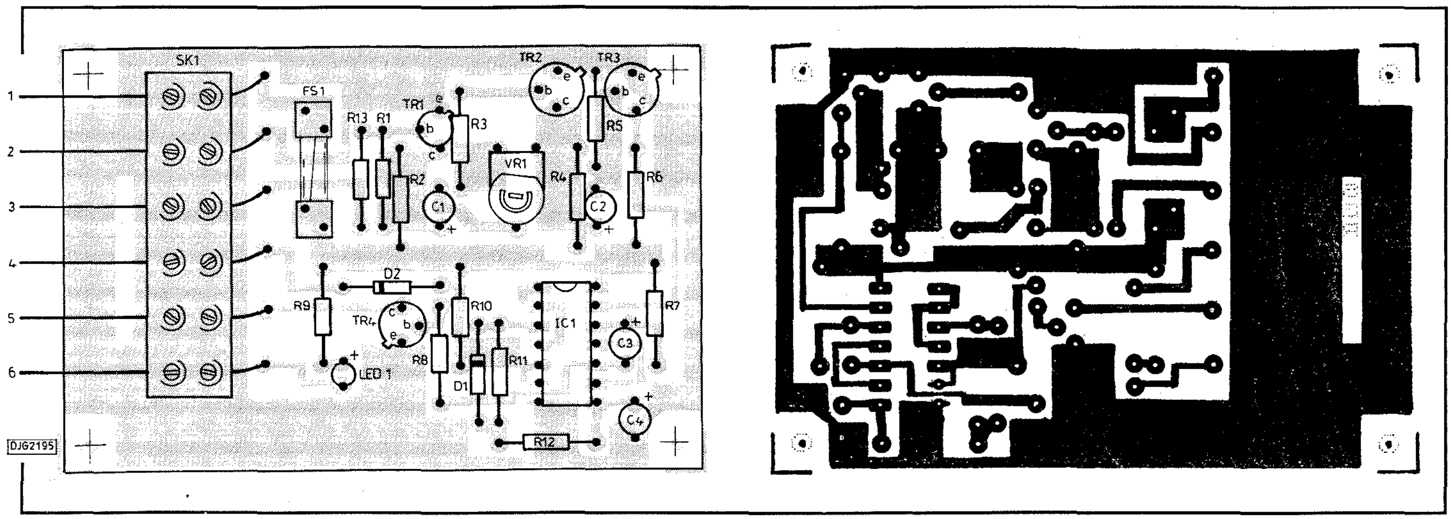
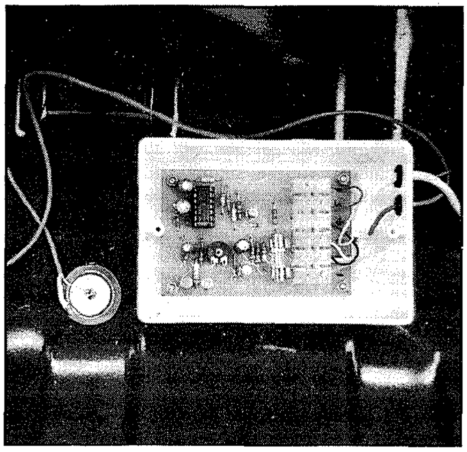


Fig. 10. Shock sensing unit circuit diagram.


SK1
1
2
3
4
5
6
FS1
R13
R1
TR1
R3
TR2
TR3
R5
VR1
R4
R6
R2
C1
C2
D2
R9
TR4
R10
IC1
R7
C3
R8
R11
D1
LED 1
C4
R12
DJG2195

Figs. 11 and 12. Shock sensor pcb component and track layouts.



Shock sensor mounting in car.

SHOCK SENSOR

RESISTORS

R1	1M
R2-R4,R6-R8	47k (6 off)
R5	6k8
R9	1k2
R10,R12	2k2 (2 off)
R11	150k
R13	100k
VR1	47k subminiature preset

SEMICONDUCTORS

D1,D2	1N914 or 1N4148 (2 off)
LED	5mm Red
TR1-TR4	BC108 (4 off)
IC1	4903 quad 2 i/p NAND Schmitt

CAPACITORS

C1-C4	10µ electrolytic (4 off)

MISCELLANEOUS

Box to suit, piezo transducer (eg, Maplin QY13P), fuse 20mm 100mA, fuse clips (2 off), 2 amp connector (6-way), connecting cable, screened cable.

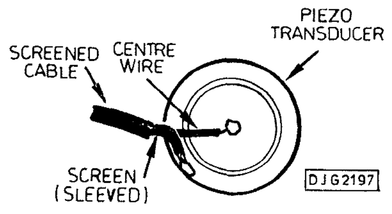

PIEZO TRANSDUCER
SCREENED CABLE
CENTRE WIRE
SCREEN (SLEEVED)
DJG2197

Fig. 13. Transducer connections.

SHOCK SENSOR TESTING

Fit a wire link between terminals 5 and 6, and connect the transducer to terminals 2 and 3 (screen to 3). Carefully attach the transducer to the bench using a length of insulating tape. Connect up a bench PSU, set to 12 volts, to terminals 1 and 2. Set the sensitivity control of VR1 to midway. The led should be lit. Gently tap the bench close to the transducer - the led should flick off for short periods of time. Now apply a 0 volt condition to terminal 4; this time tapping the bench should have no effect on the led which should remain lit.

VISUAL DETERRENT UNIT

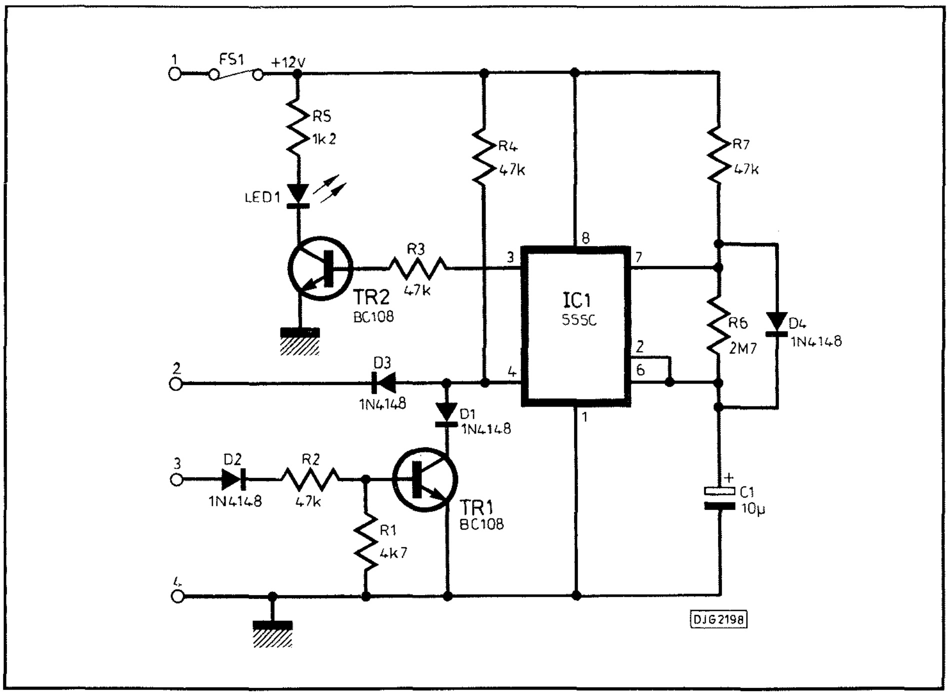
The operation of this circuit (Fig.14) is very simple indeed. IC1 is connected as an astable multivibrator, R6, R7 and C1 set the frequency and periodicity to give about a 500ms flash of the led every three seconds or so. D4 is included to enable IC1 to give a shorter 'on' than 'off' period, something not normally possible with a 555 timer ic.

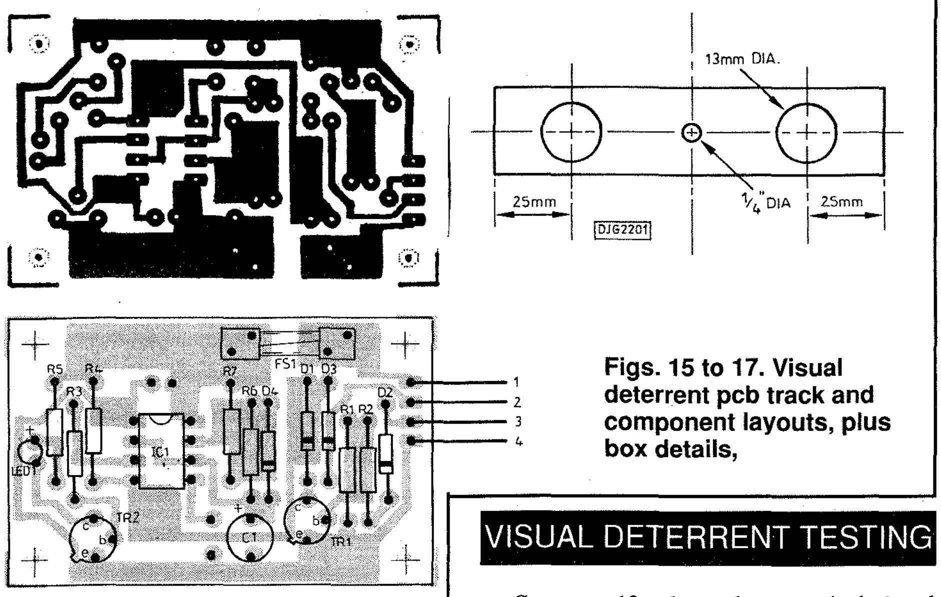
The two input terminals 2 and 3 provide for a +12V or a 0V inhibit condition in order to switch the flashing led off, when the alarm system is deactivated.

VISUAL DETERRENT CONSTRUCTION

The assembly of this pcb is the easiest yet (Figs. 15 and 16), with only a dozen or so

Fig. 14. Visual deterrent unit circuit diagram.


1
FS1
+12V
R5
1k2
LED1
R4
47k
R7
47k
R3
47k
TR2
BC108
8
3
7
IC1
555C
R6
2M7
D4
1N4148
2
D3
1N4148
4
2
6
D1
1N4148
1
3
D2
1N4148
R2
47k
TR1
BC108
R1
4k7
C1
10µ
4
DJG2198


13mm DIA.
1/4" DIA
25mm
25mm
DJG2201
R5 R4 R3 R7 R6 D4 FS1 D1 D3 D2 R1 R2
IC1
LED1
TR2
TR1
C1
1
2
3
4

Figs. 15 to 17. Visual deterrent pcb track and component layouts, plus box details,

components to mount. The led is not mounted on the pcb, so connect two lengths of stranded wire to the pcb for connection to the led. Also connect wires to points 1 to 4 for connection to the terminal block.

Holes should be cut in the front of the box as shown in Fig.17. It is worth spending some time doing this, as appearance is the most important part of this unit. The easiest way I found of making the large holes, was to drill a 0.25 inch hole, then ream out the hole to the required size, either with a purpose-made tool or with a small half round file. Once you are satisfied with the holes, stick two pieces of aluminium mesh (for example, the type supplied with glass fibre kits to repair rust holes in car bodywork) over the inside of the large holes to give the appearance of a pair of ultrasonic transducers peeping through. Add a further hole in one side of the box, complete with grommet for the connecting cable. Mount the pcb in the bottom of the box, using two small countersunk nuts and bolts. Connect up the terminal strip which should also be stuck in the bottom of the box. Clip the led in the centre hole and connect to the pcb.

VISUAL DETERRENT

RESISTORS

R1	4k7
R2-R4,R7	47k (4 off)
R5	1k2
R6	2M7

SEMICONDUCTORS

D1-D4	1N914 or 1N4148 (4 off)
LED	5mm red
TR1,TR2	BC108 (2 off)
IC1	TLC555C cmos timer

CAPACITOR

C1	10µ 50V Electrolytic

MISCELLANEOUS

box to suit, fuse 20mm 100mA, fuse clips (2 off), led clip, aluminium mesh, connecting cable.

VISUAL DETERRENT TESTING

Connect a 12 volt supply to terminals 1 and 4. The led should flash about once every two to three seconds. Apply a 0V condition to terminal 2, the led should remain off. Remove this condition, then apply 12V to terminal 3; the led should again stop flashing and remain off.

FITTING THE ALARM SYSTEM

At this stage it is worth spending some time considering the various connections required to the car's electrical system and at what point a suitable connection can be made. It is useful to have access to a circuit diagram of the electrical system, which should give the colour coding of the various wires making identification easier. For making the actual connections to the existing wiring, I used the 'Scotchlock' type connectors which are avaiable from any car accessory shop. These are small blue plastic devices which slip over an existing wire. A quick squeeze with a pair of pliers forces a small metal blade through the insulation of the old and new wires to complete the connection.

Secure the alarm control unit box to the car using a couple of self-tapping screws. The site chosen for this should be convenient for most of the interconnecting wiring. I mounted mine inside the engine compartment, but it could equally as well be mounted under the dashboard. Connect the earth wire from the alarm control unit (terminal 1).

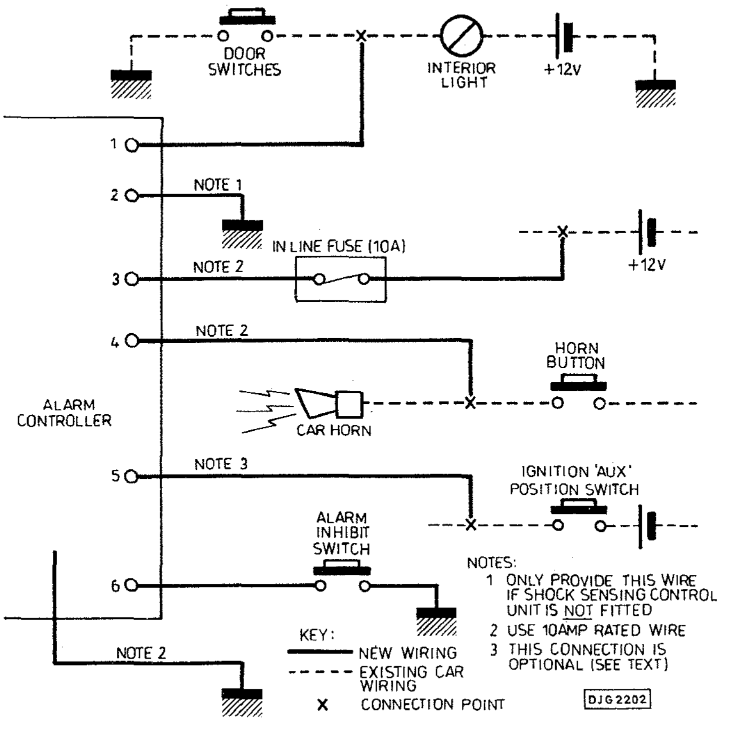
The wire to terminal 3 should be connected to a permanent 12 volt battery supply. This wire, along with the wire to terminal 4, should be a heavy duty 10 amp wire. For safety reasons, an in-line fuse holder containing a 10 amp fuse should be fitted in this wire at a convenient point. It is advisable to leave the fuse disconnected until all the other wiring is complete.

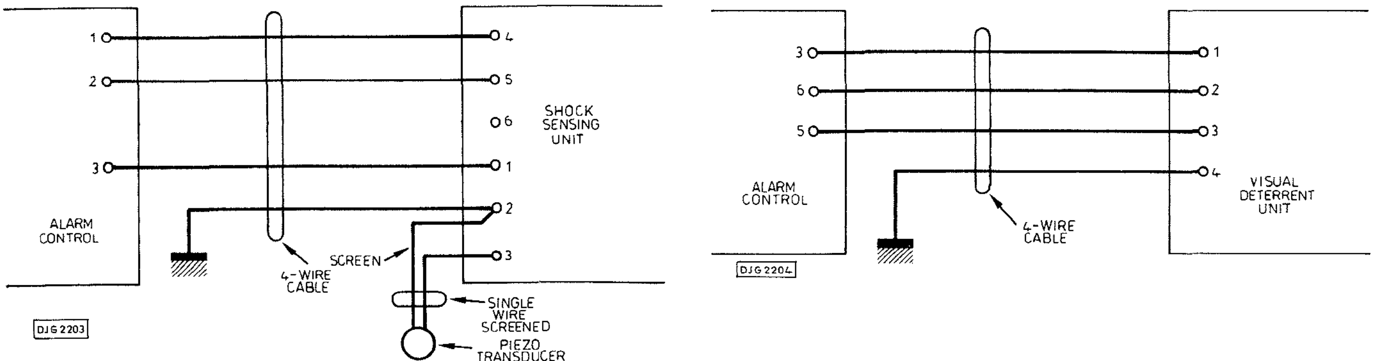
Next, identify the wiring from the horn button to the car's horn(s). This is the connection point for terminal 4. Leave this wire disconnected until after testing the alarm installation, to avoid disturbing the peace!

Wire number 5 is optional and may be omitted if not required. This circuit allows the alarm system to be controlled by the ignition key of the car. To use this facility, the concealed switch should be left enabled, control of the alarm system is now made dependent on the ignition key. Identify a wire from the ignition switch which is only live once the key is turned to the auxiliary or first step position. This wire should be connected to terminal 5.

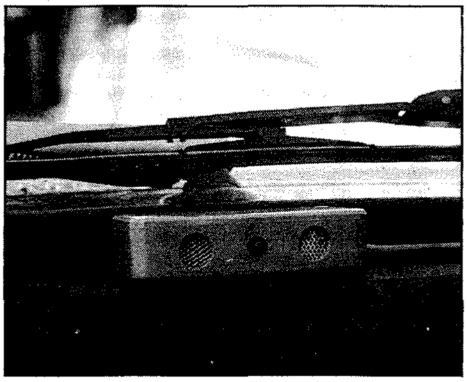
Finally fit the alarm inhibit switch. This is a subminiature toggle switch, mounted out of sight, yet convenient to operate. Two lengths of wire should be attached to the switch, one connected to the metal bodywork of the car using a small bolt ring and self-tapping screw,

Fig. 18. Wiring the alarm control unit.


DOOR SWITCHES
INTERIOR LIGHT
+12V
1
2
NOTE 1
IN LINE FUSE (10A)
+12V
3
NOTE 2
4
NOTE 2
HORN BUTTON
ALARM CONTROLLER
CAR HORN
5
NOTE 3
IGNITION 'AUX' POSITION SWITCH
ALARM INHIBIT SWITCH
6
NOTE 2
KEY:
NEW WIRING
EXISTING CAR WIRING
X CONNECTION POINT
NOTES:
1 ONLY PROVIDE THIS WIRE IF SHOCK SENSING CONTROL UNIT IS NOT FITTED
2 USE 10AMP RATED WIRE
3 THIS CONNECTION IS OPTIONAL (SEE TEXT)
DJG2202



Figs. 19 and 20. Wiring the shock sensing and visual deterrent units.



Visual deterrent mounting.

the other run to the alarm control unit and terminated on terminal 6.

Secure the lid of the alarm control unit and replace the in-line fuse.

TESTING THE INSTALLATION

At this stage it is a good idea to test the installation so far. Close all the car doors, except one, and turn on the alarm system by what ever means you have chosen. Close the last car door and listen to the alarm control unit. Nothing should happen. Open a door, and after the delay period (which was roughly set during the initial testing) the alarm relay should be heard operating and releasing. Switching off the alarm should stop the relay operating. At this stage, it is advisable to fine tune the delay period, experimenting with the time taken to open the door and switch off the alarm. Within reason, the shorter the delay period the better.

If it is intended to fit the rest of the alarm system the wiring to the horn should be left disconnected at this stage, otherwise connect the horn up now.

FITTING THE SHOCK SENSOR

The piezo transducer which is used to detect shock waves in the car is best fitted as near central as possible. I fitted mine centrally beneath the rear seat of the car. The brass base of the transducer should be stuck firmly to the metal framework of the car using a small amount of epoxy resin type glue. Ensure that the transducer is not in a position where it could be crushed by the seat when it is replaced. Cover the transducer with a small area of foam rubber to provide sound insulation. Temporarily place the shock control unit nearby and connect up the screened cable.

The next task is to run a 4-wire connecting cable between the shock sensing unit and the alarm control unit. Disconnect the power from the main alarm control unit by removing the in-line fuse, remove the temporary wire connected to terminal 2 of the alarm control and discard. Connect up the 4-wire connecting cable as shown in Fig.19, remembering to pass the cable through the sealing grommet first. Where two wires are in the same terminal it may be advisable to twist them together and solder them for security. The earth connection should be made to the same earth point as the alarm control, again using a bolt ring. On the shock sensor connect all wiring as shown in the diagram, except for the wire to terminal 5. Instead connect a temporary strap between terminals 5 and 6.

Secure the lid of the alarm control unit and reconnect the power.

TESTING THE SHOCK SENSOR

Place the shock sensing unit in a position where it can be seen from outside the car, and close all windows and doors. The red led on the unit should be lit. By thumping various parts of the car it should be possible to make the led flick off briefly. Adjust the sensitivity control until hefty thumps will flick the led but accidentally brushing against the car should have no effect on it. Spend some time experimenting with various settings to ensure satisfactory operation.

Once you are satisfied with the sensitivity settings, disconnect the temporary strap between terminals 5 and 6 and connect up the remaining wire. A check should now be made to ensure a hefty thump will trigger the alarm system, after of course the entry delay period has expired.

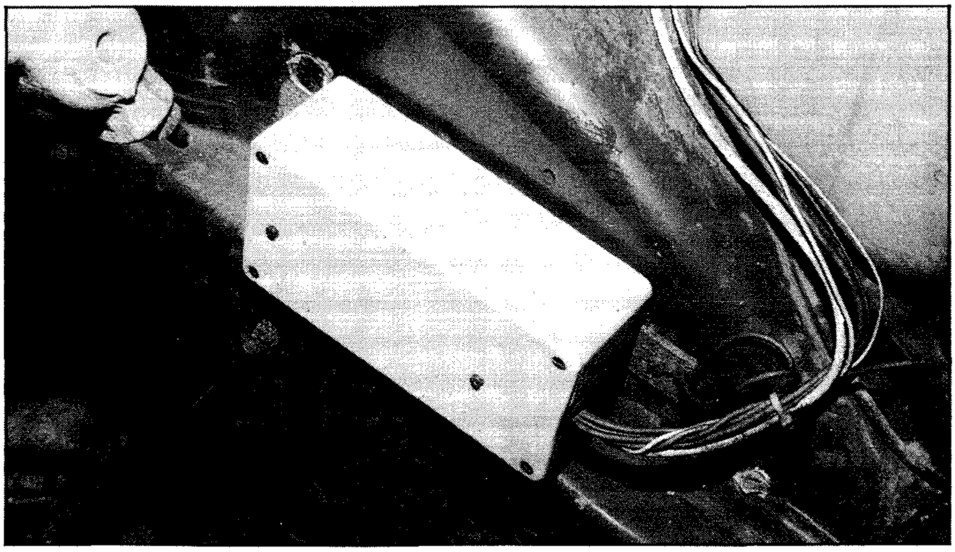
Finally secure the shock sensing unit to the car in a convenient position.

VISUAL DETERRENT FITTING

Fitting the visual deterrent unit is easy. First, run a 4-wire connecting cable between the visual deterrent and the alarm control unit, and terminate it at both ends as shown in Fig.20. Remember to remove the in-line fuse from the alarm control unit before making any connections. Mount the visual deterrent until centrally on the dashboard with the 'ultrasonic' detectors pointing into the car. The unit is best held in place with a small piece of double-sided tape.

TESTING THE INSTALLATION

If you have not already done so, connect up the car horn to the system. Switch on the alarm and close the car doors. If all is well the visual deterrent led should flash every two to three seconds. Trigger the alarm by opening a door. After the entry delay period, the horn should sound in short bursts. Switch off the alarm system and the horn should cease immediately.



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MINIATURE PASSIVE INFRA-RED SENSOR-RP33

Switchable Dual range, detects intruders up to 6 or 12 metres

This advanced sensor operates by detecting the body heat of an intruder moving within the detection field. Slow ambient changes such as radiators, etc. are ignored. Easily installed in a room or hallway. Providing reliable operation from a 12V supply, it is ideal for use with the CA 1382 or equivalent high quality control unit. Supplied with full instructions. Quantity discounts start at 3 units

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Crystal controlled movement detection module operating at 50kHz with an effective range up to 20ft. Suitable for operation in household or vehicle security systems. 12V operation and built-in timing makes it suitable for a wide range of applications.

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Automatic Loop Test & Switch On ★ Automatic Siren Re-Set ★ Audible Entry/Exit Warning Buzzer ★ Two Separate Loop Inputs + 24-hr Circuits ★ Easily Installed, Full Instructions Supplied.

This advanced control panel provides effective and reliable control for all security installations, yet its operation is sheer simplicity for all members of the family, and is supplied with two keys. Housed in a steel case with an attractive moulded front panel, it compares with units costing twice the price

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This tried and tested control unit provides the finest value for money in control systems, with many thousands protecting houses all over the country. A suitable steel enclosure is available separately.

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DIGITAL VOLTMETER MODULES

DVM 456 HIGH PERFORMANCE 3½ DIGIT PANEL METER

Sensitivity	*0-± 1.999V*
Accuracy	*Within 0.1 ± 1 digit*
Input Impedance	*100M ohm*
Supply Voltage	*8V-12V*
Dimensions	*95.5 x 55 x 11mm*

This exciting new module provides a large, bright digital read-out with an accuracy within 0.1%. It incorporates a built-in regulator which allows it to be used from an unregulated supply of between 8V-12V. Full over-load protection is included and the unit is supplied with a mounting bezel and filter, together with full application instructions showing how to extend its range and measure resistance, current and temperature.

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DVM 356 VERSATILE 3-DIGIT PANEL METER

The DVM 356 is a low-cost module offering 3-digit performance with an FSD of + 999mV and − 99mV. Supplied with a comprehensive Data Sheet. No bezel available

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DT10 TEMPERATURE MEASUREMENT MODULE

A simple, though effective module which when constructed provides a linear output of 10mV/°C over the temperature range − 10 to + 100°C.

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PS209 DUAL POWER SUPPLY

Fully built mains power supply providing two 9V outputs of up to 250mA each. Suitable for use with either DVM modules and other equipment.

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★★ AUDIO ★★

AL 12580-125W POWER AMPLIFIER

A rugged, high powered module that is ideal for use in discos & P.A. Systems where powers of up to 125W, 4 ohms are required. The heavy duty output transistors ensure stable and reliable performance. It is currently supplied to a large number of equipment manufacturers where reliability and performance are the main considerations, whilst for others its low price is the major factor. Operating from a supply voltage of 40-80V into loads from 4-16 ohms.

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AL 5070-ULTRA LOW DISTORTION 50W AMPLIFIER

Provides sound reproduction of the highest quality with distortion levels below 0.02%, this module offers superlative performance in all types of audio equipment. Full over-load protection is incorporated ensuring reliability of the highest order. Supplied with its own heat sink, it opertes from a 40V-65V supply rail into loads of 8-16 ohms.

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AL 2550-COMPACT LOW-COST 25W AMPLIFIER

One of our most popular audio modules with tens of thousands installed. Ideal for domestic applications where low distortion and compact size are the prime requirements. Used with supply rails of 20V-50V into loads of 8-15 ohms.

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AL 1030-RUGGED 10W AMPLIFIER

This low cost unit provides a powerful 10W output making it ideal for all medium power applications requiring quality reproduction with rugged performance. Representing excellent value for money it operates from a supply of 18V-30V into loads of 8-16 ohms.

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MM 100-BUDGET 3-INPUT MIXER

With a host of features including 3 individual level controls, a master volume and separate bass and treble control, it provides for inputs for microphone, magnetic pick-up and tape, or second pick-up (selectable), and yet costs considerably less than competitive units. This module is ideal for discos and public address units and operates from 45V-70V.

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MG 100G

As MM 100 with two guitar + 1 microphone input intended for guitar amplifier applications.

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50FT INFRA-RED BEAM-IR1470

The IR1470 consists of a separate transmitter and receiver providing a beam of up to 50ft which, when interrupted, operates a relay in the receiver which in turn may be used to control external equipment. The system requires only 65mA from a 12V supply. Size: (each unit) 82 x 52 x 57mm

£25.61 + VAT

TIMER SWITCH & POWER SUPPLY-DP3570

The DP3570 consists of an adjustable timer switch and 12V stabilised power supply designed to provide switching of loads up to 4A at 240V A.C. for a preset time between 10 secs and 6 mins, the timed period being initiated by the normally open or normally closed inputs.

£13.95 + VAT

GENERAL PURPOSE ULTRASONIC MOVEMENT DETECTOR US4012

This module uses ultrasonic techniques to detect movement at distances up to 5 metres with an operating range of 60°. Supply voltage 10-14V (12mA). Size: 147 x 52.5 x 15mm.

£11.72 + VAT

STABILISED SUPPLY & SWITCHING UNIT-PS1265

The PS1265 provides stabilised 12V output for current levels up to 700mA. Additionally it incorporates a high impedance input for switching loads up to 1kW at 240V without timing

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7409	0.30
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7411	0.30
7412	0.30
7413	0.27
7414	0.28
7416	0.33
7417	0.30
7420	0.20
7421	0.60
7422	0.36
7423	0.36
7425	0.13
7426	0.20
7427	0.18
7428	0.43
7430	0.22
7432	0.27
7433	0.30
7437	0.24
7438	0.40
7440	0.40
7441	0.90
7442A	0.70
7443A	1.00
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7445	0.70
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7447A	1.00
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7450	0.36
7451	0.16
7453	0.38
7454	0.38
7460	0.55
7470	0.27
7472	0.30
7473	0.23
7474	0.40
7475	0.30
7476	0.23
7480	0.65
7481	1.80
7483A	1.05
7484A	1.25
7485	0.70
7486	0.26
7489	2.10
7490	0.33
7491	0.70
7492A	0.42
7493A	0.55
7494	1.10
7495A	0.60
7496	0.80
7497	2.90
74100	1.90
74107	0.30
74109	0.75
74110	0.75
74111	0.55
74116	0.82
74118	1.10
74119	1.70
74120	1.00
74121	0.66
74122	0.70
74123	0.18
74125	0.37
74126	0.42
74128	0.55
74132	0.75
74136	0.70
74141	0.90
74142	2.50
74144	2.70
74143	2.70
74145	1.10
74147	1.70
74148	1.40
74150	1.75
74151A	0.38
74153	0.80
74154	1.40
74155	0.80
74156	0.90
74157	0.43
74159	2.25
74160	0.47
74161	0.80
74162	1.10
74163	0.80
74164	0.48
74165	1.10
74166	1.40
74167	4.00
74170	2.00
74172	4.20
74173	1.40
74174	0.58
74175	0.53
74176	1.00
74178	1.50
74179	1.50.
74180	1.00
74181	3.40
74182	1.82
74184	2.50
74185A	2.50
74190	1.30
74191	1.30
74192	1.10
74193	1.03
74194	1.10
74195	0.80
74196	1.30
74197	1.10
74198	2.20
74199	2.20
74221	1.10
74251	1.00
74259	1.50
74265	0.80
74273	2.00
74276	1.43
74278	1.70
74279	0.73
74283	0.68
74285	3.20
74290	0.90
74293	0.90
74298	1.22
74351	2.00
74365A	0.80
74366A	0.80
74367A	0.80
74368A	0.70
74376	1.60
74390	1.10
74393	1.20
74490	1.40

74LS SERIES

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74LS01	0.10
74LS02	0.10
74LS03	0.10
74LS04	0.10
74LS05	0.10
74LS08	0.10
74LS09	0.12
74LS10	0.10
74LS11	0.10
74LS12	0.10
74LS13	0.18
74LS14	0.22
74LS15	0.12
74LS20	0.12
74LS21	0.12
74LS22	0.12
74LS24	0.33
74LS26	0.12
74LS27	0.12
74LS28	0.12
74LS30	0.12
74LS32	0.13
74LS33	0.13
74LS37	0.14
74LS38	0.13
74LS40	0.13
74LS42	0.23
74LS47	0.50
74LS48	0.46
74LS51	0.11
74LS54	0.11
74LS55	0.13
74LS73A	0.30
74LS74A	0.18
74LS75	0.21
74LS76A	0.24
74LS78	0.42
74LS83A	0.37
74LS85	0.24
74LS86	0.22
74LS90	0.24
74LS91	0.50
74LS92	0.29
74LS93	0.24
74LS95B	0.75
74LS96	0.46
74LS107	0.25
74LS109	0.25
74LS112	0.25
74LS113	0.25
74LS114	0.25
74LS122	0.33
74LS123	0.33
74LS124	1.40
74LS125	0.30
74LS126	0.28
74LS132	0.28
74LS133	0.28
74LS136	0.28
74LS138	0.26
74LS139	0.26
74LS145	0.62
74LS147	0.86
74LS148	0.72
74LS151	0.25
74LS152	2.00
74LS153	0.28
74LS154	0.76
74LS155	0.34
74LS156	0.34
74LS157	0.20
74LS158	0.25
74LS160A	0.40
74LS161A	0.40
74LS162A	0.40
74LS163A	0.38
74LS164	0.34
74LS165A	0.48
74LS166A	1.50
74LS168	0.58
74LS169	0.53
74LS170	0.66
74LS173A	0.60
74LS174	0.28
74LS175	0.30
74LS181	1.48
74LS183	1.58
74LS190	0.44
74LS191	0.41
74LS192	0.39
74LS193	0.39
74LS194A	0.43
74LS195A	0.43
74LS196	0.43
74LS197	0.40
74LS221	0.43
74LS240	0.43
74LS241	0.40
74LS242	0.41
74LS243	0.48
74LS244	0.38
74LS245	0.38
74LS247	0.38
74LS248	0.38
74LS249	0.68
74LS251	0.22
74LS253	0.34
74LS256	0.50
74LS257A	0.34
74LS258A	0.36
74LS259	0.48
74LS260	0.28
74LS261	1.20
74LS266	0.20
74LS273	0.42
74LS275	1.25
74LS279	0.31
74LS280	0.86
74LS283	0.49
74LS290	0.24
74LS292	14.00
74LS293	0.24
74LS295	0.38
74LS297	14.00
74LS298	0.63
74LS299	1.18
74LS231	5.62
74LS323	1.78
74LS324	2.20
74LS348	1.18
74LS352	0.78
74LS353	1.88
74LS356	2.10
74LS363	1.38
74LS364	1.38
74LS365	0.24
74LS366	0.28
74LS367	0.26
74LS368	0.28
74LS373	0.42
74LS374	0.42
74LS375	0.4
74LS377	0.70
74LS378	0.62
74LS379	0.86
74LS381	4.50
74LS390	0.39
74LS393	0.34
74LS395A	1.00
74LS399	0.66
74LS445	1.50
74LS465	2.78
74LS467	2.78
74LS540	0.93
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74LS626	2.18
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74LS629	0.93
74LS640	0.84
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74LS641	0.86
74LS642	0.82
74LS642-2	3.00
74LS643	0.84
74LS643-1	2.48
74LS644	0.84
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4014	0.29
4015	0.32
4016	0.16
4017	0.26
4018	0.27
4019	0.25
4020	0.30
4021	0.33
4022	0.33
4023	0.11
4024	0.22
4025	0.11
4026	0.58
4027	0.16
4028	0.26
4029	0.31
4030	0.15
4031	0.86
4032	0.49
4033	0.57
4034	0.73
4035	0.39
4036	1.76
4037	0.72
4038	0.43
4039	1.76
4040	0.27
4041	0.33
4042	0.27
4043	0.33
4044	0.33
4045	0.69
4046	0.39
4047	0.42
4048	0.24
4049	0.16
4050	0.18
4051	0.35
4052	0.32
4053	0.32
4054	0.50
4055	0.49
4056	0.49
4059	3.44
4060	0.37
4063	0.45
4066	0.16
4068	0.11
4069	0.11
4070	0.11
4071	0.11
4072	0.11
4073	0.11
4075	0.11
4076	0.39
4077	0.11
4078	0.11
4081	0.10
4082	0.11
4085	0.33
4086	0.30
4089	0.72
4093	0.16
4094	0.41
4095	0.55
4096	0.86
4097	1.23
4098	0.47
4099	0.39
4501	0.24
4502	0.33
4503	0.27
4504	0.52
4505	1.76
4506	0.55
4507/4030	0.35
4508	0.64
4510	0.29
4511	0.27
4512	0.35
4513	0.77
4514	0.62
4515	0.62
4516	0.33
4517	0.96
4518	0.33
4519	0.25
4520	0.33
4521	0.82
4522	0.40
4526	0.35
4527	0.38
4528	0.35
4529	0.62
4531	0.58
4532	0.45
4534	2.61
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4538	0.57
4539	0.63
4541	0.63
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4551	0.78
4553	1.36

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4585	0.37
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40097	0.36
40098	0.40
40100	1.12
40101	0.74
40102	1.04
40103	1.12
40104	0.85
40105	1.36
40106	0.32
40107	0.47
40108	2.56
40109	0.68
40110	1.60
40114	1.76
40147	1.76
40163	0.50
40173	1.20
40174	0.44
40175	0.52
40192	0.45
40193	0.45
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LM319N	1.50
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LM334Z	1.15
LM335Z	1.30
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LM339	0.40
LM348	0.60
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LM380N	0.90
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LM382	2.00
LM384	3.25
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LM387	2.40
LM391	2.65
LM392N	1.10
LM393	0.35
LM394CH	4.50
LM709	0.48
LM710	1.00
LM711	1.00
LM723	0.50
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LM741	0.20
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NE556	0.30
NE564	1.79
NE565	1.00
NE566	1.00
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NE571	3.00
NE592	0.70
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TBA810S	0.90
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TBA820M	0.75
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TDA2003	1.90

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TDA2006	3.20
TDA2020	3.20
TDA2030	2.50
TDA3810	7.50
TDA7000	3.50
TEA1002	7.00
TL061CP	0.40
TL062	0.60
TL064	0.38
TL071	0.30
TL074	0.85
TL081	0.35
TLO82	0.40
TLO83	0.75
TLO84	0.86
TLO94	2.00
UA759	3.20
UA2240	1.30
UCN5801A	6.00
ULN2003A	0.75
ULN2004A	0.75
ULN2068	2.90
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15V	7815	0.33	7915	0.38
18V	7818.	0.33	7918	0.38
24V	7824	0.33	7924	0.38

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5V	78L05	0.26	15V	78L15	0.26
6V	78L06	0.28	5V	79L05	0.45
8V	78L08	0.28	12V	79L12	0.43
12V	78L12	0.26	15V	79L15	0.50

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75110	0.90
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75113	1.20
75114	1.40
45115	1.40
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75122	1.40
75122	1.20
75150P	1.20
75154	1.20
75159	2.20
75160	5.00
75161	6.50
75162	7.50
75172	4.00
75182	1.50
75188	0.60
75189	0.60
75365	1.50
75451	0.50
75452	0.50
75453	0.70
75454	0.70
75480	1.50
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75492	0.65
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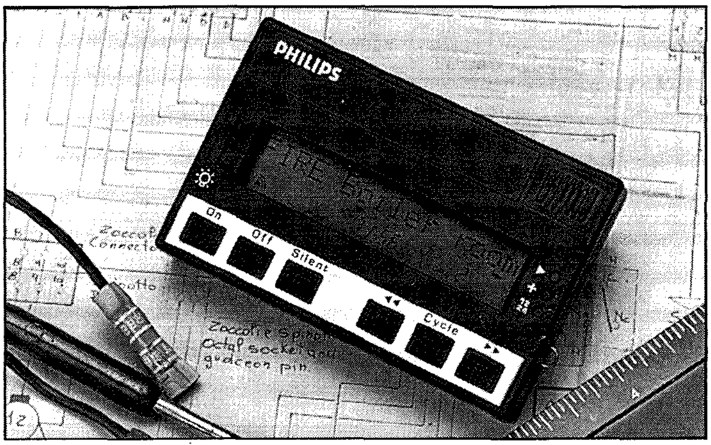
UNDERSTANDING PRIVATE RADIO PAGING

John Lord, Senior Product Manager, Philips Communications and Security, improves our awareness of the nature and uses of a radio paging system about which the general public is largely unaware.



The Philips pager pictured above features a 16-digit liquid crystal display with nine memories and 512 character capacity. An on-board time clock time-stamps time-stamps all messages received.

In the past few years we have seen a massive increase in the use of radio paging as an aid to locating people on the move.

At the forefront of this expanding market have been the national paging systems operated by British Telecom, Mercury, Racal, Intercity, Aircall, etc. There is another sector of the market, however, which plays a very prominent role but about which many people know very little - it's called private radio paging.

THE CONCEPT

The concept is simple - with national or public systems the user rents or purchases a pager and pays a fixed monthly charge for airtime - which may be part of the rental. The infrastructure is owned by the service provider who has a national paging licence.

With a private system, however, the user has total control of all the equipment - including input terminals and transmitters - which he owns or rents. A typical private paging system would consist of a control desk, a telephone interface to a PABX or Key system, transmitter and aerial.

Private paging systems have been in existence for over 30 years. They were first used in hospitals, but are now commonplace throughout all business sectors and have quickly become more sophisticated in their design and capabilities.

As a result we have seen a steady growth in the market at a rate of 8-10% per year, with around 2,000 new systems being installed during 1989 with some 32,000 pagers.

CATEGORIES

The systems are divided into two basic categories - those where the paging is restricted solely to the user's premises, and those which allow paging over a specified range based on the topography of the area, the location and power of the transmitters, and the receiver sensitivity.

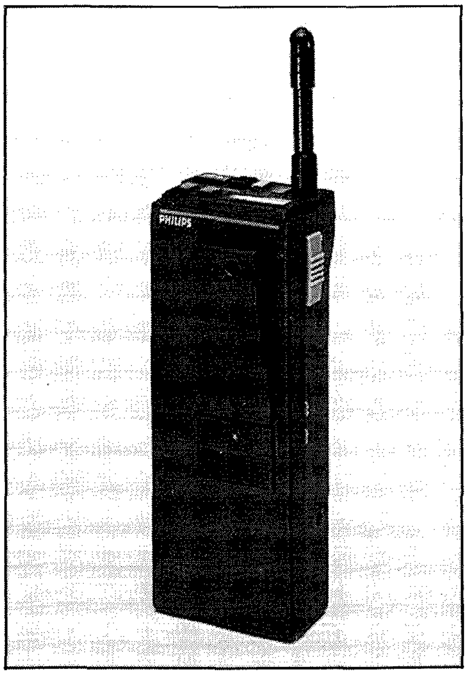
A variety of frequency bands is available for private paging ranging from 26 MHz to 460 MHz.

For paging within the confines of a site, the 26 MHz (formally 27 MHz) and 49 MHz bands are generally used. (49 MHz was permitted for paging use by the Department of Trade when Band I television was closed). Both bands allow paging with data, ie, a simple number or plain text message. Speech is not permitted except in hospitals in the event of an emergency.

Hospitals also have three exclusive channels in the 31 MHz band on which paging with data and speech is allowed.

Private systems which allow paging outside the parameters of a user's site operate on the vhf 153 MHz and uhf 454 MHz frequency bands. The vhf 153 MHz band is shared with public systems. There are three companies that have exclusive channels for private paging over this band - Motorola, Multitone and Philips. A common channel is also available to other suppliers.

This compact transceiver for the 'man protection' system incorporates a 'zero-movement sensor' – if a person fails to move and reset the unit within a specified period of time, an alarm is automatically triggered at a control centre. It also functions as a digital paging system and offers two-way speech facilities plus the possibility to receive coded messages on an lcd.



Systems required for speech make use of the uhf frequency band. For paging away from the users premises the 454 MHz band is used, and for systems used within a site the 459 MHz band. Two-way speech is available with cross band working between 459 MHz from base to transceiver and 161 MHz from transceiver to base.

This latter category of paging is known as Local Communications and permits the use of talkthrough from mobile to mobile, as well as allowing calls to be made from mobile to telephone handset. It even allows calls to be made into the public switched telephone network - although this facility puts the paging system into the cordless telephone category and can tie up a system for long periods. It is therefore not generally favoured in paging circles because it degrades the system's efficiency.

LICENCES AND FACILITIES

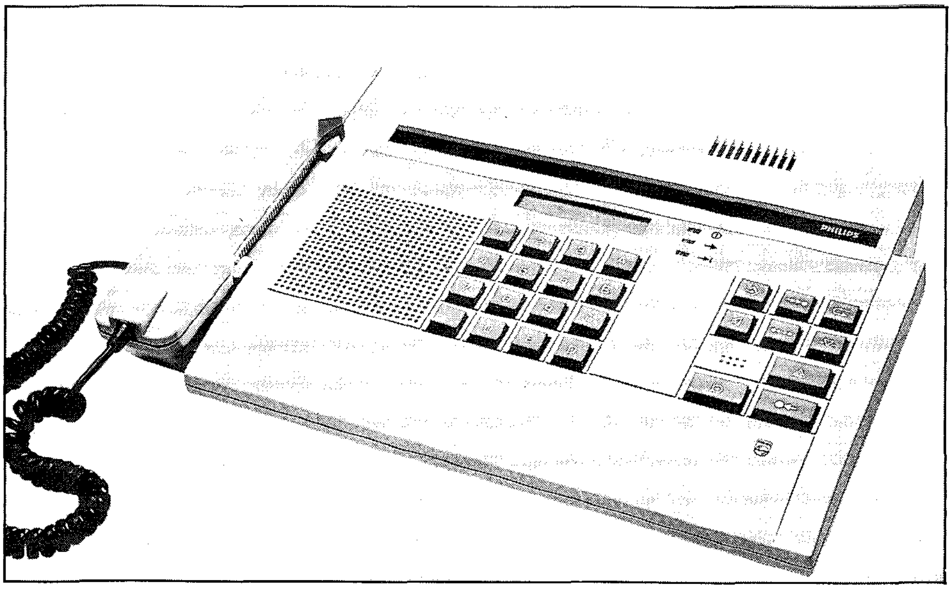
Private paging system users are required to have a licence - unlike national paging systems where the network provider pays the licence fee. The cost of these licences varies between £25 and £75 for local systems to £250 per base station for local wide area paging systems.

Advances in technology have meant that private paging systems can now provide facilities which are not available to public system users in terms of interfacing capability, operating frequency and the range of pagers available.

For example, a typical private paging supplier would have pagers which offer tone only, tone with speech, tone with speech and numeric display, tone with speech and alphanumeric display, two way speech with and without display, and two way speech with dial-out.

Many of these pagers offered with a private system can be designed to meet BASEEFA or CENELEC standards for intrinsic safety as well as providing vibrating and printer options.

A public system, on the other hand, would



Paging control desks such as the Philips DP6000 have a wide range of facilities which offer flexibility in system design. These include a facility which enables calls to be relayed through one or more operators, or independent access to special users, e.g. security personnel or emergency teams. Receivers can be paged individually, in groups, or all at once.

typically offer a range of three receiver types - tone only (which could be linked to a voice bank), numeric and alphanumeric.

SYSTEM ACCESS

Means of access to private systems are as varied as the receiver range. Control desks, telephone couplers, intercom couplers, alarm couplers and computer couplers are all common methods of generating calls.

This variety is particularly advantageous in environments such as industry where we are experiencing a high degree of automation with fewer staff employed to operate machinery. By connecting machines to a paging system - either by simple alarm contacts or into the computer controlling the machines - a paging call can be programmed to activate if a fault occurs on the system, for example.

Different messages can be relayed to different people giving them a variety of instructions within a matter of seconds. This minimises the downtime and any potential losses which a company might otherwise have experienced.

SITE TRIALS

When a private system is specified, the user defines exactly what coverage he requires and most suppliers will undertake a site trial before producing a detailed plan showing the signal coverage. Any dead spots are highlighted to the user who can decide whether or not they are acceptable. If they are not, the aerial can be relocated, or additional transmitters used to give the required coverage.

With a public system the coverage and reception area depend on the service provider selected - one service provider, for example, may provide better coverage of a particular area than another.

BENEFITS

One of the major benefits of the private system over public systems is the time saving factor. It only takes a few seconds for a call being sent over a private system to reach its recipient. With public systems the time between a message being sent and received varies with the service provider and the time of day the call is being made - this can vary from a few seconds to several minutes.

There are a number of facilities offered by private systems which are beneficial to users in a wide range of environments.

They commonly use storage and absence racks where units can be placed when they are not in use. As well as re-charging the units, an absence signal is sent to the caller, whether the call has originated from a control desk or telephone coupler.

In some applications the control equipment will automatically refer to a look-up table when the absence signal is received, and call a substitute pager. More sophisticated systems are programmed to continually check the storage racks and display a list of those pagers on a computer screen.

CALL LOGGING

An increasing requirement on the larger private paging systems is call logging. This provides the user with information on which pagers have been called, what message has been sent, the time and date of the call, whether the pager was in the storage rack, and whether it was a group call. Such systems normally use personal computers with an interface, and the data is stored on hard disk for future analysis. This facility enables the user to operate the paging system more efficiently, and can even be used to assess staff workloads.

DEVELOPMENTS

The development potential of private paging systems appears almost limitless. They do not suffer from the same airtime constraints as public systems and offer features such as immediate transmission and speech with data which provide more scope for future development.

In the past few years we have seen the emergence of a private paging network where two or more sites can be linked either by private wire or data lines. This enables a call transmitted at one site to be broadcast automatically to other sites linked to the same system.

A 'man protection' system is already available whereby a security guard or maintenance person is automatically checked at frequent intervals for a manual or automatic confirmation that all is well.

If a pager remains in a static position for a specified period of time, a local alarm sounds on the pager which will automatically cease if the pager is moved. If it remains static for an even longer period, the control unit is alerted as well as the local alarm on the pager. This can be reset by pressing a button on the pager whilst moving it, or it can be cancelled from the control console. If it is not reset, the alarm tone on the pager will provide an audio signal for search parties. Systems are also being developed which will indicate to central control the exact location of the alarm.

COSTS

The cost of private systems start from around £500 for a tone-only transcoder, (integrated desk, transmitter) with a range of about 100 metres and three to four paging units. Systems required for multi-site use with a multi-access capability and hundreds of pagers and/or transceivers can cost several thousand pounds.

The price of individual pagers varies from about £120 for tone-only, £180-£250 for numeric/alphanumeric units and £450-£600 for two-way speech pagers with numeric/alphanumeric displays.

The big price advantage of private over public systems is in airtime cost savings. Because they are not charged for airtime, users of private systems can quite easily recover their costs in about eighteen months, whereas users of public systems always have a monthly rental charge to pay for airtime.

Everyone in today's competitive environment is conscious of the need to increase the operational efficiency of their organisations and to save money.

Even the simplest paging systems make a major contribution towards this increased efficiency and also significantly reduce costs in the form of telephone bills. They enable people to be contacted quickly when there is a call for example - so they do not need to return the call later on. And it does not take many saved call-back charges to pay for a pager! PE

Philips Scientific Communications and Security Division are at Cromwell Road, Cambridge, CB1 3HE. Tel 0223 248191.

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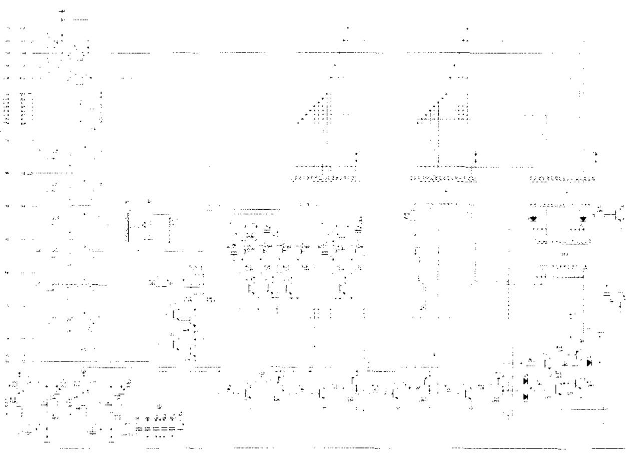

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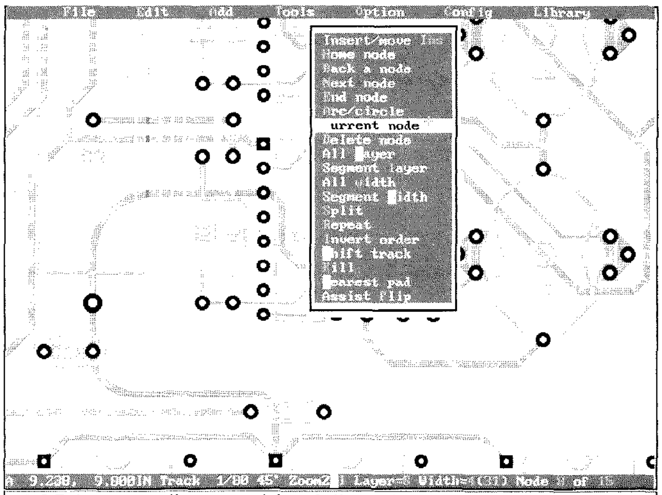

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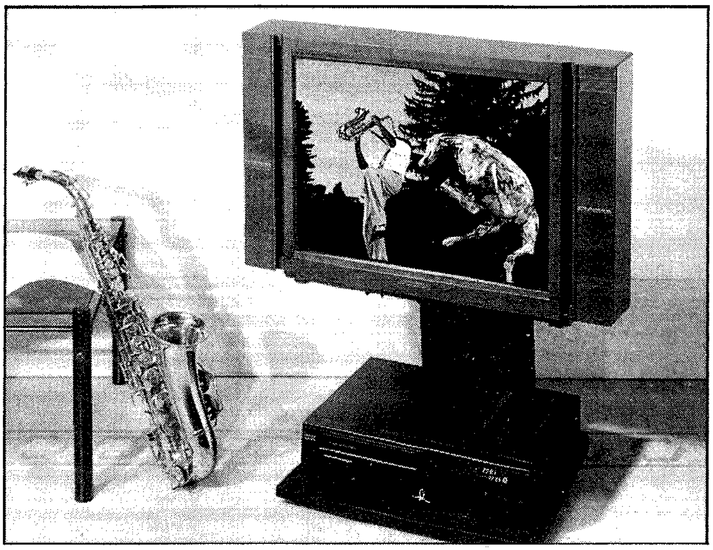
NICAM STEREO TV

Ian Poole takes time out from researching technology history to report on technology now, explaining how stereo sound is superimposed on a tv signal without overloading the spectrum.



Stereo radio has been with us for years. Now stereo tv is making a big impact on the domestic market. This can be seen by the fact it is impossible to go into an electrical store selling televisions these days without noticing that Nicam stereo has arrived. After remote control and teletext, steroe tv is the next major development.

WHAT IS NICAM

Nicam stands for Near Instantaneous Companded Audio Multiplex. Essentially it is a method of digitally encoding an audio signal onto a radio signal - in this case a television signal. Being digital it offers the possibility of transmitting very high quality sound. However, if standard techniques were used then it would take up too much bandwidth. It should be remembered that this extra signal has to be transmitted in addition to the standard analogue audio signal. It also has to be fitted onto the overall television signal without increasing its bandwidth so that the existing signal is impaired, or so that it makes the signal spread over onto the next channel to any appreciable degree.

The additional audio is added in a very sophisticated way by reducing the data rate, which in turn is achieved by keeping the amount of information sent to an absolute minimum. Essentially, this is done by using a form of compansion, or compression and expansion. In addition to this, the digital signal is encoded onto the overall television signal so that it causes virtually no degradation to the existing signal.

SOME SPECIFICATIONS

Before investigating how Nicam works in any detail it is worth looking to see some of the specifications that it meets because these have a direct bering on the way some ideas are implemented.

The main specification of note is the frequency response. A limit of 15kHz has been chosen. This is the same as that of the vhf fm broadcasts and over the years it has been found to be quite satisfactory. This limit is at the top of the hearing range of many people and above that of many others. Any higher limit would not give any real benefits and would use up valuable spectrum space.

The other limitation is that the dynamic range of signal, or the ratio of the loudest to the quietest signal, is limited to about 85dB. This is thought to be quite acceptable for television transmission as levels are controlled anyway so that the sound stays at a suitable level for easy listening for most of the time.

HOW IT WORKS

The first stage in generating a Nicam television signal is to generate the digital signal. This is done by the use of an analogue to digital converter. The instantaneous level of the incoming audio signal is measured or sampled at a rate well above the highest frequency which will be heard, as shown in Fig.1. This level is then converted into a digital signal which is then sent. This process is repeated and a digital representation of the signal is built up by the successive samples which have been made of the signal.

The sampling rate which is used for Nicam is 32kHz. This is not as high as that used for compact discs, but it is adequate for the top frequency limit of 15kHz. Also each sample is a 14-bit representation of the instantaneous voltage level it measured. It is the number of bits which limits the resolution or dynamic range of the signal and the 14-bit sample gives the dynamic range of just under 85dB.

Unfortunately, a signal consisting of two channels of data at 32kHz and each containing 14 bits still gives a data rate which is far to high to accommodate on the television signal. To overcome this a way of compressing the signal is used. This relies heavily on modern day integrated circuit technology in order to do this, and it works very well.

Essentially the signal has to be reduced so that it contains only 10 bits of data whilst still having the dynamic range of a 14-bit signal. This is done by only using those bits in the sample which are needed. During the periods of loud signals the least significant bits become less important, and during the times when the signals are quiet the most significant bits carry no information. With this idea in mind, the Nicam system selects one of five ranges to coincide with the signal level of the time. This range selection is done in groups of 32 samples because it is assumed that the overall level of the signal will not change much faster than this. As this is done at one millisecond intervals it is performed nearly instantaneously and this gives rise to the near instantaneous part of the Nicam name.

Then, according to the range which has been chosen, only the necessary bits are sent. Having done this it is also necessary to send information about which range has been selected to the receiver. This is done by encoding this information into the parity bits of the data.

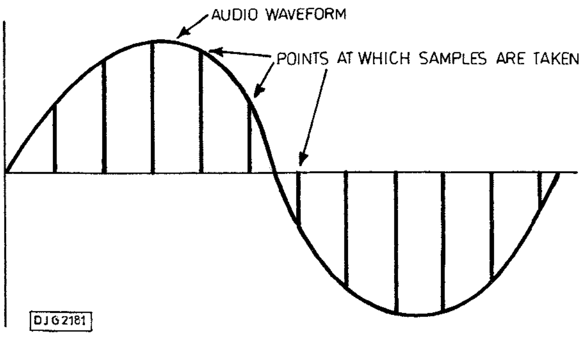


Fig. 1. Sampling an audio signal.

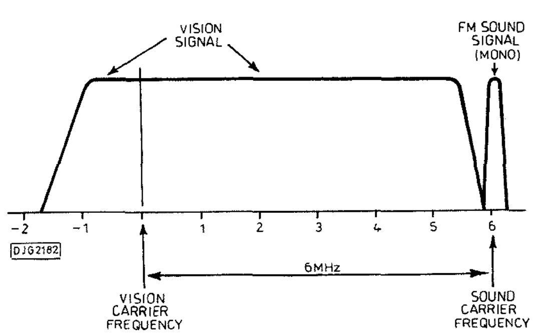


Fig. 2. Spectrum of an existing tv signal.

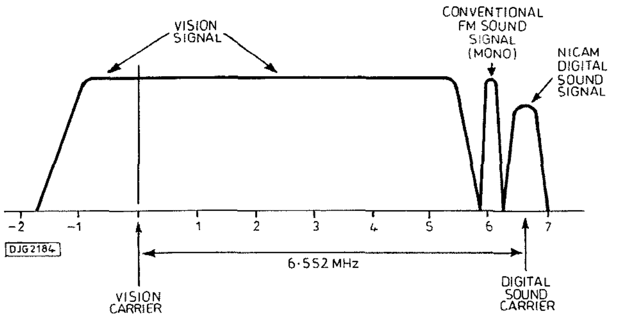


Fig. 5. Spectrum of a tv signal with Nicam digital sound

Channel No	Vision Carrier Frequency	Sound Carrier Frequency
21	471.25	477.25
22	479.25	485.25
23	487.25	493.25
24	495.25	501.25
25	503.25	509.25
26	511.25	517.25
27	519.25	525.25
28	527.25	533.25
29	535.25	541.25
30	543.25	549.25
31	551.25	557.25
32	559.25	565.25
33	567.25	573.25
34	575.25	581.25
39	615.25	621.25
40	623.25	629.25
41	631.25	637.25
42	639.25	645.25
43	647.25	653.25
44	655.25	661.25
45	663.25	669.25
46	671.25	677.25
47	679.25	685.25
48	687.25	693.25
49	695.25	701.25
50	703.25	709.25
51	711.25	717.25
52	719.25	725.25
53	727.25	733.25
54	735.25	741.25
55	743.25	749.25
56	751.25	757.25
57	759.25	765.25
58	767.25	773.25
59	775.25	781.25
60	783.25	789.25
61	791.25	797.25
62	799.25	805.25
63	807.25	813.25
64	815.25	821.25
65	823.25	829.25
66	831.25	837.25
67	839.25	845.25
68	847.25	853.25

All frequencies are in MHz

Fig. 3. UHF Television Channels and Frequencies.

NOISE

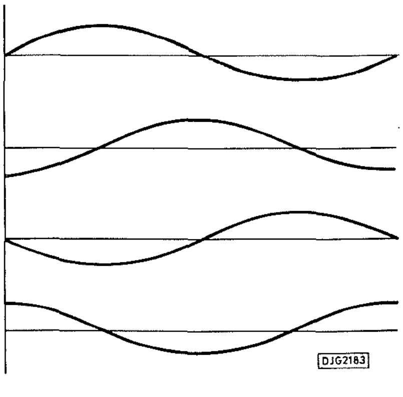
One of the problems in reducing the number of bits which carry the audio signal is that the noise level rises. This is caused by a process known as quantization noise. Basically it results from the fact that the conversions between the digital and analogue signals cannot exactly reproduce the original signal. It is found that the more bits that are used to carry the signal the better the representation and the lower the noise.

With the way the Nicam system works, masking off the lower bits for louder signals, the level of noise actually rises with louder signals. To a large degree the level of noise is masked by the louder signal and it is not too much of a problem. Even so to reduce the effects of noise, on both the louder and quieter signals, the higher frequency signals are pre-emphasised before they are encoded. Similarly, the high frequency signals are reduced in level in the receiver. By doing this noise in the high frequency portion of the audio spectrum (where it is most noticeable) is reduced to a level where it is not a problem.

TRANSMITTING THE SIGNAL

Having generated the digital signal the next stage in the process is to encode it onto the television signal. This is not as easy as it might seem at first sight. Fig.2 shows the spectrum of a standard television signal. It occupies an 8 MHz channel which fits in with the channel allocations shown in Fig.3. As can be seen, there is very little space left to fit in the Nicam signal. This has to be included on top of the standard audio signal in order to maintain compatibility for televisions using the conventional system.

Fig. 4. Four signals with the same frequency but phase changes of 90°.



The actual way in which the signal is modulated onto the carrier is quite complicated. First of all the digital audio is scrambled to give a noise-like signal, however there is a control word to allow it to be unscrambled in the receiver. The reason for scrambling the audio is so that it causes less interference. A television signal occupying a wide bandwidth can tolerate a fair degree of interference on a narrow band of frequencies, especially if it appears as noise.

Once this has been done the digital signal is modulated onto a 6.552 MHz carrier using a technique known as differential quadrature phase shift keying or DQPSK. This form of modulation is quite often used for modulating data onto a radio frequency carrier, and essentially it operates by phase modulating the carrier in increments of 90 degrees depending upon the different states of the data to be transmitted, as shown in Fig.4.

Once the DQPSK modulated carrier at 6.552 MHz has been generated it is in turn modulated onto the main television carrier to give the final signal as shown in Fig.5.

Finally the television receiver has the job of performing the reverse operations to all of those used in the transmission. First it strips off the 6.552 MHz DQPSK modulated carrier and regenerates the digital data. Then it has to descramble the data using the control word. Next it sorts out the two different channels and decompresses the digital audio. Finally, it is passed through digital to analogue converters to regenerate the two channels of audio.

PROS AND CONS

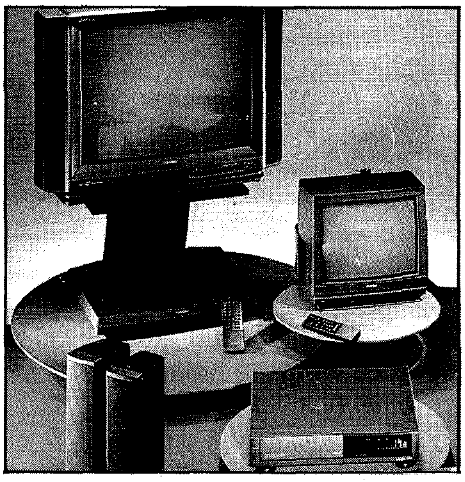
Some people doubt whether stereo tv is worth all the trouble. Purists argue that to enjoy proper stereo the speakers should be placed reasonably well apart so that a proper stereo image can be created. In the case of a television the two speakers can only be placed a small distance apart if the sound image is to follow the picture. Often this distance will only be a matter of about two feet or so. Whether this distance would be sufficient to give a worthwhile improvement in sound is a matter for debate. Alternatively, some televisions have detachable speakers to create a much better stereo image. However, this can give a larger than life image.

Inspite of this argument it cannot be denied that stereo can add a further depth to the sound, and an added impact to the material which is being transmitted. In addition to this it can improve the quality of the sound which is being received. In fact in the past television sound has always been thought of as the poor partner to the vhf fm sound broadcasts. Now with the introduction of Nicam digital sound the possibilities of sound improvement are vast, making hifi tv a reality now.

However, the final decision has to be made by anyone buying a tv. Is the added cost worth the extra benefit? And, do we really need stereo tv? But all these arguments have been heard in the past with every new development from radio itself to television, and from stereo records to stereo radio. In fact in a few years we will probably look back on the old system, see all its shortfalls and wonder what all the debate was about.

The photos of Nicam equipment in this feature were kindly supplied by Ferguson and Toshiba respectively.

PE



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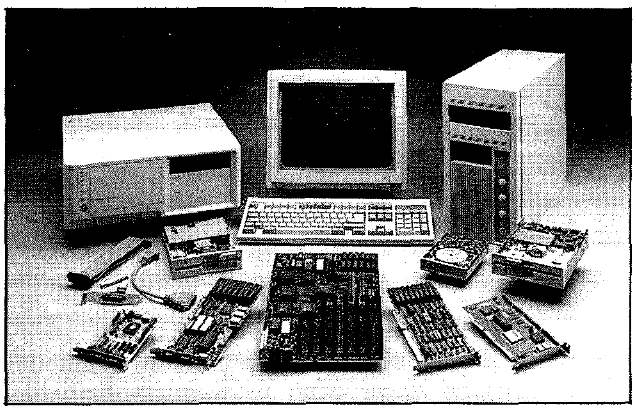

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MICROCONTROLLING THE ROBOT CAR

Part two. Alan Pickard attends to more hardware and software aspects, giving greater automatic control to the Microbe robot car.

Now that a simple robot has been produced and a system of on-board intelligence provided, consideration can be given to some more advanced software and also some hardware extensions.

In its current form, Microbe 3(4) can be controlled via the BBC micro or in conjunction with the BBC with autonomous control via the Nikam.

Machine code programs can be written and debugged on the 'mother ship' and then implemented in ram or eprom. This provides a fairly flexible control system and also introduces the concepts involved with cpu to cpu communications.

The techniques discussed so far could be utilised on an alternative 6502 microcontroller arrangement, or even a different cpu. It would be possible to store machine code programs for say, a Z80 cpu as hex files in BBC ram. (Experimental work was carried out with an 8060 cpu, but there were difficulties with both hardware and software interfacing. A sample 8060 machine code program listing in shown however, in Listing 3).

As mentioned earlier, Microbe 5 is equipped with up to 14 lines of i/o or 16 lines (including PB0 and PB7) without communication with the BBC.

In this concluding article, particular attention will be given to the hardware and software aspects of the robot vehicle Microbe (4), which has now progressed from a simple motor/wheel arrangement driven by the BBC Micro cassette motor switching circuit to a steerable, collision detecting vehicle controlled by the user port. In its final form it is a '14-bit' vehicle with on-board intelligence capable of being controlled by the BBC Micro or its own 6502-based microcontroller.

```
OF20  CA  0A  INITIALISATION
OF22  35
OF23  C4  00
OF25  31
OF26  C4  FF  SETTING OF
OF28  C9  23  DIRECTION REGISTER
OF2A  C4  01  LOADING BINARY
OF2C  C9  21  FOR 'FORWARD'
OF2E  C4  FF  TIME DELAY
OF30  8F  FF
OF32  C4  FF
OF34  8F  FF
OF36  C4  00  LOADING OF BINARY
OF38  C9  21  VALUE FOR 'STOP'
OF3A  9C  F8  JUMP TO START
```

Listing 3. 8060 test program

```
1500 A9  7F       LDA £&7F
1502 8D  62  FE   STA &FE62
1505 A9  05       LDA £&05
1507 8D  60  FE   STA &FE60
150A 20  1B  15   JSR &151B
150D A9  0F       LDA £&0F
150F 8D  60  FE   STA &FE60
1512 20  1B  15   JSR &151B
1515 A9  05       LDA £&05
1517 8D  60  FE   STA &FE60
151A 60           RTS
151B A0  FF       LDY £&FF
151D A2  FF       .LOOP1 LDX £&FF
151F CA           .LOOP2 DEX
1520 D0  FD       BNE LOOP2
1522 88           DEY
1523 D0  F8       BNE LOOP1
1525 60           RTS
```

Listing 4. Assembled 6502 machine code

MACHINE CODE PROGRAMS

As mentioned in the previous article, a simple program can be written in 6502 code to enable to robot to go forward for a short period and then stop. (See Fig. 5).

Such a program can be input via the BBC assembler and then tried out in the usual way.

This basic program can be extended to provide the same function as the FSRS test program previously written in Basic.

All of the test modules from the full menu-driven Basic program can be converted in this way to machine code modules, but without the frills of screen display, sound effects, etc, (initially anyway!).

Before embarking on this conversion exercise, it is useful to try out the 'FS' program using the microcontroller.

USING THE MICRO-CONTROLLER

The Nikam 6502 microcontroller operates as follows (in conjunction with the BBC Micro).

The Basic Terminal program is loaded into ram in the usual way (kept on disk for convenience). This provides direct communication between the two machines, with the BBC micro in the role of vdu.

Running the program produces an exclamation mark on the cleared screen, which provides the system prompt (return to Basic at any time is achieved by pressing TAB).

Once in Nikam mode, the usual system commands are provided, eg, M for memory examination, G for running programs, etc. By use of the memory command a 2K block of (Nikam) ram can be displayed on the screen.

At a convenient point, perhaps before running TERMINAL, 'FS' can be loaded and run. This should be assigned to memory &4000 (BBC) onwards for conversion (see amended listing, lines 40, 110, 140). Once run, the assembled code then resides at &4000 - &4025.

The Fast Loader program (which also contains the Terminal program) is then itself

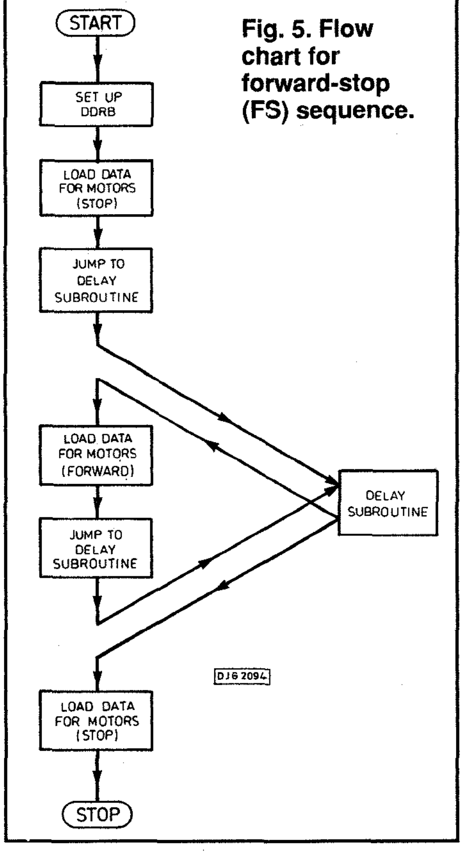

START
SET UP DDRB
LOAD DATA FOR MOTORS (STOP)
JUMP TO DELAY SUBROUTINE
LOAD DATA FOR MOTORS (FORWARD)
JUMP TO DELAY SUBROUTINE
DELAY SUBROUTINE
LOAD DATA FOR MOTORS (STOP)
STOP

Fig. 5. Flow chart for forward-stop (FS) sequence.

loaded and run. This program provides the vdu mode and also downloads the contents of BBC ram from &4000 to &47FF (2K), thus transferring the FS program already in memory (BBC ram). Thus data is transferred from the same point in the memory map of both machines.

Although the identical section of memory is used in this case, the 6522 VIA ports reside at address locations which are different to the BBC micro. (See Fig. 6).

	BBC port B	Nikam port A
Data direction register	&FE62	&8003
Data register	&FE60	&8001

Fig. 6. Memory map differences (6552 via).

Thus these addresses must be altered if programs have been used for BBC control.

Memory to memory transfer can be checked by using the Nikam memory command, and the FS program should be found occupying the first 25H bytes of Nikam ram. The transferred program can then be run using 4000G, providing the appropriate connections are made between controller and Microbe 4!

Full operating instructions and circuit diagrams are included in the Nikam Technical Manual. See also last month's block diagram details.

Once the Nikam system has been tested, it is then simply a case of systematically converting the Basic test program modules to 6502 machine code, using the BBC assembler with appropriate address modifications as required, or writing them from scratch if not required in Basic form. The BBC Micro is, however, a useful facility for testing the programs (and indicating errors!) during development.

6502 assembly language and direct machine code programming are subjects in themselves and beyond the scope of this series, but with practice some useful programs can be produced.

The 6522 VIA provides a hardware time delay facility via its built in timer/counter registers. A sixteen bit latch is used to store a number which can be loaded into the counter and then continually decremented.

```
10  REM FS
40  P%=&4000
50  CLS
60  [
70  LDA £&7F
80  STA &FE62
90  LDA £&05
100 STA &FE60
110 JSR &401B
120 LDA £&0F
130 STA &FE60
140 JSR &401B
150 LDA £&05
160 STA &FE60
170 LDY £&FF
180 .LOOP1 LDX £&FF
190 .LOOP2 DEX
200 BNE LOOP2
210 DEY
220 BNE LOOP1
230 RTS
240 ]
4000    A9 7F        LDA £&7F
4002    8D 62 FE     STA &FE62
4005    A9 05        LDA £&05
4007    8D 60 FE     STA &FE60
400A    20 1B 40     JSR &401B
400D    A9 0F        LDA £&0F
400F    8D 60 FE     STA &FE60
4012    20 1B 40     JSR &401B
4015    A9 05        LDA £&05
4017    8D 60 FE     STA &FE60
401A    60           RTS
401B    A0 FF        LDY £&FF
401D    A2 FF        .LOOP1 LDX £&FF
401F    CA           .LOOP2 DEX
4020    D0 FD        BNE LOOP2
4022    88           DEY
4023    D0 F8        BNE LOOP1
4025    60           RTS
```

Listing 5. Simple forward-stop program, including machine code for transfer to Nikam memory.

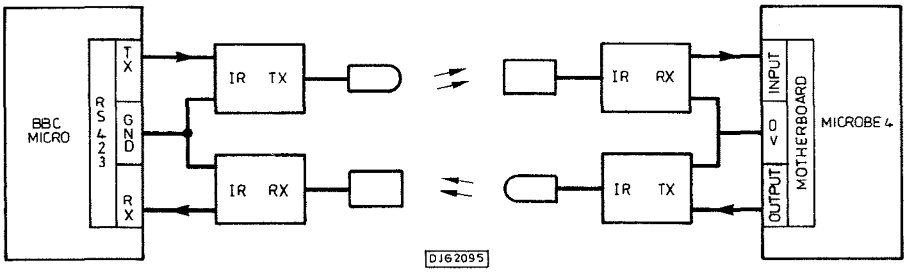
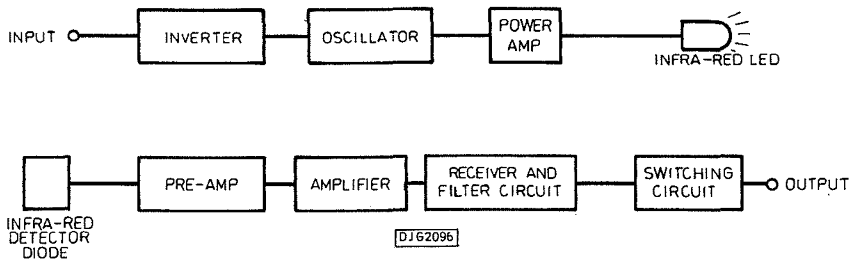


Fig. 7. Alternative connection between two micros via infra-red link.
Fig. 8 (below). Block diagram of infra-red system (data link)



FURTHER HARDWARE DEVELOPMENTS

As Microbe 4 can deal with a total of 14 inputs or outputs, additional leds, collision switches, etc, can be fitted.

A/D conversion is easily achieved with the BBC micro, but additional a/d circuitry would need to be fitted to Microbe 4 as the Nikam has only digital inputs. It is not desirable to introduce further wires (ie, for connection to BBC Analogue In), as the existing set up requires only three wires (TX, RX and ground) to link with the BBC Micro. These can ultimately be replaced by two infra-red channels. Thus with on board voltage supplies, ie, 4.8V NiCad for motherboard/cpu board, 10/11 volts to control board and suitable motor supplies (eg 6V), Microbe 4 can be physically separated from the 'mother ship' and from mains derived power supplies.

INFRA-RED LINKS

Two types of infra-red link could be used for robotic vehicle control. A simple transmitter and receiver could be used to trigger or de-activate the robot ('panic mode') by disabling or enabling its power supplies. This control function could be activated from the keyboard.

A suitable system uses a transmitter based on a 555 timer and a 741 opamp circuit for the receiver.

A more sophisticated application would be the replacement of the RS423 transmit channel (TX and GND) by two infra-red transmitter and receiver pairs. This would have to be suitable for use as a data link.

The data link detailed in Figs. 3 and 4 uses a 555 timer for the transmitter and receiver is based on a NE567 phase locked loop tone decoder.

CONCLUSION

This article concludes the series on experimental robotics at the point where a reasonably sophisticated system has been achieved, from both a micro-electronics and electronics point of view and also the associated software.

A system including all of the features discussed would enable the experimenter to design (or program) a hardware specification using straightforward relay switching, led driving, inclusion of a two-tone oscillator and some simple sensing devices in the form of microswitches. This system could then be controlled by BBC Basic or by 6502 assembly language programs. The importance of hardware and software 'matching up' will be realised, and for example how a choice between hardware or software can sometimes be made, eg, swapping motor/switch wires or altering binary codes in a program.

The use of machine code and its implications can be demonstrated when utilising a separate microcontroller and requirements for cpu to cpu (or ram to ram) communication understood.

```
10    REM FSRS
40    P%=&4000
50    CLS
60    [
70    LDA £&7F
80    STA &FE62
90    LDA £&05
100   STA &FE60
110   JSR &4022
120   LDA £&0F
130   STA &FE60
140   JSR &4022
150   LDA £&05
160   STA &FE60
170   JSR &4022
180   LDA £&00
190   STA &FE60
200   .DELAY LDY £&FF
210   .LOOP1 LDX £&FF
220   .LOOP2 DEX
230   BNE LOOP2
240   DEY
250   BNE LOOP1
260   RTS
270   ]
```

```
4000 A9 7F     LDA £&7F
4002 8D 62 FE  STA &FE62
4005 A9 05     LDA £&05
4007 8D 60 FE  STA &FE60
400A 20 22 40  JSR &4022
400D A9 0F     LDA £&0F
400F 8D 60 FE  STA &FE60
4012 20 22 40  JSR &4022
4015 A9 05     LDA £&05
4017 8D 60 FE  STA &FE60
401A 20 22 40  JSR &4022
401D A9 00     LDA £&00
401F 8D 60 FE  STA &FE60
4022 A0 FF     .DELAY LDY £&FF
4024 A2 FF     .LOOP1 LDX £&FF
4026 CA        .LOOP2 DEX
4027 D0 FD     BNE LOOP2
4029 88        DEY
402A D0 F8     BNE LOOP1
402C 60        RTS
```

Listing 6. Forward-reverse motion loop program and machine code.

Various other electronics systems can be introduced, eg, infra-red link a/d, d/a.

Many improvements could be made to such a system whose design itself is completely re-programmable. For example, the vehicle could be upgraded to one with stepper motors, positional control, light sensing, gas sensing, sound sensing, speech synthesis, etc. Software can be easily tailored for these requirements using the advanced software facilities of the BBC Micro, eg, BBC Basic procedures operating system routines, 6502 assembler.

An upgraded monitor rom can be obtained from Nikam Electronics which includes some minor improvements. Driver software is also included for an eprom programmer which is available as a bare board or complete.

ADDRESSES

Nikam Electronics Ltd, West End Gardens, Fairford, Glos, GL7 4JB. (This address supercedes that quoted in PE December 1990.)

Infra-red link - simple version - available from: **Ambit International**, 200 North Service Road, Brentwood, Essex CM14 4SG.

The author would be very pleased to receive feedback on readers' experiments and developments in this area. He may be contacted at 34 Queen's Walk, Thornbury, Bristol, Avon, BS12 1ST.

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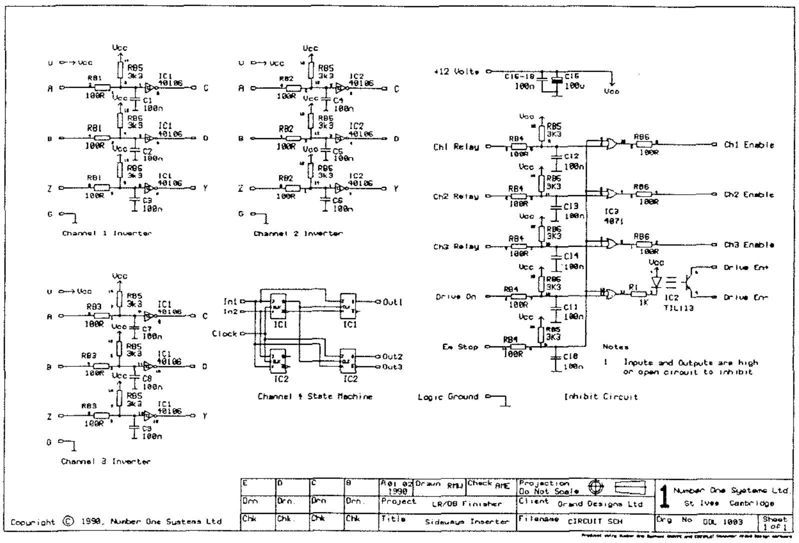
Channel 1 Inverter
Channel 2 Inverter
Channel 3 Inverter
Channel 4 State Machine
Logic Ground
Inhibit Circuit
+12 Volts
Ch1 Relay
Ch2 Relay
Ch3 Relay
Drive On
Em Stop
Ch1 Enable
Ch2 Enable
Ch3 Enable
Notes
1 Inputs and Outputs are high or open circuit to inhibit
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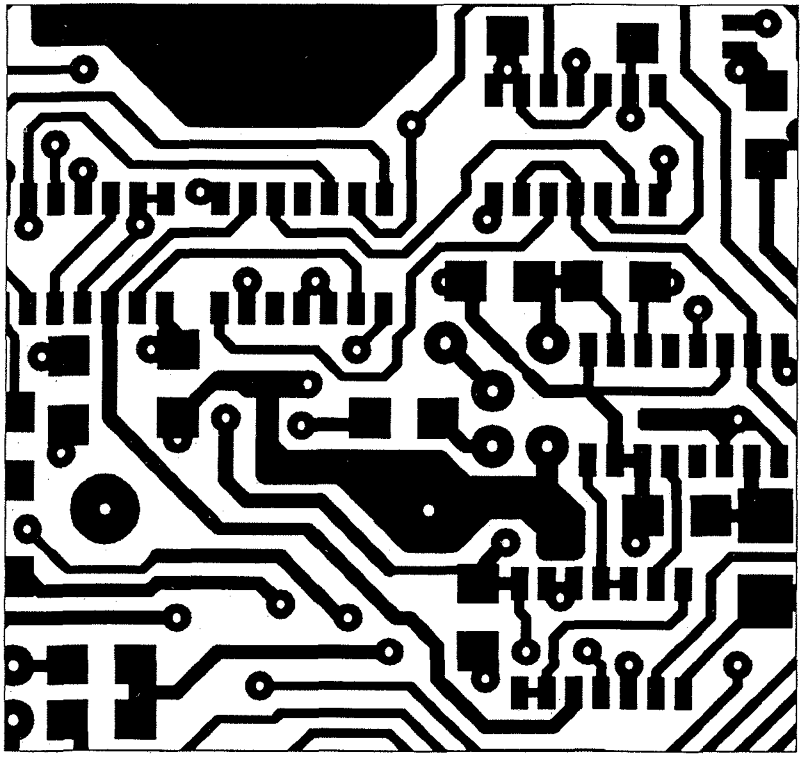

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TRACK FEEDBACK

TACHOS

Dear Ed,

Congratulations on the on-going excellence of PE!

Having read PE for a number of years now, as an interested 'low level' hobbyist, I never thought that I would have need of having to write to you for help and information, but despite my own efforts I am now forced to do so.

My cry for help relates to a project I would like to attempt for use in conjunction with my other hobby, aero modelling, and my desire to build a handheld tachometer with lcd for use 'in the field'.

In the past I have used strobe systems for bench checking of engine rpm. This is all well and good, but not very suitable for use outside, and with concealed ducted fans it is almost impossible. So a hand-held tacho thinks I!

Having investigated all sources, the belief seems to be that the LM2917 frequency to voltage converter is the ideal beast, linked to a light level sensor circuit. However, my problem arises in the area of the lcd display: requirement for a 5-segment lcd and matched driver; the possible need for a bcd counter between the LM2917 and the display; requirement to be able to divide the output by various factors between 1 and 8 to take account of the blade configurations or different designs for fan assembly.

Before I go mad and scrap the whole idea, maybe you could offer some guidance or at least tell me where I can obtain applicational data sheets for the LM2917.

As a matter of interest, the whole subject of lcds is bothering me, and I would be grateful for any in-depth systems books and or articles which you might be able to suggest.

Jeff Dandy, Walton, Liverpool.

First, the source information: data sheets for the LM2917 can be obtained from Electromail, (their data sheet number 4901), PO Box 33, Corby, Northants, NN17 9EL, tel 0536 204555.

I reviewed two books during 1990 which might interest you: 101 Optoelectrical Projects *(Tab Books - April),* Electronic Display Devices *(John Wiley & Sons - Sept), your local bookshop or library should be able to get them for you. There was also my article* Intelligent LCD Modules *published in May-June which discusses the LCM570 device and its operations.*

It is not clear, though, why you think you need to convert the tacho pulses to a voltage in order to use the data. All you seem to be after is a frequency counter, so why not keep the data digital and then read out on a digital unit? For example, there are several handheld digital meters available cheaply which can give a frequency readout. Build the sensor you describe, then feed its pulses into the meter. Alternatively, buy a frequency counter module such as that which I described in my Frequency Counter and Generator *project of PE Sept 89. Or, build the module I've been inspired to design (by your letter) for this month's issue!*

Ed.

DATA BASING PE

Dear John,

I am sure you and your readers will be interested to know that one of our BAEC members is going to set up a computer database containing details of project articles published in the main amateur electronic periodicals in recent years.

The idea is that any BAEC member who wants to know where he can find an article about, say, a long period timer, or a car battery charger or anything else, he could be given references to such articles in the periodicals. It would then be possible for him to get hold of back numbers from the publishers or from libraries, or from other BAEC members and so get the information he wanted.

Herbert Howard, British Amateur Electronics Club, 41 Thingwall Park, Fishponds, Bristol, BS16 2AJ.

What a good idea, and another excellent reason for people to join the BAEC!

Ed.

BARS DETECTOR

Dear Sir,

Some years ago PE was able to help me by supplying information on building a differential thermostat to control a solar heating system. I am pleased to say that the system has worked perfectly ever since. I now have another problem on which I hope you can help: I would like to build a form of metal detector that will locate the bars in a cavity brick wall. Do you have any information?

Colin Statham, Sheffield.

Our master index shows that the most recent articles we have published relating to this are Robert Penfold's Metal Detector articles of July and October 1988, back issues of which are available from us at £1.75 each (overseas £2.25) including post.

Ed.

CAT AMONGST THE PIGEONS

Dear Sir,

I am a pigeon fancier who is having trouble with cats. Consequently, the birds are not performing to their full potential.

I am informed that it is possible to deter cats from the vicinity of the pigeon loft with ultrasonic sound waves without affecting the birds. Has PE ever published an ultrasonic cat repeller?

There is a definite need for such an instrument. The cat is the bane of all bird keepers and such a device would be welcomed by all who keep birds in outside aviaries.

N. Rowney, Wyken, Coventry.

No, PE has not covered this obviously vital matter, but I know a man who has! PAL Electronic Systems Ltd have a wide range of devices for deterring all sorts of creatures, including birds, rats and moles. The company is at PO Box 7, Oadby Industrial Estate, Leicester, LE2 4YE. Tel 0533 713361.

Curiously, a near neighbour's problem is just the opposite. Their cat is terrified by pigeons, and other large birds such as magpies and rooks, retreating urgently from the garden at the merest hint of wing flaps!

Ed.

YOUTHFUL

Dear Ed,

We have an Electronics and Radio Club for Youth here in Thanet, which has been going for a number of years with Dr Ken Smith who works in the University, as our leader. The average age of members is 13 years, and though some people say Youth is not interested in Radio and Electronics, that is certainly not so with our band of young people! So here is a report about the new session and what the boys want to get done.

The main project this term will be everyone building RDF (radio direction finder) receivers for Club outings to "find the hidden transmitter". Also, as quite a lot of old members passed the RAE (and GCE/GCSE) from the Clubwork over the years, some of us will study that Course this year. Others are interested in the new RSGB 'novice' licence.

Some of us went with Ken on a week's Youth Hostels cycle tour around the New Forest, Isle of Wight (yes, we do that too). We visited the "Wireless Museum" at Arreton Manor, and were most impressed with the interesting things there. Our Leader is so keen on collecting and giving talks on Old Wirelesses. We can see why now!

We also like writing on the word processor, (like I'm doing now writing to you). We write a magazine/newsletter called the *TECnician*.

We don't think many 13 year olds will read PE, but what is important is the older people (teachers, uncles, etc) who do. Please ask them to think about running a similar club, persuading other young persons to become as interested as we are. Our members are very keen, and help to run the Club. It is very democratic and we have a Members committee who run things.

Ross Collins, Ramsgate, Kent.

I am delighted to have heard from you about your interesting activities and hope that many more people, whether Youth or Olders will follow suit.

Ed.

ORIGINALS

Dear Mr Becker,

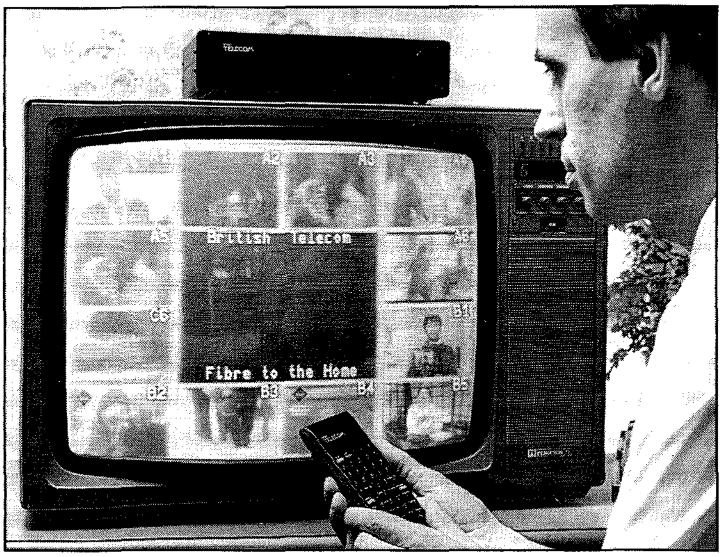
With reference to the letter in PE October 90 from Joe Hill regarding Sargrove: I have six UA55 Sargrove/Tunsram tubes in mint condition and one with heater failure which would be suitable for display purposes, together with three lenses for the same, one with original resistors, also an original leaflet on their use. Collectors items all of them, and I'm open to offers!

I am constructing your *Scope Expander* (Aug-Sept 90). It's a beautiful design - I congratulate you. I am, however, having difficulty in obtaining the 74HC251. I can get the LS version, though. Can you suggest a source of supply?

H.W. Howlett, New Malden, Surrey.

I have passed your Sargrove comments on to Joe Hill. The 74HC251 can be bought from Electromail, tel 0536 204555. Thanks for your kind letter.

Ed.



HOME-BASE

Ian Burley reports that Bishop Stortford is on the fibre optic map and that a form of Caller-ID has arrived in the UK. He's also found that HDTV, CD-I and Telepoint are making progress, and that Casio's digital diary is in time for Christmas.

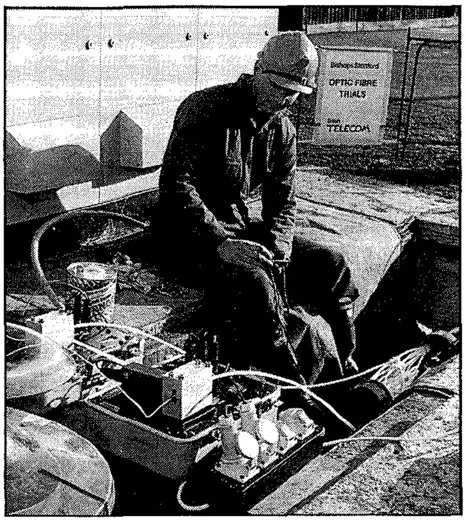
FIBRE OPTIC TRIALS

A British Telecom lead research group has unveiled its plans for what you might describe as the cable tv system of the 21st century. Up to 400 Bishop's Stortford homes and business in Hertfordshire are being connected up to fibre optic cables in order to assess two versatile communications systems which will offer multi-channel television, phone and videotex transmission. BT claims the trial will be the world's first practical demonstration of the next century's network standards.

Participating sites will be able to receive up to 18 television channels, including satellite tv, and conventional phone calls via fibre optic cables. The first phase of the trial will see existing copper wire phone cables maintained until the fibre optic system has been fully tested. It's expected that these will be retained as an emergency backup even after the switch over to optic fibre cables.

The two rival systems being evaluated are TPON (telephony over passive optical networks) from Fulcrum Communications and BIDS (broadband integrated distributed star) which is the work of both Fulcrum and GPT.

Cable tv as we know it today almost universally relies on ordinary screened wires with a relatively limited bandwidth. They normally only transmit tv channels though some of the more advanced systems have primitive two-way communications built in, though not usually a phone line. The advantages of an optical fibre digital link are many, including far fewer cables being piped into your premises yet carrying many more services and with the prospect of interactivity through videotex and don't forget the bonus of noise free phones.



UK CALLER ID

Over the past few months I have been keeping an eye on Caller ID in the States. This is a facility available to a small but growing number of American telephone users which enables the identity of an incoming caller to be revealed before the recipient answers the phone. A Caller ID add-on box or specially adapted phone will have an lcd display to show the phone number of the caller as the phone rings. You can do all sorts of things with this information - ignore the call, switch it to an answering machine, log the number to return the call without re-dialling, or even forward the number to the police if the caller is suspected of being an undesirable. Caller ID is a function of some digital exchanges and is totally automatic. The user pays a premium to his or her phone company as well as having to go out and buy a Caller ID phone or adapter box.

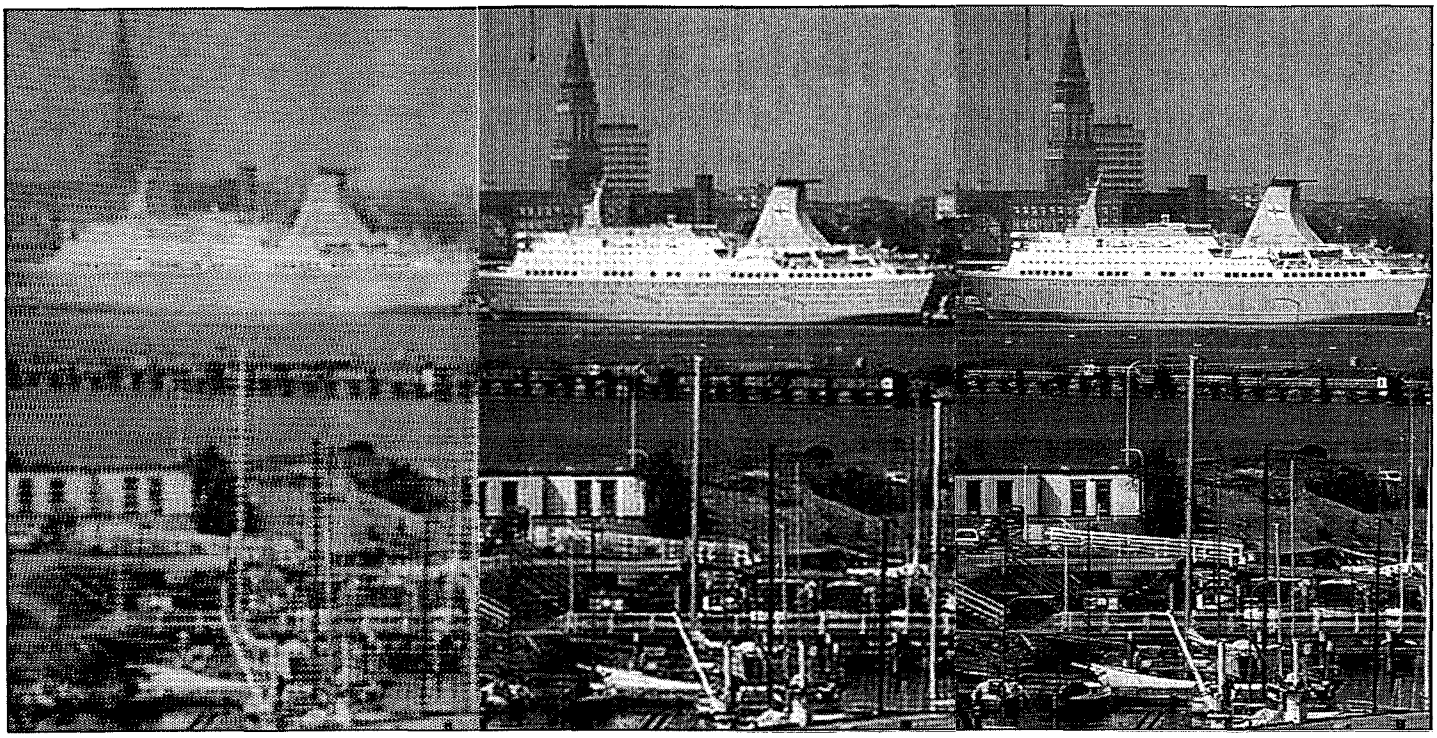
M.B.C. Communications in Maidstone, Kent, has come up with a device which it also refers to as a Caller ID unit. Unfortunately (depending on your point of view - Caller ID is under fire in the US as being anti-social) - Caller ID is not enabled on any UK digital exchanges and there are no firm plans to introduce it. So how does M.B.C. manage such a marvellous sounding feat with its Caller ID unit? Quite simply the caller must cooperate and punch up his or her number in response to the M.B.C. unit answering the phone itself with a synthesised voice prompt. The obvious disadvantage here is that you have to rely on the caller keying in their number honestly. Another problem is that the caller must have a DTMF (tone dial) phone in order to enter the number which will then be displayed on an lcd for the recipient to peruse.

CALL-FILTER
OGM PHONE
PRIVATE
1
2
3
4
5
6
7
8
9
*
0
#

After being aware of the advantages of the fully automatic system available in the States it's rather too easy to be initially unenthusiastic about M.B.C.'s comparatively primitive device, however I can see that plenty of people would find it useful. In its present form the unit features a three-digit security code for callers familiar to the recipient, the call times are logged and there is a sensitive microphone which can be used by the owner to listen for any activity in his or her house remotely - ideal for keeping an ear on the children if you're away for the evening for example. Unfortunately the latter feature will probably have to be removed if the unit is to be BABT approved for use in the UK. Until Caller ID proper arrives in the UK, I can see that M.B.C. will probably do a lot of business with their next best solution. The M.B.C. Caller ID unit costs £155 including vat. For more details, contact M.B.C. on 0622-691 666.

BEEB REVEALS PAL HDTV

The advent of commercially available high definition television (HDTV) is slowly getting closer, however, there is a whole host of serious problems to be overcome before we will see its widespread adoption. One of these problems is that if existing terrestrial television broadcast transmitters are to be used to distribute HDTV, a way of compressing all the picture information into the available transmitter bandwidth will have to be devised. Otherwise,



Left to right: Conventional 625-line PAL, 1250-line enhanced PAL, 1250-line HDTV.

HDTV broadcasts might be restricted to high powered satellite transmission. After all, an HDTV picture has over four times the resolution of a conventional tv picture (1250 horizontal lines compared with 625 lines and slightly more than double the horizontal dimension). Another problem is that a full HDTV system would render everybody's old 625 line tv sets obsolete overnight.

Now the BBC's engineering department has come up with a possible solution to the problem. Under development in conjunction with another research group in Germany is an "enhanced" PAL standard which would offer 1250 line, wide screen, near-HDTV pictures to those with suitably equipped television receivers. Enhanced PAL would remain compatible with old 625 line PAL tv sets and it would be broadcast with existing tv transmitter equipment.

As you can see by the three sample photographs the intermediate enhanced PAL screen which the BBC has accomplished is considerably superior to the existing 625 line system, if not quite comparable with the "straight" HDTV picture you would obtain with a satellite-based broadcast, for example.

The trickery involved in squeezing the necessary picture information - colour, luminance and picture detail into the broadcast signal is extremely complex. For example, some localised movement - a bird on the wing for example - is actually transmitted in a lower resolution. But as the subject is moving, the eye won't be sensitive to the missing detail. Inbetweening techniques are also employed - where intermediate images are digitally created to fill in some frames of movement.

Enhanced PAL is a nice sounding compromise but there have been no firm proposals for its adoption yet. Development work is still continuing, but it's encouraging to know that many of the benefits of HDTV will be available to all without sacrificing compatibility with the existing tv system.

CD-I PROGRESS

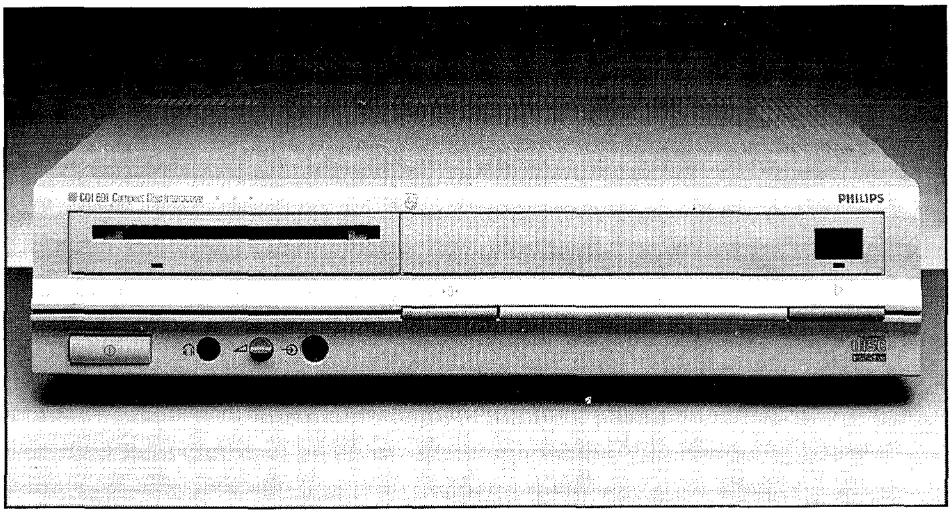
Interactive Compact Disc or CD-I has taken a couple of notable steps forward in its long development journey with the announcement of a new generation of CD-I players aimed at professional and institutional markets. There's also news that Maxwell Communications is in serious negotiations with Philips to establish a joint CD-I multimedia software publishing venture.

CD-I is an extension of music cd technology which incorporates high quality still and motion picture video as well as computer graphics and data files in a format which can be conveniently accessed in an "interactive" manner by the user. CD-I will let you access information on conventional looking 5 inch cds much in the manner that you can loop up data from computer databases except that not only can you access text files but also pictures, audio and video and link them all up logically.

CD-I will be ideal for interactive training and education. The proposed Maxwell and Philips deal underlines this. A new company to be formed by the two firms, Maxwell Multi Media, will produce and sell self-teach language courses for the home, school and office. But that's hopefully only the tip of an iceberg which could be as big as the audio cd market today. Home entertainment and personal productivity software on CD-I discs could take off in 1992 when the first domestic CD-I players will go on sale in Europe. Americans and Japanese get their domestic players a little earlier next year.

Meanwhile, Philips has announced two new CD-I players, the CDI 601 and 602 (which has a 3.5 inch floppy disc. At around £1,500 neither of these players are exactly home-affordable, but they're not meant to be.

The new Philips CD-I 601 player – designed for professional and institutional markets.



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64KB DIGITAL DIARY

Flagship of Casio's range of digital diaries, the new SF-9500 64kB Digital Diary with IC Card expansion and moving keys.

They are heavy-duty units designed for professional use. However, they are the first all-in-one CD-I units to be made available to customers other than development houses and considerably cheaper than their bulky forebears - they provide a hint at what will eventually become available for the domestic market. An important part of the new machines' specification is the ability to be conveniently upgraded to full screen motion video capability, the Motorola chips for which are in the final stages of production development.

CASIO DIGITAL DIARY

Just in time for Christmas, Casio's latest pocket digital diary - the SF-9500 has reached these shores. The unit is a development of the SF-8000 which was Casio's first really useful pocket organiser simply because it had proper raised keys with a decent movement. Earlier models had to make do with a Sinclair ZX81 (remember those?) flat plastic membrane keyboard.

With your SF-9500 you have a full function calculator, you can store business card details, telephone numbers and addresses, there's an appointments schedular and alarm, a world time clock, a password protected information storage option and you can slot in a range of optional IC-cards like spelling checkers and a thesaurus. On top of all that you can link two SF-9500s together via a special cable and even link up to a PC.

The new SF-9500 has a revised keyboard layout with the shift, search, combine and other important keys more logically grouped and there is the facility to memory card expand the SF-9500 to 128K storage. At £189.95 I wouldn't say no to one of these falling down the proverbial chimney this Christmas.

TELEPOINT PRICES SLASHED

The tiny Forum Telepoint phone produced by Shaye Communications has had £70 knocked off its price to just under £100 plus vat. This answers one of the main criticisms of Telepoint services. For a cheap alternative to cellular phones, Telepoint hardware was surprisingly expensive and not surprisingly very few have been sold to date. Further good news is that Shaye has also reduced the price of its personal base station and you can now buy a Forum phone, base station, rechargeable battery and recharger for £249.95 including vat. That's a saving of £140.

Regular readers might recall that I promised myself a Telepoint phone once the price for a phone and base station dropped below £200. It's not quite there yet, but I am now sorely tempted. However, there are still a couple of points to consider. The Forum phone can only talk to the Mercury Callpoint and BT Phonepoint networks. If inter-system roaming becomes possible eventually, you will need to upgrade to a CAI (common air interface) compatible hand-set to benefit. The prices are just for the hardware - it still costs about £25 to register and you will pay £8 a month on top of any call charges.

The question now is how will the other two operators, BYPS Rabbit and Ferranti Zonephone respond to Shaye's aggressive new pricing and will it be enough to save Telepoint? Watch this space!

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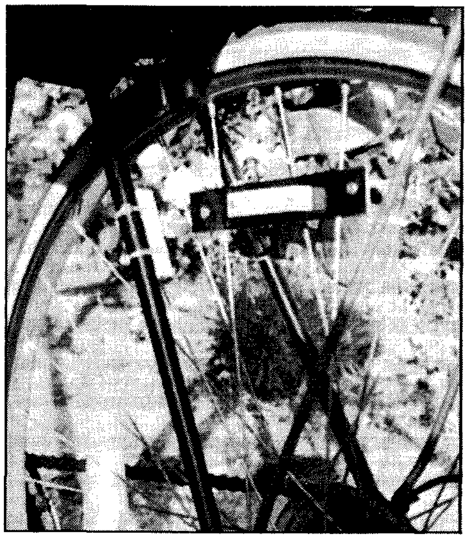
BIKE COMPUTER

Part three. John Becker concludes the project and describes the use of the independent 6502 microcontroller.


Bike wheel rotation sensor mounting.

TEST SWITCH

As discussed in part one, the computer has been programmed to make calculations just once per second, effectively being put into suspended animation between bursts of activity. During these quiet periods, time and wheel rotation are constantly monitored so that nothing is overlooked. I have, though, allowed for the unit to be put into continuous run mode for testing purposes.

Look back to Fig.9: a test switch is shown. In the open position (as shown), the unit is in the power saver burst-mode. If the switch is closed, or a wire is soldered between IC8b pin and +5V, the action of IC8a cannot affect IC8b. Consequently, the computer will immediately start another round of calculations once the previous batch has been completed. The timing factors will of course no longer be related to one second intervals, but the triggering from the wheel's magnetic sensor will otherwise be correctly processed. You can if you prefer, couple in a 5V pulse generator to the computer instead of the magnetic sensor during test procedures. (Using a pulse generator during program development I had the unit showing that my bike was thought to be travelling at several hundred mph. Mind boggling!)

SENSOR MOUNTING

The end section of the power saver pcb (Fig.10 in part one) should be neatly cut off. This holds the sensor ic and a couple of resistors and is mounted on the rear forks of the bike inside a suitable enclosure. My own enclosure and the magnet needed to trigger the sensor ic came from the same source. I bought the type of magnetic detector that is used with burglar alarm systems (specifically the RS/Electromail proximity detector 333-192). It consisted of two miniature plastic 'cases', one holding a magnet and the other a reed switch. I removed and discarded the reed switch and inserted the bike sensor pcb instead. Wires of a suitable length were brought out through a hole in the case.

Although the reed switch is theoretically capable of sensing the wheel's rotation, there is a limit to the number of times it will open and close before failing, typically around 100,000 for the security alarm type. A 27 inch bike wheel rotates around 750 times over one mile, and small wheels rotate even more, so you can see that the travelling lifetime of this type of reed switch would be only around 100 miles or so. Other reed switches with a greater lifetime of up to 10 million operations are available, though the typical required proximity to the magnet is around 7mm to 16mm, a distance which might be hard to maintain on a bike.

To mount the magnet, two strips of fibreglass were cut to a length long enough to span between two adjacent bike wheel spokes. To one of them I screwed the magnet housing. The two strips were then placed on opposite sides of the spokes and bolted together at their ends (see the photograph). The sensor housing was then secured to the rear vertical fork using two cable ties. The sensor's position was ultimately adjusted so that the rotation of the magnet on the wheel activated it cleanly. A non-conducting waterproof compound of some sort could be used to prevent water getting into the housing.

MOUNTING THE UNIT

To secure the computer, I originally used Velcro glued to the handlebars and to the base of the unit. As I am sure you know, two bits of Velcro couple together when brought into contact. This provides a fairly secure fixing when riding on smooth surfaces and allows the computer to be detached for security reasons. However, much of my cycling is done on rough terrain and I found that Velcro did not respond too well to hard-hit pot-holes! I now use a tough rubber strap around the unit and handlebars with a piece of sponge rubber underneath the box.

Another possible method would be to screw a spring clip to the base of the unit, allowing it to be clipped to the handlebars. Alternatively, you may be able to think of a way to mount it on the headlight bracket.

To allow removal of the computer from the bike, I brought the wires from the battery and magnetic sensor module along the bike frame, using cable ties to secure them. They were then terminated on a DIN plug, plugging into an equivalent socket on the side of the computer (you can see this in the cover photo of PE Nov). I am unable to offer a fully satisfactory solution to the possible problem of rain getting into the unit. Covering or removing it seems a reasonable method should you insist on going out in all weathers (I'm not that fanatical!).

ALARM

The alarm function is turned on by pressing the '#' key. This causes a message to be set on screen line 1: "ALARM ON". From then on, until a code number is entered from the keypad, the processor will look out for any wheel rotation or incorrect use of the keys. If such behaviour is detected, IC3 pin 8 (PA6) goes low, so sending the output of IC6d high. This can be used to directly drive a low current audible warning device, or a higher powered one via TR1 (as in Fig. 13.). No provision has been made on the pcb for TR1. This can be hard wired to the awd, or mounted on a tiny bit of Veroboard. The alarm will continue sounding until either the correct code is keyed in, the battery runs out, or a would-be thief unsportingly disconnects the battery! However, a thief caught by surprise when the alarm sounds will hopefully be sufficiently taken aback that he overlooks such options. Detection of the correct coding is very simple and no elaborate security measures have been taken. Providing that sooner or later the correct sequence of four digits is keyed in the alarm will be switched off.

UPDATE

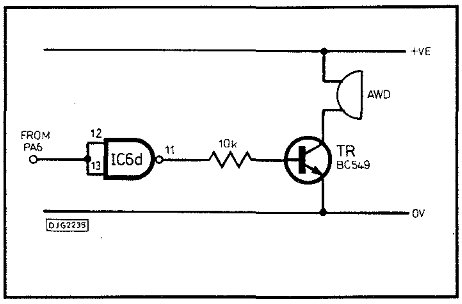
A few points have arisen since going to press with parts one and two:

If you are using a 1N4001 to drop the psu voltage, a 22µF 16V electrolytic capacitor should be connected between the positive side of the diode and the 0V line.

In Fig. 9, C9 should go to IC7a pin 13, not to pin 12.

In part two, the Basic program line 330 should say "LINE 720" not "LINE 730", and line 340 should say "LINE 728" not "LINE 738".

Fig. 13. Alternative method for driving an awd.



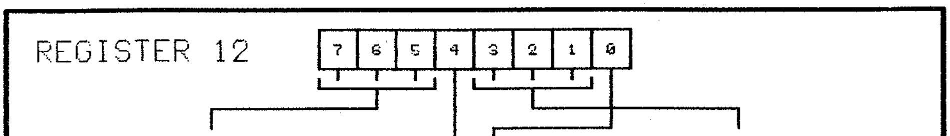
MEASUREMENTS

You should also be beware of what diameter value you tell the Basic program to base its calculations upon. A bike's quoted wheel diameter does not take into account the thickness of the inflated tyres. The actual diameter when measured could be at least one inch greater. To confuse the matter further, the diameter will decrease when you ride the bike since the tyres will be flattened slightly by your weight (especially if you forget to pump them!). I too overlooked this obvious fact but have now told the computer that my wheel diameter is 27.5 inches instead of the manufacturer-quoted 27 inches. Adding the extra half inch seems a reasonable compromise.

Following a lengthy cycle trip out and back along the same route I discovered a discrepancy between the readings obtained for both parts of the trip. Outwards the journey was mostly uphill, on the return it was mostly down hill, resulting in different top and average speeds. Examination of the problem showed that the readings from the faster trip were incorrect. The reason was found to be due to the inclusion of R11, R13 and C12, which had been designed in to inhibit the chance of the magnetic sensor producing erroneous double-pulses. The damping effect was too great to keep up with the higher speeds I was reaching. Removing all three components and replacing R12 with a link wire cured the problem.

UNIT ADDRESS	REGISTER NUMBER	RS CODING				REGISTER/DESCRIPTION	
		RS3	RS2	RS1	RS0	WRITE (R/W̄ = L)	READ (R/W̄ = H)
$2000	0	0	0	0	0	OUTPUT REGISTER B	INPUT REGISTER B
$2001	1	0	0	0	1	OUTPUT REGISTER A	INPUT REGISTER A
$2002	2	0	0	1	0	DATA DIRECTION REGISTER B	
$2003	3	0	0	1	1	DATA DIRECTION REGISTER A	
$2004	4	0	1	0	0	T1 LOW-ORDER LATCHES	T1 LOW-ORDER COUNTER
$2005	5	0	1	0	1	T1 HIGH-ORDER COUNTER	
$2006	6	0	1	1	0	T1 LOW-ORDER LATCHES	
$2007	7	0	1	1	1	T1 HIGH-ORDER LATCHES	
$2008	8	1	0	0	0	T2 LOW-ORDER LATCHES	T2 LOW-ORDER COUNTER
$2009	9	1	0	0	1	T2 HIGH-ORDER COUNTER	
$200A	10	1	0	1	0	SHIFT REGISTER	
$200B	11	1	0	1	1	AUXILIARY CONTROL REGISTER	
$200C	12	1	1	0	0	PERIPHERAL CONTROL REGISTER	
$200D	13	1	1	0	1	INTERRUPT FLAG REGISTER	
$200E	14	1	1	1	0	INTERRUPT ENABLE REGISTER	
$200F	15	1	1	1	1	OUTPUT REGISTER B*	INPUT REGISTER B*
						NOTE: * SAME AS REGISTER 1 EXCEPT NO HANDSHAKE	

Table 1. Addressing the 65C22 registers.



CB2 CONTROL

7	6	5	OPERATION
0	0	0	INPUT NEGATIVE ACTIVE EDGE
0	0	1	INDEPENDENT INTERRUPT INPUT NEGATIVE EDGE
0	1	0	INPUT POSITIVE ACTIVE EDGE
0	1	1	INDEPENDENT INTERRUPT INPUT POSITIVE ACTIVE EDGE
1	0	0	HANDSHAKE OUTPUT
1	0	1	PULSE OUTPUT
1	1	0	LOW OUTPUT
1	1	1	HIGH OUTPUT

CA2 CONTROL

3	2	1	OPERATION
0	0	0	INPUT NEGATIVE ACTIVE EDGE
0	0	1	INDEPENDENT INTERRUPT INPUT NEGATIVE EDGE
0	1	0	INPUT POSITIVE ACTIVE EDGE
0	1	1	INDEPENDENT INTERRUPT INPUT POSITIVE ACTIVE EDGE
1	0	0	HANDSHAKE OUTPUT
1	0	1	PULSE OUTPUT
1	1	0	LOW OUTPUT
1	1	1	HIGH OUTPUT

CB1 INTERRUPT CONTROL — — CB1 INTERRUPT CONTROL

0 = NEGATIVE ACTIVE EDGE 1 = POSITIVE ACTIVE EDGE

Table 2. Peripheral control register addressing.

MISCELLANY

In the paragraph before POWER SUPPLY on page 24 last month, I erroneously referred to reprogramming the *eeprom.* I should have said that if you are using a *lithium battery-backed memory chip* and have an eeprom programmer then you might consider programming the *memory* to hold zeroes in all locations, so resetting it once you have finished checking-out the Bike Computer.

In Fig. 6 of part one, CB2 is shown going to +5V though the link is not shown on the pcb layout. Since the 65C22 has internal pull-up resistors an external link is not necessary on this pin, though you may make one if you wish.

A reader queried the rate at which the current-speed readout appears to change. This is due to my having written an averaging subroutine into the speed calculating routine. The speed shown is the average of the last ten calculations (taken over 10 seconds, of course), allowing a speed reading to be seen even when the wheel is turning at less than one revolution per second.

INDEPENDENT MICROCONTROLLER

The microcontroller board may be used as an independent module for controlling other functions, using an eeprom/eprom programmed with your own code.

The programming code necessary for making use of the power saver board in other situations is too complex to discuss and you should consider using it only if you are an experienced programmer. In brief, with the Bike program, PA5 is sent high at the end of each full sequence. This causes the power saver to stop the clock feeding to the 65C02. The power saver then waits until PB7 goes high at the end of a timed period programmed into the 65C22 timer registers. On receipt of the signal, the clock signal is again permitted to go to the 65C02, whereupon the sequence repeats.

To dispense with the power saver board, you just replace it by a link wire between IC5a pin 10 and the eprom OE/CE input pins 18 and 20, and with another link wire between the clock generator IC5b pin 8 and the 65C02 clock input (phi-zero) pin 37. The other connections shown as going to the power saver board are ignored.

LOCATIONS

The board has been designed so that the eprom lives at hex locations $4000-47FF, the memory at $0000-07FF, and the VIA at $2000-200F.

The microprocessor needs to have clear access to one block of the memory for its internal housekeeping routines, but you are free to use all other locations to either side of that block for your own purposes. The restricted block is between $0100 and $01FF, ie memory Page 1. You thus have the all-important Page

Zero ($0000-00FF) at your command, plus $0200-07FF.

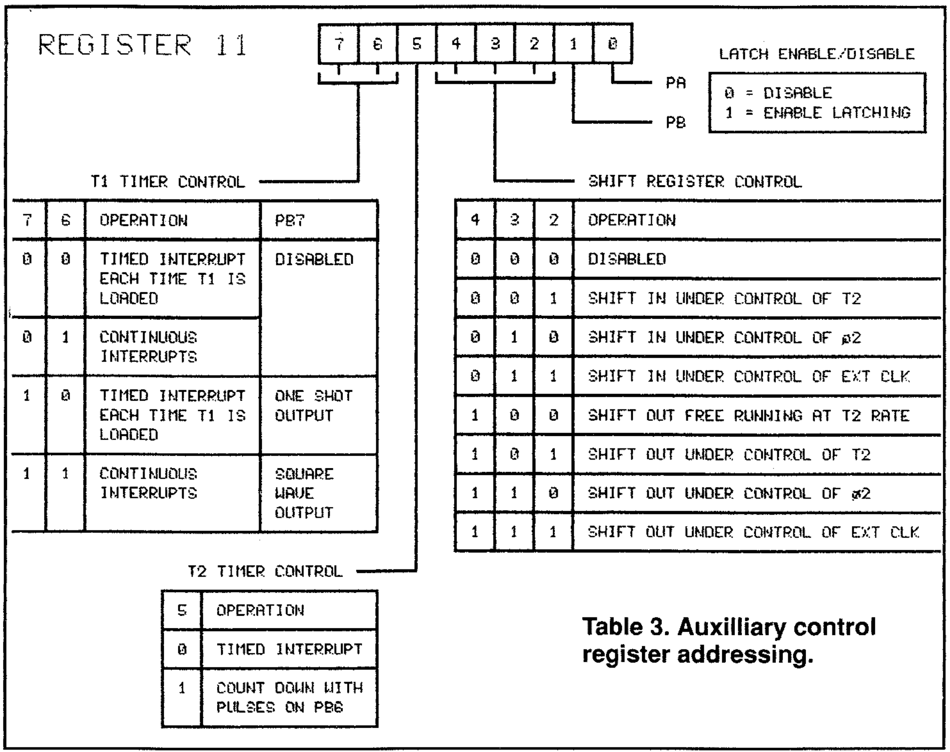
Table 1 shows the VIA register address locations related to the $2000-200F block. You will need to refer to your 6522/65C22 data sheet to make full use of the registers, though the ones you will normally only be interested in are $2000-2003, although I have included tables 2 and 3 covering registers 11 and 12.

There is a choice of two input/output registers you can use for external communication, ports A and B. For many applications they can be regarded as identical, though experienced programmers will know that there are useful differences beneficial to some more sophisticated control options.

Before using either of the ports the relevant data direction register (DDR) must be set to nominate the ports as inputs or outputs. Any of the eight pins on each of the ports can be set as inputs or outputs. Poking the DDR with zeroes at specific bit locations sets the equivalent bit of the port as an input, poking a 1 sets it as an output.

Suppose you want to set port A so that the first four bits are outputs and the second four are inputs: The bit order is regarded as running from left to right, from bit 7 to bit 0. Bits 7-4 are set to zeroes, thus 0000, and bits 3-0 are set to 1s, thus 1111. The resulting code is thus 00001111, which translated into decimal is 15, or 0F in hex. Port A's DDR is at $2003, so you would poke that location with $0F, enabling you then to write to or read from port A whose register is at $2001. Alternatively, you could poke $0F to DDR B at $2002, and then read from or write to port B at $2000. Note that, unlike the ports of some computers, the 6522 VIA uses the same register for both input and output.

Regrettably, I now have to refer you to books on 6502 and 6522 programming for more information. However, let me say that in many ways machine code programming is as easy and fun to learn as Basic. I originally taught myself over the Christmas holidays some years ago, about 10 days of reading and experimenting. You do, though, need to concentrate far more on your logic than with Basic, and to be prepared for programs to be far less tolerant of errors: if you are working directly with a computer always Save any new code prior to running it! If you don't already know about machine code programming, do learn it, it really opens up a whole new world of electronic possibilities. PE


REGISTER 11
7
6
5
4
3
2
1
0
PA
PB
LATCH ENABLE/DISABLE
T1 TIMER CONTROL
SHIFT REGISTER CONTROL
T2 TIMER CONTROL

LATCH ENABLE/DISABLE
0 = DISABLE
1 = ENABLE LATCHING

T1 TIMER CONTROL

7	6	OPERATION	PB7
0	0	TIMED INTERRUPT EACH TIME T1 IS LOADED	DISABLED
0	1	CONTINUOUS INTERRUPTS	
1	0	TIMED INTERRUPT EACH TIME T1 IS LOADED	ONE SHOT OUTPUT
1	1	CONTINUOUS INTERRUPTS	SQUARE WAVE OUTPUT

SHIFT REGISTER CONTROL

4	3	2	OPERATION
0	0	0	DISABLED
0	0	1	SHIFT IN UNDER CONTROL OF T2
0	1	0	SHIFT IN UNDER CONTROL OF ø2
0	1	1	SHIFT IN UNDER CONTROL OF EXT CLK
1	0	0	SHIFT OUT FREE RUNNING AT T2 RATE
1	0	1	SHIFT OUT UNDER CONTROL OF T2
1	1	0	SHIFT OUT UNDER CONTROL OF ø2
1	1	1	SHIFT OUT UNDER CONTROL OF EXT CLK

T2 TIMER CONTROL

5	OPERATION
0	TIMED INTERRUPT
1	COUNT DOWN WITH PULSES ON PB6

Table 3. Auxilliary control register addressing.

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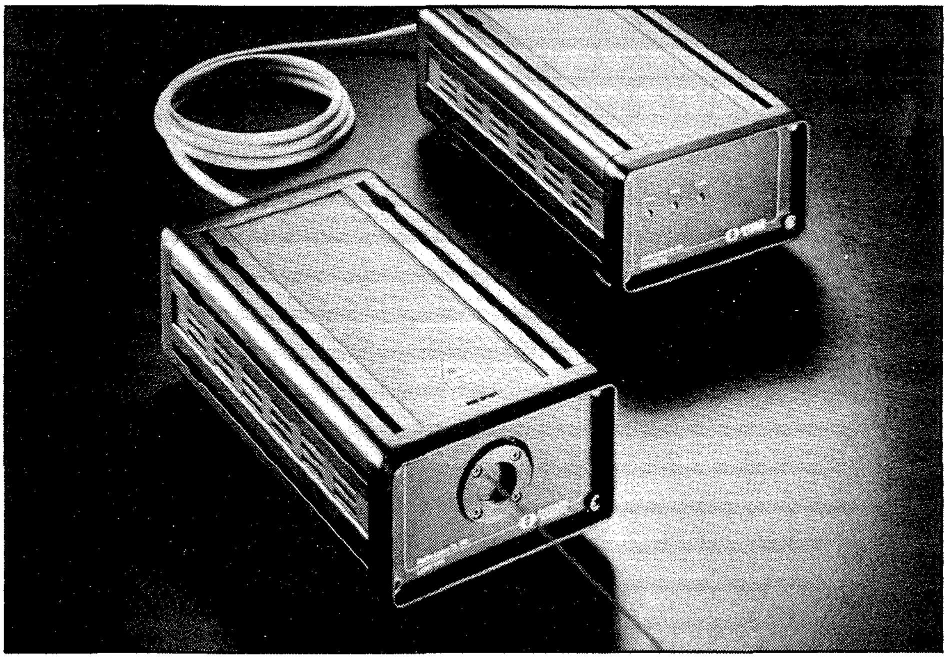
LASERS

Part Three. Mike Sanders concludes the series by examining the industrial applications for lasers.



Spindler and Hoyer's frequency stabilised HeNe laser ZL150. One important area of application is in interformetric measurement technology. It can also be used as a highly accurate frequency standard.

The industrial application of lasers has been in welding, cutting, drilling, machining, surface hardening and scribing. The materials worked on include metal, wood, plastic, paper, cloth and jewels.

In medicine the laser has been used in eye surgery. The ability to focus to a small spot size leaves only a small scar.

Perhaps the most enthusiastic application of lasers has been in telecommunications. The widespread use of semiconductor devices plus digital techniques has kept the cost of communications low to the public. It is just as well that the need to communicate quickly and widely has been matched by the pace of technology.

Lasers are also used in the entertainment industry to create holograms and for security marking credit cards.

Some of the techniques used in each of the above areas will be explored briefly.

HOLOGRAPHY

The first papers on holography were published in 1948 by Dennis Gabor. Between 1948 and 1960 nothing much happened since an intense source of light with good coherence was not available. The first hologram was produced in the 1960s at the University of Michigan's Institute of Science and Technology by Emmett Leith and Juris Upatnieks.

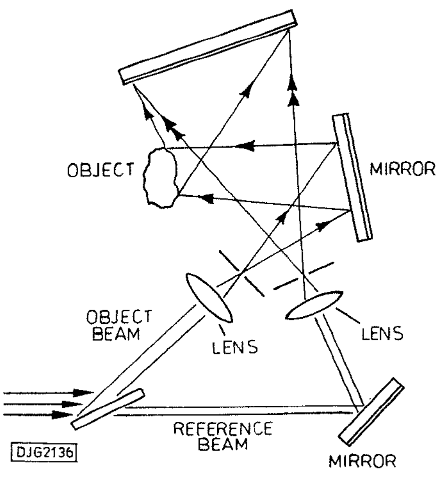
The word hologram comes from the Greek word *holos* meaning whole or complete and *gram* meaning graphic or written. Therefore the world hologram is used to describe the whole picture or three dimensional images.

In ordinary photography the image is described by the electric field intensity amplitude of the light, whereas in holography, a reference beam and object beam are used to record both phase and amplitude. A hologram is therefore a complete record.

Continuous wave lasers like helium - neon, argon and krypton are used. Fig.1 shows that both beams are spread by lenses and the object beam is reflected off a mirror, then off the object and onto a photographic plate. The reference beam is also reflected off a mirror and then directly onto the photographic plate.

The pinholes placed in front of the lenses act as filters to remove optical noise owing to the light scattering by particles of dust.

Fig. 1. Holography



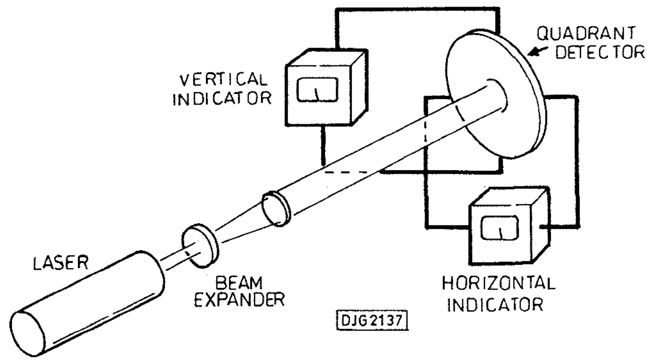
INTERFEROMETRY

Interference fringes can be created using lasers to measure velocity, displacement and surface variations. A reference and reflected ray is used. The alternative method of checking a surface without a laser is to have the test surface in intimate contact with the new surface. Using lasers, the two surfaces can be quite far apart since the laser is coherent over a long distance.

ALIGNMENT

In the building industry it is necessary to ensure that walls and ceilings are perpendicular to each other and lasers can be used as in Fig.2. When the beam is off centre, the position indicators will show this as left or right of the centre mark.

Fig. 2. Alignment



A beam expander is used to increase the diameter of the beam if alignment is required over long distances. The expander also reduces divergence of the beam and the hazard to eyes.

PRINTING

Lasers can be used to produce metal printing plates by burning away the surrounding metal so that the required alphabets stand out. All this can be carried out remotely from a computer terminal.

EYE SURGERY

Lasers are now widely used in opthalmoscopes for eye surgery. Regrettably do-it-yourself kits are not available to those who have been on the beer the previous night and required their eyeballs spot welded back on!

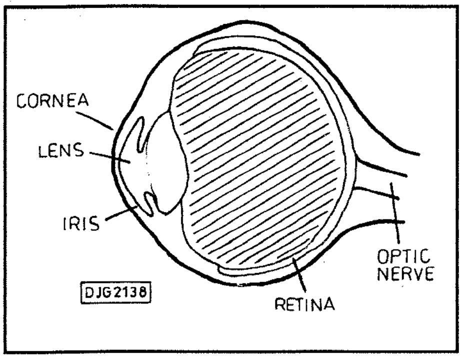
Previously a xenon arc lamp was used and left a 800 µm scar. Compared to this, the small spot size of the laser leaves only a 50µm scar. The scar is a blind spot on the retina therefore it is important to keep this area to a minimum.

Using lasers, energy of one Joule for 300 µS is sufficient and the eye does not need anaesthetic or clamping. A wavelength of 6943 Angstroms is used and passes through the front of the eye without absorption.

With the xenon arc lamp, anaesthetic was required and the eye had to be clamped since a long exposure to the light was required.

Fig.3 shows a sketch of the human eye. If the retina becomes detached or tears, the vitreous humour gets behind the retina. This results in further detachment or tearing, leading eventually to total blindness.

Fig. 3. The eye.



MACHINING

Machining with the aid of lasers employs a laser to heat the material ahead of the cutting tool. This increases the machinability of ceramics and superalloys. The advantage is that the force required from the cutting tool is then reduced which reduces the wear on the tool. A smoother cut is also obtained at a higher cutting speed.

MARKING

The carbon dioxide or neodymium-YAG lasers are used to mark materials. The object of marking may be security and identification as in placing serial numbers, or prestige and advertising as in inscribing logos.

By pulsing the laser, a small quantity of the material can be evaporated from glass, wood, plastic, paper, metal, etc. The main advantage of lasers is that there is no mechanical contact and marking can be carried out even through a transparent enclosure by focusing on the object within.

By using a laser with an average power of 8W and pulsing at 1kHz, oxidised aluminium can be cleaned, leaving a bright surface. Even transparent materials like acrylic can be marked by using an absorbent material on the part or in the part. A neodymium-YAG laser could be used, employing Q switching and providing an average power of 10W. Most modern systems use an average of 50W for such applications.

Industrial application of lasers could be divided into low and high power. The low power applications being alignment, holography and interferometry. The high power applications are in cutting, welding, machining, marking, heating and surface hardening.

Important aspects of the laser beam are its wavelength, mode and size of spot. For continuous wave lasers, the output power and speed at which the beam traverses the workpiece are significant.

In pulsed systems, the peak power, energy per pulse, length of pulse and the shape of the pulse are all important parameters. These will help decide the quality of the finished article. For instance, spikes in a beam will affect the quality of drilled holes.

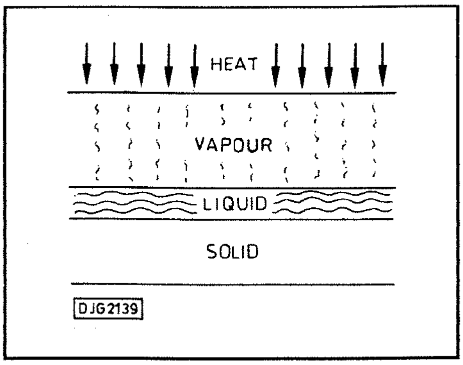
HEATING AND SURFACE HARDENING

In order to evaporate part of a material, energy of the order of 10^6W per square centimetre is required. In between the vapour front and the solid material, there is a liquid front. (Fig. 4).

By contrast, in order to harden the surface of a material a defocussed beam from a carbon dioxide laser of output greater than 1kW is applied. No external cooling is applied to the material, cooling being conduction of heat into the rest of the material.

Hardening with the use of lasers is no different from hardening by any other process. The temperature at the surface is raised about the Martensitic transformation temperature but not above the melting point. When the surface is allowed to cool, the rate of cooling exceeds 1000°C per second.

Fig. 4. Heating.



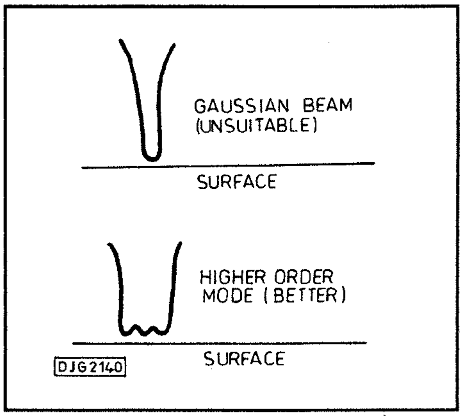


Fig. 5. Surface hardening

The advantage of using lasers for hardening is that the depth of hardening can be kept shallow in thin materials so that other desirable properties such as durability in the bulk material can be retained. In some instances the hardness can be induced in a lower cost material. Also, with lasers, small areas can be hardened without affecting the surroundings.

The main disadvantage of using lasers for hardening is that the coverage rate is low so the process is unsuitable for large volume production or where the area to be treated is large. Also the high reflectance of metals means wasted energy and absorptive coatings must be used.

The absorption coefficient for uncoated iron and steel is 10% to 40%. Coating the metal raises the absorption to around 60% to 80%. The correct thickness of coating is required. If the coating is too thin, it is removed too quickly. If it is too thick then too much energy is wasted. Therefore if the thickness of coating is just right, maximum energy is coupled into the metal.

Common coatings are graphite, black paint and zinc phosphate. A common industrial coating is Lubrite (manganese phosphate) and is useful at lower power up to 1kW. A thick coat of black paint is suitable for higher power around 5kW.

To prevent the coating from catching fire and the metal from oxidising, an inert gas should be used near the work area. If the gas is blown across the work area, the laser optics are also kept clean of smoke and spattering paint. In practice, for economic reasons, air is used instead of an inert gas.

Although carbon dioxide lasers are used for surface hardening, the beam itself is unsuitable because the cross-section is not regular, and therefore the power density is not uniform. Gaussian (single, inverted, half sine wave) and low order modes are not suitable because the peak is too high even if there are no irregularities.

Single high order modes are better, (Fig.5), because the power density is better at the edges of the beam and the heat loss is also compensated. But it is difficult to maintain a good quality higher order mode over extended periods.

It is impossible to obtain contoured (parallels, spirals, etc) tracks when the beam is not symmetrical. Two tricks can be employed. The beam may be rotated or rocked, (Fig.6), using lenses or mirrors.

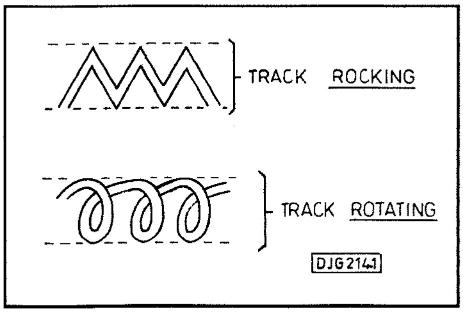


Fig. 6. Producing uniform tracks

Alternatively the beam may be moved linearly but the optics made sophisticated enough to adjust the cross section. The Spawr Optical Company produced a mirror with thirty-two segments to provide such a correction. Another method uses hollow copper tubes which are highly polished. The beam enters at one end of the tube and the corrected beam leaves by the other.

DRILLING

The neodymium laser is used to drill holes in ruby jewels for the watch industry. Since the laser can focus down to about 10nm, any size of hole can be drilled, down to a minimum size of 10nm. By contrast, metal drill bits can drill holes down to 250nm only. One of the main limitations of metal bits being the drill pressing the bit against the work piece, which results in a broken drill bit. The laser has no such limitation.

WELDING

In the micro-electronics industry it may be necessary to solder wires inside a glass enclosure and, whereas a soldering iron would be useless, lasers can be employed quite easily. Similarly, in areas where heat from a soldering iron would be a hazard to neighbouring components, a laser can be usefully employed.

In general the advantages of using a laser for welding are:

1 Greater speed than other techniques
2 Possible to weld in inaccessible areas
3 Minimum heat generated in welding area
4 Narrow weld seam
5 Easy to weld metals which are difficult to weld by other processes, particularly dissimilar metals
6 Good strength weld seams
7 Easy to automate the process

The main disadvantages are the high capital cost of lasers though this is offset by a good weld and low maintenance cost to the machinery. In hardenable materials, hard welds are a problem since it could lead to cracking due to rapid cooling.

Both continuous wave as well as pulse welding can be used and each has its applications.

CONTINUOUS WAVE WELDING

Continuous wave welding employs carbon dioxide lasers around 500W. Between 300W and 500W a phenomenon called keyholing begins. Melting is predominantly due to conducting up to 1kW and keyholing above 1kW.

The pressure of the vapour on the molten material becomes sufficient to push the molten metal away to form a hole, (Fig.7). When the beam has passed, the molten metal flows back. The normal weld depth is about 1mm but the keyholing phenomenon allows weld depths of several centimetres.

An interesting thing happens when a 5kW laser and 2.5kW laser are used to produce a 5.5mm deep weld. With the 2.5kW laser, the metal was too hot to touch after it had been welded. Using the 5kW at twice the traversing speed of the 2.5kW laser, the metal could be touched immediately after welding.

The welding efficiency is defined as the ratio of energy to melt the material to the total energy supplied to the laser.

A cover gas is usually employed coaxial with the beam by means of a trailing cup, (Fig.8). The common gases used are helium, argon and nitrogen. Argon is the best cover against oxidisation because of its high atomic mass. However, this very advantage results in a disadvantage since the gas interacts with the metal vapour plasma causing more laser energy to be lost in the plasma than with helium for instance. This results in metal penetration depths which are lower with nitrogen and argon than with helium.

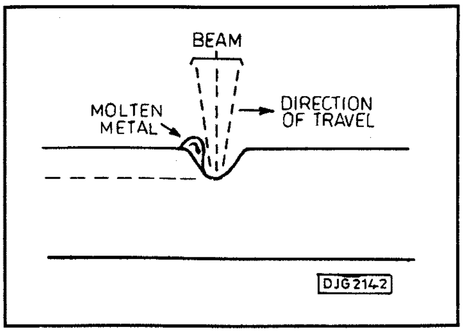
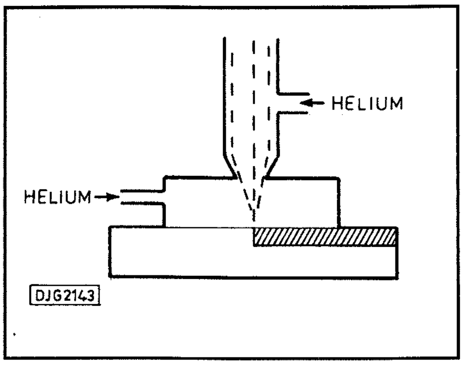


Fig. 7. Keyholing.

Nevertheless, the overall advantage of a cover gas in preventing oxidisation and atmospheric pollution outweigh the disadvantages, and the cover gas is introduced both before and after the weld as in Fig.8. A cover gas is particularly essential for oxidisable materials like aluminium.

The cover gas also protects the laser optics from grit. If, in the welding process, the metal is penetrated completely, a cover gas is required for the underside as well.

Fig. 8. Trailing cup.



PULSE WELDING

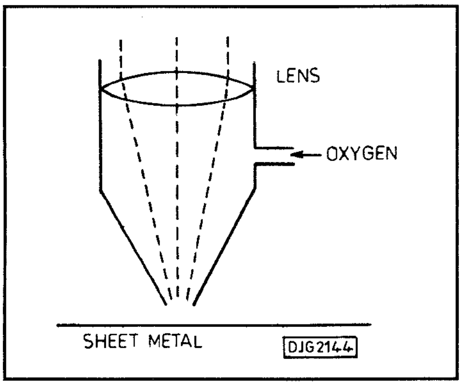
Most pulse welding is done with neodymium-YAG and neodymium-glass lasers. The neodymium-glass laser is used for low repetition spot welding of small parts like wires to terminals in electronic circuits. The neodymium-YAG is more suitable for high speed spot welding.

Although the carbon dioxide laser can be used for spot welding of small parts as in microwelds, it is more often used for welding larger parts. Multi-kilowatt lasers emitting pulses of a few tenths of a second can achieve spot welds of several millimetres in diameter and up to a few millimetres deep.

CUTTING

Since gas lasers are more monochromatic than solid lasers they provide more power. Carbon dioxide lasers can cut aluminium for a third of the cost of conventional methods in the aircraft industry. The cover gas used is oxygen, with oxidisable materials, which not only burns the swarf but improves the cutting speed, (Fig.9).

Fig. 9. Cutting oxidisable materials.



Industrial laser cutting is by both continuous wave and pulsed carbon dioxide lasers as well as high repetition neodymium-YAG lasers. Pulsed laser cutting plays a large part in the manufacture of aircraft engine parts. Both carbon dioxide and neodymium-YAG lasers are used for cutting and drilling turbine blades as well as combustion parts for the engine.

Superalloy materials like Waspalloy and Hastalloy-X are difficult to machine and the conventional methods of cutting and drilling them were by electrochemical machining (ECM) and electrical discharge machining (EDM).

A laser of low average power may not have sufficient energy for cutting but when pulsed may do the job quite adequately. For instance thick film resistors may be cut with a neodymium-YAG laser with a continuous power of only a few watts. When pulsed at a high repetition rate, not only is the thick film cut, but the laser power can be controlled to vary the resistance of the material being cut.

There are other good reasons for using pulsed lasers. Microcracking at the cut edges can be reduced by reducing the heat affected zone by suing pulsed lasers.

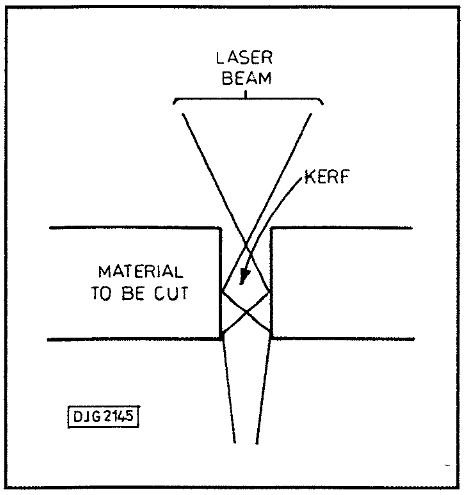


Fig. 10. Cross section of kerf.

In general the advantages of laser cutting are:

1. Absence of tool contact with the material
2. Ability to reach areas inaccessible to mechanical tools
3. Easily cut low machinability materials like superalloys
4. Easily automated process
5. Higher cutting speed than mechanical tools
6. Narrow cut (kerf)
7. Small heat affected zone

The main disadvantage is the high capital cost. For instance three dimensional contouring costs, not three times the cost of a basic laser, but ten times the basic cost.

The cross section of a kerf is shown in Fig.10. When cutting metal the beam is usually focused at the surface but for materials that are thick and non metallic, best results are obtained when the beam is focused below the surface.

Straight sided cuts can be achieved in thick materials because of the light guiding properties of the sides which cause multiple reflections.

MANUFACTURE OF SEMICONDUCTOR LASERS

The old method of growing laser crystals was to diffuse donor and acceptor impurities into a substrate, which was really the old method of manufacturing transistors.

The present method of growing laser crystals is the same as the modern method of manufacturing transistors, which is liquid phase epitaxy. In this process aluminium and gallium are placed in a crucible with a piece of gallium arsenide on top.

The gallium arsenide is called the source crystal and if the temperature is raised to 800°C, part of the source crystal dissolves into the aluminium and gallium. A weight is placed on top of the source crystal to assist this process.

The temperature is then dropped to 980°C which upsets the concentration of the melt and a film of gallium aluminium arsenide is deposited on the source crystal. Using this process layers of gallium aluminium arsenide and gallium arsenide are built up to give the required semiconductor.

SUMMARY

Lasers operate in the ultraviolet to infrared (0.1 µm to 1000µm) and have enormous bandwidths compared to radio frequency carriers. Lasers can be operated continuous wave or pulsed providing energies from microwatts to kilowatts.

Lasers display a high degree of chromaticity compared to ordinary light sources. This is because of their good spatial and temporal coherence. The types of laser discussed were the helium-neon, ruby, carbon dioxide, dye, neodymium-YAG and semiconductor lasers to work on materials like metal, wood, plastic, paper, cloth and jewels.

Lasers operate by stimulated emission as two, three or four level systems, the wavelength of light emitted depending on the length of the forbidden gap between valence and conduction bands. This gap can be altered slightly by doping the host material.

The process of raising electrons to the higher energy levels is called population inversion and three level systems require more energy than four level systems since the whole population needs to be inverted. Methods of pumping to achieve population inversion include gas discharge and physical collision of atoms.

Carbon monoxide lasers are much more efficient than carbon dioxide but since they are toxic and corrosive, they are not used in high power applications.

Various applications of lasers were explored which included cutting, welding, drilling, scribing, marking, spectroscopy, photochemistry, pollution detection and control, holography, eye surgery, alignment, interferometry, surface hardening, machining, entertainment, communications.

For time keeping the ammonia maser has been replaced by rubidium and caesium atomic clocks.

Methods of producing short, high energy pulses include Q switching, cavity dumping and mode locking. The methods of interruption are rotating mirrors and mechanical choppers, acoustic optic modulators and Pockels and Kerr cells.

The semiconductor laser was examined in detail to reveal how large optical cavities with stripe geometry act as waveguides. It was noted that the light emitting diode has a linear characteristic whereas the laser has a non-linear characteristic.

Modes were explained and the techniques of producing single frequencies by coupled cavities, frequency selective feedback, injection locking and controlling the geometry were examined. Finally the manufacture of semiconductor lasers was explained.

There is no doubt that lasers will continue to be refined and used even more widely in the 21st century. Methods of providing purer frequencies at higher output powers will be pursued vigorously by researchers.

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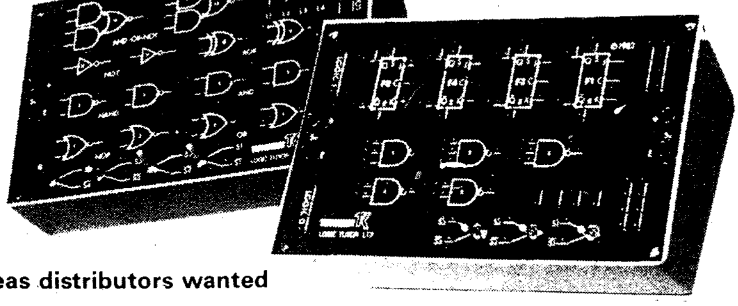

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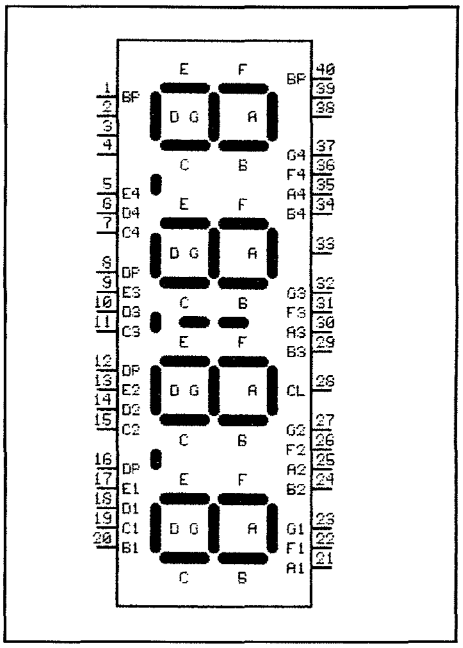
Inspired by a reader's query John Becker offers a simple solution to keeping count of multi-bladed revolutions and other chopped-up data sources.

Reader Jeff Dandy wrote to me recently asking if I could offer advice on a small problem he had. His letter is quoted on this month's *Track Feedback* page. To summarise, he is as much interested in aeromodelling as he is in electronics, and wanted to build a tachometer that responds to the rotations of multi-bladed fans concealed within his models. He had figured out how he could shine a light through the fan duct and then use a light sensor at the other end to produce pulses as each blade cuts through the light beam. However, Jeff needed advice on converting the pulses to an equivalent engine rev count shown digitally on a liquid crystal display. He was also interested in knowing a bit more about lcds.

As chance would have it, I was at that time designing a circuit which used an lcd and a counter chip for its readout display. It was a simple matter to slightly modify my circuit by adding a few chips to produce a circuit to suit Jeff, especially since I now use *Easy-PC* pcb cad software. For the benefit of the rest of you, the following is that circuit.



E F BP
1 BP 2 3 4
40 39 38
D G A
C B
G4 F4 A4 B4
37 36 35 34
5 E4 6 D4 7 C4
33
8 DP 9 E3 10 D3 11 C3
G3 F3 A3 B3
32 31 30 29
12 DP 13 E2 14 D2 15 C2
CL 28
G2 F2 A2 B2
27 26 25 24
16 DP 17 E1 18 D1 19 C1 20 B1
G1 F1 A1
23 22 21

Fig. 2. 4-digit lcd module pinouts.

LCD REV COUNTER

FREQUENCY CONVERSION

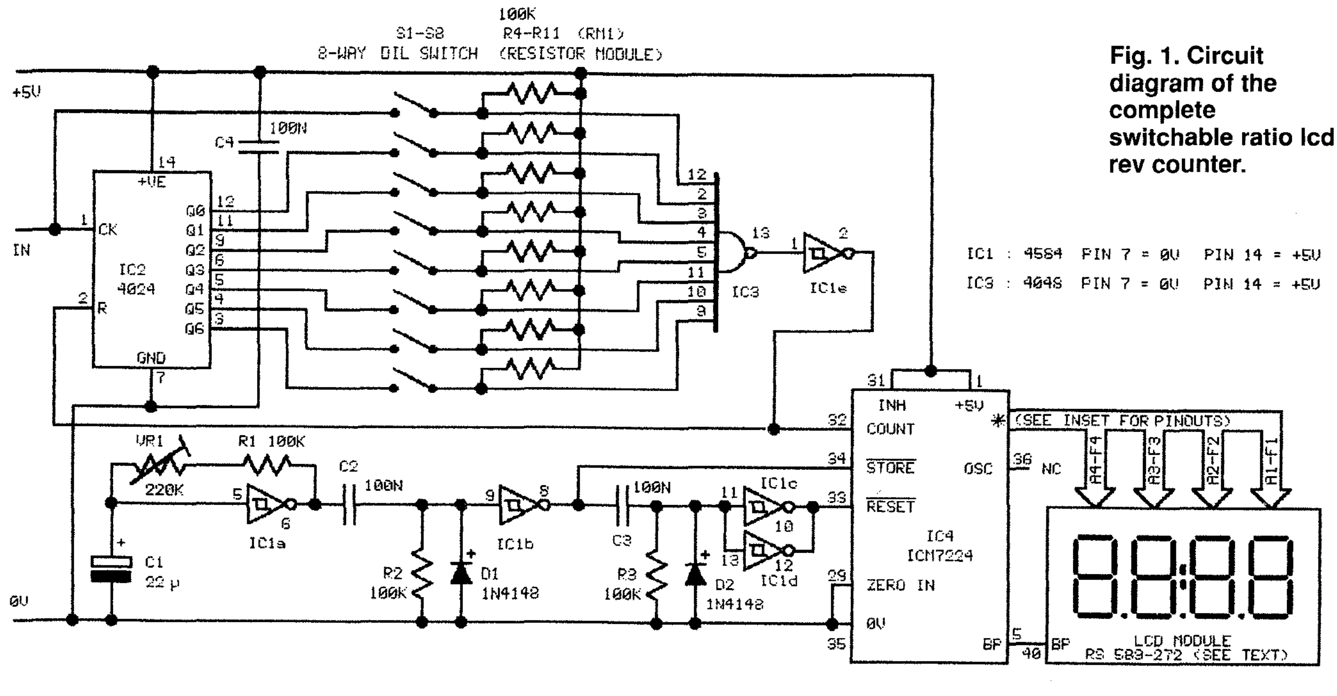
Jeff had thought of converting the pulses to an analogue voltage and then to convert that to a form suitable for outputting to an lcd. That's certainly one way in which it could be done. But there is simpler technique that makes direct use of the pulses without an intermediate frequency to voltage conversion stage.

Consider what it is that defines frequency: it's the number of complete cycles that occurs within a given period of time, conventionally taken as one second. Indeed, although we now use the term Hertz (Hz) as the unit of frequency, the unit was until only a few years ago expressed as cycles-per-second (cps). Let's assume, therefore, that Jeff's fan has only one blade (unlikely, but I'll come to multiple blades in moment). What we need to know is the number of times the blade shuts off the light during one second. Basically, the answer is simple: use a timer which allows pulses to be counted only for exactly one second. Then read out the counter status on an lcd.

In reality, we probably need to constantly sample the bladed pulses, so allowing for variations in rotation speed to be repeatedly monitored. It is preferable, too, that the display should only show the final count at the end of each timed period and not to show the intermediate count values. The control logic sequence then becomes: reset the counter to zero, start counter, stop counter, update readout display, reset and repeat.

Although we can go out and buy units which have the necessary circuitry for direct frequency display, our object here is to design our own circuit. I make one concession to embedded circuit sophistication, though, by using a chip which acts both as the counter and as the display driver. That chip is the ICM7224 which can control a four and half digit lcd. It is shown as IC4 in Fig.1.

The chip has three inputs which concern us here, Count, Store and Reset. With Reset held high, IC4 will successively count each pulse received on its Count input. The count status will be seen incrementing on the lcd display



100K
S1-S8
R4-R11 (RM1)
8-WAY DIL SWITCH
(RESISTOR MODULE)
+5V
IN
0V
C4 100N
IC2 4024
+VE
CK
R
GND
Q0 Q1 Q2 Q3 Q4 Q5 Q6
IC3
IC1e
VR1 220K
R1 100K
C2 100N
C1 22µ
IC1a
IC1b
R2 100K
D1 1N4148
C3 100N
R3 100K
D2 1N4148
IC1c
IC1d
INH +5V
COUNT
STORE
RESET
OSC
IC4 ICM7224
ZERO IN
0V
BP
NC
* (SEE INSET FOR PINOUTS)
A4-F4 A3-F3 A2-F2 A1-F1
LCD MODULE RS 583-272 (SEE TEXT)
IC1 : 4584 PIN 7 = 0V PIN 14 = +5V
IC3 : 4048 PIN 7 = 0V PIN 14 = +5V

Fig. 1. Circuit diagram of the complete switchable ratio lcd rev counter.

IC1 : 4584 PIN 7 = 0V PIN 14 = +5V
IC3 : 4048 PIN 7 = 0V PIN 14 = +5V

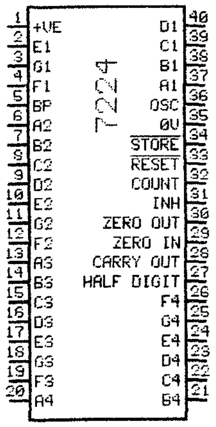


Fig. 3. lcd driver-counter type ICM7224.

only if the Store input is held low. If it's held high, the count will proceed within IC4, but will not be seen on the lcd, which will continue to show the count reached when Store was last high. The counter is reset by taking Reset low.

The oscillator formed around the Schmitt trigger inverter IC1a sets the basic timing period. The oscillator's frequency is governed by the values of C1, and the total value of VR1 and R1 in series. For this circuit, the sampling rate is set for 1Hz. Each time the output of IC1a goes high a pulse is sent across the network of C2, R2 and D1 to the next inverter IC1b. Its negative-going output causes IC4 to transfer its count data to its output latches, which in turn cause the lcd to display the equivalent count number. Immediately the pulse ends, so the count data remains latched, irrespective of any further count pulses being received.

When the pulse ends, with IC1b's output returning high, a positive-going pulse is generated across the network C3, R3 and D2. This is inverted by the two parallel inverters IC1c and IC1d, causing IC4 to be held reset for the duration of this second pulse. Once the pulse ends, so IC4 will start counting again, from zero. The sequence thus causes the lcd display to show the number of count pulses received during each period.

D1 and D2 prevent the pulse forming network from producing negative voltages. IC1c and IC1d are used in parallel in order to provide the necessary current required by IC4's Reset input.

PULSE DIVISION

The circuit so far behaves simply as a frequency counter, for use with any source producing 5V pulses, whether it is a singled blade prop rotation detector, or other pulse producer. However, Jeff says that his props can have varying numbers of blades and that he wants to know the rate at which the engine is rotating irrespective of the number of blades it has. No problem! Just divide the input pulses by the same number as the blade count: two blades, divide by two; seven blades, divide by seven; 255 blades, divide by 255.

In fact I've restricted the division number to 128, using a 7-stage ripple counter IC2 plus a NAND gate and inverter to perform the division. IC2 counts the incoming pulses from the pulse source. Its outputs can be switch-selected by any or all of S1-S8 and routed to the NAND gate IC3. Each time IC3 detects the selected binary number, its output goes low causing IC1e's output to go high, so resetting IC2. This same output is the pulse source seen by IC4's Count input, which consequently only responds to the divided pulse rate. All that's needed is to switch S1-S8 to the binary number corresponding to the number of engine blades and you then have an engine rotation counter. S1 selected on its own causes the pulses to bypass the input counter. With all switches off, no pulses reach IC4.

HZ AND RPM

Some of you will now be saying that engine speed should be expressed as revs per minute (rpm) not Hertz. Ok, three options then: mentally multiply the counter's readout by 60; extend the oscillator period to one cycle per minute; shorten the oscillator period to 1/6th of a second and mentally multiply the counter display by ten.

When setting the oscillator rate, remember that IC4 will only count following the ending of the Reset pulse, and that the display latches are

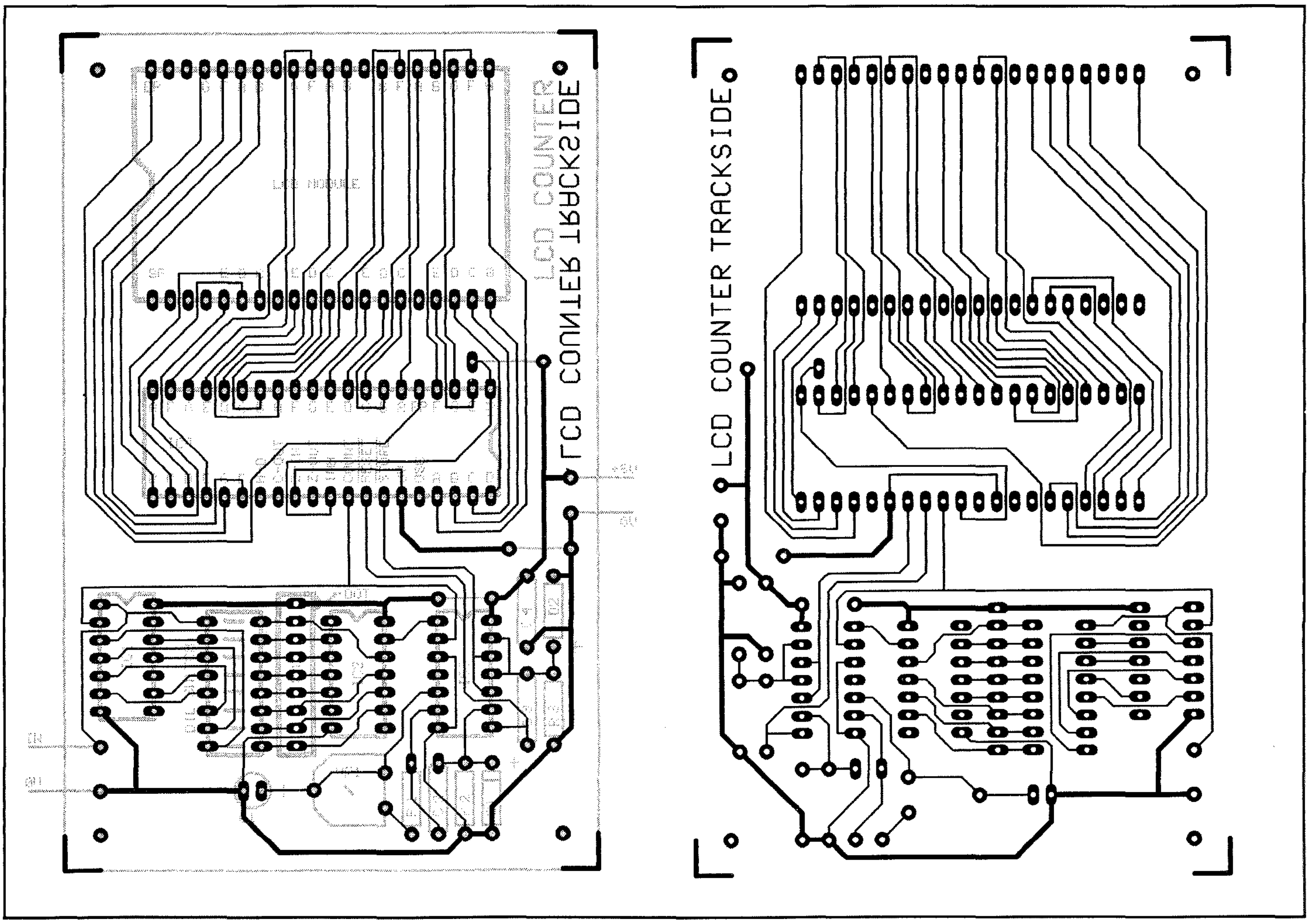


Fig. 4. PCB component and track layouts.

open for the duration of the Store pulse. You can experiment with different values for C2, C3, R2 and R3 in order to reduce the pulse widths to their minimum acceptable lengths.

The pcb for this circuit does not allow for all functions of the ICM7224 to be implemented. For other applications control options are available for blanking leading zeroes of any display number; for inhibiting the count; for controlling the 'half digit' of a suitable display; for chaining one or more 7224s together; for varying the lcd's backplane frequency. The pin outs are shown in Fig. 3. The full use of a 7224 is beyond the scope of this article, but I'll comment on Inhibit and Leading Zero:

To allow the counter to count, Inhibit must be held high, as it is in this circuit. Taking it low (to 0V) stops the counter. Leading zeros are displayed in this circuit since Zero In is held low, eg with a 4-digit lcd the number 62 will be displayed as 0062. Taking it high (to +5V) blanks all leading zeros, thus 62 will appear as 62.

LIQUID CRYSTALS

It may well come as a surprise to you to know that liquid crystals were discovered as far back as 1888, by the Austrian biologist F.Reinitzer. However, it was not until 1963 that Williams in the USA published the first paper on the electro-optic effect of liquid crystals. Then, in 1968 Heilmeier and others in the USA published details of DS (dynamic scattering) and GH (guest-host) type lcds. Details the TN (twisted nematic) technique were published by Schadt and others in Switzerland in 1971. The first commercial lcds became available around 1975.

Whereas most substances change from solid to liquid states at a single melting point temperature, liquid crystals have two transition temperatures. They become an opaque liquid at the first temperature, and then at the second temperature become a fully transparent liquid. Within the temperature range, the orientation of the molecules causes them to behave as a light polariser. The angle of polarisation can be modified by the application of a small electric field. If you have ever played with two polarising filters you will know that by changing their relative orientations you can vary the amount of light that is allowed to pass through, from maximum to nil. In an lcd, a filter of a fixed polarisation is placed in front of the liquid crystal, orientated in phase with the crystal's polarisation so that light passes through. When a small electric field is applied to the liquid, its polarisation phase shifts through 90 degrees, so preventing the light from the first filter from being passed through. By switching the electric field on and off, the crystal appears to change from dark to light. In most lcds, a second polariser and a reflecting rear surface is included so that light falling on the device passes through the polarisers, is reflected back and again passes through the polarisers before reaching our eyes, so enhancing the clarity of the display and enabling us to view it from above.

In manufacture, the patterns are created by etching a matrix of fine wires into the glass surface. These form half of the electrode pair required to electrically drive the display. Each segment of the pattern is wired independently to permit external control of its field. The second electrode, though, is common to all segments and is controlled via a single external connection. It is commonly known as the backplane (BP).

Although it may seem that an lcd could be driven by switching a dc voltage on and off across the electrodes, in reality, this technique could cause the device to fail. For satisfactory operation it needs to be driven by a highly symmetrical squarewave, usually running at between 32Hz and 60Hz. If the oscillator rate is less than 30Hz, the display will be seen to flicker. If the rate is greater than 60Hz, image 'ghosting' becomes apparent due to the response time of liquid crystal and the capacitive effect between segments causing them to remain partially active even when their control voltage has been removed. Above 100Hz, current consumption begins to increase. Since the ICM7224 has its own built in oscillator set within the desired range, you do not normally need to concern yourself with the control frequency.

ASSEMBLY

Provision has been made on the pcb for the S1-S8 to be dual-in-line switches. Ordinary single pole toggle switches may be used instead, mounted directly to the front panel of a box. Resistors R4-R11 are eight resistors in a single module. Alternatively, you could use individual resistors mounted vertically. Dil ic sockets should be used for all ics. Since it is unlikely that you will be able to obtain a dil socket of the right size for the lcd, I suggest that you use a standard 40-pin dil socket, cutting it into two halves, mounting each half separately. Although I quote the RS/Electromail code for the lcd module, similar versions are available from many suppliers, but check that the pin configuration is the same.

COMPONENTS

RESISTORS

R1-R3	100k (3 off)
RM1	100k x 8-resistor module (or 8 x 100k resistors - R4-R11)
VR1	220k horizontal skeleton preset

CAPACITORS

C1	22µ 16V electrolytic
C2-C4	100n polyester (3 off)

SEMICONDUCTORS

D1, D2	1N4148 (2 off)
IC1	4584 hex Schmitt trigger inverter
IC2	4024 7-stage ripple counter
IC3	4048 8-input NAND gate
IC4	ICM7224 lcd driver-counter

MISCELLANEOUS

4-digit lcd module, eg RS 589-272 or similar, printed circuit board, 14-pin dil ic sockets (3 off), 16-pin dil ic socket, 40-pin dil ic sockets (2 off), 8-way dil spst switch module (or 8 individual spst switches).

You will need to be extremely precise with your soldering of the pcb. Many of the fine tracks run between the lcd and ic pins, and there is a danger that careless soldering could cause shorts between pins and adjacent tracks. You should use a fine tipped iron and fine gauge solder. If solder bridging occurs, reapply the iron and draw the solder away from the area. I have occasionally found that this does not always completely clear the problem and that I have to use a sharp pointed knife to carefully cut and scrape through the solder bridge. In extreme circumstances you could alternatively cut through the tracks to either side of the problem, then remake the connections using link wires. PE

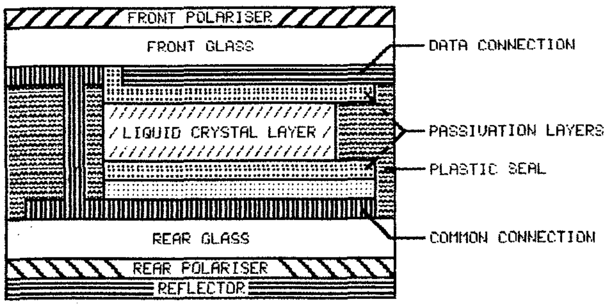
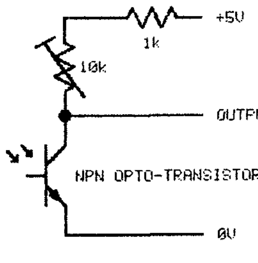


Fig. 6. Typical lcd structure.

Fig. 7. Jeff Dandy's opto detector circuit. Any npn opto-transistor can probably be substituted and optimum values for the preset found by experimenting.



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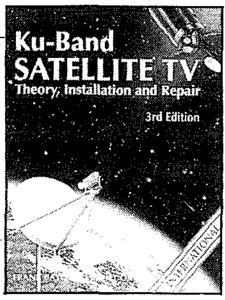

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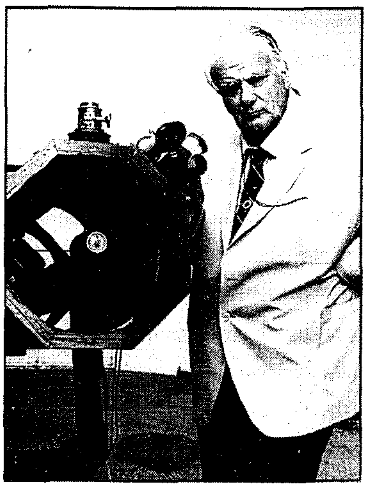


BY DR PATRICK MOORE CBE

The IRAS satellite has improved our knowledge about our Galaxy's motion through space, and the Great Attractor theory has had to be rejected.

When Voyager 2 sent back images of Triton, Neptune's major satellite, it was found – to everyone's surprise – that part of the surface was covered with pink nitrogen 'snow', and that there were active geysers. New studies have confirmed that the geysers do indeed erupt. Dark polymers collect below the metre-thick surface layer of nitrogen ice; when sunlight percolates through, and warms the dark material by a greenhouse effect, the temperature rise of around four degrees increases the pressure by a factor of 10. The result is an eruption which may send a plume up to a height of at least eight kilometres. The surface temperature of Triton is -233 degrees C, and it is emphatically not the sort of world which would be expected to show activity – and yet the geysers seem certainly to exist.

Pictures coming in from the Hubble Space Telescope show that excellent results can still be obtained, despite the fault in the main mirror. A spectacular view of Saturn has been received, and the clearest-ever image of Pluto and its satellite Charon. Images of active galaxies are also excellent, and Europe's Faint Object Camera has been studying the strange star R Aquarii, which is highly explosive. It is what is termed a symbiotic star, made up of a white dwarf with a nearby companion. The Hubble picture shows the 'core' of the system, with linear filamentary features emanating from it – clearly composed of plasma due to an explosion; this plasma emerges in streams twisted by the force of the outburst, and channelled upward and outward by strong magnetic fields. The material can be traced out to 2500 astronomical units from the core.

Meanwhile, Earth-based astronomers at the La Silla Observatory in Chile have identified what is thought to be the furthest known normal galaxy, G 0102-190. Its existence had been inferred from the presence of absorption lines in the spectrum of a quasar which is much further away – in the background, so to speak. G 0102-190 seems to be at a distance of at least 10,000 million light-years; its luminosity is around twice that of our own Galaxy.

NO GREAT ATTRACTOR!

In 1983 IRAS, the Infra-Red Astronomical Satellite, was launched successfully, and operated for most of the year. At a wavelength of 60 microns, over 80,000 galaxies were detected, most of them spirals. New studies of these IRAS galaxies have enabled astronomers at Queen Mary and Westfield College to make a very important discovery connected with the motion of our Galaxy in space.

Our Galaxy is a member of a Local Group, of which other members include the Andromeda Spiral, the Triangulum Spiral and the two Magellanic Clouds. It has long been known that there is a background radiation pervading the observable universe, indicating an overall temperature of 3 degrees above absolute zero and almost certainly the remnant of the Big Bang which took place at the moment of creation, between 15,000 million and 20,000 million years ago. Observations, confirmed by the COBE satellite launched last year, have shown that our Galaxy, together with the rest of the Local Group, is moving through this background radiation at a velocity of 600 kilometres per second, and it has been assumed that we are being pulled upon by a huge concentration of matter hidden behind the Milky Way – the so-called Great Attractor.

However, the survey of IRAS galaxies has made it possible to work out the amount of the pull exerted upon us by the dozen or so large clusters of galaxies in the region examined, which extends out to 2,000 million light-years. Remarkably, the net direction in which these galaxies are pulling us agrees very well with the direction actually observed. Therefore, we can explain the motion of the Local Group through the microwave background without any need for a super-massive object, and there is no longer a case for the Great Attractor: it does not exist.

Certainly there is a great deal about the distribution of galaxies and clusters of galaxies which we do not know, and we may hope for important results from future satellites such as ISO, the Infra-red Space Observatory, due to be launched in 1993. But at least we are making progress – even if some astronomers will feel rather sad at the rejection of the intriguing Great Attractor!

THE DECEMBER SKY

Several of the bright planets are on view at the end of this year. Jupiter, which reaches opposition early next month, rises before midnight, and is a brilliant object in Cancer; any small telescope will show its yellowish disk, its cloud belts and its four major satellites. Mars, only just past opposition, is visible for most of the night; it remains in the area of Taurus (the Bull), roughly between the two lovely starclusters of the Hyades, round Aldebaran, and the Pleiades. Saturn has been almost lost in the evening twilight, and Mercury is too close to the Sun to be seen, but by the end of December the glorious planet Venus will be an evening object, even though it is a long way south of the celestial equator and will be seen only briefly after sunset. No doubt it will give rise to the usual speculations that it may have been the Star of Bethlehem, but this is quite out of the question; Venus is a familiar object, and if the Wise Men had been deceived by it they would hardly have been very wise!

There are no eclipses this month, but there are two meteor showers: the Geminids, which reach their maximum on December 14, and the Ursids, which peak on the 21st. The Geminids are much the more plentiful of the two, and should be favourably seen this year, because the Moon will be out of the way. The Moon is at last quarter on December 9, new on the 17th, at first quarter on the 25th and full on the 31st. It was also full on December 2, so that this calendar month has two full moons.

Orion is now on view after dark, and will dominate the night sky right through until the spring. From the Hunter's Belt, you can find Sirius and Aldebaran; Aldebaran is orange-red, but is at present far inferior to Mars, which is in the same part of the sky. Capella, in Auriga (the Charioteer) is near the zenith or overhead point; Ursa Major (the Great Bear) is rather low in the north-east, with the W of Cassiopeia high in the north-west. The Square of Pegasus is still on view, sinking toward the western horizon. When the sky is really dark, look for the Milky Way, which stretches right across the sky; unfortunately city-dwellers never seen it to advantage, because of the increasing amount of light pollution.

BASIC ELECTRONICS

Part 13.

Owen Bishop discusses time and frequency, with particular regard to audio and other analogue circuits.

The feature common to this month's circuits is that the prime factor in their operation is *time*. This makes a change, since we usually ignore the time element. From the practical viewpoint, we consider that the action of a circuit takes place instantaneously, even though there are obviously delays of the order of nanoseconds whenever the state of the circuit changes. In essentially time-dependent circuits, changes usually occur at slower rates, and the exact rate of change is generally significant.

CAPACITORS

One of the most commonly used components for introducing the time element into a circuit is the capacitor. As explained in Part 3 (PE, March 1990), a capacitor is a device for storing electric charge. Connected in a suitable circuit, a capacitor can be made to charge or discharge at a precisely controlled rate. This is how we introduce the time element. In Part 3 we investigated the charging rate when a current flows from a steady voltage source, through a resistor, into a capacitor (Fig. 1). This combination of resistor and capacitor is referred to as an *RC network*. Starting with the capacitor discharged, the voltage across the capacitor rises rapidly at first, the rate gradually decreasing as the capacitor becomes fully charged. The time taken to charge is directly proportional to the resistance R and the capacitance C. We define the *time constant* of the RC network as the product of R and C:

$t = RC$

In this equation, t is in seconds, R is in ohms and C is in farads.

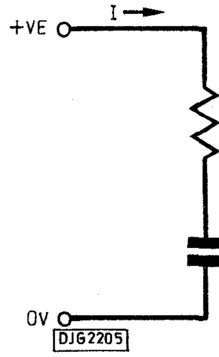
Theory shows that t is the time in which a discharged capacitor in a circuit such as that in Fig. 1, charges to 63% of the input voltage. When a fully-charged capacitor is discharged, t is the time taken for the voltage to fall to 37% of the input voltage (Fig 2).

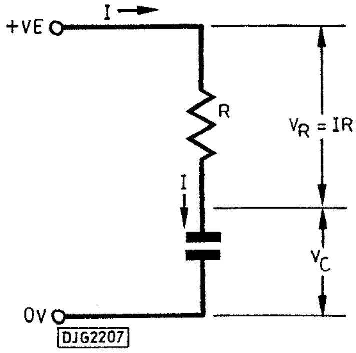
When a current passes through a resistor (Fig. 3) a voltage develops across it, according to the 'Ohm's Law' equation, $V = IR$. Similarly, when a capacitor is charging or discharging, there is a voltage across it. In this way it has the same effect in the circuit as a resistor, except that the voltage varies with time.

EFFECT OF ALTERNATING VOLTAGE

Since charging does not occur instantaneously, but proceeds at a predetermined rate, it is interesting to look at what happens when the voltage applied to the network is itself regularly changing, or alternating. In Fig. 4 we show the RC network connected across an alternating voltage source. The source could be the output from an audio signal generator, producing a sine-wave signal at, say, 1000Hz. To fully explain what happens we should treat the subject mathematically, but here we will attempt to describe the effects with the minimum of mathematics.

Although no current actually flows through it, a capacitor has the ability to control the amount of current flowing in a circuit. As explained above, it acts like a varying resistor. Fig. 5 repeats the voltage curve of Fig. 1 and also shows the *current* flowing to the capacitor as it charges. At first, the current is high, but it gradually dwindles to zero as the capacitor becomes fully charged. In Fig. 5, the 'resistance' is increasing with time. If an alternating voltage is applied to a capacitor so that, before the capacitor is fully charged, it begins to discharge again, the current flowing in or out of the capacitor alternates too. Here we skip the mathematics and show only the result (Fig. 6). An increase of current flowing into the capacitor leads to an increase in voltage. The current varies with the same frequency as the voltage but it is out of phase.





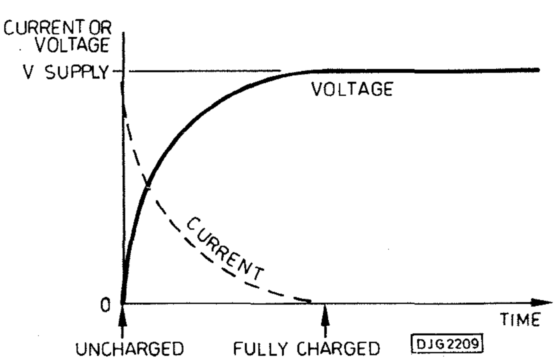


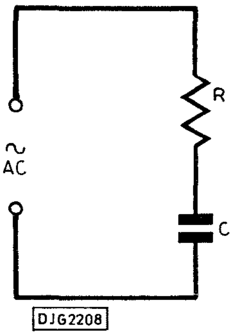
Fig. 1 (above) Charging a capacitor.

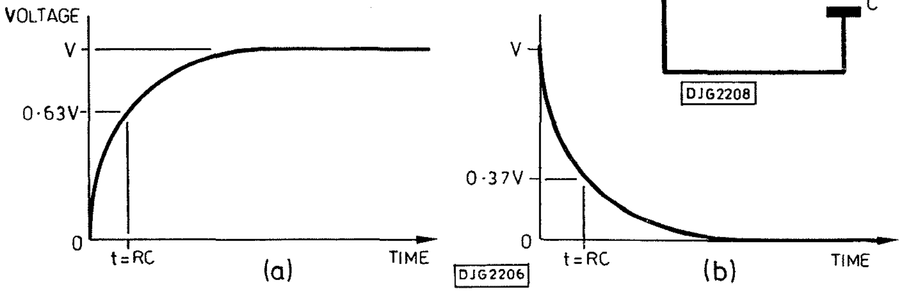
Fig. 2 (below) Charging and discharging curves for an RC network.

Fig. 3 (above centre). Voltages across the resistor and capacitor in an RC network.

Fig. 4 (right) Applying an AC signal to an RC network.

Fig. 5 (far right). Voltage and current in a charging capacitor.





ROOT MEAN SQUARE

It is of interest to know the average current flowing into or out of the capacitor. We approximate to this by noting the current at regular intervals during a single cycle and averaging the readings. (Fig. 7). The first two

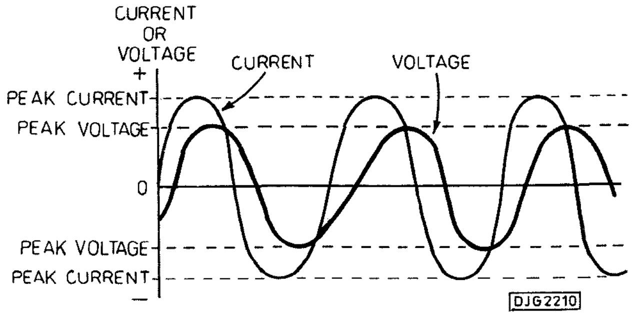
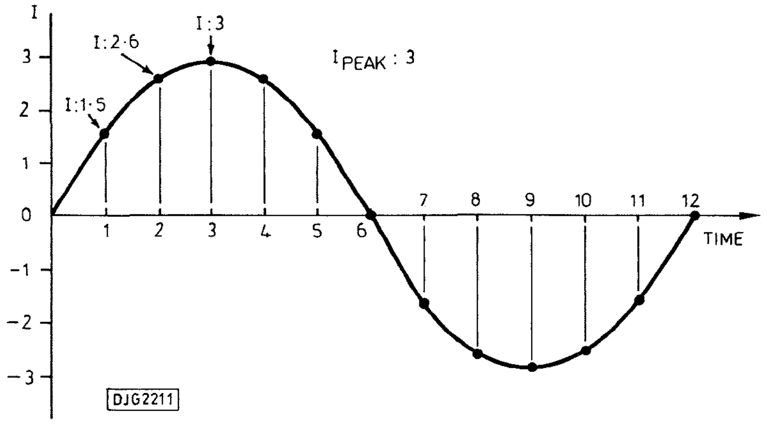


Fig. 6. Changes in voltage across the capacitor when an alternating current is supplied to an RC network.

Fig. 7 (below). Calculating the average current.



columns of Table 1 show the results. Since current flows both ways and the waveform is symmetrical, the average current is zero. This is not a useful answer! A better way of reckoning the average current is first to square it, which gets rid of the minus signs, then to work out the mean of the squares and take the square root of this. This gives us the *root mean square* current, often known as the rms current. We can do the same thing with the varying voltage and obtain calculation, since there is a fixed relationship between rms current and the peak current:

rms current = I = Ipeak/√2
Similarly, rms voltage = V = Vpeak/√2

REACTANCE

As Fig. 6 shows, the ratio between voltage and current varies from instant to instant. However, the ratio of their rms values has a fixed value. For example, the rms voltage VR across the resistor R and the rms current through it simply obey Ohm's Law:

$$VR = I.R$$

There is a similar 'law' for the capacitor, governing the rms voltage VC across it and the rms current flowing to or from it:

$$VC = I.Xc$$

By comparing the two equations it is seen that Xc in the second equation corresponds to resistance in the first equation. Xc is known as the *reactance* of the capacitor. It acts like a resistance in reducing current, and it has the same unit as resistance, the ohm. But there is an important difference between reactance and resistance. Reactance depends on *frequency* but resistance does not. This is understandable since, if a capacitor takes *time* to charge and discharge, then the flow of current must be affected by the rate at which the applied voltage is alternating.

The reactance of a capacitor C is given by the equation:

$$XC = \frac{1}{2 \pi fC}$$

where f is the frequency of the alternating voltage. This equation shows that impedance is high when frequency is low and is low when frequency is high. In other words, the capacitor acts as a *frequency-dependent* resistor.

Table 1: Calculating rms current

Given peak current = 3A

Time	current	current^2
0	0	0
1	1.5	2.25
2	2.6	6.76
3	3.0	9.00
4	2.6	6.76
5	1.5	2.25
6	0	0
7	-1.5	2.25
8	-2.6	6.76
9	-3.0	9.00
10	-2.6	6.76
11	-1.5	2.25
	Total 0	Total 54.04
	Average 0	Average 4.50

rms current = √4.50 = 2.12 A
(peak/√2 = 3/√2 = 2.12)

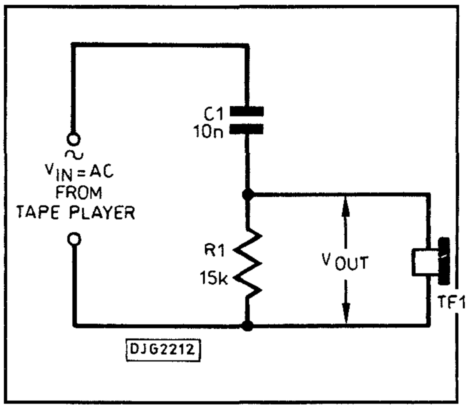


Fig. 8. RC filter for investigation 1.

FILTERS

One way of making use of the reactance of capacitors is in *filter circuits.* These are circuits designed to accept an alternating signal (usually an audio signal) consisting of many mixed frequencies but to reduce the strength of the frequencies of a given range. One type of filter consists simply capacitor and a resistor, and we refer to this as an *RC filter.* The investigation demonstrates the effect of such a filter.

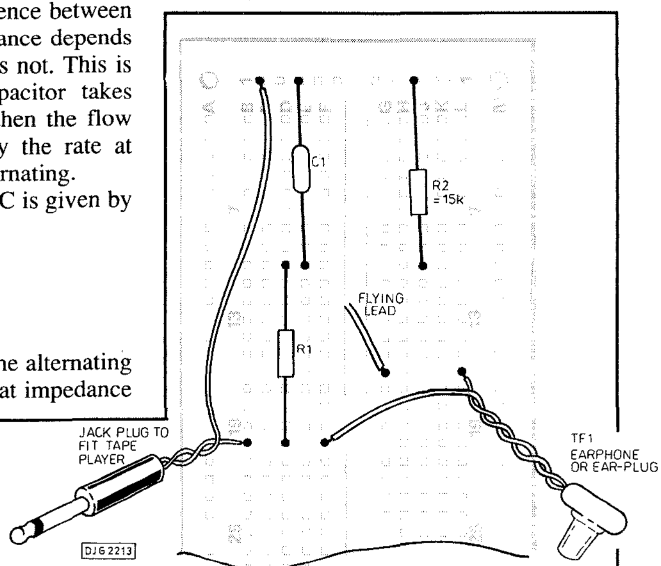
Investigation 1 - RC Filter

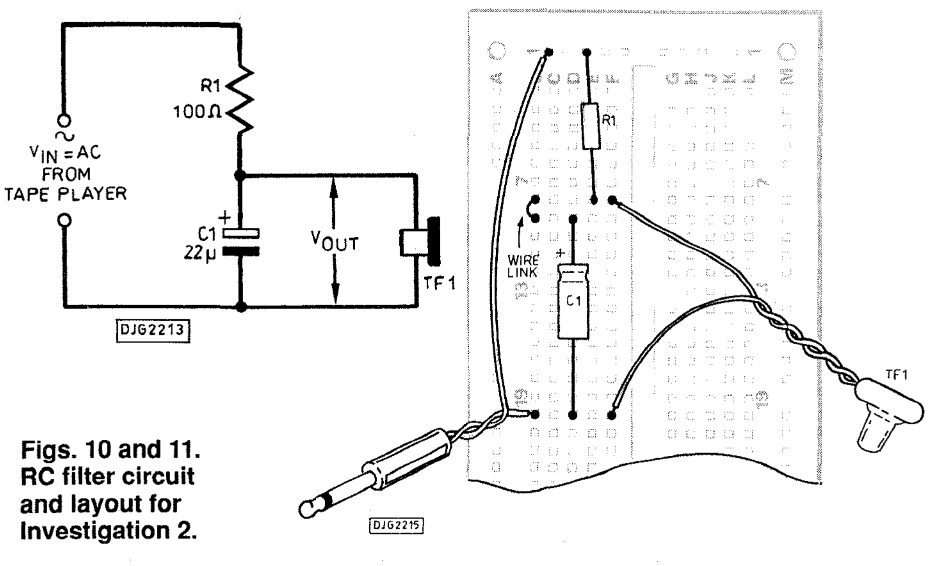
The source of mixed audio frequencies is a tape player loaded with a music tape. Instead of plugging the earphone directly into the earphone output, we interpose a filter consisting of a capacitor C1 and a resistor R1, as in Fig 8. There is a second resistor R2 used to by-pass C1, and a flying lead to connect the earphone either to C1 or R2 (Fig. 9).

In all audio demonstrations this month, begin with the volume of the tape player turned fully down, to avoid a sudden loud sound through the earphone.

Start the tape, connect the earphone to R2, then turn up the volume. This is the unfiltered sound, as normally heard from the

Fig. 9. Breadboard RC filter for investigation 1.





Figs. 10 and 11. RC filter circuit and layout for Investigation 2.

tape player, though the effect of the resistors means that you need to turn up the volume a little more than usual.

Now move the flying lead to connect the earphone to the capacitor. This brings the filter into action. What do you notice about the quality of the sound?

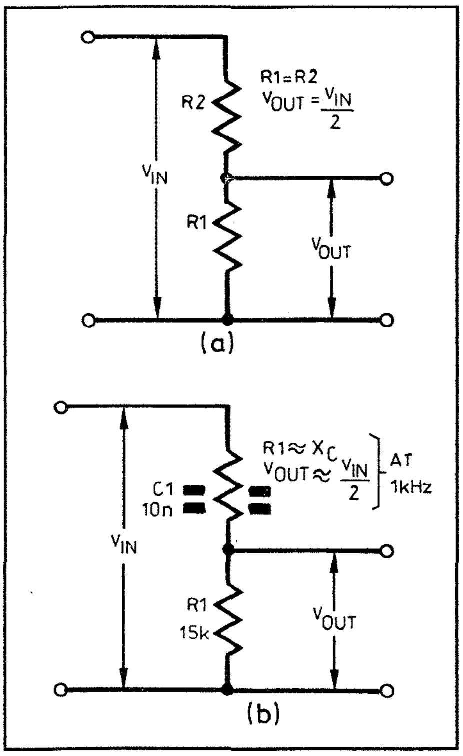
Investigation 2 - Another RC filter

This is like the previous filter except that C1 and R1 are interchanged, and have different values (Figs 10 and 11).

Begin without the wire link in place, so that the capacitor is not connected into the circuit. Start the tape, then turn up the volume. This is the unfiltered sound.

Insert the link to bring the capacitor into the circuit. This brings the filter into action. What do you notice about the quality of the sound?

Fig. 12. The RC high-pass filter as a potential divider.



HIGH PASS AND LOW PASS

The filter in Investigation 1 is an example of a high-pass filter. When the filter is in circuit, the sound loses its lower (bass) frequencies, leaving the higher (treble) frequencies relatively unaffected. The explanation of this is illustrated by Fig. 12. In Fig. 12a we have the signal being sent to a potential divider (see part 2, February 1990). Since R1 and R2 are equal in value, the voltage across R1 is always half the input voltage. The signal going to the earphone has the same waveform as the input, but only half the amplitude. This is why you needed to turn up the volume.

In Fig. 12b the impedance of C1 is represented by a resistance so, in effect, we again have a potential divider. The important difference is that the resistance of the upper 'resistor' depends on frequency. For high frequency, the impedance of C1 is low. For example, for a signal of 1kHz the impedance is $Xc = 1/(2\pi \times 1000 \times 10 \times 10^{-9}) = 15915 = 16k$ (approx).

Since R1 has approximately the same resistance, the amplitude of a 1kHz signal is reduced approximately to half. As we increase the frequency above 1kHz, Xc falls further and further below 16k. For example, at 10kHz it is only 1.6k. Thus the amplitude of the signal increases as frequency increases. Treble notes are passed on to the earphone with virtually no reduction in amplitude. Conversely, at low frequencies Xc is more than 16k. At 100Hz, for example, it is 160k. The output of the potential divider falls. Bass notes are removed by the filter and are not heard in the earphone. We summarise the action of this filter by describing it as a *high-pass filter*.

The action of the filter of Investigation 2 is the inverse of this. (Fig. 13). At high frequency, the low impedance of C1 means that the output from the filter is low in amplitude. But low frequencies are relatively unaffected. This is a *low-pass filter*. One point to mention in passing is that, in both investigations, the earphone itself acts as a high resistance. You may have noticed in Investigation 1 that removing R1 from the circuit makes no detectable difference to its action. The filter in fact consists of C1 and the resistance of the earphone, which is relatively high for a crystal earphone. Having a relatively small resistor R1 in parallel with this makes little difference to the potential-divider.

FILTER CHARACTERISTICS

Before we can describe these, we must discuss the meaning of the term decibel. The decibel (symbol, dB) is a way of describing the ratio between two quantities. In connection with filters we use it for describing the ratio between two voltages, the input and output voltages at any given frequency. Given Vin and Vout, we calculate the ratio n like this:

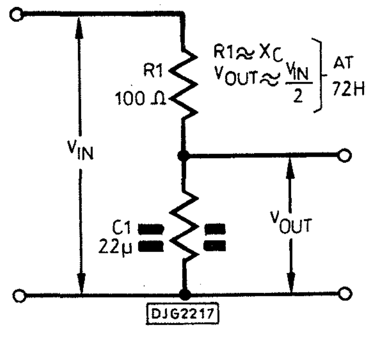
$n = 20 \times \log_{10}(Vout/Vin)$

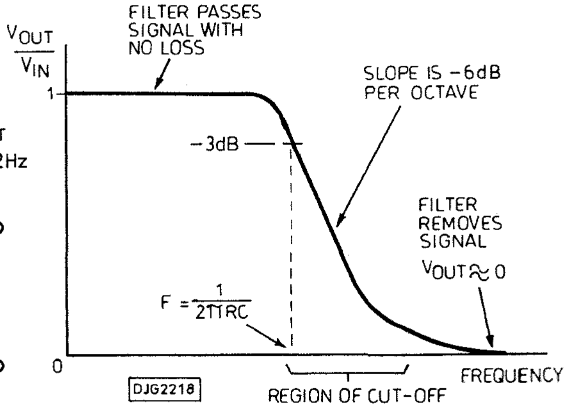
For example, if Vin is 10V and Vout is 7V, then $n = 20 \times \log_{10}(7/10) = 20 \times 0.1549 = 3dB$.

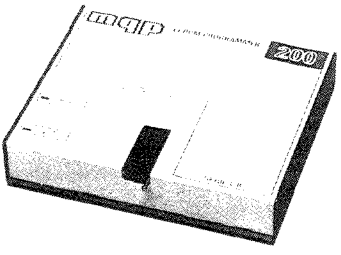
Fig 14 shows the characteristic of a low-pass filter. The vertical line represents the frequency at which Vout is 70% of Vin. In terms of decibels, n = -3dB or, in words, Vout is 3dB down on Vin. This is known as the *half-power point*, since a drop of 3dB in voltage reduces the power to half. The frequency at this point is given by $f = 1/2\pi RC$.

Continued next month PE

Fig. 13. The RC low-pass filter as a potential divider.
Fig. 14. Graph showing characteristics of a low-pass filter.







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AMBROSE FLEMING

As well as inventing the thermionic valve, Fleming made great advances in the efficiency of measuring instruments. Ian Poole reports.

It has been suggested that Fleming is the father of modern electronics. Whether this is true or not is a matter for discussion. What is certain is that through his invention of the diode valve for radio applications he made a tremendous advance and made the foundations for many future discoveries and inventions.

Inspite of his contributions to electronics Fleming is little known these days. To most people the name Fleming is synonymous with penicillin and its inventor Alexander Fleming. yet inspite of this Ambrose Fleming was a truly remarkable man. His experience covered the fields of small signal electronics and radio to the large electrical machines. To all of these fields he gave inventions and innovation.

Photograph by courtesy of the Institution of Electrical Engineers.

EDUCATION

John Ambrose Fleming was born on 29th November 1849 and was the eldest of seven children born to a Congregational minister. He spent the first seven years of his life in Lancaster, and then moved to Kentish Town in the North of London.

At the age of ten the young Ambrose started his formal education at a private school. Then in 1864 he moved to University College School on Gower Street in London where he excelled in mathematics. He was a bright and intelligent child and went on from here to University College itself to study Physics and Mathematics. However, after two years he was forced to leave to earn some money. Nevertheless he planned to return once he had earned enough to finish his course. First of all he worked at a ship building company, but he did not like this job at all and soon left to take up a post as a clerk on the stock exchange. This job suited him particularly well. He finished early in the day and this enabled him to continue his studies in the evening. Despite this he still managed to graduate with a first class degree.

Having completed his course he started teaching. However, Fleming felt he was not reaching his potential and he decided to further himself by undertaking more studies. This he did when he entered the Royal School of Mines to study Chemistry. Again he had to break his course to earn his living and so in 1874 he found himself teaching at Cheltenham College as a science master. This post was in many ways to shape the rest of Fleming's career. It was whilst he was teaching here that he came across some of Maxwell's work. It fascinated him and he decided to further his studies in this direction.

In 1877 Fleming started at Cambridge. Here he studied Electricity and Magnetism with a particular bias towards Maxwell's new equations. Although he was not directly under Maxwell he came across him quite frequently and attended many of his lectures. In fact it is said that Maxwell had a very dry style of presentation and Fleming was one of the very few people who could follow him. Then in 1880 Fleming took his D.Sc. and a year later he was elected a Fellow by his college.

CAREER DEVELOPS

At Cambridge Fleming was quite successful. He became a demonstrator, but like many of his previous posts this did not last for long because he was chosen as the Professor of Mathematics and Physics at an institution which is now Nottingham University. Again this appointment did not last for long as Fleming became a consultant at the Edison Telephone Company. Here Fleming came across many of the inventions from Edison in the States. At one time he even visited Edison's Laboratory in the States and it is likely that he saw many of some of the experiments with evacuated bulbs. One of Edison's discoveries was a bulb with a second element which allowed current to flow in only one direction across the two elements. In an uncharacteristic error Edison could not think of a use for it and used it purely to demonstrate the effect he called the Edison effect.

Fleming's long term aim was to return to London where he wanted to be a professor at one of the larger institutions. At the time there were no positions in the new and developing science of electrical engineering. Instead the nearest subject was physics. However Fleming was invited to give a series of lectures on electrical engineering at University College London which is part of London University. Then in 1885 he was asked to set up a new department for electrical engineering for which he would be professor. This was the first department of its sort in the country and it reflected the forward thinking of the College.

Fleming greatly enjoyed his time at UCL. He was able to spend time lecturing, he was able to undertake his research and in addition to this he was in London where he wanted to be.

In the first years at UCL much of his time was devoted to work on various aspects of ac machines. He became a leading authority on ac transformers and he wrote a book on the subject as well as presenting several papers at the Institution of Electrical Engineers.

Another area of his research was devoted to improving the accuracy of ac measurements. At the time ac measurements could not be made at all accurately as they had to be made with comparatively crude instruments. Fleming's work enabled him to achieve accuracies of around 0.25% which was a tremendous improvement over anything that was previously achievable.

OSCILLATION VALVE

In 1899 Fleming became a consultant to the Marconi Company in addition to his duties at UCL. At this time Marconi was making his first long distance transmissions. In view of his previous contact with Maxwell, Fleming was particularly interested in the new radio developments which were taking place. In fact Fleming became quite absorbed in the subject. He even designed the transmitter which made the first transatlantic transmission.

Fleming recognised that the major problem preventing vast improvements being made was that of detecting the signals themselves. In these early days the coherer was the best form of detector and it was very insensitive. It was with this in mind that Fleming wondered about the possibility of using a bulb and the Edison effect to rectify the radio waves. Having previously performed some experiments using these bulbs he was quickly able to set the idea to his assistant who duly implemented the experiment and found it to work. It then took less than a month for the patent of what he called his "oscillation valve" to be filed. This he did on 18th November 1904 when a friend saw him walking along Gower Street towards the Patent Office oblivious of all around him.

COMPETITION

The invention of the diode was a revolutionary idea. Unfortunately it had very little impact because in the States ideas were overtaking him. In less than two years the de Forest Wireless Company produced the cat's whisker, a very crude form of semiconductor rectifier which consisted of a thin wire positioned on a lump of suitable material (even coal) to produce a point contact rectifier. This was far more convenient than Fleming's diode and it soon caught on.

The de Forest Company also investigated various aspects of valve technology. In 1906 they introduced a device called an Audion. It used the same basic thermionic technology as Fleming's diode, but a third electrode had been added. This they called a grid because of the nature of its construction. Yet this triode was only used for detection of signals, it took another four years before it was used as an amplifier.

The Audion caused a great deal of comment in the scientific and legal community, whether it was an infringement of Fleming's original patent. However at no time did Fleming claim the idea of introducing the third element was his. In fact he wished he had thought of it himself. All he claimed was the idea of using the rectifying action of the valve. Unfortunately the matter was eventually settled in favour of de Forest.

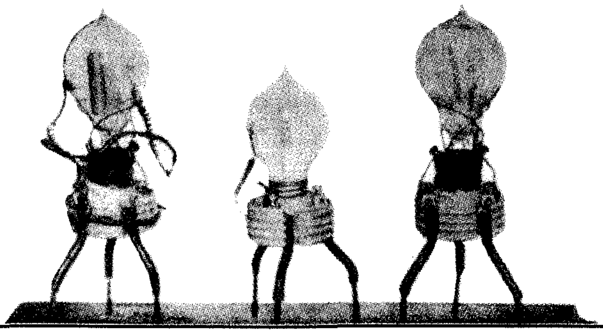
RETIREMENT

Fleming stayed at University College until 1926 when he retired at the age of 77. He moved out of London to the quiet seaside town of Sidmouth in Devon. Then two years after his retirement Fleming was knighted in honour of the great advances he had made for the whole field of electrical and electronic engineering.

Inspite of the fact that he was retired, Fleming still took an active interest in many new developments in the electronics world. For fifteen years he was president of the Television Society, often travelling to London for their meetings. He was also a supporter of Baird in his fight to have his television system adopted.

Fleming still had time for many interests outside his work. He had a keen interest in photography and loved walking. He was also a devout Christian, and he often preached at various churches as well as once being asked to at St Martin's in the Fields. However he did not like socialising and he never liked being in the public eye.

With his advancing age Fleming became increasingly deaf, however he remained active until his death on 18th April 1945 at the great age of 95. During his life he had battled against lack of funds, yet he had managed to succeed in giving himself a first rate education. He had also helped electrical engineering advance in terms of improving efficiency as well as enabling more accurate measurements to be made. But it is without doubt that he will be remembered as the person who invented electronic thermionic valves.



The photo shows three early Fleming diode valves, and was kindly supplied by the Marconi Co Ltd for PE's Jan 65 issue

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INDUSTRY NOTEBOOK

MAN AND MIPS

By Tom Ivall

Why don't we hear any more computer atrocity stories these days?

Is it because computer systems are now better behaved and don't produce so many embarrassing gaffes and cock-ups? Or is it because the computer is no longer perceived as a mysterious, looming threat, to be exorcised by telling jokes and stories about it?

Certainly, with home computers and PCs all over the place, the creature has become domesticated and is now about as threatening as the average washing machine. Familiarity has bred acceptance.

If this is so, and the computer atrocity story is a thing of the past. I am rather sorry. We should always maintain a healthy disrespect for the products of our own technology.

In themselves computers are only bits of metal and plastic. But when activated by software and used in various systems – for administration, commerce, law-enforcement and so on – they take on the properties of the purposeful human mind. And however benign these systems are intended to be, they are applying influences to us through mentally directed information.

In the simplest instance, a computer prints out a bill which comes through your letter-box. You react to it psychologically – for example "I am a debtor and must pay this bill promptly" or "I don't want to pay this bill and intend to ignore it for a while." The mind that devised the system that printed out the bill is not personally involved and doesn't even know of your existence. But through the information conveyed, and the responsive activity of your own mind, you are certainly involved on a personal level.

We should always maintain a healthy disrespect for the products of our own technology, or risk impoverishing our humanity.

MANACLES

So it's through our own psychological responses that we are influenced by information systems. The poet William Blake had an insight about this two centuries ago when he wrote that chilling phrase: "The mind-forg'd manacles". If we feel restricted or oppressed by information it is through the reactions of our own minds to the messages we read from it.

The remedy, as I've suggested, is a healthy disrespect. If you are in a situation where you feel intimidated by some impressive boss man behind a huge desk, try imagining him sitting in the lavatory with his trousers down. Intimidating systems can be handled mentally in an equivalent way, though the imaginative technique may be different for each individual.

Norbert Wiener, the American mathematician and father of cybernetics, once wrote that information is "the content of what is exchanged with the outer world as we adjust to it." This notion is rather like the concept of temperature information flowing round a control system comprising a thermostat and an oven.

Similarly, the anthropologist Gregory Bateson has proposed that what we call 'mind' is the process of information transfer within closed loops – not only the neural loops within the brain and central nervous system but those which pass through the larger system of man functioning in an environment. Thus, when you are soldering, your 'mind loop' controlling the iron includes the bit and the globule of molten solder on the circuit board.

Electronics and information technology are getting increasingly involved in this man-world exchange process. Beyond the telephone and broadcasting, more and more new information systems are becoming part of our environment. Home banking and shopping, fax, programmed learning, radio paging, electronic mail, videoconferencing, library information retrieval, electronic tagging of persons, are just a few that come immediately to mind. To an increasing extent they mediate how we see the world and how we act towards it.

DETERMINISTIC SLAVERY

As this column noted in the June 1989 issue, our increasing use of such information processing systems has given rise to a new socio-economic indicator to measure our 'consumption' of their output. It's not based on the straightforward bits, and bits per second, of information theory but – because these systems commonly use software-programmed digital processing – on mips (million instructions per second) as a measure of processing power. So our 'consumption' is reckoned in 'mips per capita'.

All these systems introduce special constraints into the man-world exchange process – typically constraints of time, space, power, bandwidth and signal/noise ratio. Thus in using such information systems we have to submit to the mechanistic disciplines imposed by these constraints. So, although we may think we are big, clever guys with all this processing power at our command, to the extent that we are dependent on deterministic systems we are in fact becoming their slaves. It's rather like the ingenious servants manipulating the master who all the time thinks he is in complete control.

I'm not concerned here with the deliberate use of information systems for social control or oppression. But even in a fairly benign and open society, say a liberal democracy, there could be subtle influences at work on us. We have to consider how our participation in these systems could be modifying our central beliefs of what a human being should be. Are our values being changed? Not by some sinister scheme to manipulate us, but simply by our being in constant contact with the logical, the mechanistic and the functional: the good being identified with what works.

Where William Blake spoke for the late 18th century, another poet, T.S. Eliot, was moved to express similar concerns in our own century.

In his long poem *The Rock*, for example, you find the following lines:

"Where is the life we have lost in living?
Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?"

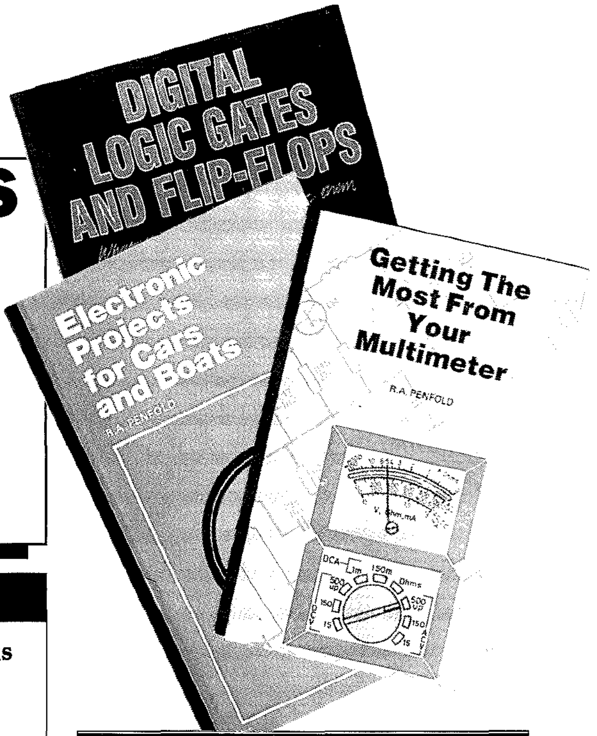
T.S. Eliot earned his living for some years by working in a bank.

The ecology movement has now made us aware that man cannot go on ravaging the biosphere without in the end impoverishing himself. We may soon need another movement to teach us that man cannot go on making himself even more of a slave to deterministic systems – from clocks and factory machines in the 19th century to information systems in the 20th – without impoverishing his own humanity.

PRACTICAL ELECTRONICS

BOOK SERVICE

Here is your Editor's choice of books he thinks will be of interest to electronics and computer enthusiasts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BEGINNERS AND EARLY STARTERS

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From Atoms to Amperes. F.A.Wilson. 160 pages. £3.50. Order Code BP254.

For the absolute beginner, clearly explaining the fundamentals behind the whole subject of electricity and electronics.

Electronic Projects for Beginners. F.G.Rayer. 128 pages. £1.95. Order Code BP48

Specially for the newcomer to electronics who is looking for a book containing a wide range of easily made projects. Some circuits need no soldering and many others show actual component and wiring layouts.

Electronics Build and Learn R.A.Penfold. 128 Pages. £5,95. Order Code PC 101

Combining theory and practice, the book describes a circuit demonstrator unit that is used in subsequent chapters to introduce common electronic components and circuit concepts, complete with practical experiments.

Practical Electronic Building Blocks R.A.Penfold. There are two books - Book 1 : 128 pages. £1.95. Order Code BP117 Book 2 : 112 pages. £1.95. Order Code BP118

Book 1 is about oscillators and gives circuits for a wide range, including sine, triangle, square, sawtooth and pulse waveforms and numerous others from voltage controlled to customised ic types.
Book 2 looks at amplifiers, ranging from low level discrete and opamp types to ic power amps. A selection of mixers, filters and regulators is included.

30 Solderless Breadboard Projects R.A.Penfold. Two books each of 160 pages. Book 1 : £2.95. Order Code BP107. Book 2 : £2.25. Order Code BP113.

Each project is designed for building on a Verobloc breadboard and is accompanied by a description, circuit and layout diagrams and relevant constructional notes. Many of the components are common to several projects. Book 1 covers linear devices, and Book 2 covers cmos logic chips.

Beginners Guide to Building Electronic Projects R.A.Penfold. 112 pages. £1.95. Order Code BP 227

Shows the complete beginner how to tackle the practical side of electronics and includes simple constructional projects.

SATELLITE TV

Satellite TV Installation Guide - 2nd edition John Breeds. £11.95. Order Code STV1

Full of vital information for any competent diyer who wishes to install a satellite tv antenna and obtain optimum reception quality.

An Introduction to Satellite Television F.A.Wilson. 112 pages. £5.95. Order Code BP195

Informative answers to many of the questions about this communications revolution. The information is presented on two levels, one aimed at the complete beginner, the other at professional engineers and serious amateur enthusiasts.

TEST AND MEASUREMENT

Getting the Most from Your Multimeter R.A.Penfold. 112 pages. £2.95. Order Code BP239

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Test Equipment Construction R.A. Penfold £2.95. Order Code BP248

Describes in detail how to construct some simple and inexpensive, but extremely useful, pieces of test equipment.

Oscilloscopes 2nd Edition I.Hickman. £12.95. Order Code NT3

Subtitled 'How to Use Them, How They Work' the book is illustrated with diagrams and photographs and is essential reading for any one who wants to know about scopes, from first principles to practical applications.

How to Get Your Electronic Projects Working. R.A.Penfold. 96 pages. £2.50. Order Code BP110.

Essential reading for anyone who wants first-time success in project assembly. Covers tracing mechanical faults as well as testing for failures of active and passive components of most types.

AUDIO AND MUSIC

Introducing Digital Audio I.Sinclair. 112 pages. £5.95. Order Code PC102

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Electronic Music Projects R.A.Penfold. 112 pages. £2.50. Order Code BP74

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Practical Midi Handbook R.A.Penfold. 160 pages. £5.95. Order Code PC103

A practical how-to-do-it book for musicians and enthusiasts who want to exploit the capabilities of Midi. Covers keyboards, drums, sequencers, effects, mixers, guitars, and computer music software.

Midi Projects R.A.Penfold. 112 pages. £2.95. Order Code BP182

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Electronic Synthesiser Construction. R.A.Penfold. 112 pages. £2.95. Order Code BP185.

Even relative beginners should find the monophonic synthesiser described here within their capabilities if the book is thoroughly read. Individual aspects of the synth are dealt with separately and pcb designs are shown for the main modules.

DIGITAL AND COMPUTING

A Concise Introduction to MS-DOS. N. Kantaris. 64 pages. £2.95. Order Code BP232
A ready-reference guide for those who need a quick insight into the essential command functions of this operating system, but who don't have the time to learn it fully.

An Introduction to Computer Peripherals R.A. and J.W. Penfold. 80 pages. £2.50. Order Code BP170
Covers such items as monitors, printers, disc drives, cassettes, modems, etc, explaining what they are and how to use them with your computer and with each other.

NEW! Digital Logic Gates and Flip-Flops. Ian R. Sinclair. 192 pages. £8.95. Order Code PC 105
Intelligently looks at the basic building blocks of all digital circuits and is intended for enthusiasts, students and technicians who seek to establish a firm grasp of fundamental principles.

Introduction to 6800/6802 Microprocessor Systems R.J.Simpson and T.J.Terrell. 238 pages. £10.95. Order Code NT9
The book covers systems hardware, programming concepts and practical experimental work that will assist in understanding the 6800/6802 microprocessor, with additional information on the 6802D5E evaluation system.

An Introduction to 68000 Assembly Language. R.A. and J.W.Penfold. 112 pages. £2.95. Order Code BP184
Covers the fundamentals of writing programs that will vastly increase the speed of 68000 based machines such as the Commodore Amiga, Atari ST range, Apple Mackintosh, etc.

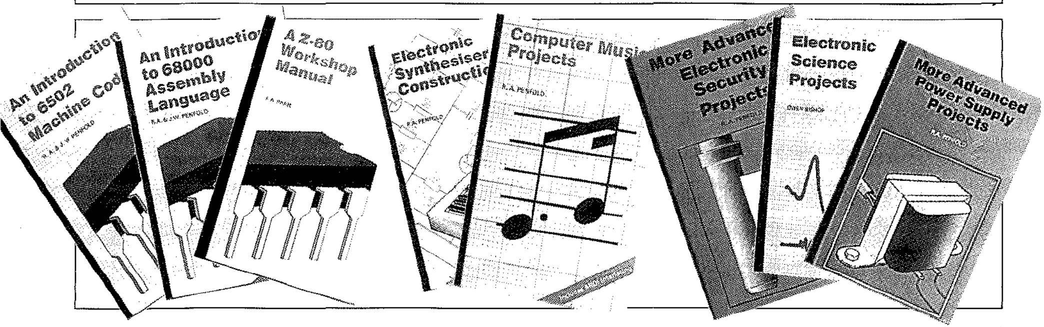
Getting the Most from Your Printer J.W.Penfold. 96 pages. £2.95. Order Code BP181
How to use the features found on most dot-matrix printers from programs and popular wordprocessors, showing examples of what must be typed to achieve a given effect.

Micro Interfacing Circuits R.A.Penfold. Two books, each of 112 pages.
Book 1 : £2.25.Order Code BP130.
Book 2 : £2.75. Order Code BP131
Both books include practical circuits and useful background information though pcb layouts are not included. Book 1 mainly covers computer input-output techniques. Book 2 deals primarily with practical application circuits.

An Introduction to 6502 Machine Code. R.A. and R.W. Penfold. 112 pages. £2.95. Order Code BP147
Covers the main principles of machine code programming on 6502-based machines such as the Vic-20, Oric-1/Atmos, Electron, BBC and Commodore 64. It assumes no previous knowledge of microprocessors or machine code and gives illustrative programming examples.

A Z-80 Workshop Manual. E.A.Parr. 192 pages. £3.95. Order Code BP112
A book for those who already know Basic but wish to explore machine code and assembly language programming on Z80 based computers.

Practical Digital Electronics Handbook M.Tooley. 208 pages. £6.95. Order Code PC 104
Nine constructional projects introduce digital circuits, logic gates, timers, microprocessors, memory and interface circuits - an essential book for anyone interested in digital devices.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GENERAL CONSTRUCTIONAL

Electronic Science Projects. Owen Bishop. 144 pages. £2.95. Order Code BP104
A bumper bundle of experimental projects ranging in complexity and including a colour temperature meter, electronic clock, a solid state (led display) scope, an infra-red laser, a fascinating circuit for measuring the earth's electrical field strength, and many more.

Electronic Security Devices R.A.Penfold. 112 pages. £2.50. BP56
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Electronic Projects for Cars and Boats. R.A.Penfold. 96 pages. £1.95. Order Code BP94
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Electronic Hobbyists Handbook R.A.Penfold. 96 pages. £4.95. Order Code BP233
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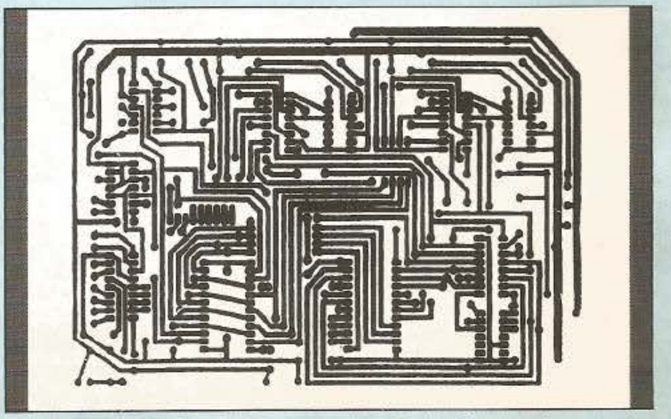

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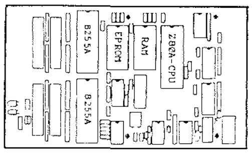

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A star feature is that no special or custom chips (ie PALs, ULAs, ASICs etc) are used — and thus there are no secrets. The Z80A is the fastest and best established of all the 8-bit microprocessors — possibly the cheapest too!

Although no serial interface is included, it is easy for a Z80A to waggle one bit up or down at the appropriate rate — the cost is a few pence worth of code in the program: why buy hardware when software will do?

Applications already identified include: Magnetic Card reader, mini printer interface, printer buffer, push button keypad, LCD alphanumeric panel interface, 40-zone security interface for auto sending of security alarms, code converter (eg IBM PC keyboard codes to regular ASCII), real time clock (with plug in module), automatic horticultural irrigation controller.

By disabling the on-board Z80A-CPU this card will plug into our Interak 1 CP/M Plus disk-based development system, so if you don't fancy hand-assembling Z80 machine code you don't have to!

The idea is (if you are a manufacturer) you buy just one development system and then turn out the cheap SBC-1 systems by the hundred. If you are really lazy we can write the program for you and assemble the SBC-1 cards so you can get on with manufacturing your product, leaving all your control problems to us.

Greenbank

For more details write or phone us:
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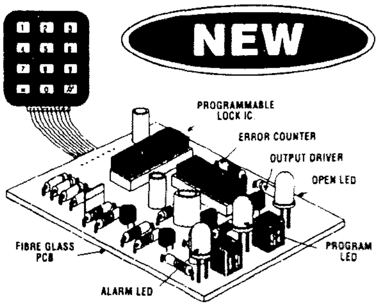
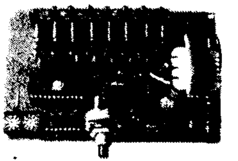
PROGRAMMABLE ELECTRONIC LOCK KIT



Keys could be a thing of the past with this new high security lock. Secure doors to sheds, garages, even your home or prevent the unauthorised use of computers, burglar alarms or cars. One 4-digit sequence will open the lock while incorrect entries will sound an alarm. The number of incorrect entries allowed before the alarm is triggered is selected by you. Further entries will be ignored for a time also set by you. Only the correct sequence will open the lock and switch off the alarm. The sequence may easily be changed by entering a special number and code on the supplied keyboard. Kit includes: keyboard, alarm buzzer, high quality PCB and all electronic components. Supply: 5 – 15V d.c. Will drive our Latch Mechanism (701 150 @ £16.50) or relay directly.

XK131 .... £19.95

DISCO LIGHTING KITS



DL8000K 8-way sequencer kit with built-in opto-isolated sound to light input. Only requires a box and control knob to complete £39.95

DL1000K 4-way chaser features bi-directional sequence and dimming 1kW per channel £23.95

XK139 Uni-directional version of the above. Zero switching to reduce interference £12.95

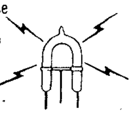
DLA/1 (for DL & DLZ1000K) Optional opto input allowing audio 'beat'/light response 95p

DL3000K 3-channel sound to light kit, zero voltage switching, automatic level control and built-in mic. 1kW per channel £19.55

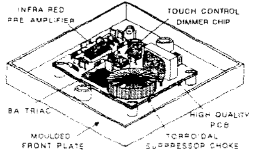
POWER STROBE KIT

Produces an intense light pulse at a variable frequency of 1 to 15Hz. Includes high quality PCB, components, connectors, 5Ws strobe tube and assembly instructions. Supply: 240V ac. Size 80×50×45.

XK124 STROBOSCOPE KIT £17.25



NEW REMOTE CONTROL DIMMER KIT



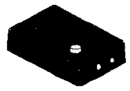
Imagine controlling the brightness of your lights or switching them on or off from the comfort of your armchair! This kit contains all the components from front panel to the last screw to enable you to do just that and fit the shallowest wall boxes. Max power 300W (not fluorescents).

XK132 .... £19.95

IR TRANSMITTER KIT

Designed for use with the XK132 and comes complete with a pre drilled box. A PP3 9 volt battery is required.

MK6 .... £4.95



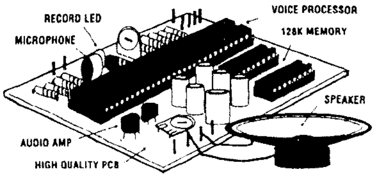
XK136 TOUCH DIMMER KIT £12.95

VERSATILE REMOTE CONTROL SYSTEM

These kits can switch up to 16 pieces of equipment on and off or control 16 functions depending on the keyboard selected for the MK18 transmitter. MK12 receiver has 16 logic outputs and operates from 12 to 24V dc. or 240V ac. via the transformer supplied. The MK18 reqires a 9V battery and keyboard. Great for controlling lights, TVs, garage doors etc.

MK12 IR Receiver £19.55
MK18 Transmitter £8.95
MK9 4 – Way Keyboard £2.75
MK10 16 – Way Keyboard £7.95
601 133 Box for transmitter £2.95

VOICE RECORD/ PLAYBACK KIT



This simple to construct and even simpler to operate kit will record and playback short messages or tunes. It has many uses – seatbelt or lights reminder in the car, welcome messages to visitors at home or at work, warning messages in factories and public places, in fact anywhere where a spoken message is announced and which needs to be changed from time to time. Also suitable for toys – why not convert your daughter's £8 doll to an £80 talking doll!!

Size .... 76 x 60 x 15mm
Message time .... 1 - 5 secs normal speed, 2 - 10 secs slow speed

XK129 .... £25.95

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FAX: 01-566 1916
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PRICE £33.99 + £3.00 P&P.

NEW SERIES II MOS-FET MODULES

OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor, >300, Slew Rate 45V uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. –125dB. Size 300 × 123 × 60mm.
PRICE £39.99 + £3.00 P&P.

OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor >300, Slew Rate 50V uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. –130dB. Size 300 × 155 × 100mm.
PRICE £62.99 + £3.50 P&P.

OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz – 100KHz –3dB, Damping Factor >300, Slew Rate 60V uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. –130dB. Size 330 × 175 × 100mm.
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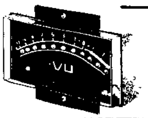
NOTE:— MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS STANDARD INPUT SENS 500mV BAND WIDTH 100KHz PEC (PROFESSIONAL EQUIPMENT COMPATABLE) - INPUT SENS 775mV BAND WIDTH 50KHz ORDER STANDARD OR PEC



Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D. diodes (7 green, 4 red) plus an additional on off indicator. Sophisticated logic control circuits for very fast rise and decay times. Tough moulded plastic case, with tinted acrylic front. Size 84 × 27 × 45mm.
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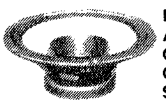
LOUDSPEAKERS



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RES. FREQ. 45Hz FREQ. RESP. TO 7KHz SENS. 103dB **PRICE £47.48 + £2.50 P&P.**
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RES. FREQ. 45Hz FREQ. RESP. TO 7KHz SENS. 98dB **PRICE £36.66 + £3.50 P&P.**
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RES. FREQ. 40Hz FREQ. RESP. TO 7KHz SENS. 100dB **PRICE £64.17 + £3.50 P&P.**
12″ 300 WATT C12300GP HIGH POWER BASS LEAD GUITAR, KEYBOARDS, DISCO, ETC.
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RES. FREQ. 40Hz FREQ. RESP. TO 4KHz SENS. 99dB **PRICE £73.26 + £4.00 P&P.**
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10″ 50 WATT EB10-50 DUAL IMPEDENCE, TAPPED 4 8 OHM BASS, HI-FI, IN-CAR
RES. FREQ. 40HZ FREQ. RESP. TO 5KHz SENS. 99dB **PRICE £12.00 + £2.50 P&P.**
10″ 100 WATT EB10-100 BASS, HI-FI, STUDIO
RES. FREQ. 35Hz FREQ. RESP. TO 3KHz SENS. 96dB **PRICE £27.50 + £3.50 P&P.**
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RES. FREQ. 28Hz FREQ. RESP. TO 3KHz SENS. 92dB **PRICE £21.00 + £3.00 P&P.**
12″ 100 WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO
RES. FREQ. 26Hz FREQ. RESP. TO 3KHz SENS. 93dB **PRICE £32.00 + £3.50 P&P.**

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5¼″ 60 WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC
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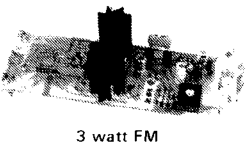

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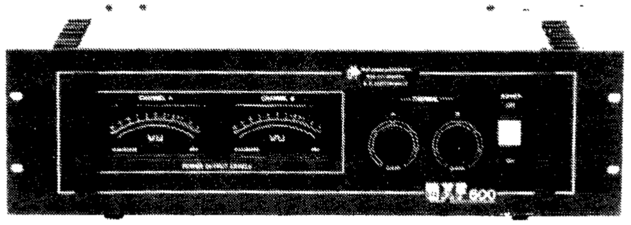

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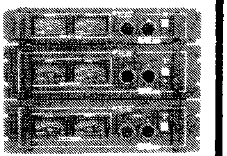

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MXF 200 **W19″ × H3½″ (2U) × D11″**
MXF 400 **W19″ × H5¼″ (3U) × D12″**
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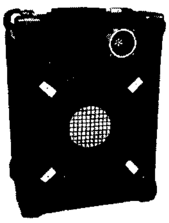

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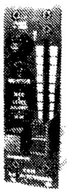

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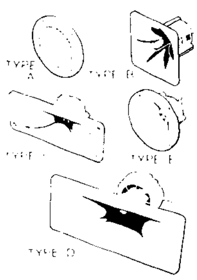
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover **is not** required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3″ round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each** + 50p P&P.

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TYPE 'D' (KSN1025A) 2″ × 6″ wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £9.99 each** + 50p P&P.

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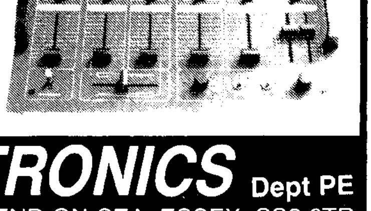
STEREO DISCO MIXER



STEREO DISCO MIXER with 2 × 5 band L & R graphic equalisers and twin 10 segment L.E.D. Vu Meters. **Many outstanding features** 5 Inputs with individual faders providing a useful combination of the following:—
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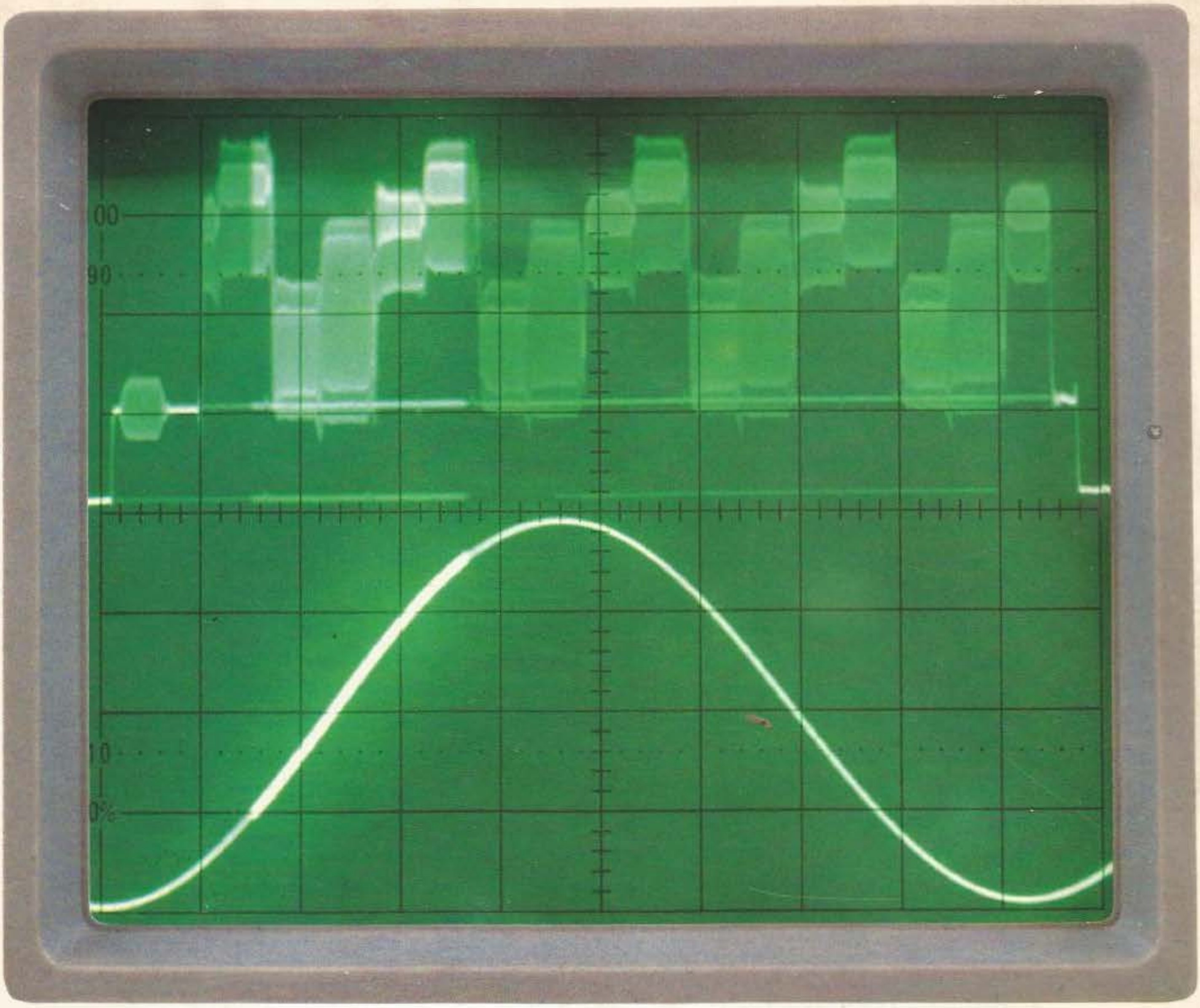

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TOA10 (20MHz Triple Scope)	**£334.95**
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